

Computer Graphics Products OEM Imaging Plug-in Oscilloscopes Portable Oscilloscopes Logic Analyzers Data Converters General Purpose Instruments Signal Processing Systems Semiconductor Test Systems Curve Tracers Cable Testers Microcomputer Development Products TV Demodulators Vectorscopes Generators Waveform & Picture Monitors Automatic Measurement System Spectrometers & Swept Frequency System Meters-TDR Photometer/Radiometer Cameras Probes Carts & Accessories

## Expanded coverage.... for a growing product line.

Tek's 1983 Catalog is thicker by some 80 pages, describing the superior performance, increased productivity and unmatched value you expect from Tektronix. Each major product introduction is marked **NEW** for easy reference.

Each Tektronix Sales Engineer specializes in the products and applications for a major area of customer activity: digital design and test, computer graphics, communications, and general test and measurement.

You can receive additional product information by calling your nearest Tektronix Sales Office listed on pages 9, 10, 11, or by returning the reply card in this catalog.

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### IMPORTANT INFORMATION

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### DESIGN AUTOMATION DIVISION

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### INFORMATION DISPLAY DIVISION

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### COMMUNICATIONS DIVISION

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### INSTRUMENT SYSTEMS DIVISION

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<b>Service and Support</b> 2	<b>Terms Of Sale</b> 8	<b>IEEE-488 Compatible Instruments</b> 21
Details about ordering, training, calibration, maintenance, repairs, parts, service, terms of sale and warranty.	Information on prices, terms, shipping estimates, and best method of transportation on Tektronix products, accessories and replacement parts.	An overview of some of the important factors involved in selecting products to meet your needs. Tektronix GPIB product systems are described, as well as individual waveform measurement instruments, graphic controllers, and peripherals.
<b>Power Source Considerations</b> 6	<b>Sales and Service Offices</b> 9	<b>Quality</b> 448
Information on power sources and power cord/plug options.	A complete listing of Tektronix worldwide sales and service offices. Consult the listing for the one nearest you.	Discussion of Tektronix quality standards.
<b>Environmental Characteristics</b> 6	<b>Indexes</b> 12	
Information about how to interpret environmental specifications.	Functional and alphanumeric indexes for quick, easy access.	

<b>Microcomputer Development Products</b> 37	<b>Logic Analyzers</b> 54	<b>Semiconductor Test Systems</b> 78
The 8500 Series offers the broadest range of quality multiple microprocessor and microcomputer development support available today.	Tektronix Logic Analyzers save time and money in designing, evaluating, manufacturing and servicing digital products. From 8 to 104 channels with sophisticated modules for high speed timing analysis, stimulation of the circuit under test, and microprocessor analysis.	Tektronix offers comprehensive solutions for automated test and measurement problems encompassing linear and digital ICs, LSI/VLSI devices, microprocessors and discrete components.

<b>Computer Graphics Products</b> 86	<b>OEM Imaging Products</b> 117
A wide range of computer display terminals, desktop computers, graphic peripheral products and supporting software.	For both OEM and end-users, we offer a wide range of display monitors for direct viewing or photography; X-Y (random dot scan or vector) and raster scan (video) displays. Modular Packaging is available on many instruments.

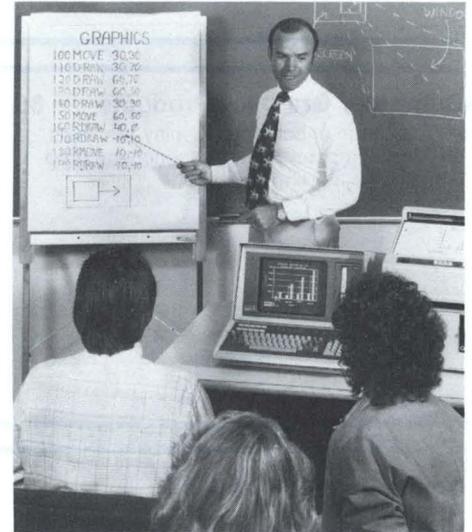
<b>Communication Network Analyzers</b> 127	<b>Fiber Optic Time Domain Reflectometer</b> 138	<b>Television Products</b> 142
The 830 Series family of Data Communications Testers are designed to identify faulty elements in a data communications network. The 834 offers a high degree of programmability which allows easy go/no-go testing. The 851 Digital Tester is a first-line, multifunctional service instrument developed to meet the needs of the digital service industry.	The OF150 is capable of making quantitative, calibrated loss and distance measurements on multimode fiber optic cables and installations.	Tektronix Television Products time, test, measure, correct and display the television signal world-wide.
	<b>Cable Testers/TDR</b> 140	<b>Spectrum Analyzers</b> 198
	These TDR cable testers provide installation and maintenance people with fast, accurate, portable tools for checking the internal condition of fiber optic and metallic cables and locating faults.	High performance 490 Series Portable Spectrum Analyzers covering 50 kHz to 220 GHz with full programmability/GPIB option and ease of operation features. 7000 Series compatible, lab grade plug-in spectrum analyzer family covering 20 Hz to 60 GHz.

<b>Laboratory and Portable Oscilloscopes</b> 216	<b>IEEE-488 Programmable and Manual General Purpose Instruments</b> 338	<b>Curve Tracers</b> 396
Versatile, easy-to-operate oscilloscope families, with your choice of plug-in or portable configurations. From 500 kHz to 1 GHz bandwidth.-Conventional, dual beam oscilloscopes. Multimode, variable persistence storage, waveform digitizers, realtime and sampling, choose the configuration that fits your application.	TM 5000 products are fully programmable via the IEEE-488 bus, and provide state-of-the-art calibration standards. They are compatible with almost 40 TM 500 manual instruments. You link together literally hundreds of customized systems. Programmable, manual, or mixed.	Deliver comprehensive information about a multitude of semiconductor devices and integrated circuits.
<b>Signal Processing Systems</b> 225		<b>Photometer/Radiometer</b> 406
Waveform Digitizing Instruments and Systems, with specifically designed digitizers, systems and software.		Measures luminance, illuminance, irradiance, light-emitting diode output, & relative intensity.
		<b>Cameras, Isolators, Probes, Carts and Accessories</b> 410
		Extend your measurement capabilities. Contains selection guides, charts, descriptions, and specifications.

# CUSTOMER INFORMATION

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When you buy a Tektronix product, you are buying more than an oscilloscope ... or a computer terminal ... or a logic analyzer ... or any of our numerous test and measurement products. You are also investing in the many people and services behind your Tektronix product.

A staff of Customer Service Representatives serves as your initial interface with the company.

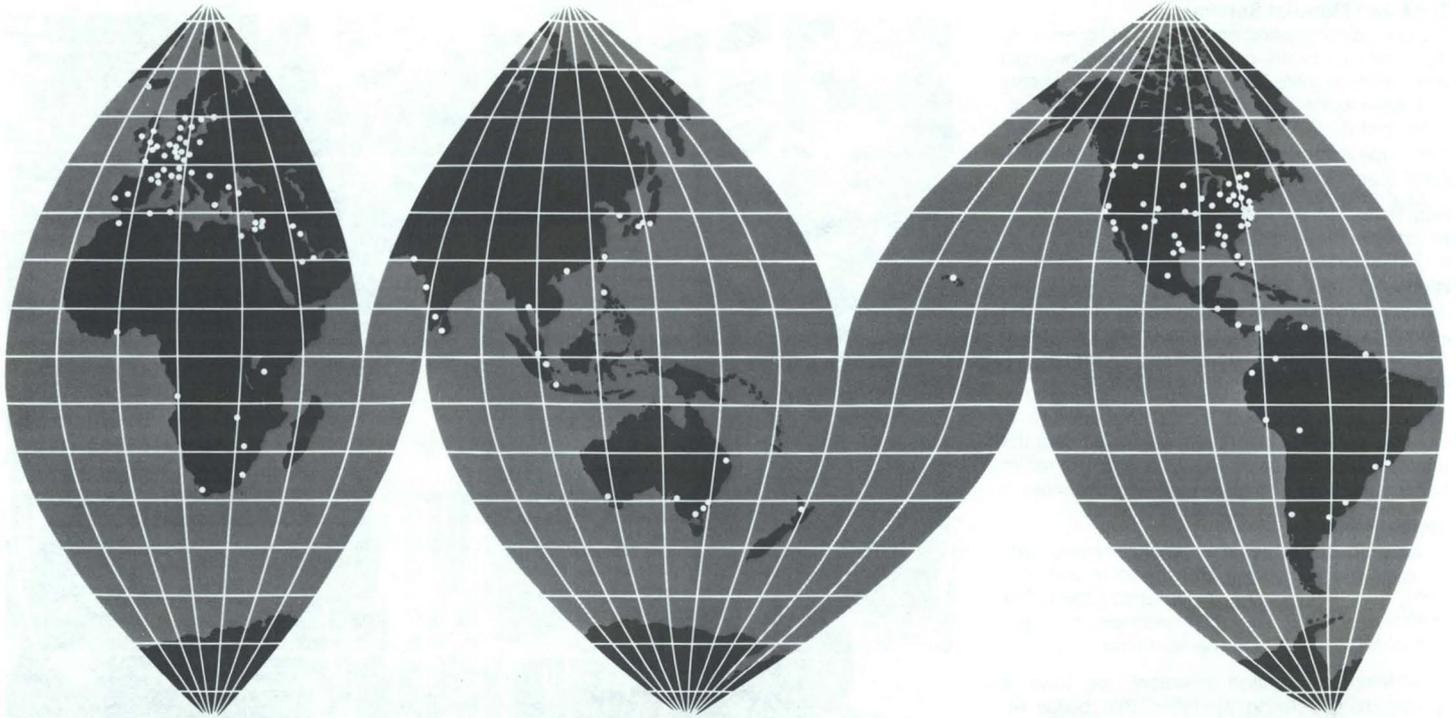
Trained Sales Engineers give you expert advice, applications assistance and after sales support.

A network of service centers throughout the U.S. and around the world provides prompt and competent calibration, maintenance, and repair service.

The long term support program ensures years of service after a product is removed from the production line.

The training and support program offers classes in Tektronix product theory, operation, maintenance, and repair at our main plant in Beaverton, Oregon and at various locations throughout the world. Audio and video training tapes are also available.

Each of these services adds value to your Tektronix product.



### Sales Engineers

Your Sales Engineers are fully prepared to respond to your technical and business requirements. They have a strong technical background and extensive product and business training. Periodic refresher courses fully acquaint them with new products and services. Be sure to take advantage of their services.

### Worldwide Service Network

With every Tektronix product comes a long-term commitment to professional service, extending far beyond your warranty period. We seek to establish a working partnership to best meet your requirements, at the time of purchase and in the years to come. No product is shipped until service support is solidly in place.

We offer a worldwide service network with the technical back-up and total company resources to keep your Tektronix products running as reliably as the day they're installed. Local accessibility is offered by 85 Service Centers and Tektronix supported service technicians in over 50 countries (see pages 9-11 for specific locations). Some 1,400 people around the world are dedicated to servicing Tektronix products exclusively.

### Communications

Your Sales Engineers are a valuable communication link between you and the factory. They know the exact person to contact in each circumstance, and can reach that person fast and easily. Let them help your communications on any problem related to your Tektronix products.

Training programs, service bulletins and our own diagnostic tools all contribute towards making our service people among the most highly skilled in the world.

Today's business demands put a higher-than-ever requirement on equipment uptime. You can depend on Tektronix for the technical expertise, extensive inventory and prompt response that make us your best choice and, at bottom line, your best value in long-term service support. It's our business keeping yours on-line.

For more detailed information please use the reply card in this catalog.

### Maintenance Agreements

A Tektronix Maintenance Agreement provides a planned program of regular service that protects the continuity of your product's operation--and paves the way for the fastest, most effective response to unplanned downtime. A Maintenance Agreement assures you of priority service, be it an emergency situation or otherwise.

One agreement covers all scheduled inspections, repairs, replacement parts, adjustments, and labor costs. Required product updates are installed automatically, keeping your product in top condition. You can confidently plan maintenance programs and budgets without facing open-ended service charges later. Additionally, a Tektronix Maintenance Agreement eliminates special training costs for your own maintenance personnel, as well as expensive service equipment, spare parts and special tools. It's everything you need within a low, fixed fee.

We also offer several other types of Service Programs. A Tektronix Service Representative can help tailor one to the requirements of your operation.

### Ordering

There are many types of products, each designed for specific application areas. Your Sales Engineer can help you select the one best suited to your present and future needs, and will be happy to arrange a demonstration of the product ... in your application if you so desire.

If you are a Purchasing Agent or Buyer, your Sales Engineer or Customer Service Representative can provide information on prices, terms, shipping estimates, and best method of transportation on Tektronix products, accessories and replacement parts.

**Time and Material Service**

Factory-trained technicians are standing ready to repair and calibrate, or recondition and overhaul your Tektronix instruments. Marginal components and worn parts are replaced and required updates installed. All qualified calibration measurements meet requirements for traceability to National Standards.

Firm Price Service tells you service charges in advance for repair and calibration of over 250 test and measurement products. Ask us for price information and program details. Pick-up and delivery is available at selected locations. On-site service is offered for information display products, microprocessor development, signal processing and semiconductor test systems.

For service, replacements parts, answers to warranty questions, or other help, please contact the Tektronix facility nearest you. Please do not return instruments or parts before receiving directions.

**Repair Parts**

In support of its self-maintenance customers, Tektronix maintains over \$40 million in available parts, from components to assembly level. Our objective is to be able to provide you the right part in the right place at the right time.

In addition to on-hand inventory, we have a special manufacturing operation that builds replacement parts for discontinued items.

Parts ordering is more convenient when you use the toll-free phone number in your area to contact a Tektronix parts order desk. Phone numbers for the continental United States are shown on the adjacent map. Parts orders for current and discontinued products are usually processed and shipped from on-hand inventory. Please give product type number and serial number for fastest possible service.

**Module Repair and Return**

Tektronix factory service offers a convenient, cost-effective means for many customers to obtain repairs on specified modules for information display products, microprocessor development, signal processing and semiconductor test systems. Modules are sent to our Beaverton repair facility, repaired and returned promptly. Our module repair center offers good turn around, helping maximize customer uptime.

**Provisioning**

If desired, Tektronix can provide complete packages of spares for both individual products and product groups. Provisioning assures you of stock on-hand in case of component failure. Recommendations are based on study of field-failure data of product components. Cost ceiling and time frame for which a spares kit applies are to customer specifications.

**Service Training**

Tektronix has established a comprehensive Customer Service Training Program designed to enhance the value of our products as long-term investments.

Formal classroom training is offered at a number of Tektronix field locations throughout the world.



*Match Your Own Location With Ours  
No matter where in the world you put your Tek equipment to work, Tek Service is nearby.*

*From Australia to Zambia, at 44 Sales Offices across the U.S.A., and in 50 countries around the world, local service is at hand. Some 1400 service people the world over are dedicated to servicing Tek products exclusively.*

We also offer audiotapes on operation, circuit description and calibration; videotapes covering basic concepts, operation and applications; and multimedia training packages that incorporate printed material, audiotapes and videotapes for independent study.

Information regarding these training opportunities is available from your nearest Tektronix Sales/Service Office. You may also request a copy of the Tektronix Service Training Schedule on the return card in this catalog.

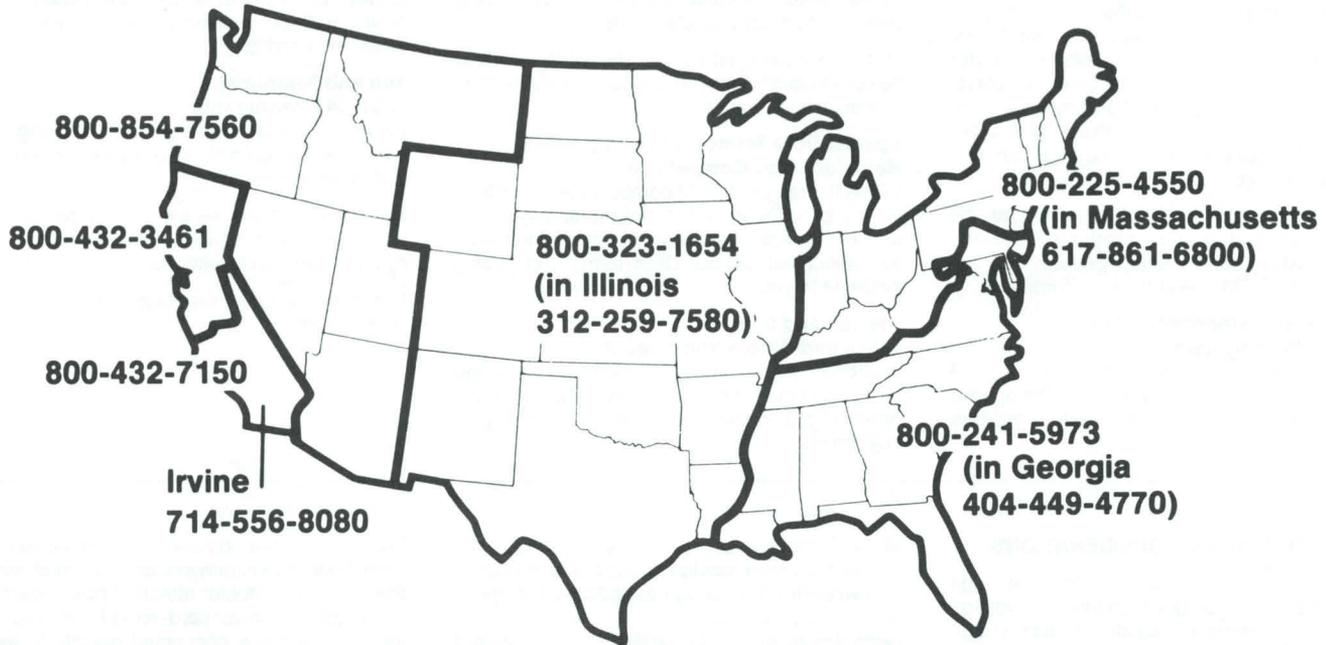
**Service Publications**

Service manuals, available for every Tektronix instrument, contain circuit schematics, parts lists, operating, maintenance and troubleshooting information.

TEKNOTES (an English only publication) is a periodic newsletter with information about product modifications, new service procedures and maintenance functions. Your Tektronix Sales Representative can place your name on its mailing list.

In addition, service information is available to customers on ANSI standard 105 x 148 mm negative microfiche. Included in a product maintenance set are operator/service manuals, manual changes, data sheets, reference cards and information regarding product modifications. A subscription, available through your local Tektronix Sales/Service Office, includes a basic set of microfiche and quarterly updates to keep information current.

**Tektronix Direct Parts Order Desk Toll-Free Numbers**



*For your convenience, you may order parts directly by calling the desk at the toll-free number for your area.*

**Operation**

Your Tektronix product can be most useful to you when you are familiar with all control functions. Your Sales Engineer will be glad to demonstrate the use of your product in various applications to help you become more familiar with its operation. If your product is to be used by several engineers or other users, your Sales Engineer will be happy to conduct informal classes on its operation in your location.

**Applications**

To assist you with in-depth knowledge of specific areas, your Sales Engineers are backed up by specialists in such fields as: Signal Processing Systems, Television Products, Information Display Products, Spectrum Analyzers, Logic Analyzers, and Microcomputer Development Products. At your request, they will arrange to demonstrate Tektronix instruments for you — in your application, if you wish.

**Traceability**

The reference standards of measurement of Tektronix are compared with the U.S. National Standards through frequent tests by the U.S. National Bureau of Standards.

The Tektronix working standards and testing apparatus used are calibrated against the reference standards in a rigorously maintained program of measurement control.

The manufacture and final calibration of Tektronix products are controlled by the use of Tektronix reference and working standards and testing apparatus in accordance with established procedures and with documented results.

Certificates of traceability to NBS are available with new products, as well as products you may have serviced at a later date.

A certificate of compliance stating that a particular product being shipped conforms to its published (or quoted) specification is also available.

**International Service**

Tektronix products are serviced in all countries where they're locally sold. Conditions within a country may limit the type of service available; therefore, some of the programs discussed here are not available in all countries. Specific country service capability can be obtained from your local Tektronix Sales or Distributors Office.

**A Quality Partnership**

The advantages of working with Tektronix extend far beyond our excellence in products. You also get a long-term commitment to professional service. All-out support backs designed-in performance.

Your local Tektronix Service Representative can tell you more about those services by which you can best benefit and profit from your working partnership with Tektronix.

**Our Product Reliability Is Your Foundation**

Any system is only as reliable as the components that go into it. At Tektronix, we're committed to producing the most dependable system components possible. You can be confident that the reliability we design into our equipment can help keep your customers satisfied. That's reliability you can build on.

*\*See the listing of Tektronix Worldwide Sales and Service Offices at the end of this section. For countries where a local representative is not listed, contact the appropriate Tektronix Worldwide Marketing Center.*

**OEM COMPONENTS**

**Special Information for OEMs**

At Tektronix we offer many products with terms, conditions, and pricing for OEMs. Computer graphics components, small screen displays, certain cameras, tv signal test and measurement instrumentation — we offer these and other products on a special basis to the original equipment manufacturer.

But terms and conditions tell only part of the Tektronix OEM story. Our products have the quality, reliability, and the top performance per dollar that the OEM needs to stay competitive.

**Choose The Performance Level To Match Your System**

In many product areas our wide range of OEM components allows you to select just the optimal performance you need for the system you are

building. When your systems demand highest performance, Tektronix will provide the quality products to meet your standards.

In price-sensitive situations, the wide Tektronix selection usually lets you pay for exactly the performance level you need — no more, no less.

**Special OEM Terms and Pricing Help Keep You Competitive**

Within the range of OEM components, we offer a variety of different OEM pricing arrangements and terms. Ask your local Tektronix representative about the special OEM terms and pricing available to you.

**Service and Support — When and Where You Need It**

Tektronix has service centers throughout the U.S. and in many countries around the world. We offer long term parts support to protect your investment.

If you need applications assistance, we're ready to help. Our OEM specialists are trained to help solve interface problems. That's solid support when you need it.

**You and Tektronix: A Quality Partnership**

Explore the advantages of working with Tektronix: excellence in products, in support, and in service.

Your local Tektronix representative can help you get full details on how you can profit from a quality partnership with Tektronix.

See how our OEM expertise can add value to your system.

**POWER SOURCE CONSIDERATIONS**

Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order.

Many Tektronix instruments are designed to operate from a power source that will not apply more than 250 Volts RMS between the supply conductors or between either supply conductor and ground.

Many Tektronix instruments can be fitted with one of the power cord/plug options listed below and wired for the voltage as indicated, if specified on the purchase order.

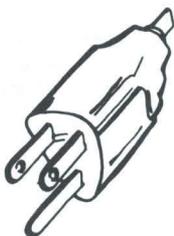
North American	120 V/15A	Standard
Universal Euro	220 V/16A	Option A1
United Kingdom	240 V/13A	Option A2
Australian	240 V/10A	Option A3
North American	240 V/15A	Option A4
Switzerland	220 V/10A	Option A5

During the life of this catalog the power cord/plug options will be made available on additional instruments. Refer to the individual product ordering information for those products offering these options as of publication date.

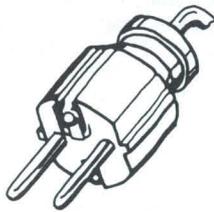
Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

Power-cord coding follows one of the two following schemes:

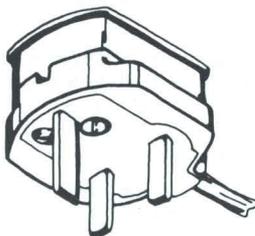
	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow



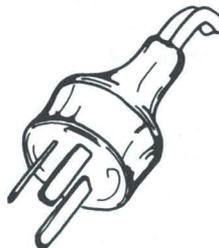
Standard  
North American  
120 V/15A



Option A1  
Universal Euro  
220 V/16A



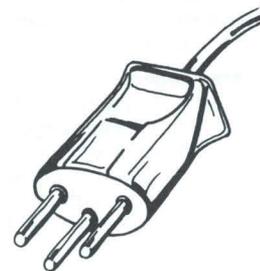
Option A2  
UK  
240 V/13A



Option A3  
Australian  
240 V/10A



Option A4  
North American  
240 V/15A



Option A5  
Switzerland  
220 V/10A

**ENVIRONMENTAL CHARACTERISTICS**

The environmental characteristics listed in instrument specifications may include some or all of the following: temperature, altitude, humidity, vibration, shock, and electromagnetic compatibility (EMC previously RFI or EMI).

The specifications for humidity, vibration, shock, and transportation are intended to be beyond what can be expected in use, and operation at these extremes may cause minor physical dete-

rioration. Such operation, however, should not cause electrical performance to deteriorate outside specifications.

The specifications for temperature and altitude are such that continual use at the limits will not cause significant short-term deterioration. Naturally, higher temperature operation can be expected to reduce long term reliability and should be avoided if possible. The EMC test is completely nondestructive.

Sample production instruments are tested periodically as part of a continual quality-control process. Complete tests on every production instrument are undesirable as well as uneconomical.

For more specific information on the environmental characteristics and how they apply to given instruments, please refer to the page covering that instrument.

**CORPORATE WARRANTY**

Tektronix warrants to its Customers that the products that it manufactures and sells will be free from defects in materials and workmanship for the periods set forth in the table below. If any such product fails to operate properly during the applicable warranty period as a result of a defect in materials or workmanship, Tektronix, at its option, either will repair the defective product and restore it to normal operation without charge for parts and labor or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of any defects before the expiration of the warranty period and make suitable arrangements for the performance of service. Tektronix will provide such service at Customer's site for certain categories of products, as indicated in the table below, if Customer's site is within the normal on-site service area. Upon prior agreement, Tektronix may provide on-site service outside its normal on-site service area, subject to payment of all travel expenses by Customer. In all other cases, Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to customer if the shipment is to a location within the country in which the service center is located. Customer shall be responsible for paying all shipping charges, duties and taxes, if the product is returned to any other location. The location at which the services will be provided for different categories of products or product groups are set forth below.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty: a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS THE ONLY WARRANTY GIVEN BY TEKTRONIX AND IS GIVEN IN LIEU OF ANY OTHER WARRANTY EXPRESS OR IMPLIED. TEKTRONIX DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF THIS WARRANTY. TEKTRONIX WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES.

For information on the warranty period for any specific product and further details regarding Tektronix warranties and service policies, please consult your local sales office. A complete statement of Tektronix' warranty for specific products will be supplied upon request.

**SOFTWARE WARRANTY**

Tektronix warrants that any Software furnished by Tektronix (including Software embodied in Firmware), for which Software support is specified in the applicable Software product description or data sheet, will conform to the description set forth in such document. Tektronix' sole obligation under this warranty will be to provide the support services, if any, described in the product description or data sheet. Such services are intended to make the Software conform to its description. Tektronix does not warrant that the Software is free from defects or that the support services will correct all defects which might exist. Software for which there is no specification of Software support in the applicable software product description or data sheet is furnished without warranty of any kind and without any representation regarding quality, performance or suitability.

TEKTRONIX SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Tektronix' liability for damages, if any, whether based upon contract, negligence, strict liability in tort, warranty or any other basis, shall not exceed the fee paid by the customer for the Software.

PRODUCT CATEGORIES	WARRANTY PERIOD	SERVICE LOCATION
Oscilloscopes and Plug-Ins; General Purpose Instruments; Data Communications Analyzers; Logic Analyzers; Spectrum Analyzers; Television Products (except ANSWER System); Waveform Digitizers; Cameras, Carts, Probes, and Isolators.	1 year from date of shipment	Service center designated by Tektronix
Display Monitors: 608, 620, 624, 634	90 days from date of shipment, except 1 year from date of shipment for CRT.	Service center designated by Tektronix
Computer Graphics Products; Microcomputer Development Products; ANSWER System.	90 days from date of shipment; except 1 year from date of shipment for CRT	Customer's site, if within normal on-site service area
Signal Processing Systems; Semiconductor Test Systems; 4081 Graphics System.	90 days from date of installation or 120 days from date of shipment, whichever is shorter; except 1 year from date of shipment for CRT	Customer's site, if within normal on-site service area

Orders should be placed with your Tektronix Office listed on page 9.

Tektronix, Inc. offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning. Any of the following terms may be arranged with a Tektronix Sales Engineer.

#### **NET 30 DAYS**

Tektronix, Inc. standard terms of sale are NET 30 days following the date of shipment. As will all credit terms, satisfactory credit accommodations must be arranged.

#### **EXTENDED TERMS OF SALE**

Extended terms of 60 to 180 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the invoice. The amount of the service charge depends upon the number of days the terms are extended.

#### **SECURITY AGREEMENT**

This program provides monthly installment payment terms while Tektronix products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

A minimum advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months.

Minimum balance amounts may be financed, ranging from \$200 for six months to \$2000 for thirty-six months. Longer terms of 48 to 60 months are available by quotation for financed balances of more than \$10,000. There are no maximum finance balances.

All products carry the standard Tektronix, Inc. warranty. The customer is responsible for the equipment and applicable property taxes, licenses, etc. Upon completion of the term of agreement and prescribed payments, the customer owns the equipment.

#### **COMPUTER GRAPHIC PRODUCTS**

Most Computer Graphic Products are available under an *operating lease program*. The minimum fixed terms of this program are 12, 24, 36 months, or longer. Automatic extension on a month-to-month basis is also available after the fixed minimum term. Equipment leased on this program is maintained by Tektronix, Inc. during the terms of the agreement. Rental of Computer Graphic Products for customer evaluation is available for periods of 90 or more days.

During the term of the operating leases or rentals described, the customer may exercise an option to purchase the equipment provided 30 days notice is given. A portion of the installments already paid will be credited toward the purchase price. Questions regarding warranty should be discussed with your Tektronix Sales Engineer.

#### **SHIPMENT**

All prices, quotations, and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical method. Surface and air shipments will be insured at full valuation unless your order instructs otherwise.

**Specification and price change privileges reserved.**

**Tektronix, Inc.**

P.O. Box 1700,  
Beaverton, Oregon 97075  
Telephone:(503)627-7111

**Corporate Office**

**Mailing Address:** Tektronix, Inc.,  
P.O. Box 500

Beaverton, Oregon 97077  
4900 S.W. Griffith Drive,

Beaverton, Oregon

**Principal Plant:** Tektronix Industrial Park,  
Beaverton, Oregon

For additional literature or the address  
and phone number of the Tektronix Sales  
Office nearest you, phone: (800)547-1512  
Oregon only 1 (800)452-1877

TLX:15-1754, TWX:910 467-8708

TEKTRONIX BEAV. Cable: TEKTRONIX

**Direct Order:** For 2200 Series

and accessory products,  
phone 800-426-2200 extension 99.

In Alaska, Hawaii and Oregon

call collect (503) 627-9000 extension 99.

**SALES SERVICE OFFICES****ALABAMA****Huntsville 35801**

3322 S. Memorial Parkway  
Suite 203  
Phone:(205)881-2912

**ARIZONA****Phoenix 85040**

4130 East Wood Street  
Suite 100

Phone: (602)268-8861  
Tucson Area:790-3099

**Mailing Address:**

P.O. Box 29540

**Phoenix, Arizona 85038**

**CALIFORNIA****(Concord)**

3451 Vincent Road  
**Pleasant Hill 94523**

Phone:(415)932-4949

From Oakland:(415)254-5353

From Sacramento:(916)447-5072

**Irvine 92714**

17052 Jamboree Blvd.

**Mailing Address:**

P.O. Box 19523

Irvine 92713

Phone:(714)556-8080

**(Los Angeles)**

21300 Erwin Street

**Service Center**

20920 Victory Blvd.

**Woodland Hills 91367**

Phone:(213)999-1711

**Mailing Address:**

P.O. Box 8500

**Woodland Hills 91365****San Diego 92123**

5770 Ruffin Rd

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## TEKTRONIX Means . . . Measurement Capability, GPIB Compatibility

As measurement needs grew in number and complexity over the past few decades, people began to realize that traditional design and test procedures were becoming inadequate. When the inadequacies became intolerable, special interfaces were designed and various instruments were connected to controllers to form specialized test systems. From these beginnings, some major benefits of automated test and measurement were quickly realized:

- Test and measurement labor costs were reduced.
- Human error decreased through precise and repeatable automation of measurements.
- Skilled people were released from mundane or repetitive procedures to pursue more creative research and design activities.
- Sophisticated analysis techniques could routinely be applied to provide greater insight into devices and processes.

But, for all their benefits, automated test and measurement systems still had some significant problems. Mostly, these stemmed from each system being unique, custom built. The automation need had to be severe to justify custom design costs. Systems and data formats were not generally compatible with each other. And changing the system or adding instruments meant another custom design effort.

Test and measurement automation was still too fragmented and costly for general use, even though the benefits were generally needed. A standard interfacing system providing across-the-board compatibility for a variety of instrumentation and instrument controllers seemed to be the solution.

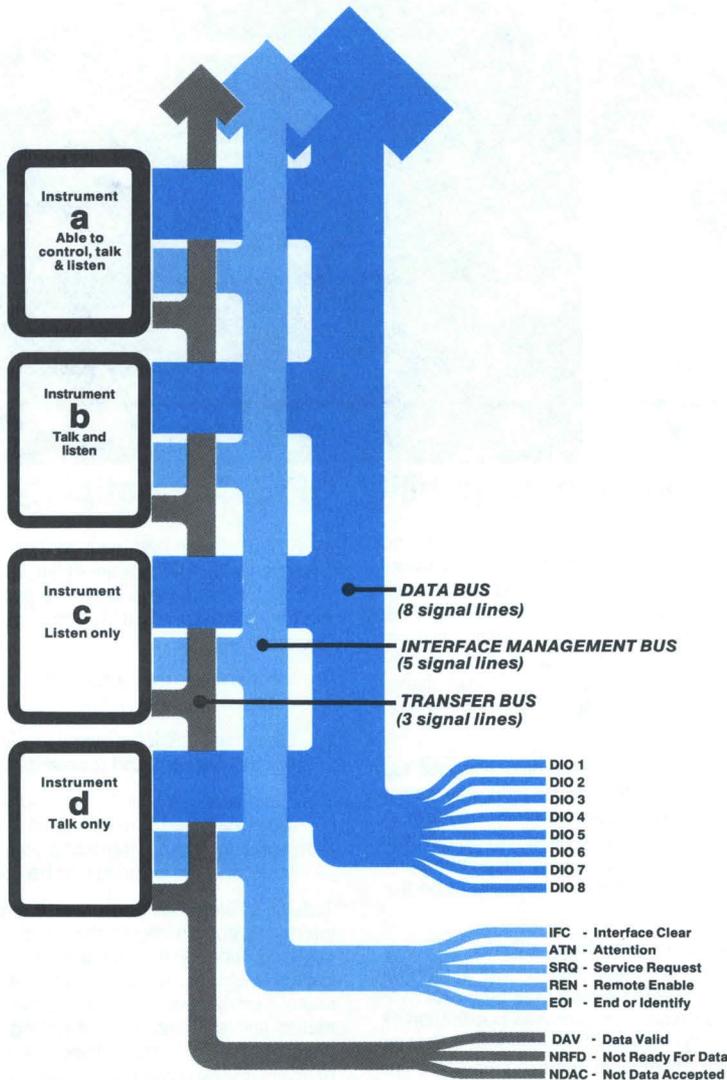
### The First Step Toward Compatibility

In 1975, the first major step toward general compatibility in electronic instrumentation for systems use was taken. This step was publication of the IEEE Standard 488-1975 defining an interface and communications bus for programmable instruments. This bus is commonly called the GPIB—the General Purpose Interface Bus.

In 1978 the standard was further refined (IEEE Standard 488-1978) defining an interfacing system that has become a widely accepted instrument industry standard. The major areas it specifies are:

1. Mechanical—the interface connector and cable.
2. Electrical—the logic signal levels and how the signals are sent and received.
3. Functional—the tasks an instrument's interface may perform—such as sending data, receiving data, triggering the instrument, etc.—and the protocols to be used.

Today, a wide variety of instruments include interfaces conforming to this mechanical, electrical, and functional standard. These GPIB-compatible instruments and instrument controllers make it possible to achieve the benefits of automated test systems without paying the previous price of custom system design. With GPIB compatibility, measurement capability can be chosen off-the-shelf and simply cabled with standard bus cables in either a linear or star configuration.



**GPIB Hardware Characteristics**

- Cable lengths up to and not exceeding 20 meters (approximately 66 feet) with a device load required for every 2 meters of cable.
- Up to 15 devices (1 controller and 14 instruments) may be connected in linear or star configurations.
- Voltages are generally TTL-compatible.
- GPIB signal and data lines are asserted (or true) when pulled low ( $\leq +0.8$  V) and released (or false) when pulled high ( $\geq +2.0$  V).
- Maximum data rate of up to 250 kilobytes/second over a distance of 20 meters with 2 meters per device or faster with some special restrictions (refer to IEEE Standard 488-1978 for details).

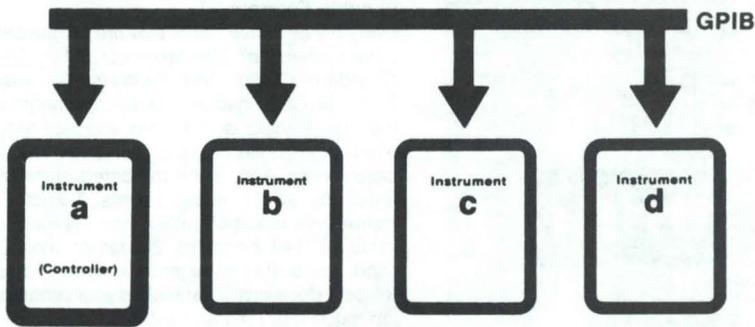
**Interface Functions Defined by IEEE Standard 488-1978**

Function	Description
Talker (T)	Allows instrument to send data
Listener (L)	Allows instrument to receive data
Source Handshake (SH)	Synchronizes message transmission
Acceptor Handshake (AH)	Synchronizes message reception
Remote-Local (RL)	Allows instrument to select between GPIB interface and front-panel programming
Device Clear (DC)	Puts instrument in initial state
Device Trigger (DT)	Starts some basic operation of the instrument
Parallel Poll (PP)	Allows up to eight instruments to simultaneously return a status bit to the controller
Controller (C)	Sends device addresses and other interface messages

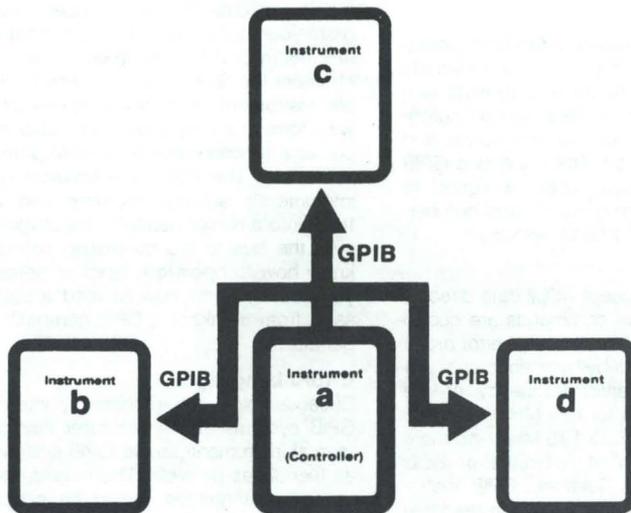
**Tektronix' Systems Experience**

Long before publication of the IEEE Standard 488-1978, Tektronix had entered the test and measurement systems business. The measurement speed and capabilities of the Tektronix automated oscilloscope and Tektronix semiconductor test systems quickly highlighted the benefits to be gained from measurement automation. And just as quickly came the realization that a system interfacing standard was needed. But what standard?

The possibilities of the proposed IEEE Standard 488 were recognized. And, when the IEEE Standard 488 became reality, GPIB compatibility was already an integral part of Tektronix product planning and engineering. The result is that Tektronix is now a recognized major supplier of a full line of GPIB system components—a supplier that puts more than a decade of systems planning, design, and implementation experience into each product.



**Linear Configuration**



**Star Configuration**

### GPIB System Components

An automated test and measurement system usually consists of the following components:

- Multiple instruments: these are either *stimulus* instruments, such as function generators, pulse generators, and power supplies, or *measurement* instruments, such as counters, waveform digitizers, and multimeters.
- Controller with software: this tells the instruments what to do, collects the results, and processes them. The system controller is generally a small computer. The software or firmware operating system must have a powerful, flexible I/O structure to handle GPIB bus traffic. It must also have processing power for waveform manipulation and graphics power for display.
- Computer peripherals: these are devices such as tape drives, printers, and plotters that store or display the results of the tests.
- A keyboard: this enables the user to send commands or information to the system.
- A display: the display allows the user to review intermediate results and to monitor system operation.

For smaller systems, these last three components are often incorporated in the system controller—a desktop computer, such as the Tektronix 4050 Series, that is specifically designed for use with instrument systems. Larger, more powerful systems, however, may be minicomputer-based, augmented by one or more high-speed mass storage devices, a graphic display terminal, and run under specialized instrument control and signal processing software such as TEK SPS BASIC.

All these components can be easily interconnected if the standard GPIB interface has been built in and appropriate functions made programmable. Before GPIB, most measurement systems were operated by controllers that required a separate connector (port) for each instrument. With the GPIB this is no longer a requirement. Users can directly link up to 14 instruments with the controller via the bus, and set up the systems in linear or star configurations. Additionally, some controllers can drive more than one GPIB port. The Tektronix 4041 has an option for a second port, allowing control of up to 28 instruments. Or, if you need more, TEK SPS BASIC operated with a properly optioned DEC PDP-11 minicomputer can drive up to four GPIB ports, providing a total system potential of 56 instruments.

All these devices (the controller, measurement instruments, and peripherals) comprise the hardware. The system cannot operate, however, unless it is driven by software.

There are two levels of software necessary, the operating system software and the user written application programs. The operating system software provides a set of commands and functions that the user combines into a program that delineates the measurement and processing task to be performed. The software, guided by the user program, works through the controller to tell the instruments what signals to generate, what measurements to make, and tells the controller what to do with the results.

The software and the program in the controller make the system do what the user wants. The GPIB interface allows users to plug system components together, but without software, the system can do nothing.

In programmable instrument systems, the "language" of the software or program has several meanings:

1. The controller has its own language, such as BASIC, and users must express their intentions in this language.
2. Within the context of the controller's language, the instrument's commands (or "language") have to be sent over the GPIB.
3. The actual control of the GPIB interface is transparent to the user with Tektronix instrument controllers and software.

In order to make the system operate, the user has to:

1. Know what tasks the system is to perform—the system can do nothing by itself.
2. Know the controller's language.
3. Know the kind of data or language the instruments are designed to exchange.

To make these tasks easier for you, Tektronix has taken several steps beyond simple IEEE Standard 488-1978 compatibility. Consistency has been designed into each system component for the greatest degree of compatibility. Intelligence has been designed in to relieve you from interfacing details. And firmware and software have been designed and written to provide the maximum in programming ease and measurement capability.

### Consistency Makes a Big Difference

Tektronix GPIB products are designed and thoroughly evaluated for compliance with IEEE Standard 488-1978 and for compatibility with one another. Because these products are designed to be compatible (i.e., meet the same standards), users usually won't need to make hardware and software modifications for each new addition or deletion to the configuration. Many software routines need to be written only once, after which only minor modifications are needed with the addition of new instruments.

A status check routine, for instance, will work on all Tektronix GPIB instruments. A message terminator common to all Tektronix GPIB instruments is a further benefit. But, since the IEEE Standard 488-1978 allows several optional message terminators, Tektronix instruments go an extra step by providing a switch for selecting optional terminators. These features provide users with the capability of quickly configuring and reconfiguring interactive and automated measurement systems.

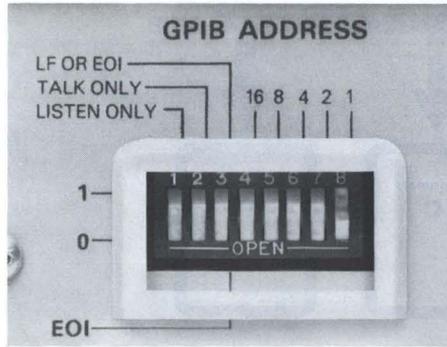
The result is a line of products that are not only GPIB compatible—but are capable GPIB instruments with the features that make them useful and the compatibility that makes them work together.

**Tektronix Standard Codes and Formats Means Programming Ease**

The IEEE Standard 488-1978 specifies the hardware interface and its basic functional protocol. It also specifies a set of codes called interface messages that control interface functions. However, the IEEE Standard 488-1978 does not specify the syntax or coding of device-dependent messages—the messages that control the programmable features of the instrument.

Since the device-dependent messages are not specified, instruments that conform to the IEEE Standard 488-1978 may use inconvenient or even incompatible message formats. It's much like a telephone system—the hardware link is well defined, but unless both parties speak the same language, communication is impossible. That's why Tektronix developed a Codes and Formats Standard that specifies the syntax and coding of device dependent messages, while retaining full IEEE Standard 488-1978 compatibility. The Tektronix *Standard Codes and Formats* specifies message coding to:

- Be simple and unambiguous
- Use commands that are common among similar devices
- Use simple, easy-to-remember mnemonics.



Each GPIB instrument or peripheral, called a device, must be assigned a different system address; this can be done simply by setting switches, usually located on the back panel of the device.

The benefits of the Tektronix *Standard Codes and Formats* are numerous. Codes and Formats is a major feature of the Tektronix GPIB communications protocol. Because of their natural English-like structure, instrument control commands and messages are easy to use. The result is a GPIB implementation that is specifically designed to overcome the programming rigidity and cumbersome procedures of other GPIB systems.

**ASCII Data Standard**

Since most controllers accept ASCII data directly, Tektronix GPIB instrument commands are coded in ASCII. This eliminates the need for error-prone data conversions or byte-by-byte encoding. For example, to set the center frequency of the 492P Spectrum Analyzer to 1.75 MHz, the command is simply written `FREQ 1.75 MHz`—no more calculated percentages of full-scale or BCD equivalents. Settings for Tektronix GPIB instruments are sent as ASCII data in human readable form.

**Flexible Formats**

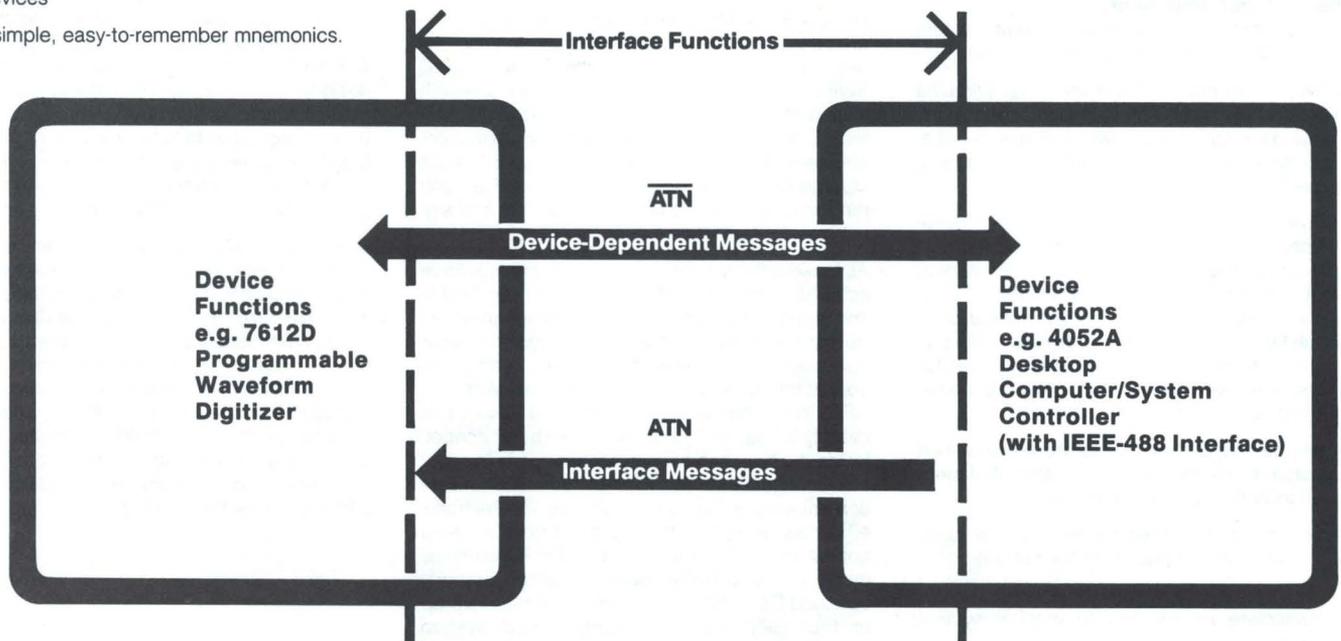
Many minor format items that are aggravations in other systems are also taken care of by Tektronix *Standard Codes and Formats*. For example, Tektronix GPIB instruments accept negative zeros and leading and trailing spaces; they also overlook inconsistent use of upper and lower case letters. And, since truncated numbers can drastically affect measurements, Tektronix GPIB instruments round off rather than truncate: e.g., a value of 2.49 becomes 2.5 rather than 2.4. In short, the built-in intelligence is used to make intelligent decisions. That makes your programming job much less rigid and substantially easier.

**Common Messages**

To make things even easier, Tektronix *Standard Codes and Formats* also specifies messages that are to be common to all Tektronix programmable instruments. For example, you can program your system to learn the current settings of any Tektronix GPIB instrument by sending the instrument the `SET?` message. Any GPIB compatible instrument from Tektronix—whether it is a waveform digitizer, a programmable power supply, or a function generator—interprets `SET?` the same way. The instrument firmware gathers the instrument's settings together and assembles them into a human readable message to be sent over the bus to the controlling software. If you know how to operate a function generator, then you already know how to read a settings message from a Tektronix GPIB compatible function generator.

**BASIC Languages**

Because users are increasingly interacting with GPIB systems at the controller keyboard rather than at instrument panels, GPIB systems must be as friendly as possible. This means, too, that the controller languages should be simple, logical, and easy to interpret and implement. That's why Tektronix *Standard Codes and Formats* specifies BASIC as the language of preference for Tektronix instrument controllers.



BASIC is an established language with wide use and familiarity. It is also an English-like language that is easy to learn and understand. So, combined with the English-like messages used with Tektronix GPIB instruments, it becomes a consistent and familiar means of communicating with your system. And your program listings are easy to read and follow, with very little interpretation required. (For more details on Tektronix *Standard Codes and Formats*, ask your Tektronix Sales Engineer or Representative.)

#### Controllers to Match Your Needs

Tektronix offers three controller-software packages to meet varying GPIB system needs. These packages are:

- the 4041 System Controller, optimized for instrument control in a variety of situations
- the 4050 Graphic Computing Systems, optimized for desk-top instrument control and computing with full graphics capabilities
- TEK SPS BASIC software with the DEC PDP-11 Series minicomputer, optimized for systems with full waveform acquisition, processing, and graphics.

#### The 4041 System Controller

The 4041 System Controller is a compact, modular controller designed for rackmount, bench-top, or portable use. Its operating system language is an extended BASIC designed for use by both the casual and the sophisticated programmer.

The 4041 controller contains three microprocessors, with the CPU being the powerful 16-bit 68000. Standard memory is 32 kilobytes with optional 32-kilobyte increments to a maximum of 160 kilobytes. A 20-character alphanumeric LED display, a 20-character thermal printer, a DC 100 cartridge drive, 18 function keys, a GPIB port, an RS-232 port, and a real-time clock and calendar capability are all standard. An additional GPIB/RS-232 port pair is optional, with the second GPIB port having Direct Memory Access capability. With 14 GPIB instruments per GPIB port, the 4041 System Controller offers the capability of controlling up to 28 GPIB instruments.

Also optional are an 8-bit parallel TTL port, program development ROMs with a carrier, and a detachable program development/debug keyboard.



Tektronix 4041 System Controller

The program development ROMs and keyboard, or an RS-232 terminal, give the engineer or production test programmer access to the system language. This language is an extended version of BASIC designed for use by all skill levels. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for a friendly and interactive system. A variety of other features are also included to increase friendliness. For example, variable names may be up to eight characters long, allowing meaningful names such as RISETIME, VOLTAGE1, or DELAY. And, as another example, subprograms and program lines can be named—e.g., 1000 SRQPOLL: or 200 RMS VOLTS:—for quick and easy access.

Beyond enhancements for simplicity, 4041 BASIC also has enhancements that make it a powerful tool for sophisticated programmers, too. It includes capabilities for FORTRAN-like subprograms, variable passing from main program to subprograms, declaration of local and global variables, and many other features.

Yet, for all its sophistication, the 4041 is still particularly desirable for use by low-skill operators in a production environment. Instrument control programs can be designed and written to print user prompts on the 4041 display and the programs can be assigned to any of the ten user-definable keys on the 4041 front panel. Then the

4041 program development keyboard and ROM pack carrier can be removed from the controller. This puts the 4041 into an execute only mode with its programs protected. The low-skilled user need only follow the front-panel display prompts and press the designated keys to execute programs.

To return to the engineering or program development mode, simply plug the program development ROM pack carrier and keyboard or an RS-232 terminal back into the 4041. You again have access to all of the ease and power of 4041 BASIC programming.

#### The Tektronix 4050-Series Desktop Computing Systems

The 4050-Series systems are especially convenient for engineering bench or laboratory support of GPIB compatible instruments. The typewriter style keyboard, built-in calculator keypad, and special programmable keys provide easy operation. In addition, the GPIB interface port provides for control of up to 14 GPIB instruments at a time.



*Tektronix 4052A Desktop Computer*

Tektronix 4050 Series systems have an exclusive high-resolution storage display for unexcelled graphic clarity and detail. There is no distracting screen flicker. All lines are continuous, never detracting from or distorting information.

This built-in graphics capability allows interactive graphic manipulation to help visually analyze waveform data before it is processed. A user can often gain valuable insights or decide to investigate a new direction once the acquired data is graphically displayed.

Supporting the advanced, interactive graphics capability is powerful computer performance. Features such as full array processing, an invaluable tool for handling whole waveforms, and dynamic memory allocation, reduce the worry about data movement in the system.

Additionally, a range of peripheral products are available with Tektronix 4050 Series Desktop Computer Systems to provide analysis records in many sizes and formats. Tektronix peripheral products include hard copy units, digital plotters, graphic input tablets, and disc memory systems.

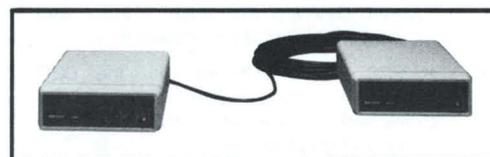
With 4050 Series Systems, you can immediately start using a high-level extended BASIC. This universal technical language is well adapted to technical needs of the user and includes extensions for increased computation power and further ease of use.

Tektronix also supplies general utility software programs for various communication routines, such as bi-directional transferring of waveform data, test results, and instrument settings. And acquired data can be quickly graphed on the display screen. Graphic waveform handling is enhanced by built-in features such as auto-scaling, where unknown quantities of waveform data can be scaled into a defined set of graphic coordinates by a few key-stroke operations. Coordinates may be defined for Log-Lin, Log-Log, or even Smith Chart and Bode plots—whichever is relevant to your application. Any of the displays can be quickly copied to paper.

Some of the more common signal processing tasks can be accomplished using firmware supplied by Tektronix. Plug-in ROM packs for the 4050 Series controllers provide specialized waveform processing commands. For example, the Signal Processing ROM Packs use versatile English-like commands to handle data arrays or whole waveforms.

Other ROM pack capabilities include fast Fourier and inverse Fourier operations. The fast Fourier transform can transfer whole waveforms from the time domain to the frequency domain in a matter of seconds.

Still other ROM packs offer a real-time clock, advanced graphic handling features, data conversion packages, and other GPIB computational tools.



**NEW**

**GPIB Extender**

The General Purpose Interface Bus Extender provides a cost-effective way to interconnect remotely located, IEEE Standard 488 compatible instruments, allowing GPIB communication over distances of up to 500 meters (1650 feet). This capability overcomes the limited range of standard length GPIB cables by using a 75-ohm RG 6/U coaxial "link".

Two versions of this Tektronix product are available: The 4932, a self-powered unit and the 4909F02 Plug-in Interface. The 4932 converts parallel GPIB data to serial form, appends various control signals, then transmits the data to the remote unit over the "link" cable.

The 4909F02 was especially designed for use with the Tektronix 4909 Multi-User File Management System. It plugs directly into the system bus and provides a coaxial "link" cable connector for use with a remote 4932. At the remote end, a 4932 GPIB Extender converts the data back to a parallel, GPIB-compatible format.

GPIB Extenders are always used in pairs: Two 4932 units or one 4932 and one 4909F02. The 4932 is compatible with any instrument that has a GPIB interface, and is compatible with the 4909F02 via the coaxial "link" cable.

The 4932 is in conformance with the IEEE Standard 488-1978 except that Parallel Poll is not supported over the "link" cable.

Additional information is available from your Tektronix Sales/Service office. Ask for Data Sheet P/N 12W-5048.

### TEK SPS BASIC Software with DEC PDP-11 Minicomputers

When equipped with Tektronix supplied GPIB interfaces, all PDP-11 series minicomputers can be operated with TEK SPS BASIC software to provide the most powerful of big-system instrument control and signal processing. A wide variety of peripherals can be handled, including plotters, line printers, graphic terminals, magnetic tapes, and single or multiple disk storage systems. Additionally, with the proper options, up to four GPIB interface ports can be supported. This means control of and data collection from up to 56 GPIB instruments.



Tektronix WP3202 Signal Processing System using TEK SPS BASIC and a DEC PDP-11 Minicomputer

Two versions of TEK SPS BASIC are available, the standard version and the extended memory version. The extended memory version permits processing of very large arrays in computers having up to 128 kilowords of memory with memory management.

Other than memory differences, both versions of TEK SPS BASIC software have the same major features. These include a modular architecture consisting of a resident monitor and an expandable library of over 100 nonresident commands. This unique design lets you configure a software system to meet your specific needs yet leaves the system open for adding new commands and processing modules.

Measurement data can be stored and accessed in a variety of ways. Information can be read or written in either ASCII or binary. Named files can be accessed on hard or flexible disks, magnetic tape, or cassettes. Information can be read from files either sequentially or randomly. TEK SPS BASIC commands give you complete file management capability.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

There's also data logging capabilities for automated waveform capture. And the software's better than 7-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Plus, there are special data structures to retain both numeric and literal information (scale factors and units) associated with a given waveform. This waveform data structure, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

Beyond extending the standard mathematical operations and functions to include waveform processing, TEK SPS BASIC also provides special waveform processing functions. Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed—all with single commands. Polar conversions can also be performed with a single command to present results as magnitude and phase.

With its large array size capabilities (limited only by memory in most cases), advanced signal processing, and program and instrument tasking capabilities (including error control for independent operation), TEK SPS BASIC offers all of the flexibility and power necessary to control anything from the simplest to the most sophisticated test and measurement system.

#### Guide for Selecting GPIB Instruments

When selecting GPIB instruments for a specific application, be sure to check several key specifications for suitability in the configuration.

First, make sure that the instrument can make the desired measurements. Next, determine that the interface functions are compatible with the proposed usage and with other instruments in the GPIB configuration. The following items should be used as a checklist with your Sales Representative when considering instruments to be used in GPIB configurations:

1. Is the instrument intended for interactive measurement analysis or automated measurement; i.e., are all necessary instrument functions remotely programmable, or will an operator be available to adjust settings?
2. Does the instrument's GPIB interface have the necessary set of functions implemented at the desired level? (For example, AH1 is needed for any useful interaction, SH1 is required for instruments supplying measurements to the controller.)
3. Are diagnostics available to check out the instrument from the front panel or over the GPIB interface?

4. Does the instrument use standard codes and formats conventions for terminators, numeric formats, etc.?
5. Can the instrument's front-panel setting be read from the controller and saved for later automated set up?
6. Can the front panel be "locked out" via the GPIB?

#### Tektronix Support for Your GPIB System

With GPIB products and signal processing systems from Tektronix, you're not left on your own after the product is purchased. Tektronix offers complete support and training for the operation and maintenance of its GPIB products and systems.

Every product is shipped with a set of complete and comprehensive operating and service manuals. Additionally, a variety of training services are available. For larger systems, such as those operating with TEK SPS BASIC software, formal training classes are available at our Beaverton campus.

As part of the long-term support for GPIB products and systems, Tektronix offers a variety of application literature.

For users of 4050 series controllers, there is *TEKniques*, the 4050 Series Applications Library Newsletter. It covers the field of 4050 applications and provides abstracts of new software contributions to the 4050 Application Library Programs.

*HANDSHAKE* is another newsletter provided by Tektronix. It's published quarterly and contains application and technical articles covering the broad spectrum of instrument control and signal processing. There is also an application program library associated with *HANDSHAKE*.

An extensive collection of application notes and magazine article reprints is another source of information offered by Tektronix. Our Field Offices and Sales Representatives maintain a list of current literature and will be glad to supply you with items in your areas of interest.

Warranties and service are another part of the support you get from Tektronix. All Tektronix products are warranted and Tektronix maintains a network of service centers for your maintenance needs.

**WAVEFORM ACQUISITION PRODUCTS PAGE**

468 Option 02 Digital Storage Oscilloscope	331	This portable, high-performance, 100 MHz oscilloscope uses a unique display interpolation system to store and display single-shot events. An exclusive Envelope mode can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Can be used with a 4924 Tape Drive to record waveform data on-site for subsequent filing or computer analysis. Option 02 GPIB interface for outputting waveforms as addressable talker.
*492P Programmable Spectrum Analyzer	200	A portable, 50 kHz to 220 GHz, lab quality analyzer that provides CRT readout of all important front panel settings and is fully calibrated in amplitude and frequency. Front panel adjustments can be remotely controlled over the GPIB for automated spectrum analysis via GPIB. Features microprocessor-aided, three-knob operation and flicker-free display even at the slowest sweep speeds.
*496P Programmable Spectrum Analyzer	204	Providing a CRT display of all important control settings, this 1800 MHz analyzer features microprocessor-aided, three-knob operation and automatic mode selection. Unit is fully calibrated in frequency and amplitude. Front panel settings can be remotely controlled. Digital storage eliminates time consuming display adjustments.
*7D20 <b>NEW</b> Programmable Digitizer	268	A new plug-in that converts any 7000 Series mainframes into fully programmable, digital oscilloscopes. Operating modes include: Envelope, Average, and Roll. Optimized for interactive and automated applications, from biomedical research to radio modulation. Remotely controllable over the GPIB.
*7912AD Programmable Digitizer	265	This unique product can digitize and store single-shot or repetitive signals from millisecond to subnanosecond duration. Waveform data is stored in a 4096 word memory. Designed for interactive and automated applications, this waveform digitizer is very useful in laser research. The digitizing technology employed in this instrument provides an equivalent sampling rate up to 100 GHz.
*390AD <b>NEW</b> Programmable Waveform Digitizer	261	This two-channel, 10-bit digitizer achieves excellent dynamic accuracy with a two-stage flash-conversion process. Single-channel operation can provide 60 megasamples per second. Built-in self-calibration and self-test features. Remotely controllable over the GPIB. Applications vary from ultrasonic testing to video.
*7612D Programmable Digitizer	263	Two independent waveform digitizers in one compact instrument, the 7612D is ideal for use with Automatic test Equipment or anywhere highly accurate, time-domain measurements are required. Digitizing accuracy is provided by a unique A/D converter working with an ultra-high-speed comparator. Memory partitioning helps capture fast, successive, randomly occurring events. Multiple sample rate switching is available during waveform acquisition. Remotely controllable over GPIB.
*5223 Option 10 Digitizing Oscilloscope	294	This 10 MHz digital storage oscilloscope provides a digitized display that will never fade or bloom. Selecting Roll mode yields a continually updated display of memory contents by providing a strip-chart-like view of signals at slow sweep rates. Applications range from measuring mechanical displacement transducer signals to biomedical activities. Option 10 GPIB Interface for I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through this interface for either BINARY or ASCII. Plug-in functions not remotely controllable.
*7854 Waveform Processing Oscilloscope	259	A two-channel, waveform processing, digital storage oscilloscope. Keystroke programming of local keyboard and remote Waveform Calculator allows user-designed waveform measurement routines for tests or experiments. Signal averaging capability can recover signals buried in noise and improve measurement accuracy. All mainframe keystroke functions and operating modes can be remotely controlled via the GPIB. Plug-in functions not controllable via GPIB.
WP1310 Desktop Computer-Based Waveform Processing System	229	Based on the Tektronix 7854 Oscilloscope and the 4052A Desktop Computer System equipped with ROM packs, this system can acquire, process, store, and display electrical signals. 4050 Series BASIC routines from the Utility Software permit system operation with limited programming experience. The 7854 is remotely controllable over the GPIB. The 4052A can control other GPIB-compatible instruments.
WP2110 Desktop Computer-Based Programmable Digitizer System	229	An effective combination of Tektronix instruments, the WP2110 is a high-speed, signal acquisition and transient digitizing system. Single-shot or repetitive signals from millisecond to subnanosecond duration can be digitized and stored with 9-bit resolution. Waveforms and arrays can be processed and displayed. The 7912AD is remotely controllable over the GPIB.
WP2251 Controller-Based Programmable Digitizer System	228	A self-contained signal acquisition, display, waveform processing, and data storage system, the WP2251 combines a Tektronix 7912AD Programmable Digitizer and a CP1164X Instrument Controller with a 4012 Computer Display Terminal. Software support is TEK SPS BASIC and high-density data-storage peripherals. An extensive software package on disk includes signal processing, graphics, and high-level GPIB driver in addition to instrument and system checkout programs. The Controller can accommodate up to four IEEE-488 Interfaces and features 64 kilowords of memory expandable to 128 kilowords.
WP2252 Controller-Based Programmable Digitizer System	228	The WP2252 is a complete acquisition, processing, storage, and display system for high-speed signals and transients. It is based on the Tektronix 7912AD Programmable Digitizer operating with a Digital Equipment Corp PDP-11/23 Controller, a Tektronix 4012 Computer Display Terminal and other peripheral equipment. TEK SPS BASIC software on (floppy) diskettes includes operational packages and checkout routines. The controller can accommodate two IEEE-488 Interfaces and features 64 kilowords of memory and floating-point hardware.
WP3110 Desktop Computer-Based Programmable Digitizer System	229	Based on the Tektronix 7612D Programmable Digitizer and the 4052A Desktop Computer System equipped with ROM packs, the WP3110 is a complete signal acquisition, waveform processing storage, and display system. Equipment options include a Hard Copy Unit. The 7612D is remotely controllable over the GPIB. The 4052A can control other GPIB compatible instruments.
WP3201 Controller-Based Programmable Digitizer System	228	This complete signal acquisition and waveform processing system is based on the Tektronix 7612D Programmable Digitizer and the CP1164X Controller. It is supported with TEK SPS BASIC software and high-density data storage peripherals. Stored on mag disk, resident software includes signal processing, graphics, and high-level GPIB driver in addition to major instrument and system checkout software. The CP1164X Controller accepts up to four IEEE-488 Interfaces.
WP3202 Controller-Based Programmable Digitizer System	228	The WP3202 can acquire, process, and store high-speed signals and transients on two independent channels. This system combines the Tektronix 4012 Computer Display Terminal and 7612D Programmable Digitizer with a Digital Equipment Corp PDP-11/23 Controller and other peripheral instruments. Operating software contained on floppy diskette includes signal processing, graphics, and a GPIB driver in addition to instrument and system checkout software. The controller will accommodate two IEEE-488 Interfaces and features 64 kilowords of memory and floating-point hardware.

**LOGIC ANALYZERS**

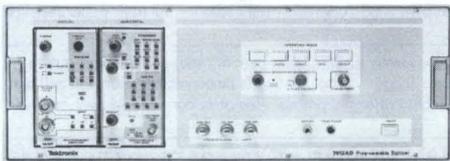
*DAS 9100 Series & *DAS 9120 Series Digital Analysis System <b>NEW</b>	58	A general purpose, configurable, and user-upgradable digital analysis instrument system. Available with black and white display (9109 Option 02 mainframe) without display (9119 mainframe) or with the new DAS 9120 Series color display (9129 mainframe). All of the functions that can be accessed from the DAS 9100 Series keyboard may be controlled via GPIB. See catalog description for list of Data Acquisition and Pattern Generation Modules, accessories and probes.
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\*Remotely Controllable

GENERAL PURPOSE INSTRUMENTS		PAGE
*DC 5009 Programmable Universal Counter/Timer	356	This dual-channel, microprocessor-based TM 5000 Series plug-in provides frequency and period measurement to 135 MHz and features push-button automatic trigger-level setting and eight measurement functions. An arming input permits measurement of selected events within complex waveforms. Option 01 provides an oven-controlled 10 MHz crystal oscillator. All front panel settings and features are remotely controllable over the GPIB.
*DC 5010 Programmable Universal Counter/Timer	358	A dual-channel TM 5000 Series plug-in that provides measurement of frequency to 350 MHz, period, ratio, and event B during A, using a reciprocal technique. Trigger levels automatically set to optimum. Trigger voltage setting is displayable. Automatic self-test feature. Probe compensation feature allows quick and accurate compatibility of signal probes. Remotely controllable over and fully programmable via GPIB.
*PS 5010 Programmable Triple Power Supply	363	This TM 5000 plug-in provides three concurrent outputs; two floating at 0 to +32 and 0 to -32 V dc and a logic level supply at 4.5 to 5.5 V dc. Operation includes auto-crossover with bus interrupt on continuous-voltage or continuous-current mode change. All three supplies may be remotely controlled over the GPIB while front panel settings are locked out.
*DM 5010 Programmable Digital Multimeter	351	This remotely controllable, TM 5000 Series plug-in measures dc and true RMS ac voltages and resistances. A diode-test function tests semiconductor junctions while a low voltage/ohms function allows in-circuit measurements without turning on diode or transistor junctions. Math functions include: Averaging (up to 19,999 readings), dB (ref to 1 mW or to user-supplied constant), Comparison (user-supplied upper/lower limits), Offset and Scaling (user supplied constants), or any combination of these functions.
*FG 5010 Programmable Function Generator	372	This TM 5000 plug-in outputs Sine, Square and Triangle waveforms. Pulses and Ramps are provided with variable symmetry in one percent steps. Phase-lock mode automatically locks to any input signal, 20 Hz to 20 MHz. Dc offset voltage is programmable from 20 mV to 7.5 V. Can store ten front panel setups to reduce programming time. Fully programmable via GPIB.
*MI 5010 Programmable Multifunction Interface	388	This TM 5000 Series plug-in interface module accommodates three front-panel plug-in cards. The MX 5010 Multifunction Interface Extender provides space for three additional cards. A total of six function cards can be remotely controlled via the GPIB. Each of the four types of function cards available includes its own ROM and specific function-related firmware. The 50M20 is a Programmable 12-bit Digital-to-Analog Converter. The 50M30 is a Programmable, Digital I/O with 16 input and 16 output lines. The 50M40 is a Programmable Relay Scanner card providing 16 normally open relay contacts. The 50M70 is a Programmable Development card containing interface logic registers, address and data buffers, and a breadboard area.
*SI 5010 Programmable RF Scanner	390	This TM 5000 Series plug-in uses sixteen RF reed relays to interconnect twenty front-panel BNC connectors in three possible combinations; four groups of four channels, two groups of eight, or one group of 16. Risettime for groups of four channels is approximately one nanosecond. Used for scanning and channel switching, this device is remotely controllable over the GPIB.
*CG 5001 <b>NEW</b> Programmable Calibration Generator	378	A microprocessor-based TM 5000 Series plug-in designed to be an integral part of a controller-based system for calibrating and verifying major oscilloscope parameters. Learn mode allows front panel control settings to be assimilated as program data by controller. All front panel settings are remotely controllable via the GPIB. Built-in self test routine is activated when power is applied.
<b>SYSTEM CONTROLLERS</b>		
4041 System Controller	119 391	A powerful and expandable, systems controller intended principally for execute-only environments such as production-line testing. Operating parameters include Interrupt and Error Handling modes. Options and peripherals equip it for interactive flexibility in research lab applications. Programming language is BASIC with English-like commands, extensions, simple syntax, and line-by-line interpreter.
4051 Desktop Computer/System Controller	97	Provides stand-alone, integrated computing power for various problem solving and data analysis applications. Simple English-like BASIC commands provide friendly, flexible graphics capabilities. Built-in mag tape drive has 256 bytes with header.
4052A <b>NEW</b> Desktop Computer/System Controller	98	This system controller offers high-performance, stand-alone computing power, flexible data communications, and easy-to-learn extended BASIC. Excellent choice for scientific/statistical research, forecasting, data acquisition and analysis. Processor uses microcode floating point and built-in mag tape drive allows easy storage of ASCII and binary programs and data.
4054A <b>NEW</b> Desktop Computer/System Controller	99	Unequaled graphics in an integrated desktop computer/system controller. Microcoded floating point processor for rapid calculation. Software is compatible with entire 4050 Series including PLOT 50 Graphics. With 4096 X and 3120 Y resolution (12 million addressable points) the 4054A has the graphics capability for even the most complex displays.
<b>PERIPHERALS FOR IEEE-488 SYSTEMS</b>		
*4663 Interactive Digital Plotter	107	This intelligent plotter has a unique front panel device that allows quick selection of operating parameters. Selections can be stored up to 90 days without power. Plots on C-size (European A2-size) paper, mylar, or acetate film with felt-tip, hard-rib, or wet-ink pens. Compatible with PLOT 10 Graphic software. Fully programmable via GPIB.
*1360P/1360S Programmable Signal Multiplexer	226	A microprocessor-based, programmable, system instrument that can be used to multiplex electrical signals. Switch matrix includes four identical, nine-pole coaxial switches. Operational modes determined by adjustable straps. Switch modes are: individual gangs of 1, 2, or 4. Multiples of eight inputs can be multiplexed to one output. Remotely controllable over the GPIB.
*4909 Multi-User File Management System	112	A high performance mass storage system with flexible file management and a multiple-level library structure. 4909 features include data protection, indexed files, and automatic self-test with LED fault indicators. In addition to the cabinet, the standard system includes a controller that can manage up to ten desktop computers, one 32 Mbyte disk drive, a disk interface plug-in, and an IEEE-488 Interface plug-in. Remotely controllable over the GPIB.
4051R14/4052R14 <b>NEW</b> GPIB Enhancement ROM Packs	100	Each ROM pack contains thirty-nine commands providing additional GPIB capabilities to their respective desktop computer/system controller. Twelve commands facilitate GPIB commands using direct call statements; twelve more improve GPIB polling by adding parallel polling, control of SRQ sensing, automatic serial polling and decoding of Tektronix Codes and Formats for standard error messages. Seventeen additional commands expand binary data acquisition and automated data acquisition and manipulation.
4932/4909F02 <b>NEW</b> GPIB Extender	26	Provides GPIB communication over distances of up to 500 meters (1650 feet) by converting parallel GPIB data to serial form, appending various control signals, and transmitting data to the remote end over 75 Ω RG 6/U coaxial "link" cable.
<b>GPIB CABLES</b>		
012-0630-01	2 Meter Single Shield	Used with 5223 Option 10 R5223 Option 10 and several S Systems.
012-0630-02	4 Meter Single Shield	Used with 4662 Option 01, AD2050 Option 21, WP1310, WP2252, WP2110 Option 27 and WP3110 Option 27.
012-0630-03	2 Meter Double Shield	Used with 390AD, 492P, 496P, 4662 Option 01, 4663S, 4663 Option 01, 4663 Option 04, 4907, 4924, 4956, 7612D, 7912AD, AD2050, AD2050 Option 21, AD3020, WP1310, WP2110, WP2251, WP2252, WP3110, WP3201, WP3202 and several S systems.
012-0630-04	4 Meter Double Shield	Used with 4909, 4909AC, 4909F, 4909 Option 11, 4909 Option 12.

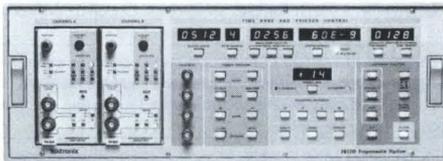
\* Remotely controllable.

**WAVEFORM ACQUISITION PRODUCTS**



**7912AD**  
Programmable Waveform Digitizer

- 100 MHz Equivalent Sampling Rate
- 500 ps/div Calibrated Sweep Rate
- 500 MHz Bandwidth at 10 mV/div
- Built-in Signal Averaging
- Remotely Controllable via GPIB



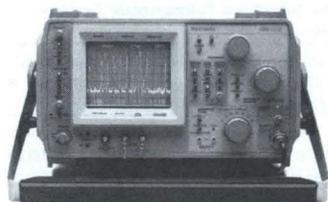
**7612D**  
Programmable Waveform Digitizer

- 200 MHz Dual Channel Sampling
- Dual Time Base
- Variable Record Lengths to 2048 Words Each Channel
- 8-Bit Resolution
- Pretrigger and Posttrigger
- Sample-Rate Switching



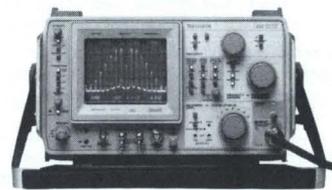
**390AD**  
Programmable Waveform Digitizer

- 30 MHz Dual Channel Sampling, 60 MHz Single Channel Sampling
- Cursor-Based Measurements
- Sample-Rate Switching
- Direct Plotter Output Capability
- 10-Bit Resolution



**496P**  
Programmable Spectrum Analyzer

- Digital Storage and Signal Processing
- 1 kHz to 1800 MHz Input Frequency
- 80 dB Dynamic Range
- Amplitude Comparison in 0.25 dB Steps
- 30 Hz Resolution Bandwidth



**492P**  
Programmable Spectrum Analyzer

- Digital Storage and Signal Processing
- 50 kHz to 220 GHz Input Frequency
- 80 dB Dynamic Range
- Amplitude Comparison in 0.25 dB Steps
- 100 Hz Resolution Bandwidth



**468 Option 02**  
Digital Storage Oscilloscope

- 10 MHz Storage Bandwidth
- Time and Voltage Measurement Cursors
- 100 MHz Non-Storage Bandwidth
- Envelope Mode
- Signal Averaging



**7854**  
Waveform Processing Oscilloscope

- 400 MHz Equivalent Time Bandwidth
- 500 kHz Maximum Sample Rate
- 10-Bit Vertical Resolution
- Pretrigger and Posttrigger
- Keystroke Programming
- Signal Averaging



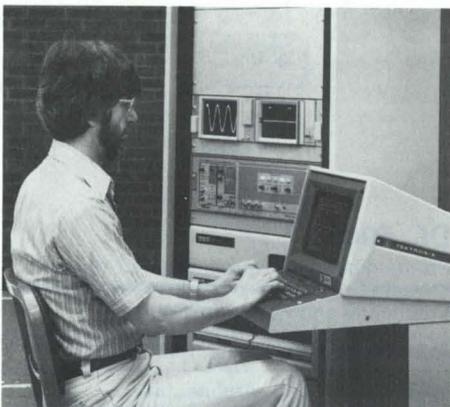
**7D20**  
Programmable Digitizer

- 70 MHz Equivalent Time Bandwidth
- 40 MHz Sample Rate
- 8-Bit Vertical Resolution
- Pretrigger and Posttrigger
- Simultaneous Acquisition on 2 Channels
- Signal Averaging and Enveloping



**5223 Option 10**  
Digitizing Oscilloscope

- 10 MHz Equivalent Time Bandwidth
- 1 MHz Equivalent Time Bandwidth
- 1 MHz Sample Rate
- 10-Bit Vertical Resolution
- Pretrigger and Bi-slope
- X-Y Analog Plotter Output
- Roll and Vector Modes



**WP1310**  
Desktop Computer-Based  
Waveform Processing Oscilloscope System

Extended Waveform Processing;  
FFT and IFT

Mag Tape Program and Data Storage

High Resolution Graphic Display

GPIB Instrument Control

**WP2110**  
Desktop Computer-Based Waveform  
Digitizer System

Acquisition to 200 MHz w/Program Control

Acquisition to 1 GHz w/Direct Access  
Plug-in

Program and Data Storage on Mag Tape

High Resolution Graphic Display

100 GHz Equivalent Sampling Rate

GPIB Instrument Control

Waveform and Array Processing

**WP3110**  
Desktop Computer-Based Waveform  
Digitizer System

Acquisition to 80 MHz w/Program Control

Two Independent Digitizing Channels

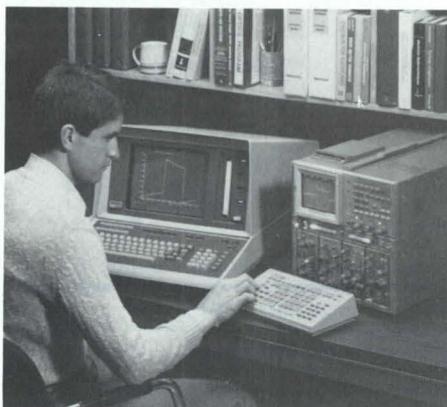
Sampling Rates to 200  
Megasamples/Second

High-Resolution Graphics Display

GPIB Instrument Control

Waveform and Array Processing

**WAVEFORM ACQUISITION SYSTEMS**



**WP2251**  
Controller-Based Waveform  
Digitizer System

Acquisition to 200 MHz w/Program Control

Acquisition to 1 GHz via Direct Access  
Plug-in

Program and Data Storage on Disk

Waveform and Array Processing

100 GHz Equivalent Sampling Rate

High Resolution Graphic Display

**WP2252**  
Controller-Based Waveform  
Digitizer System

Signal Acquisition to 200 MHz w/Program  
Control

Signal Acquisition to 1 GHz w/Direct Access  
Plug-in

Waveform and Array Processing

Program and Data Storage on Disk

100 GHz Equivalent Sampling Rate

**WP3201**  
Controller-Based Waveform  
Digitizer System

Acquisition to 80 MHz w/Program Control

Program and Data Storage on Mag Disk

Sampling Rates to 200  
Megasamples/Second

Waveform and Array Processing

Real Time GPIB Instrument Control

Two Independent Digitizing Channels

**WP3202**  
Controller-Based Waveform  
Digitizer System

Signal Acquisition to 80 MHz w/Program  
Control

Two Independent Digitizing Channels

Sampling Rates to 200  
Megasamples/Second

Waveform and Array Processing

Real Time GPIB Instrument Control

**1360P/1360S**  
Programmable Signal Multiplexer

3 ms Maximum Switching Time

Dc to 250 MHz Bandwidth (1 switch)

Rackmount or Benchtop

Input Levels up to 250 V dc or 250 mA

Expandability up to 4 Switch Modules



**DAS 9100 Series**  
Digital Analysis System

Asynchronous Sampling to 660 MHz

Up to 104 Channels of Data Acquisition

Sampling Resolution to 1.5 ns

Up to 80 Channels of Pattern Generation

Modular and User Upgradable

Full Remote Programmability

**Color DAS 9120 Series**  
Digital Analysis System

Color CRT Enhanced User Interface

Pattern Generation Modules for  
Programmed Stimulation

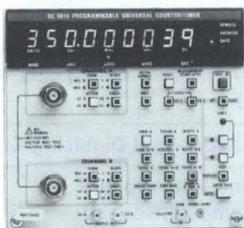
Easy-to-Use Menu-Driven Interface

Up to 104 Channels of Data Acquisitions

Asynchronous Sampling to 660 MHz

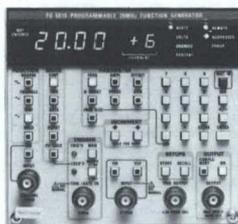
Modular and User Upgradable

**GENERAL PURPOSE INSTRUMENTS**



**DC 5010**  
Programmable Universal Counter/Timer

- DC to 350 MHz
- Auto Trigger, Auto Averaging
- 3.125 ns Clock, Ratio Architecture
- 13 Measurement Functions
- Arming Input and Shaped Outputs
- Probe and Hysteresis Compensation



**FG 5010**  
Programmable Function Generator

- 0.002 Hz to 20 MHz  $\pm 0.1\%$
- Programmable Symmetry
- 20 mV to 20 V p-p From 50 Ohms
- AM, FM, and VCF Modes
- Auto Scan Phase Lock, Haverfunction
- 10 Stored Setups
- Remotely Controllable



**DC 5009**  
Programmable Universal Counter/Timer

- Frequency and Period to 135 MHz
- Auto Trigger, Averaging, Self Test
- 10 ns Clock, Ratio Architecture
- Trigger Level and Shaped Outputs
- 8 Measurement Functions
- 8-Digit LED Display



**PS 5010**  
Programmable Triple Power Supply

- Fully Programmable
- Triple Output, Triple Display
- Voltage and Current Limit Programmable
- Front/Rear Outputs, Remote Sense
- Front Panel Lockout Capability
- $\pm 0.5\%$  Accuracy



**CG 5001**  
Programmable Calibration Generator

- Tests Oscilloscope Current Accuracy to  $\pm 0.25\%$
- Tests Oscilloscope Voltage Accuracy to  $\pm 0.25\%$
- Tests Markers and Slew-Edge Timing Accuracy to  $\pm 0.01\%$
- LED Display of Functions Selected
- Verifies Scope Probe Accuracy



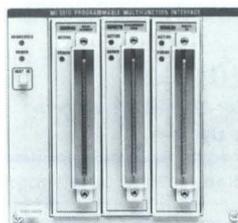
**SI 5010**  
Programmable RF Scanner

- Software Configurable
- Sixteen 50 Ohm Signal Channels
- Realtime Clock
- 350 MHz Bandwidth
- Stores 80 to 300 Commands
- Vswr 1.25:1 at 100 MHz



**DM 5010**  
Programmable Digital Multimeter

- 4.5 Digit, 0.015% Accuracy
- True RMS 200 mV to 1000 Volts
- Automatic Self Test, Math Functions
- In-Circuit Resistance Measurements
- Autoranging



**MI 5010**  
Programmable Multifunction Interface

- Customer Configurable
- Realtime Clock
- Development Card
- 16 Relay Scanner
- 16-Bit Digital I/O
- 12-Bit Digital-to-Analog Converter

**SYSTEM CONTROLLERS**



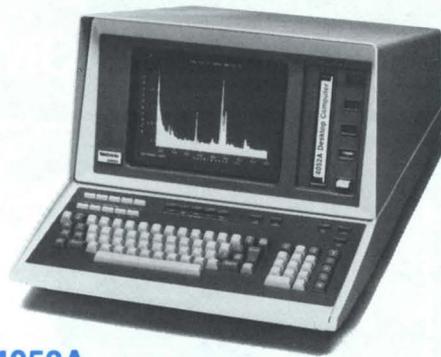
**4041**  
System Controller

- 16-Bit CPU Based on 68000
- 32 k RAM Expandable to 160 k
- 48-File Mag Tape Drive
- Full Duplex, Asynchronous, RS-232 Interface
- Modular Design, Rackmount or Portable
- 1.8 Lines/Second Thermal Printer



**4051**  
Desktop Computer

- LSI, 8-Bit CPU
- 10 or 20 User-Definable Function Keys
- High-Level BASIC Programming Language
- High-Resolution Graphics and Alphanumerics
- 16 k or 32 k Memory Workspace



**4052A**  
Desktop Computer

- Extended BASIC Programming Language
- Memory Expandable to 64 kBytes
- LSI, Bipolar, 16-Bit CPU
- 10 or 20 User Definable Function Keys
- High Resolution Graphics



**4054A**  
Desktop Computer

- 19-Inch, High-Resolution Display
- LSI, Bi-polar, 16-Bit CPU
- Extended BASIC Programming Language
- Dynamic Graphics Option
- Enhanced Graphics
- 32 k or 64 kbyte Memory Workspace

PERIPHERALS FOR IEEE STANDARD 488 SYSTEMS



**4051R14/4052R14**  
GPIB Enhancement ROM Packs

- Call Statement GPIB Control
- Binary Information Transfer
- Hexidecimal Conversion
- IEEE Standard 488 Call Names
- Utility Routines, Error Message Tables
- Automatic Configuration & Serial Poll

Signal Processing ROM Packs are described on page 100.



**4663**  
Interactive Digital Plotter

- Joystick Control
- Multi-Color Capability
- Dual-Programmable Pen Control
- 9 Character Fonts
- 5.5 k Buffer Memory
- Remotely Controllable



**4909**  
Multi-User File Management System

- Shared Access up to 10 Users
- Public and Private File Workspaces for Operational Flexibility/File Protection
- 32 or 96 Megabyte Drive Capacity
- Expandable up to 8 Drives (768 Megabytes)
- Indexed and Dynamically Allocated Files
- Variable Length Records
- Concatenated Volumes
- English Command Operation Over High-Speed GPIB
- Time of Day Clock with Battery Backup
- File Names up to 100 Characters Long
- Multiple Level Library Names



**4932**  
GPIB Extender

- Up to 500 Meters GPIB Extension
- User Transparent Operation
- 4909 Plug-in Option
- Low Unit Price
- Low Cost Cable

## DESIGN AUTOMATION DIVISION



One of the fastest growing enterprises at Tektronix is the Design Automation Division. It operates at the forefront of digital technology, offering a full line of tools to support the design of digital logic and microprocessor-based systems. Peter Strong, general manager, represents the division's commitment to anticipate long-range customer needs and changes in technology. In customer support and product development, the Design Automation Division is committed to providing flexible solutions for a future of change.





The Design Automation Division of Tektronix is a response to the far-reaching implications of LSI/VLSI technology. Since the advent of the microprocessor in the early 1970's, there has been a constant increase in both the variety and complexity of "intelligent" products under microcomputer-based control. Driving this trend is the increasing performance capacity of microprocessor hardware, exemplified by the jump from 8-bit to 16-bit microprocessors, and the recent emergence of 32-bit "micromainframes".

These advances in the hardware's performance capacity have had a profound effect on the way that new digital products are conceived and designed. More powerful hardware opens the door to more sophisticated products, which in turn generate more demanding product specifications. Consequently, the task of designing digital products has grown larger and more complex.

This ongoing expansion of the digital design task has created the need for a new approach to microcomputer design instrumentation, one that ensures the designer can maintain maximum productivity, whether working alone or as part of a team effort.

The major objective of the Tektronix Design Automation Division is to produce and support this new generation of digital design tools, elevating the efforts of individual engineers to the creative or conceptual level, where they can operate in a truly cost-effective manner. The goals of the Design Automation Division are enhanced by Tektronix' special position in the digital electronics industry.

On the one hand, Tektronix is a designer and producer of microcomputer-based equipment, and directly experiences all the challenges inherent in the digital design process. On the other, Tektronix has long been a supplier of superior instrumentation supporting all phases of electronic design. This dual role provides an ideal creative climate for the engineers in Design Automation Division to conceptualize and develop design tools that both reflect an immediate involvement with the tool's end use and help to sustain our traditional commitment to excellence in product.

Currently, the Design Automation Division's products fall into three major categories: Microcomputer Development Systems, Logic Analyzers and Semiconductor Test Systems. In addition to the dedicated functions performed by each, powerful synergistic combinations are being developed which will provide designers with the types of hybrid tools that will be necessary in the very near future.

The Division's 8500 Series Microcomputer Development Systems provide total support for microcomputer-based software development and hardware/software integration. Through a modular architecture, these systems supply "universal" support, allowing the designer to choose from a wide variety of chip families for a particular design. The 8500 Series provides extensive software support, including compilers, assemblers, and many special software tools that automate much of the code development and integration process. At the multi-user level, this support includes a powerful TNIX\* operating system, derived from Bell Lab's UNIX\*\* operating system, that permits intense interaction between team members working toward a common program goal.

The Division's Logic Analyzer products cover the spectrum of digital applications, from on-site servicing to the design of large mainframe computer systems. In all cases, product focus development has been to provide ease-of-use, combined with state-of-the-art performance. The new Color DAS Digital Analysis System, for example, brings a color CRT display to logic analyzers for the first time and also provides the fastest data acquisition speeds available. Another example is the 7D02 Logic Analyzer, a product dedicated to microcomputer-based design through a series of personality modules that automatically adapt it to the processor under test. Yet another is the portable 308 Data Analyzer, which operates in serial and signature modes as well as parallel state and timing modes.

Design Automation Division's S-3200 Series of Semiconductor Test Systems provides a complete, integrated circuit-testing environment that gives an engineer total control over all test procedures. Through a single interface, the user can easily write evaluation and characterization programs, run the tests, and format test results into quickly readable graphic or tabular displays. At the same time, upward compatibility guarantees the integrity of test software when transported to different systems within the S-3200 Series. Through advanced hardware, tests can be run on even very complex devices, including hybrids such as codecs. Specialized test devices, like memory pattern generators and waveform digitizers, permit the system to test almost any type of IC available.

To support its growing product line, the Design Automation Division has assembled a staff of technical personnel who are intimately familiar with the needs of the design engineer. From sales to applications assistance to service, you get the kind of backup that today's sophisticated design tools demand. In addition, the Division maintains a comprehensive education/training program, including workshops and seminars on all phases of microcomputer-based design.

The Design Automation Division has made a firm commitment to provide design tools built to accommodate the future. As evidence, many DAD products have modular architecture that allows the inclusion of high-performance modules as they become available. Also, many software products can migrate from one system to another as the user's hardware base is upgraded. Through techniques such as these, the Design Automation Division will continue to support the design engineer, who faces a digital world full of challenge and promise.

\* TNIX is a trademark of Tektronix  
\*\* UNIX is a trademark of Bell Laboratories

# MICROCOMPUTER DEVELOPMENT PRODUCTS

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### MDL Now Supports

<b>8088/87</b>	<b>68000</b>	<b>3872</b>
<b>8086/87</b>	<b>68120</b>	<b>3874</b>
<b>8085A</b>	<b>6800</b>	<b>3876</b>
<b>8080A</b>	<b>6801</b>	<b>Z80A</b>
<b>8048</b>	<b>6802</b>	<b>Z80B</b>
<b>8049</b>	<b>6803</b>	<b>Z8001</b>
<b>8035</b>	<b>6808</b>	<b>Z8002</b>
<b>8039</b>	<b>6809</b>	<b>TMS9900</b>
<b>8021</b>	<b>6809E</b>	<b>SBP9900</b>
<b>8022</b>	<b>F8</b>	<b>SBP9989</b>
<b>8041A</b>	<b>3870</b>	<b>1802</b>

*...with more to come*

Tektronix Microcomputer Development Products offer the broadest range of quality multiple microprocessor support available today. Tektronix won't lock you into one microprocessor family or vendor. Plus, every Tektronix MDL is backed with over 30 years of design experience. We test our Development Labs thoroughly to ensure performance and reliability. Each one provides complete development capability and the Tektronix commitment that guarantees you'll keep abreast of the fast paced microprocessor technology.

Call your local specialist today to find out more about the Tektronix 8550 MDL Systems.



### Three Basic Design Environments

Microcomputer design is currently performed in three basic work environments. These are the single-user environment, the multi-user environment, and the host computer environment. The Tektronix 8500 Series of Microcomputer Development Labs offer a full complement of development tools for all three microcomputer design environments. In each case, the most advanced technology available has been incorporated into an 8500 Series Microcomputer Development Lab that gives maximum performance in its intended setting. In this manner, Tektronix provides unmatched support for both microcomputer software development and hardware/software integration, no matter where it occurs.

### The 8550 Microcomputer Development Lab for the Single User Environment

The 8550 is a self-contained Microcomputer Development Lab that gives complete support to one user at a time. Important features of the 8550 Microcomputer Development Lab include: Guide, an optionally-invoked, menu-driven approach to system operation; high level language and assembly support with symbolic debugging for both 8-bit and 16-bit chips; emulation to install developed software in prototype hardware; and the powerful real-time debugging tool: the Trigger Trace Analyzer for 8-bit and 16-bit designs.

### The 8560 Multi-User Software Development Unit for the Multi-User Environment

The 8560 is a full microcomputer software development lab that supports up to eight separate

work stations. Multi-user support is accomplished using the 8560's powerful TNIX\* operating system, tailored specifically for team-oriented microcomputer development work. TNIX includes a fast, flexible filing system for effective data base management, advanced command capability for streamlining software development tasks, and several optional utility packages such as text processing. The 8560 uses a 16-bit CPU to control system resources. Software work stations consist of CRT terminals and the 8540 Integration Unit which has full emulation and debugging capability. Or, the 8550 can be used for hardware/software integration.

### The 8540 Integration Unit for the Host Computer Environment

In the host computer environment, a general purpose computer is used to support microcomputer-based design projects. The host computer's timesharing capability allows a number of designers at CRT terminals to simultaneously use the computer's facilities. Each designer has access to microcomputer development tools such as editors, assemblers, and compilers. The 8540 Integration Unit extends the host computer's microcomputer development support to include the task of hardware/software integration. While the 8560 or other host computer supports the software development task, the 8540 is used to integrate, test and debug the prototype hardware. The 8540 uses real-time emulation, a fast and efficient integration technique that employs an em-

ulator processor identical in function to the one targeted for the prototype. For added real-time debugging, a 62-channel Trigger Trace Analyzer is available as an option.

### 8550 Microcomputer Development Lab

The 8550 is a completely self-contained microcomputer development system that gives full support to both software development and hardware/software integration. For software development, the 8550 provides a wide range of sophisticated tools for fast, effective code generation. These include many 8-bit and 16-bit assemblers that support symbolic debugging, produce relocatable code and have powerful macro capabilities. High-level language support includes both Pascal, Microcomputer Development Lab/ $\mu$  compilers, and an enhanced form of BASIC with many microcomputer-oriented extensions. A line-oriented editor is included and an optional Advanced CRT-Oriented Editor.

The 8550 provides features carefully designed to save you time while increasing your efficiency. One feature reduces the time lost by new users as they learn to operate the system. To bring new users quickly up to speed, the 8550 includes a special menu-driven program called Guide, which offers a friendly interface for the beginner, but does not hinder the advanced user. Guide employs a series of menus that shows the user a well-documented pathway through system operations. At any time, the user can escape Guide and return to the conventional command format. In this way, the new users benefit, but not at the expense of the advanced user.

When you're experienced enough to move beyond Guide, you'll find a whole set of advanced features at your command. You'll be able to build special command files that are invoked through a few simple keystrokes to automatically execute system routines. The system will be working for you instead of you working for the system.

### Program Development and Data File Management

The 8550's DOS/50 operating system helps the designer manage all phases of program development and debugging. DOS/50 supervises general I/O, file creation and maintenance, program assembly and compilation, program execution, monitoring and debugging.

\*TNIX is a trademark of Tektronix. TNIX is a derivation of Bell Lab's UNIX Operating System Version 7.



**8550**

**Multiple Microprocessor Support**

**In-Circuit Emulation**

**Real-Time Prototype Analysis**

**Assembly and HLL Support**

The 8550's assembler packages provide full code-development support for a wide range of 8-bit and 16-bit chips. Powerful macros allow the designer to access frequently used sets of code by name reference. The linker, working with the relocating features of the assembler, links and locates multiple-code segments into a complete executable program. Additionally, a conditional assembly feature allows the designer to customize the final program by testing conditions to determine which of certain code segments are to be assembled into the final program. Extensive English language diagnostics provide easy-to-understand error messages and locate the line in which the error has occurred. When assembly is completed, the assembled code is stored on disk in a binary format file.

For selected chips, high level language support is available to increase your development power. One language offered is Microcomputer Development Lab/ $\mu$ , a BASIC-like language created specifically for microcomputer design. Another is Pascal, with its structured approach that readily adapts to microcomputer software development. For both languages, Tektronix has added a full complement of extensions that allow code manipulation at the microprocessor level, including access to microprocessor interrupt vectors, individual memory locations and I/O ports.

All software tools and files are managed by a highly flexible filing system that allows nesting to any level a project requires. Included are a linker and library generator to assist in modular code development. The 8550's two 1 megabyte floppy disks provide more than adequate mass storage.

**Line Printer Spooling Keeps the System Constantly Accessible**

One drawback of many development systems is that the system is not available to you when the printer is outputting a program listing. The system CPU directs all its attention to the operation and

cannot service other system operation. Since program printouts may be frequently required, this can mean a considerable loss in productivity.

The 8550 solves the problem through line printer spooling, which keeps your CRT fully operational even while printing is in progress. You have unhindered access to the system, resulting in a significant productivity increase.

**Time-Saving Debugging Tools**

The 8550 gives you Real Emulation for each of its modular emulator processors. This means that the emulator processor is truly identical in function to the processor targeted for your prototype. With no restrictions on interrupts, no reserved code space and no hidden hardware requirements. It also means true real-time emulation up to the processor's full specified operating speed. No need for stretched clock pulses or added wait states that cause hidden timing bugs in your final product.

For 16-bit and 8-bit designs, the Trigger Trace Analyzer uses a high speed trace buffer capable of working with bus cycle speeds up to 8 MHz. The buffer is 62 bits wide to capture 16 data bits, 24 address bits, 14 emulator-dependent bits, and 8-bits from external hardware. Up to four independent triggers can be combined in both logical and sequential combinations to form a breakpoint or data storage trigger. The individual triggers themselves can be defined from a combination of bus data, pass delay counters, and an external qualifier. Each trigger can also initiate its own external output to trigger other instruments such as oscilloscopes and logic analyzers.

The Trigger Trace Analyzer offers a powerful and diverse set of debugging operations. For instance, the real-time length of an interrupt service routine can be measured while simultaneously counting the number of assertions from a second interrupt source. Or, the maximum depth of a stack-during-program execution can be determined. To optimize code performance, the read or writes within any given address range can be isolated and counted, thus identifying heavily used areas for code optimization.

**Real Time Emulation — Three Emulation Modes**

After an error-free assembly listing has been obtained, the resulting object code may be executed in system emulation Mode 0 on the optional emulator processor. The emulator processor is identical in function to the microprocessor that will finally be installed in the user's prototype. Execution is performed under control of the debug system; during execution, program steps can be traced, software breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the text editor. It then can be reassembled and executed again. This procedure continues until the program is correct.

After the software has been debugged, it may be exercised on the prototype circuitry in the partial emulation mode (Mode 1). During partial emulation, control may be released from the 8550 to the prototype in stages. The development software runs using 8550 memory space and prototype I/O and clock. The 8550 memory mapping feature allows code to be gradually mapped over to the prototype's memory in manageable blocks. Throughout partial emulation, the user has access to prototype circuitry through the debugging system. This allows the user to trace, set breakpoints, examine and change memory and register contents.

In full emulation (Mode 2), the program is run on the prototype, but program execution is still under the complete control of the debug system. All I/O and timing functions are directed to the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor. Although the prototype is effectively free-standing, the user may still direct program activity from the 8550.

**Transform the 8550 into a general purpose computer**

Often, you will have professional and personal pursuits besides microcomputer design that lend themselves to computerization. So Tek has made it easy to transform the 8550 into the realm of general purpose computing.

It's done through an operating system package called RT-11/50, which Tek offers as an 8550 option. RT-11/50 opens the door to a wide range of third party applications software. And with it, the 8550 can quickly become a project management computer, an engineering computer, a personal computer or a small business bookkeeper. Many other useful, cost-effective applications are possible with the addition of RT-11/50.

**8550 CHARACTERISTICS**

The 8550 consists of an 8301 Microprocessor Development Unit and an 8501 Data Management Unit.

8301 MICROPROCESSOR DEVELOPMENT UNIT		
Dimensions	mm	in
Width	430	17.0
Height	280	11.0
Depth	585	23.0
Weight	kg	lb
Net	27.0	60.0

**ENVIRONMENTAL CHARACTERISTICS**

**Operating Temperature** — +32°F to +122°F (0°C to +50°C).

**Humidity** — 90% at +86°F to +140°F (+30°C to +60°C).

**Altitude** — Operating: 0 to 4500 m (15,000 ft). Storage: 0 to 15 000 m (50,000 ft).

**AC POWER**

**Line Voltage Ranges** — 115 V ac (90 V ac to 132 V ac); 230 V ac (180 V ac to 250 V).

**Line Frequency Range** — 48 to 66 Hz.

8501 DATA MANAGEMENT UNIT		
Dimensions	mm	in
Width	424	16.8
Height	267	10.5
Length	597	23.5
Weight	kg	lb
Net	25.0	55.0

**ENVIRONMENTAL CHARACTERISTICS**

**Operating Temperature** — +50°F to +104°F (+10°C to +40°C)

**Humidity** — 20% to 80% relative noncondensing

**Altitude** — Operating: 0 to 2500 m (8,000 ft) Derate maximum operating temperature by +1°C for each 300 m above 2400 m. Storage: 0 to 15 000 m (50,000 ft).

**AC POWER**

**Line Voltage Ranges** — 115 V ac (90 to 127 V RMS); 230 V ac (180 to 250 V RMS).

**Line Frequency Range** — 50 Hz  $\pm$ 1% or 60 Hz  $\pm$ 1%.

**Overload Protection** — Automatic current limit foldback.

**FLEX DISK CHARACTERISTICS**

**Encoding** — IBM compatible single or double density. Format must qualify as follows: MFM sectors = 256 bytes. FM sectors = 128 bytes.

**Diskette Type** — Single or double sided, soft sectored.

**Capacity** — Double sided, double density: 1,021,696 bytes. Single sided, double density: 509,184 bytes. Single sided, single density: 256,256 bytes.

**Order 8550 Microcomputer Development Unit ..... \$17,000**

MICROCOMPUTER DEVELOPMENT

SOFTWARE DEVELOPMENT UNITS



## 8560

**256 kb Memory Expandable to 1 Mb**

**Multi-Chip Design Support for up to 8 Users**

**TNIX Operating System**

The Tektronix 8560 is a multi-user software development system. When used in conjunction with an 8540 Integration Unit, the 8560 provides facilities to support the entire microcomputer design process from software development through hardware/software integration. At the same time, it allows maximum design flexibility by supporting a broad range of 8-bit and 16-bit chips. The 8560's multiuser capability offers numerous advantages to the design team, such as lower cost per user, shared software and hardware resources, unified project management and enhanced security.

The heart of the 8560 is a minicomputer executing the TNIX\* operating system. The CPU is a DEC\*\* PDP-11/23 that operates in conjunction with two I/O processors for high performance throughput. A separate board is included to control two spooling line printers. System memory is 256 kilobytes (expandable to 1 megabyte), and mass storage includes a 1 megabyte floppy disk (formatted) and a 35.6 megabyte Winchester hard disk. The I/O processors support baud rates up to 9600 bps, providing wide flexibility when interfacing with various terminals.

Software work stations each consist of a standard CRT terminal, with the Tektronix CT8500 being recommended. In this manner, the system's software development capability can be expanded by simply adding terminals. Possible integration stations include a Tektronix 8540 Integration Unit, which has built-in, high-speed serial communications with the 8560, or an 8550 Microcomputer Development Lab.

For added flexibility, the 8560 can be configured with 8540's and 8550's in several different communications modes. The 8540 can be connected in-line with a terminal to a single 8560 port, or without a terminal to a separate port. In either configuration, a user can control any 8540 in the system including several units at the same time. In addition, it is possible to use many of the 8560's powerful command resources when debugging with the 8540. This includes the ability to use the 8560's hardware and software for I/O simulation in the early stages of debugging.

The 8560 will support up to two line printers, with the Tektronix 4643 being recommended. The line printers operate in the spooling mode, so users' terminals are still operable while printing.

\*A trademark of Tektronix.  
\*\* Digital Equipment Corporation

## TNIX Operating System

Running under the TNIX operating system, the 8560 can include a wide variety of software design tools offered by Tektronix. These include macro assemblers and compilers for both 8-bit and 16-bit chips; linkers/loaders to combine object files into executable object code; and several types of editors including an advanced screen-oriented version. Also there is a text processing package that can be a valuable aid to software documentation, and a number of utility packages to expand system capabilities in various ways.

The 8560's TNIX operating system was derived directly from Bell Laboratories' UNIX Operating System; an operating system that has gained widespread acceptance throughout the computer world. TNIX takes all the proven advantages of UNIX and applies them directly to the specific tasks required during microcomputer design.

TNIX includes a hierarchical file management system that greatly enhances the ease and speed of file operations. It is organized with a "root" directory on top and descending levels of subdirectories underneath. Each level may contain either files or directories that point to more files on a lower level.

TNIX also provides a sophisticated system of read/write protection that guards user material but retains the interfile access needed to enhance productivity. Each user can specify read, write, or execute protection on any of three levels: a user, a group of users, or all users. In this way files can first be completely protected while under initial development, then released to those working on related sections of the program, and finally released to the entire project after debugging is completed. To enhance communication between users, TNIX includes a system of electronic mail that lets team members send messages to one another. It also allows direct communication between two users at separate terminals, plus the ability to broadcast a single message to all terminals. These various communications modes can be a valuable asset to both team members and team management.

## Powerful Command Structures Simplify Software Development and Integration

TNIX uses an extremely flexible command structure, one that permits effective programming at the expert level as well as the beginner level. In all cases, TNIX commands let the user concentrate on software design instead of system manipulation. One simple but very powerful TNIX command operation is pipelining. It permits the output of one command to act as the input to another. At an even higher level of refinement, TNIX permits the construction of intelligent command files that perform varying functions depending on the number or value of parameters being passed.

Other TNIX command features include keyboard read-ahead which lets the user type in commands as fast as possible, without waiting for previous commands to finish. Another time saver is multitasking, which lets the user concurrently run several jobs that may be at different levels of priority. For instance, a compilation could be detached and run in the background while the user started to edit a new source file. This feature saves time while making more intelligent use of the system's resources.

To minimize system learning time, TNIX includes a special user interface called GUIDE, that combines the best features of both menu-driven and command-driven systems. GUIDE lets the user select any system operation from a menu display, and then automatically performs the operation. At any time, the user can exit from GUIDE and escape back to TNIX and its direct entry command format. This way, the user can employ the menu as a learning tool, but is able to depart to the regular TNIX command format for more sophisticated operation.

## Automatic Module Combination Cuts Complexity

During debugging, software modules that exhibit defects must have corrections entered into their original source code files. Before debugging can resume, all files affected by the changed source modules must be recompiled or reassembled into new, updated object code modules. Otherwise, new and old versions of the interdependent object modules will be mixed.

TNIX includes a special feature called "Make" that uses a control file to oversee the modular combination process and ensure that all modules are the most recent version when combined for execution. "Make" can cut recompiling or reassembling time to an absolute minimum by performing these operations only on files that actually require it.

## Advanced Software Development Tools

The 8560 Microcomputer Development Lab system offers a large selection of software development tools that can be run under TNIX. These include a variety of 8-bit and 16-bit assemblers with features such as macro capability, conditional assembly, and relocatable code. Also 16-bit compilers with features like structured constants, bit manipulation, and re-entrant code.

Other specialized tools include a loader/linker and a library generator. Also two types of editors, including an Advanced CRT-Oriented Editor that allows fast, efficient text manipulation at both the line and character level.

In addition, there are a number of 8560 system utility packages available that offer advanced support to microcomputer design projects. Among these are a text processing package that can be a valuable aid when documenting software, and a native programming package for developing your own 8560 software.

## Hardware/Software Integration

To handle hardware/software-designed integration tasks, the 8560 uses the Tektronix 8540 Integration Unit as a peripheral work station. Once code for the prototype has been assembled or compiled and linked into executable object modules, it is loaded into the 8540's program memory via a high-speed interface. The code can now be gradually introduced to the hardware using real-time emulation, a powerful debugging method that employs a processor identical in function to the one selected for the prototype.

Data captured by the 8540 during debugging and testing can be displayed on the console terminal, the line printer, or stored in an 8560 file for further processing.

Real-time emulation takes place in three progressive modes, all under the control of the 8540's debug software. During the first mode, all code is executed out of the 8540's program memory, with I/O simulated by software insertions that use 8560 peripherals or files for input and output. In this manner prototype software debugging can begin even before the hardware becomes available. During the second mode, I/O and clock functions are transferred from the 8540 to the prototype, and code can be mapped over to the prototype memory in manageable blocks as it is debugged. A control probe now connects the emulator processor to the vacant processor socket on the prototype board. During the final mode, all code is installed in the prototype memory, as well as clock and I/O functions. Through the control probe, the 8540 now exercises prototype hardware in the same manner that it will function when standing alone.

During all three modes of emulation, the 8540's powerful debug software can be applied. Breakpoints can be set using mnemonic symbols for key program locations. The status of processor registers can be examined on a cycle-by-cycle basis. All registers and memory locations can be examined and modified. And for detailed analysis of real-time execution on the prototype bus and selected hardware points, an optional Trigger Trace Analyzer is available with four trigger channels that allow highly selective data acquisition.

For added power during debugging, the 8540's resident command set is also included as part of the TNIX command set. This allows the full range of TNIX command manipulation features to be applied to 8540-based operations. It is even possible to intermix conventional TNIX and 8540 commands in a single command line.

## CHARACTERISTICS ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: +10°C to +40°C. Storage: -10°C to +65°C.  
**Relative Humidity** — Operating: 20% to 80% (noncondensing). Storage: 10% to 80% (noncondensing).  
**Temperature Rate of Change** — Operating: 1°C/5 minutes maximum. Storage: 24°C/hour maximum.  
**Operating Altitude** — Sea level to 2500 m (8,000 ft). Derate maximum temperature by 1°C for each 300 m above 2400 m.  
**Storage** — Sea level to 12 200 m (40,000 ft).  
 Static Discharge Operating — 0 to 12.5 kV without effect on equipment operation. 0 to 12.5 kV without hard failures.

## AC POWER

**Line Voltage Ranges** — 115 V ac (90 to 132 V RMS); 230 V ac (180 to 250 V RMS).  
**Line Frequency Range** — 48 to 66 Hz.  
**Power Consumption** — 430 W maximum.

## PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	282	16.8
Height	267	10.5
Depth	646	25.4
Weight	kg	lb
Net	33	72.5

**Order 8560 Multi-User Software Development Unit ..... \$28,000**

## OPTIONAL ACCESSORIES

**Flex Disks** (box of 10). Order 119-1182-01 \$175  
**RS-232 Connecting Cable** (15 ft).  
 Order 012-0757-00 ..... \$140  
**HSI Connecting Cable** (8 ft/2.4 m).  
 Order 012-1009-00 ..... \$55  
**HSI Connecting Cable** (20 ft/6.1 m).  
 Order 012-1008-00 ..... \$90  
**HSI Connecting Cable** (50 ft/15.2 m).  
 Order 012-1007-00 ..... \$125  
**HSI Connecting Cable** (250 ft/76.2 m).  
 Order 012-1010-00 ..... \$395



**Block Diagram**

As shown in Figure 1, a block diagram of the 8540, the complete operating system and system diagnostics are contained in 112 kilobyte PROM/ROM memory. The operating system is loaded from PROM and executed in the 64 kilobyte system memory. User symbol table information is also stored in system memory.

Part of the 8540 memory system also contains a non-volatile EEPROM buffer to store command strings and operating system update information. Complex and repeated command sequences can be permanently stored and then recalled by employing one user-definable string name. The EEPROM is also used to store update information for operating system maintenance.

The 8540 includes 32 kilobytes of static program memory for use by the emulator processor. The static program memory can be expanded to 256 kilobytes and with the optional Memory Allocation Controller, segments of this memory can be mapped anywhere in the emulator processor's address range.

Figure 1. 8540 Block Diagram  
Note: Dashed lines indicate optional equipment.

**8540**

**Multiple Microprocessor Support**

**Real-Time Emulation**

**Trigger Trace Analysis**

**8560 Compatible**

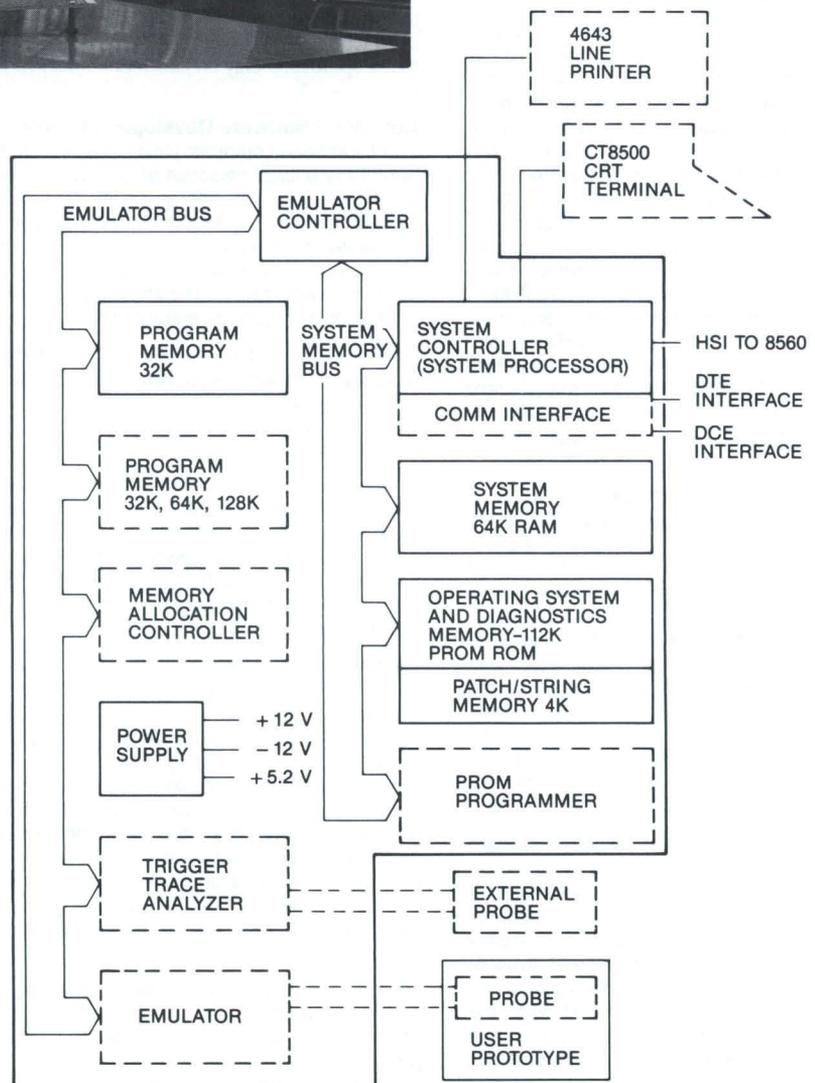
The Tektronix 8540 Integration Unit is used with a 8560 Multi-User Software Development Unit or a general host computer, to integrate, test and debug microprocessor-based software. The 8540 supports the hardware and software integration phase of a microprocessor/microcomputer based design. The Tektronix 8560 or other host computer supports the software development task.

**Application**

8540 support is employed when the software has been developed to the object code level and is ready to be tested with the hardware. The object code binary program is downloaded to the 8540 and stored in its resident program memory or, if available, in the prototype's own memory. If the prototype hardware is not available, the software can be executed on the 8540 emulator processor using Mode 0 emulation.

A wide variety of emulators are available for in-circuit testing and debugging. For in-circuit testing, the emulator probe replaces the microprocessor chip in the prototype. In emulation Mode 1 or Mode 2, the software can interact directly with the prototype hardware.

The designer controls and monitors the testing process via a CRT terminal like the Tektronix CT8500.



**8540/8560 SYSTEM CONFIGURATIONS**

**Local Interface Configuration**

The 8540 Integration Unit connects to the 8560 Multi-User Software Development Unit via a high speed serial interface (Figure 2). Interconnecting cable lengths of up to 2,000 feet can be accommodated without performance degradation. A specialized interface protocol is used between the 8540 and the 8560 to eliminate any errors that might occur in the transmission process.

**Operating Modes**

The Tektronix CT8500 CRT Terminal (or a user supplied RS-232 terminal) is the user's interface with the 8540/8560 system. 8540/8560 commands that are entered from the terminal are routed first to the 8560. The 8560 processes each command line and routes 8540 commands to the appropriate 8540. This allows commands to be intermixed on a single line and also gives the user the ability to control any 8540 (or several 8540s) in the system. (The 8540 can be configured to operate through a separate 8560 port with no terminal attached.) A local mode is also available so a user can communicate directly with the 8540.

**8540 (With Option 01 Communications Interface) Host Computer Configuration**

The 8540 Integration Unit is interfaced to a host computer via an RS-232 serial port on an Option 01 Communications Interface. Data bytes are ASCII encoded and transmitted asynchronously at speeds up to 9600 baud between the 8540 and the host computer. For location interface configurations (up to 50 feet), the 8540 can be hardwired directly to the host computer using a standard RS-232 cable (Figure 3a). For remote configurations (more than 50 feet) the 8540 interfaces to the host computer via a data set arrangement (Figure 3b). Data sets can connect over moderate distances using dedicated lines or virtually unlimited distances with conventional phone lines.

The 8540 can communicate with a host computer in several modes including:

**Local Mode** — In this mode the terminal communicates directly with the 8540 operating system to control the emulation and debugging process.

**Terminal Transparent Mode** — In this mode the terminal communicates with a host computer using standard protocol; keyboard data is transmitted to the host and host data is displayed on the terminal's display screen.

**Formatted Upload/Download** — In this mode, microprocessor object code is transferred between the host computer and the 8540 program (emulation) memory. Binary data is encoded into Extended TEKHEX format and transmitted in message blocks. Checksum information is also included in the message blocks to allow detection of communication errors.

Details of TEKHEX encoding and protocol are included in the 8540 System Users Manual.

**Emulation Support**

When a program is ready for testing, the object module is downloaded from the host computer (or 8560) into 8540 emulator memory. When a symbol table is included with the object module, it is also downloaded and stored in a separate portion of system memory. Program symbols can then be used to reference memory locations instead of the absolute addresses.

The object code is now executed by the emulator processor under control of the 8540 debugging system. Trace displays to the screen (or line printer) show all pertinent information including instruction mnemonics, processor status and any program symbols. The user can set breakpoints to stop in critical sections or use the trace display to show selected instructions or address ranges.

Three progressive emulation modes are available in the 8540. In the first (Mode 0) the 8540 supplies all memory, clock, and interface signals to the emulator processor. No prototype hardware is required. In the second (Mode 1) the clock and interface signals are provided by the prototype hardware. The emulator processor connects to the prototype microprocessor socket via the prototype control probe. The program under test still resides in the 8540 but as debugging progresses, it can be gradually transferred (mapped) over to the prototype's memory. In the third (Mode 2) all of the program is transferred to prototype memory. The 8540 still maintains control of program execution through the debugging system. For more specific emulator support information, refer to the appropriate data sheet for each (supported) emulator.

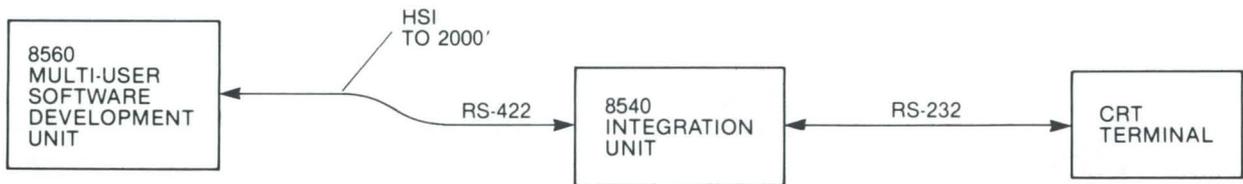


Figure 2. HSI Configuration

**Diagnostics**

The 8540 has a complete diagnostic subsystem. On each power-up cycle, diagnostic firmware checks the basic 8540 operation before leaving the operating system. In addition, a complete diagnostic system is available for an extensive system verification (including all options) and to perform board level fault isolation for quick on-site repair.

**Trigger Trace Analyzer**

The Trigger Trace Analyzer (TTA), optional equipment for the 8540, is a powerful debugging tool. It monitors program flow in realtime and allows sophisticated control and analysis of the emulator processor. The TTA stores program information in a high-speed 255-event buffer. Each event contains 62-bits of information including: up to 24-bits of address and 16-bits of data; up to 14-bits of processor information, and 8-bits of external probe information. TTA information is displayed on the terminal in processor specific mnemonics along with all pertinent register and flag information.

**PROM Programmer**

The PROM Programmer, optional equipment for the 8540 is a general purpose controller unit with plug-adaptor modules. Each module supports a group of similar programmable devices. Functions include: Read, Write, and Compare.

**CHARACTERISTICS**

**Operating System (Software)** — DOS/50 derivative (contained in 8 k PROM/ROM's) i.e., 88 k bytes, command interpreter and kernel 24 k bytes diagnostics; 4 k bytes patch and command storage (EEPROM).

**Card Slot Usage**

- Standard Boards
- System controller
- Emulator controller
- System memory (64 k RAM)
- Program memory (32 k RAM)
- System memory (240 k PROM/ROM capacity)

**Empty Board Slots —**

- System side: 1 slot
- Program side: 11 slots

**I/O Ports** — J100 (8560 Interface); J101 (remote DTE male); J102 (remote DCE female); J103 (Line Printer, Aux); J104 (Terminal).

**I/O Port Data Rates** — J100 (HSI) = 153.6 k baud. J101, J102, J103, J104 = 110/ext CLK, 150, 300, 600, 1200, 2400, 4800, 9600 baud.

**Reliability**

- MTBF — 6700 hour (calculated).
- MTTR Board — 0.5 hour.
- MTTR Component — 1.5 hour.

**Standard Compliance** — UL 1244; CSA Bulletin 556B; IEC 1348.

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature Ranges**

Operating — 0°C to +50°C (+32°F to +122°F).  
Storage — +55°C to +75°C (+67°F to +167°F).

**Altitude Range**

Operating — Sea level to 4500 m (15,000 ft).  
Storage — Sea level to 15 000 m (50,000 ft).  
Humidity — 0 to 90% noncondensing (0°C to +50°C).

**AC POWER**

**Nominal Operating Voltage** — 115 V ac and 230 V ac at 60 Hz.

**Power Requirements** — 700 W maximum.

**Line Voltage Ranges** — 90 to 132 V ac and 180 to 250 V ac.

**Line Frequency Range** — 48 to 66 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet	
	mm	in
Width	430	17
Height	280	11
Depth	585	23
Weight	kg	lb
	Net	26
Shipping*	35	77.5

**Cabinet Color** — Three tone; ivory/gray, smoke tan, earth brown.

\* Standard configuration only, no options.

**RS-232 Communications Interface**

**Option 01** — Interface signals are routed to and from the 8540 system controller board via rear panel connectors J101 (male) and J102 (female). Table 1 lists the J101/J102 pin numbers and corresponding signal names and descriptions. Baud rate on transmitted data and received data is selectable from 110 to 9600 baud. All signals are RS-232C compatible.

**Table 1**  
**Interface Signal (Option 01, Communications Interface)**

Signal Name	Circuit	J101 DTE	J102 DCE	Pin
GND	AA	Protective ground	Protective ground	1
Tx	BA	Out	In	2*1
Rx	BB	In	Out	3*1
RTS	CA	Out*2	In*3	4
CTS	CB	In*4	Out*5	5
DSR	CC	In*6	Out	6
GNC	AB	Signal ground	Signal ground	7
DCD	CF	In*7	Out	8
DTR	CD	Out	In*8	20

- \*1 Selectable, 110 to 9600 baud.
- \*2 DTE 1, DTE 2 modes; goes high when data to send.
- \*3 DCE mode; must be high before 8540 accepts data.
- \*4 DTE 1 mode; must be high before 8540 sends data.
- \*5 DCE mode; goes low when 8540 sends data.
- \*6 DTE 2 mode; must be high before 8540 sends data.
- \*7 DTE 1, DTE 2 mode; must be high before 8540 accepts data.
- \*8 DCE mode; must be high before 8540 sends data.

**Order 8540 Integration Unit ..... \$11,000**

**OPTIONAL ACCESSORIES**

- Flex Disks** (box of 10), Order 119-1182-01 ..... \$175
- RS-232 Connecting Cable** (15 ft) .....
- Order 012-0757-00 ..... \$140
- HSI Connecting Cable** (8 ft/2.4 m) .....
- Order 012-1009-00 ..... \$55
- HSI Connecting Cable** (20 ft/6.1 m) .....
- Order 012-1008-00 ..... \$90
- HSI Connecting Cable** (50 ft/15.2 m) .....
- Order 012-1007-00 ..... \$125
- HSI Connecting Cable** (250 ft/76.2 m) .....
- Order 012-1010-00 ..... \$395



Figure 3a. Direct RS-232 Configuration

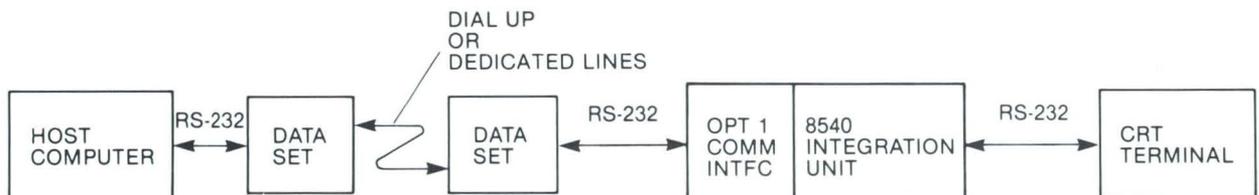
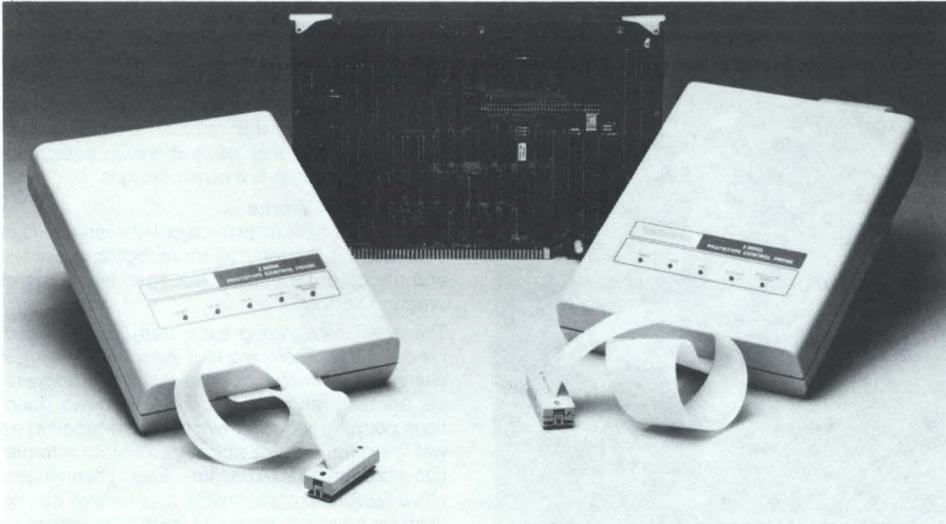


Figure 3b. Data Set Configuration



**Emulator Processor and Prototype Control Probe Support Packages**

The 8500 Microcomputer Development Lab family supports a wide variety of different microprocessors and microcomputers.

**Emulators**

Emulator packages may be ordered as systems options. These options provide capabilities necessary to fully emulate the target microprocessor in a user's prototype system.

The emulator processor, which resides on a plug-in circuit module along with controlling logic circuitry, enables the user to execute and debug the program on a microprocessor identical to the one which will be used in the prototype, while giving him access up to 256 kilobytes of Microprocessor Lab program memory.

Software execution is performed under control of DOS-50 in the 8550 system, and under control of TNIX in the 8560 system. During software development, DOS-50 allows the creation of a tree-like file structure with subdirectories to whatever nesting level a project requires. When converting source code to object code, it provides complete supervision of assembly or compilation procedures. During hardware/software integration, DOS-50 handles prototype execution monitoring and debugging operations. It also takes care of general I/O, intersystem communications and PROM programming.

TNIX, the operating system used in the 8560 system uses timesharing to apportion system resources among up to eight work stations plus system utilities. A hierarchical-type filing system is used that groups files and directories logically. Each file carries a date/time attribute to help confirm that the proper version is being accessed. A security system allows password protection, multiple-user file access, and work copies according to current project needs.

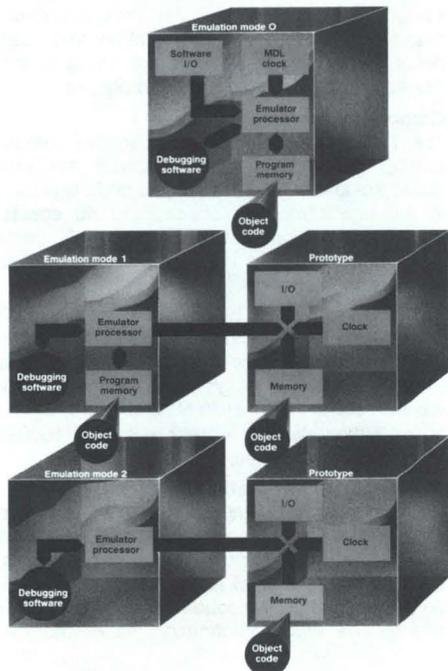
**Probes**

The prototype control probe connects the emulator processor card to the prototype microprocessor, and allows a designer to transfer program control in three stages from the 8550 or 8560/8540 Microcomputer Development Lab to the prototype.

All emulation operations are controlled by the powerful Microprocessor Lab system software. The user is able to monitor program execution, set software breakpoints, examine and change memory and register contents. Debug trace information is displayed in a format unique to the microprocessor, with instruction fetches disassembled into mnemonics for easy interpretation.

**Three Emulation Modes**

Once an object code file has been created, the program may be exercised in system Mode 0. During execution, program steps can be traced, hardware breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the text editor. Object code can then be reassembled and re-executed. This procedure continues until the developmental software program is complete and can be executed without errors.



After the developmental software has been debugged, it may be exercised on the prototype circuitry (Mode 1). During partial emulation, control may be released in stages to the prototype. Developmental software is sequenced using the emulator memory space and the prototype I/O and clock. The memory mapping feature allows code to be gradually mapped over to the prototype's memory in blocks. Throughout partial emulation, the program designer has access to prototype circuitry. This access enables the examination and changing of memory and register contents, hardware tracing, and setting of breakpoints.

In full emulation, Mode 2, the developmental software program is run on the prototype, but program execution is still under the complete control of the 8550 Microcomputer Development Lab or 8540 system. All I/O and timing functions are directed by the prototype and all memory has been mapped over to it. The Prototype Control Probe is connected and still emulating the prototype microprocessor. Although the prototype is effectively free-standing, the designer may still direct program activity from the console terminal.

**PROM Programmer**

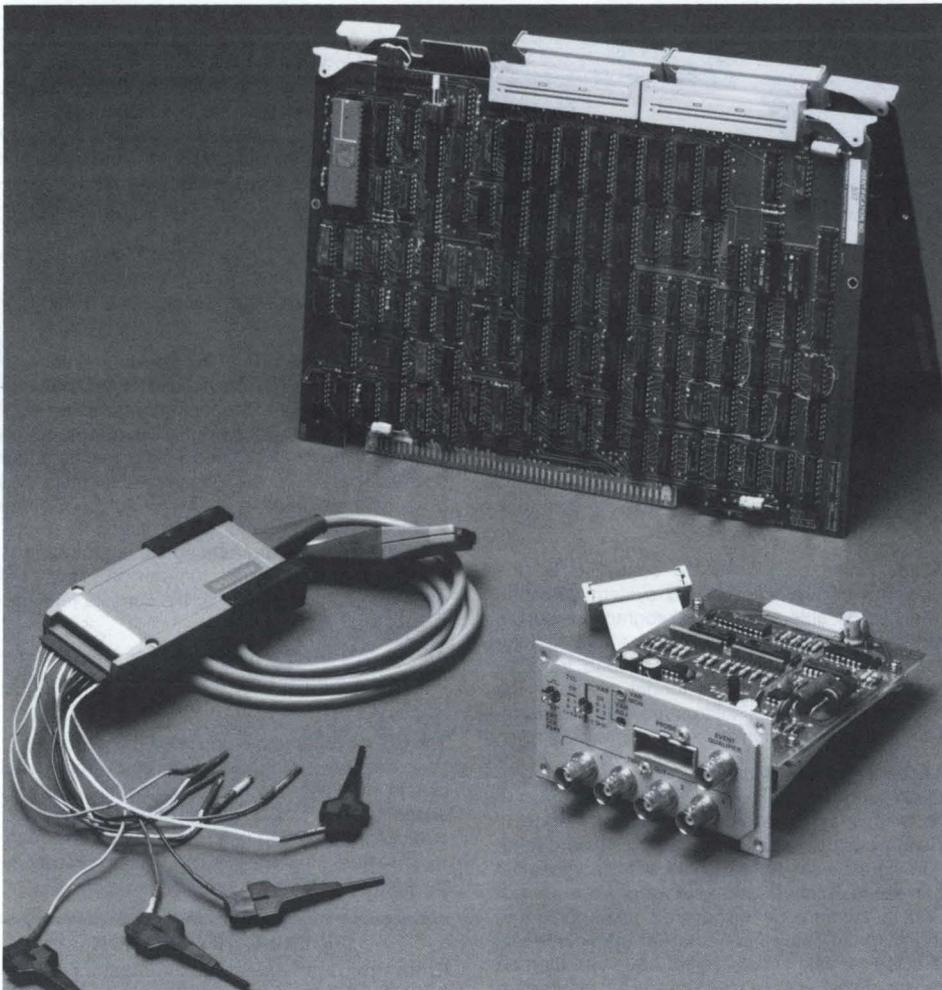
An optional PROM programmer is available for use with the 8550 MDL and the 8540 Integration Unit.

The PROM programmer includes the general purpose controller board and a series of front panel plug-in modules. Each plug-in module provides support for a similar group of PROM devices, and can be changed in a few seconds. Programming features include reading, writing, and comparing (for verification) a PROM.

**ORDERING INFORMATION**

Prom Program ..... \$2000  
Option 30 Controller ..... \$2000

PROM MODULE	DEVICE	MANUFACTURER
Option 31	TMS 2508	TI
	2758	Intel
	2758 51865	Intel
	TMS 2516	Intel
	2816	Intel
	TMS 2532	TI
	2732	Intel
	2732A	Intel
Option 32	MCM 68764	Motorola
	MCM 68766L35	Motorola
	8755A	Intel
	8748	Intel
Option 33	8749	Intel
	8741A	Intel
	2764	Intel
	27128	Intel
	2817	Intel
Option 35	TMS 2564	TI
	8751A	Intel



**TRIGGER TRACE ANALYZER**

**The TTA**

The Trigger Trace Analyzer, or TTA, is the fundamental debug and integration tool in the 8500 family. This two-board package works with emulators inside the 8550 or 8540 mainframe to provide the user with unprecedented control over software execution. The TTA is a universal tool, supporting most of the 8-bit and 16-bit emulators in the 8500 family.

**Interactive Control of Software Execution**

The TTA opens a kit of powerful tools for the user. Conventional breakpoint and trace functions are just the beginning. The programmer can trap read, write, or execute accesses to any part of memory, break when a subprogram has been called in a particular sequence, and track register contents while uninvolved instructions execute at full speed.

The bus cycle recording capabilities of the TTA permit tracing of instructions while the microprocessor runs at full speed. Trace qualification hardware gives the user the power to specify what cycles should be recorded, so an entire program execution can be recorded, for instance, as a list of call instructions.

In addition, the TTA's performance analysis capabilities can identify code "hot spots", recognize unused sections of code, measure the time nec-

essary to traverse a routine, or even dynamically monitor the growth of a list or a stack.

All of these capabilities, of course, use Tektronix' symbolic debug system, so that the programmer may work with source code symbols and need never grope through linker listings trying to find hex addresses or misplaced subprograms.

**Complete Transparency**

The TTA provides all these capabilities without making demands on the prototype. No wait states are inserted by the TTA, no code is placed in the user's memory space, and no special hardware provisions are required. Like Tektronix emulators, the TTA is completely transparent to the customer's design.

When working with 16-bit chips that feature multiple address spaces, the TTA distinguishes between the spaces. This means, for instance, that the Motorola 68000 programmer can set a hardware breakpoint at location 5000 in User Program space without causing a break at location 5000 in System Program space.

**A Network of Integration Tools**

By using its four trigger outputs and nine pattern/qualifier inputs, the TTA can work in a network with other digital measurement tools, such as the DAS 9100 family, and with conventional or digital oscilloscopes. This ability to send and receive trigger information makes the TTA

the center of a network of integration tools, permitting microprocessor, peripheral, and outside analog measurements from a variety of instruments to be correlated.

Only this level of integration support makes it practical to debug the complex systems of processors, peripheral chips, and analog equipment that occur so often in modern designs.

**How the TTA Works**

The TTA consists of two major subsystems. One subsystem is responsible for recognizing events, and the other for making real time recordings of program activity.

The event recognizing subsystem is a group of precise tools. There are four independent trigger channels. Each channel can recognize addresses, address ranges, or address windows (functions normally requiring two separate triggers) as well as data, control signals, and state information from the other channels. Each channel also has a flexible, programmable counter that can be used for counting, timing, or linking the events as they are detected. The channels may be linked in and, or, or sequence configurations to meet nearly any triggering need.

Real time recording is provided by a 255 word by 62 channel high-speed recording buffer. The record may be frozen by an event channel, so that a sequence of instructions can be recorded at full prototype speed, and then held for examination after the prototype has reached a safe stopping place. In addition, the buffer can be set to record only on command from one of the event channels, permitting a long prototype run to be condensed to a trace of the crucial events.

Working together, the tools in the TTA provide debug and integration capabilities never available in one system before the introduction of the 8500 family.

**TEKTRONIX EMULATION SYSTEMS**

**What is Tektronix Emulation, Exactly?**

Not surprisingly, every manufacturer tries to define emulation in terms of the capabilities and limitations of their own product. Unfortunately, this has led to some rather distorted views of what emulation is, and what it is for.

Tektronix has a simple, comprehensive view of emulation. Emulation is the technique of controlling the microprocessors in a device so that software execution may be observed and controlled. Emulation is accomplished by placing each microprocessor in a probe assembly, where it can be controlled by the development system without compromising the chip timing characteristics.

A Tektronix, we believe that emulation should be real time, transparent, and full-function. Real time means that the device under control runs at its intended clock speed with no wait states inserted by the development system. Transparent means that the device under control runs exactly the same way with the emulator as with the microprocessor itself. No added circuits, no "monitor" software, no compromises in chip timing at critical pins. Full-function means that all the features of the microprocessor, including interrupts, multiprocessing features, co-processing, and address space separation, are supported by the emulator.

## Tektronix Emulators

Tektronix offers emulators for most major 8-bit microprocessors and microcomputers. We set the standard for 16-bit emulation of the 8086, 8088, 68000, Z8001, Z8002, and 9900.

Each Tektronix emulator can execute code from program memory in the development system. Each provides hardware breakpoints, single-step, and trace capabilities. Each emulator can perform Service Calls (SVC's) which make the hardware resources and software tools of the development system available to user programs.

With these facilities Tektronix emulators provide a complete environment for software debug inside the development system. When the time comes to test software operation in the device under de-

velopment, Tektronix Prototype Control Probes extend the capabilities of emulators into the device.

### Prototype Control Probes

The Prototype Control Probe is the connection between a Tektronix emulator and the device under test. The probe replaces the user's microprocessor, extending all the emulator's debug capabilities to the device under test.

Via these probes, Tektronix emulators can execute code from the device under test, examine or change the device's memory contents, set breakpoints, trace program execution, and map portions of development system memory into the device's address space. Further, Tektronix 16-bit probes permit Service Calls to be performed from the device under test. This feature permits devel-

opment system resources to substitute for parts of a prototype system that are not available for testing. As an example, the winchester disk in the 8560 can be accessed from a prototype to simulate a prototype mass storage system still under development.

### The Systems

The Tektronix 8500 family provides microprocessor emulation in three formats for the three different kinds of design teams. In the 8550, emulators share a cabinet with software development facilities. This provides the most cost-effective packaging for teams in which several users do not need to work simultaneously.

In the multi-user 8560 environment, where several members of the team must be able to use the development system at once, emulation is provided in a separate cabinet, the 8540. This permits Tektronix emulators to be operated from any station in the system without tying up software development facilities.

For design teams that use mainframe computers for software development, the 8540 connects directly to the host computer to provide Tektronix emulation as a natural augmentation of the existing computer facilities.

### Emulation Accessories

Several accessories expand the emulation capabilities of the 8550 and 8540 systems. Additional program memory is available in 32, 64, or 128 kilobyte increments to accommodate large software modules. For two of the 16-bit emulators, the 68000 and Z8000, a separate memory controller permits the program memory to replace blocks of prototype memory over the chips' entire address ranges, in any of the chips' address spaces. This mapping feature makes it unnecessary to reassemble or relink code to fit it into a particular address range during debug.

Two logic analyzers, an economical Real time Prototype Analyzer for 8-bit microprocessors and the unprecedented Trigger Trace Analyzer for most 8 and 16-bit processors, extend the debug features of the 8500 family to meet the challenges of the most formidable software projects.

### The System Solution

A wide variety of emulators, mainframes to fit the needs of design teams, memory and analysis options together with the 8500 family emulation products, form a system that is cost effective for an individual project and flexible enough not to be outgrown.

**Table 2. TTA Command Set**

Command	Description
acq	Acquire Data: Controls data storage in the high-speed trace buffer; allows event four parameters to act as a storage qualifier when specified.
ad	Address Comparator: Programs address portion of each channel's word recognizer.
bre	Breakpoint Control: Halts TTA data acquisition when a specified channel's trigger output goes active; includes option to let prototype continue executing code.
bus	Bus/Control Signals Comparator: Programs control bus portion of each channel's word recognizer; specific control signal mnemonics supplied with each emulator package.
cons	Detect Consecutive Cycles: Specifies sequence in which trigger channel events must come true to cause a data acquisition trigger; selects type of bus cycle to be used.
cou	Counter Programming: Determines counter value that will cause active counter output; includes increment/decrement select, counting source select, and reset function.
ctr	Counter Output Feedback: Programs counter output feedback portion of each channel's word recognizer.
data	Data Comparator: Programs data portion of each channel's word recognizer.
disp	Display Acquisition Memory: Displays acquired bus activity in disassembled mnemonics native to the emulator processor in use.
eve	Event Comparators: Single command allowing all of a channel's word recognizer values to be programmed at once.
pro	External Probe Input Comparator: Programs probe input portion of each channel's word recognizer (8 bits).
qua	External Qualifier Comparator: Programs external qualifier portion of each channel's word recognizer (single bit received via BNC input).
tclr	Clear an entire trigger channel (event, counter and breakpoint).
ts	Trigger Status Display: Shows all trigger information current programmed on each of the four trigger channels including breakpoint status.

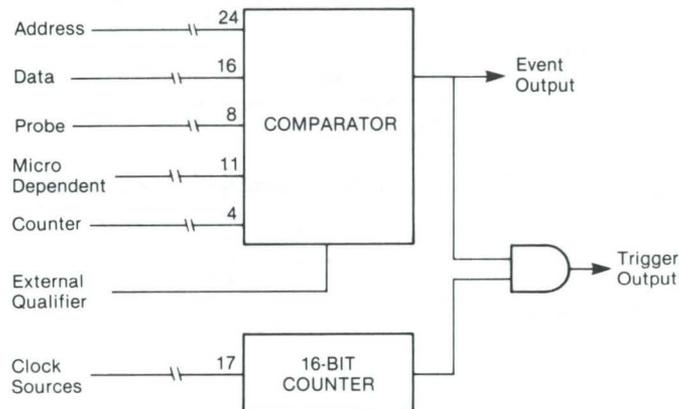


Figure 1. TTA Channel Configuration

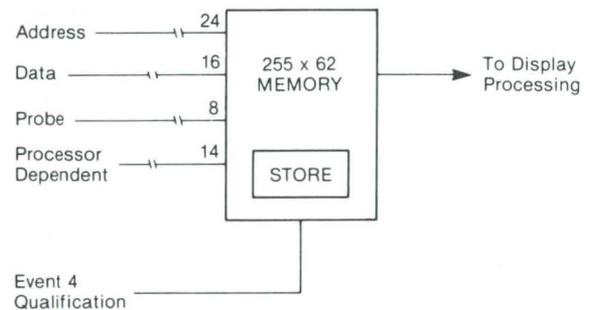
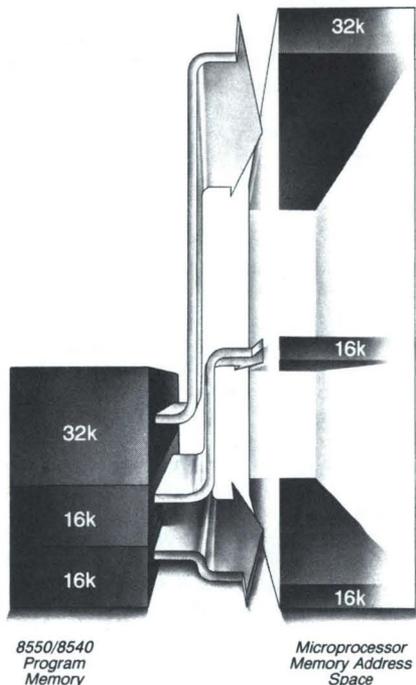


Figure 2. TTA Acquisition Control

**The Memory Allocation Controller**

The Memory Allocation Controller is an option to be used with the 68000 and Z8000 support packages. It allows full support of these processors' address ranges, as well as support of the six address spaces of the Z8000 and the four address spaces of the 68000. Memory is allocated in 4 k blocks over the entire address range, and can also be allocated as existent and nonexistent, in which case any read or write to nondefined memory will be flagged as an error condition.

The 8086 emulator supports the full 1 megabyte address range without this option.



Memory Allocation allows program memory to be assigned to different logical addresses within the microprocessor address range.

**SOFTWARE TOOLS**

Tektronix offers a variety of software tools for the microprocessor design development cycle, including:

- A Language Development System, LANDS, on the 8560, which provides an integrated set of tools from code entry through debugging.
- Editors for Data Entry: A screen (CRT)-oriented editor, in addition to the standard line-oriented editor.
- High-level-language compilers, Pascal and MDL/μ specifically designed for microprocessor applications.
- Assemblers support for a wide range of microprocessors to translate assembly language programs into relocatable object modules.
- A powerful linker to merge the object modules and a library generator to create and maintain object module libraries are standard with the operating system.

**LANDS**

The Tektronix Pascal Language Development System, optional software for the 8560, provides an integrated set of language development tools. The Language-Directed Editor (LDE), the Pascal Compiler with an Integration Control System (ICS), and Pascal Debug (PDB) are tools that support your design effort, from code entry through debugging.

**Language-Directed Editor**

The Language-Directed Editor (LDE) for Pascal, eases editing of programs written in the Pascal language. The LDE combines text manipulation functions of a general purpose editor with the syntax-checking function of a compiler.

LDE is tailored to the syntactic structure of the Pascal language, allowing more productive editing of Pascal programs than a general purpose editor. The Parse command checks the syntactic validity of the text entered, saving you repeated compiler passes for syntax checking.

The LDE provides an auto-indentation at the time of text entry by remembering the level of indentation of the previous line. Language-Directed Editing provides a generic key to facilitate entering Pascal's reserved words. When the generic key is entered during the typing of a Pascal reserved word, the LDE completes the text entry of that word, reducing spelling errors and typing effort. For example, if you type "PROC" or "PR" and then enter the generic key, the work "Procedure" is entered into the text.

As a screen-oriented process, LDE displays a screenful of text in your file, allowing you to view the text surrounding the point of editing that is indicated by the cursor. The terminal screen serves as a window into the file where you can insert or modify text. The text is automatically scrolled up or down through the display window as the cursor is moved with the cursor movement keys. New text can be entered at the position of the cursor by simply typing in characters. LDE commands, implemented by programmed keys on the keyboard are available to modify or delete text.

**LANDS Pacal Compiler**

Pascal, high-level programming language, is receiving much attention in the electronics industry. Features, such as program structure, strong data typing, and readability, greatly enhance programmer efficiency, and thereby reduce software development and maintenance costs.

The Tektronix Pascal Compiler implements the proposed ISO Standard Pascal, with microprocessor application extensions. A true compiler rather than a P-code interpreter, the Pascal Compiler generates object code for the targeted chip directly. Each program statement is translated to machine code only once instead of every time the statement is executed, resulting in faster and often more compact code. LANDS Pascal on the 8560 is currently targeted for the 8086/8088 and Z8001/Z8002 chips.

**Standard Pascal Feature**

Pascal is a block-structured language that allows the program to be divided into subprograms called procedures and functions. This block structure encourages programmers to logically plan and construct programs, so debugging time is greatly reduced.

Pascal's control structures correspond closely with flowchart elements and make algorithm coding very natural. All control structures have a single entrance and exit, so program modifications are unlikely to introduce errors into the program.

Pascal allows programmers to use many flexible forms of data representations and to define data types that accurately express their particular problems. Tektronix Pascal allows all standard data types: integer, real, character, Boolean, enumerated, set, array, record, file, and pointer.

Pascal programs are easy to read, and thus to maintain. Pascal allows extra spaces, tabs, and carriage returns almost anywhere, so indented spaces can be added to make the program more readable. Variable, procedure, and function names can be meaningful and easily understood because they are not restricted in length.

**Tektronix Pascal Extensions**

Extensions have been added to the standard Pascal to assist in microprocessor applications.

**Separate Compilations**

The Tektronix Pascal Compilers support separate compilations. The main program module's first word is the keyword Program. Submodules to be separately compiled begin with the keyword Module.

Global variables, procedures, and functions can be referenced between separately compiled Modules and the main Program via Public and Extern attributes.

**Linkage with Assembly Language Modules**

Speed-critical or timing-critical applications may require some program segments to be written in assembly language. Because the code generated by the Pascal Compiler is compatible with the Tektronix-Linker, assembly code can be linked to Pascal code.

**Interrupt Handling**

Tektronix Pascal allows full use of the microprocessor interrupts. You can specify the procedure to be executed for an interrupt routine with the Interrupt attribute in the procedure heading.

**Input/Output**

Tektronix Pascal allows full use of the Chip I/O. The Port and Origin attributes can be used to locate a variable at a given I/O port or memory location.

**Nondecimal Integers**

In many microcomputer applications, programmers want to use nondecimal integers. The Pascal Compiler supports binary, octal, and hexadecimal integers for input and output.

**Bit Manipulation**

To allow bit manipulation and masking, Boolean operators can be used with integers in the Tektronix Pascal.

**Compiler Directives**

Tektronix Pascal recognizes a set of compiler directives to format the listings, include external files, and generate a pseudo-assembly language listing of the object code produced by the compiler.

**Integration Control System**

Included with the LANDS Pascal is a software program, known as the Integration Control System (ICS), that simplifies the integration of your Pascal program to your particular hardware configuration. With Pascal, there is no direct way to specify implementation-specific requirements such as interrupt vectors, restart routines, or memory configuration. The ICS allows the programmer to specify such configurations and create the necessary assembly language routines and linker commands automatically.

ICS allows the user to configure the program to run on his prototype after the source program is compiled and checked. Changes in the hardware configuration do not require recompiling the source programs.

**Pascal Debug**

The Tektronix Pascal Debug is a real-time symbolic debugging tool for programs that are written in Pascal. Pascal Debug (PDB) allows the programmer to use Pascal language constructs to examine and modify the program during execution.

With PDB, the programmer can debug his program without a detailed knowledge about the compiler-generated code, thus, extending the efficiency of coding in a high-level-language to the debugging cycle.

Pascal Debug, which runs on the 8560 Multi-User Software Development Unit, controls the program as it executes at full speed on the targeted emulator in the 8540 Integration Unit. Usable in any emulation mode, PDB generates 8540 commands to run the emulator. Any 8540 error messages returned are examined and, in some cases, repaired allowing the debugging session to proceed.

**Displaying/Modifying Variables**

PDB provides the programmer with a high-level-language interface to display and modify variables.

Variable modification commands in PDB are used to examine and change the values of variables. PDB allows the programmer to refer to the variables using the same symbolic names declared in the original source code.

PDB recognizes the same types of expressions as the Pascal compiler. General expressions are accepted as arguments for PDB commands.

**Controlling Program Execution**

PDB allows the programmer to control the execution of the program flow with breakpoints, single-steps of Pascal statements, returns to calling procedures, and program resets.

**Recording and Displaying Debug Information**

PDB has several commands to record and display important debugging information, including the trace command to trace previous calls; TB (traceback) command to interpret the activation record list, in reverse order, the procedures called, displaying a traceback to the main program; and a Log command that records all PDB input and output to a file, so it can be reviewed and analyzed later.

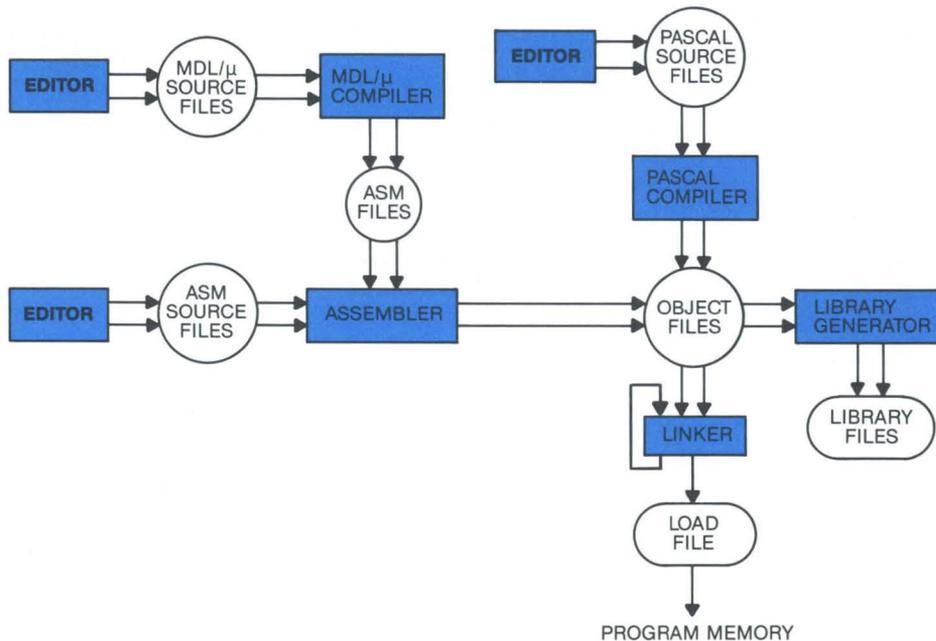
**EDITORS**

In addition to the Language-Directed Editor on the 8560 and the standard line-oriented editors, Tektronix offers ACE, an Advanced CRT-Oriented Editor. Optional software to both the 8550 and 8560, ACE eases program creation and editing tasks.

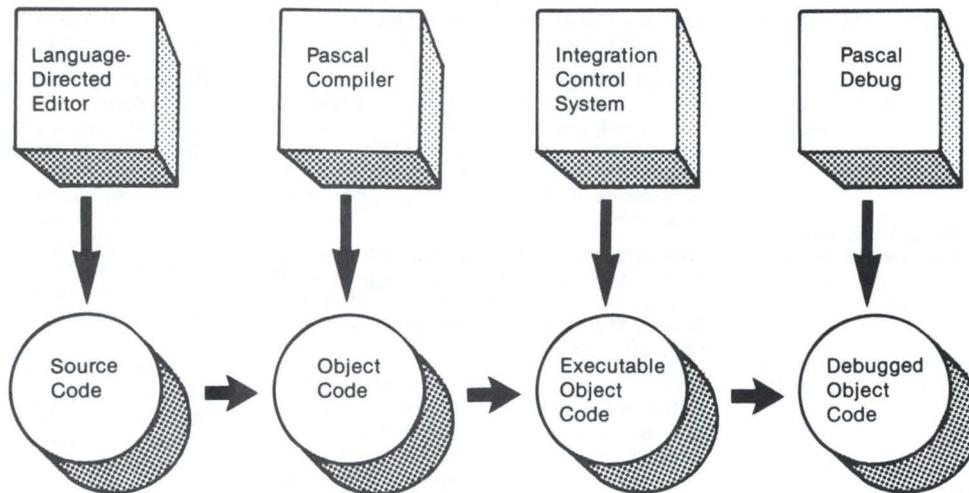
With the ACE Editor, programmers may conveniently view and edit the program text. A window, the CRT, shows the text surrounding the ACE Editor's pointer. The text can be edited either as a sequence of lines or a stream of characters.

**Screen Oriented Editing**

ACE divides the display screen of the CRT into two areas: a monitor area to display messages, and a window area to display text that is being edited. The window constantly shows the text surrounding the cursor, a visible pointer in the window area of the screen. The cursor is moved by the user to the specific character within the text where editing will occur. Text displayed in the window can be moved both horizontally and vertically to bring different parts of the file into view. After an edit command has been processed, the window will display the change(s) made to the text.



**LANGUAGE DEVELOPMENT SYSTEM (LANDS)**



*Pascal Language Development System (LANDS) — Together, the Language-Directed Editor, Pascal Compiler, Integration Control System and Pascal Debug provide the most efficient and productive environment for high-level language programming in microprocessor design.*

SOFTWARE DEVELOPMENT

**Character and Line Manipulation**

It is often desired to edit text at one place as a sequence of lines and at another place as a stream of characters. ACE is versatile, permitting both character and line manipulation. Character manipulation features allow the user to find, or find and replace, multiple occurrences of a character string, to insert or delete characters. Other character manipulation capabilities such as overtyping, copying from one position to another, and changing alphabetic character case can also be accomplished. Line manipulation features include insert and delete lines, move lines, split one line into two, and combine two lines into one. The operator can, at any time, use line-oriented commands.

During execution of ACE, the user may define, view and invoke macros. The use of macros allows the user to define a sequence of ACE commands that may be called many times during an editing session.

**Terminal Selection**

The advanced CRT-oriented Editor is configured to operate with the Tektronix CT8500 Terminal. For optimum performance and software support under the license agreement, Tektronix recommends the CT8500. ACE, however, may be configured to operate with alternate CRT terminals. Depending on the terminal functions, some degradation may occur. While ACE is designed to work with terminals of varying characteristics, Tektronix does not warrant or support ACE with terminals other than the CT8500.

The advanced CRT-oriented Editor requires 64 kilobytes of program memory for correct operation. At no time does the size of the workspace affect the size of the file that can be edited.

**COMPILERS**

**Pascal Compilers**

In addition to the LANDS Pascal on the 8560, Tektronix offers Pascal compilers for the 8086/8088 and 8080/8085 microprocessors on the 8550 Microcomputer Development Lab.

Both Pascals implement the proposed ISO Standard Pascal and are developed for microprocessors designed with the TEK Pascal extensions. The 8086/8088 Pascal includes the Integration Control System.

**MDL/μ Compilers**

An expanded form of ANSI Minimal Basic, the MDL/μ Compiler is a high-level language designed specifically for microprocessor-based product development. A system option available with the 8550 MDL, MDL/μ supports software development of the 8080A, the 8085A and the 8080A subset of the Z80 microprocessors. A second system option supports software development of the 6800, 6802, and 6808 microprocessors.

Like Minimal Basic, MDL/μ is easy to learn and use. Offering additional advantages such as increased flexibility in variable name and string definition, direct access to I/O ports and absolute memory addresses, MDL/μ also provides enhanced function, statement and operator capabilities.

The MDL/μ compiler produces executable, not interpreted assembly language code. Each program statement is compiled into machine code only once, instead of every time the statement is executed. Thus, fewer operations result in faster and often more compact code for final program execution.

MDL/μ makes possible a module-oriented approach to software development. The programmer may create user-defined libraries of assembly language code or may use routines from the MDL/μ support routine library. These callable routines are stored on flexible disks in object code and are brought into the main program at link time. All support routines except those relating to I/O activities are serially re-entrant; that is they use no temporary values other than those in the registers and on the stack. Register contents are saved when an interrupt occurs and restored when the interrupt is completed.

An additional feature of the MDL/μ compiler is that two statements, Uses and Provides, allow variables, functions and procedures to be shared by different modules of the main program.

**Tektronix offers service training classes on Microprocessor Development Labs. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.**

**Assemblers Support**

Tektronix Assemblers support software development for a wide range of microprocessors, thus allowing you the flexibility to choose the microprocessor best suited to your particular application. Each assembler also maintains identical operational characteristics for each microprocessor supported, greatly facilitating your ability to move from one microprocessor to another.

The assembler, which recognizes the instruction set, registers addressing modes, and full address space of the specific microprocessor, then translates assembly language statements into machine instructions (object code) for that microprocessor. However, the programmer may use the same assembler directives and advanced programming features, such as time-saving macros and language extensions, with every assembler.

Powerful macro capability enables the programmer to write a segment of source code only once, and call it up for in-line code expansion as often as required. Additionally, parameters can be passed to the macro, allowing a different sequence of code for each invocation.

Conditional assembly directives allow a sequence of source code statements to produce object code that varies according to conditions. For example, a statement or statements inside an IF block will be assembled if the operand expression with the IF directive is true. This feature serves to reinforce the macro capability, allowing the designer to customize the final program.

Other language extensions allow operand expressions to contain bit and string manipulations as well as standard arithmetic operations. Data constants may be entered as binary, octal, decimal, hexadecimal, or ASCII characters.

8550 Assembler Support: 8080A, 8085A, Z80, 6800, 6801, 6802, 9900, 9989, 3870, 3972, F8, 1802, 8048 Family, 8051, 6500/1, 6809, 8086, 8088, 68000, Z8001, and Z8002.

8560 Assembler Support: 8080A, 8085A, Z80, 6800, 6801, 6802, 1802, 8048 Family, 8051, 6809, 9900, 9989, 8086, 8088, 68000, Z8001, and Z8002.

**Linker**

The Linker merges one or more object modules into a load file that is suitable to load into the development system's program memory. The load file contains executable program instructions and data. The Linker assigns exclusive address ranges that each program section will occupy.

Any of the following attributes may be defined at link time: relocation type of a section, exact or approximate location of a section, global symbol values, and address of the first instruction to be executed. The programmer may specify simple linking operations with a single command line. Special or complex operations can be specified with a series of Linker commands from a command file.

The user can list the location of all global symbols and sections, section length, unresolved references, undefined symbols, and the transfer address.

**Library Generator**

The Library Generator is used to create and maintain object module libraries. Subroutines commonly used by one or more object modules may be stored in a library file. These subroutines are developed and assembled separately and the resulting object modules stored together in the library.

The Library Generator allows you to insert, delete, or replace object modules in the library. Any object module contained in a library can be individually accessed by the Linker. At link time, the Linker will insert in the load file the object module of any routine that your source program calls. The user can list defined and undefined global symbols in each module of the library.



**CT8500 TERMINAL**

The CT8500 Terminal is an optional peripheral recommended for use with the Tektronix 8540, 8550 and 8560.

The CT8500 can display a full 25 lines at 80 characters per line on its 12 inch diagonal display screen. A complete set of upper- and lower-case ASCII characters is provided. The green-on-black display with adjustable brightness level is easy to read and can reduce eye fatigue in extended use.

The detachable keyboard for the CT8500 Terminal is arranged in an office typewriter configuration to aid new user familiarity. Eight programmable function keys can be user-defined. Up to a 64-character command or character string can be generated with a single key stroke. The two page memory of the CT8500 allows buffering and scrolling of up to 4000 characters. Visual field attributes of blink, reduce, inverse, underline, and blank, as well as seven combinations of these attributes can be obtained. Alternative modes of operation allow the terminal to be used for local editing or to be controlled by a host computer using the many available remote commands. Other terminal operating modes are described in the following paragraphs.

**TERMINAL OPERATING MODES**

**Local**

Off-line data entry with full editing capability. Block mode transmission by page or line.

**Remote Power Up**

Full duplex character-by-character transmission. Local Functions active include: full editing capability, two page download memory with paging and scrolling.

**Remote-Host Control**

Full duplex character-by-character transmission. Remote Power Up local functions are disabled. Keys transmit a two-byte code sequence to the host.

**Monitor**

Displays all transmitted characters, including control characters.

**Test**

Provides verification of the display unit capabilities.

**Learn**

Allows the terminal to learn the user definition of the eight programmable function keys.

**CHARACTERISTICS**

**Display Parameters**

Alphanumeric Mode Format: 25 lines at 80 characters/line. Memory: Two pages (50 lines x 80 characters per line = 4000 characters). CRT Size: 12 inch (304 mm) diagonal. CRT Type: Non-glare (P31 Phosphor). Refresh Rate: 50 or 60 Hz, switch selectable. Visual Attributes: Blink; Reduce; Blank; Inverse; Underline; Blink and Underline; Blink and Reduce; Blink and Inverse; Reduce and Underline; Blink, Reduce and Underline; Inverse and Reduce; Blink, Inverse and Reduce.

**Keyboard Characteristics**

Detached 79 key with auto repeat. Separate cursor positioning, programmable tab, backspace, eight programmable function keys, edit capability.

**COMMUNICATIONS**

Interface — EIA Standard RS-232C; full duplex; parity enable/disable. Selectable Baud Rates — 110, 150, 300, 600, 1200, 2400, 4800, 9600 externally switched. Cable — 3 m (10 ft).

**ENVIRONMENTAL CHARACTERISTICS**

Operating Temperature Range — +10°C to +40°C (+50° to +104°F). Storage Temperature Range — -55°C to +75°C (-67° to +167°F). Operating Altitude Range — Sea level to 3000 m (10,000 ft). Storage Altitude Range — Sea level to 12 000 m (40,000 ft). Operating Humidity — To 90% relative noncondensing.

**AC POWER**

Input Voltage Selection — 115 or 230 V ac switch selectable at 50 or 60 Hz. Power Consumption — 65 W maximum.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet		Keyboard	
	mm	in	mm	in
Width	456	18.0	456	18.0
Height	318	12.5	76	3.0
Depth	508	20.0	222	8.7
Weight	kg	lb		
			19.2	42.5

Order CT8500 CRT Terminal ..... \$2,700

*Tektronix software tools include various Editors (Language-Directed and CRT-oriented), Pascal and MDL/μ Compilers, a variety of Assemblers, a Pascal Debug, and a Linker to merge object modules.*



**4643 Printer**

The Tektronix 4643 Printer provides fast, high-quality, impact printing that is suitable for most data processing applications. With high reliability built in, the 4643 is a convenient and economical choice requiring no preventive maintenance and infrequent servicing.

The 4643 is a fast and highly reliable serial printer for use with the 8500 Series development systems. The 4643 can be connected to either the 8540, 8550 or 8560 to provide high quality hard copy at a modest cost. The 4643 connects via an RS-232 interface, so no special interface cards or mainframe options are required for operation.

Long, reliable service can be expected from the 14-wire matrix head component. The 4643 backs up the printing of each character with more head wires to assure an expected (head) life of more than 300 million characters with no maintenance except normal cleaning. This figure normally means at least two full years of continuous work from a single matrix head. The fabric ribbons continuous loop cassette is usable for at least 5 million characters. Both the matrix head and ribbon cassette are quickly operator-replaceable, eliminating the need for a service call.

High quality matrix printing is ensured by the unique 14-wire printing head. The 7 x 7 format print font permits easy reading and the operator can specify condensed, expanded or standard characters. In the condensed (character) face the 4643 prints out a 132-character line format on an 8 1/2 x 11 in sheet.

Because the 4643 uses impact printing, six very legible copies (including five NCR or carbon copies) can be made to save time and avoid the expense of photo copies.

You can generate output simply with the easy-to-use 4643 Printer. The few operator controls needed are conveniently clustered at the front of the machine.

No attendance is necessary when the 4643 is running because the paper supply sensor automatically lets the machine print to the end of the last form. With either front, back or bottom loading ports, loading the machine is also an easy task. The operator may quickly position the paper to be loaded with the help of built-in horizontal and vertical alignment guides.

**Compatibility**

The printer of choice for high technology systems, the standard Tektronix 4643 is RS-232 compatible and can be interfaced with most standard RS-232 data processing instruments and systems. Option 01 provides a parallel interface. The 4643 is compatible with the following Tektronix products: 4010 and 4110 Series Terminals, 4020 Series Terminals, and 4050 Series Desktop Graphic Computing Systems; the 8001, 8002A, 8540, 8550 and 8560 Microprocessor Labs; the S-3250, S-3270 and S-3280 Semiconductor Test Systems; the 7612D and 7912AD Programmable Digitizers.

**Fast But Not Expensive**

The 4643 Printer uses bi-directional logic technology to print 340 characters/second. With a full 132 character line, speeds of 125 lines/minute are nominal. Even faster throughput rates are used for printing graphs and tables. The 4643 Printer rivals the speed of many line printers but is available for the modest price of a matrix printer.

**Practical for Many Applications**

This versatile printer can be used, for example, as a fast way to record the stages-in-process of software program development. It can also pro-

vide the hard copy needed to analyze research and development data. Because the 4643 output is of report quality, you need only to push a button to generate reports on your research, programming or statistics directly from your data base. For added convenience, you will find the 4643 very useful in time consuming tasks such as label generation, previewing text and correcting the format of manuals or letters prior to typesetting.

Virtually no maintenance means an even greater savings, and less downtime for repairs as well. A diagnostic display and self-testing routine virtually eliminate the need for preventive maintenance calls. On the infrequent occasion that something goes wrong, you will find out directly from the machine.

Both the matrix head and ribbon cassette are quickly operator-replaceable, eliminating the need for a service call.

**CHARACTERISTICS**

- Printing Speed** — 340 characters/second.
- Character Density**
  - Condensed — 219 characters/line.
  - Standard — 132 characters/line.
  - Expanded — 72 characters/line.
- Throughput Rate**
  - 132 Columns Wide — 125 lines/minute.
  - 72 Columns Wide — 200 lines/minute.
  - 40 Columns Wide — 300 lines/minute.
- Paper Slew Rate** — 254 mm/s minimum (10 in/s minimum).
- Character Set** — 128 (96 ASCII plus 32 commonly used international characters).
- Vertical (Line) Spacing** — 2.4 lines/cm.
- Horizontal (Standard Character) Spacing** — 3.9 characters/cm (10 or 5 characters/in).
- Printing Matrix** — 7 x 7 half-dot matrix.
- Paper**
  - Type — Continuous fan fold, edge perforated.
  - Width — 76.2 mm to 406.4 mm (3 to 16 in) at 0.7 mm (0.028 in) maximum thickness.
- Ribbon**
  - Type — Fabric, continuous loop, cassette.
  - Life — Five million characters nominal life.

**AC POWER**

- Line Voltage Ranges** — 90 to 140 V ac or 187 to 275 V ac.
- Line Frequency Range** — 50 to 60 Hz.
- Power Consumption** — 250 W operating; 125 W in stand-by.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	676	26.6
Height	203	8.0
Depth	592	23.3
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	27.1	60.0

**INCLUDED ACCESSORIES**

Ribbon Cassette (118-1314-00); RS-232 Interface.

**ORDERING INFORMATION**

**4643 Printer (2400 Baud Standard) .... \$4,200**

<b>Option 01</b> — Parallel Interface .....	<b>NCR</b>
<b>Option 02</b> — Specify Baud Rate 110, 150, 300, 600, 1200, 4800, 9600 .....	<b>NCR</b>
<b>Option 03</b> — 8500 Series Interface .....	<b>NCR</b>
Compatibility .....	<b>NCR</b>

**OPTIONAL ACCESSORIES**

**Pedestal Order 118-1335-00 ..... \$195**

**PROM Programmer**

An optional PROM programmer is available for use with the 8550 MDL and the 8540 Integration Unit.

The PROM programmer includes the general purpose controller board and a series of front panel plug-in modules. Each plug-in module provides support for a similar group of PROM devices, and can be changed in a few seconds. Programming features include reading, writing, and comparing (for verification) a PROM.

**Chips Currently Supported Include:**

Intel	Motorola	Texas Instruments
2716	MCM68764	TMS2508
2732/32A		TMS2516
2758/2758S1865		TMS2532
2816		
8741A		
8748		
8749		
8755A		

**8540/8560 ACCESSORIES**

Flex Disks (box of 10) Order 119-1182-01 .....	<b>\$175</b>
RS-232 Connecting Cable (15 ft)	
Order 012-0757-00 .....	<b>\$140</b>
HSI Connecting Cable 2.4 m (8 ft)	
Order 012-1009-00 .....	<b>\$55</b>
HSI Connecting Cable 6.1 m (20 ft)	
Order 012-1008-00 .....	<b>\$90</b>
HSI Connecting Cable 15.2 m (50 ft)	
Order 012-1007-00 .....	<b>\$125</b>
HSI Connecting Cable 76.2 m (250 ft)	
Order 012-1010-00 .....	<b>\$395</b>

**Microcomputer Development Lab Workshops and Seminars**

Tektronix offers Microcomputer Development Lab Workshops and Seminars in a number of locations throughout the year. The workshops and seminars are intensive and are designed to meet the demanding challenges of the growing microcomputer development market.

**The Development System in the Design Process Workshop**

The Development System in the Design Process Workshop follows the microcomputer-based design process for initial software development through hardware/software integration and PROM programming. The workshop stresses the overall operation of the 8550 development system, the DOS-50 operating system, and how the 8550 supports the design process. Topics covered include volume structures, program design, editing, assembling, linking, library generation, program debugging, I/O simulation with service calls, PROM programming, and intersystem communications.

This highly intensive four and one-half day workshop is intended for the user who has performed at least one microprocessor-based software design at the assembly level with one or more microprocessors. Throughout the workshop the attendee gets extensive hands-on experience, for a total understanding of development system concepts.

**Software Design and Debugging Workshop**

The Software Design and Debugging Workshop emphasizes the basics of 8-bit microprocessor software design. The workshop also covers the use of development systems for editing, assembling, debugging, hardware/software integration, and PROM programming.

This intensive four and one-half day workshop provides an educational experience for the person who has limited microprocessor-based software design experience and wants to learn about software design and the use of the development system in microcomputer designs. The workshop includes detailed hands-on lab time to complete the learning experience.

**Productivity and the Design Team Environment Workshop**

This workshop follows the progression of the software design process, using the team-oriented approach. The design process is first examined from the standpoint of problems encountered in the traditional single-user design environment. The "productivity environment" is then examined as a means of solving the traditional design problems. Students are divided into design teams and are given specialized tasks to simulate the multiuser environment. The productivity tools supported by the 8560's TNIX operating system are demonstrated.

**Guidelines for Microprocessor Selection Seminar**

The Guidelines for Microprocessor Selection Seminar is a one-day seminar designed to clarify how to evaluate and select the microprocessor best suited for a given application. Several 8- and 16-bit microprocessors are examined and compared based on pertinent selection criteria. By the end of the seminar, the attendee will know the factors to consider when selecting a microprocessor, as well as how to select the microprocessor that best suits his application.

The seminar is designed for the person who has an introductory knowledge of computer hardware and software architecture.

**Maximizing Microprocessor Software Design Productivity Seminar**

This one-day seminar presents methods for organizing and managing a software design team to achieve maximum productivity. Targeted at software project leaders and managers, the seminar presents information about the methods used at Tektronix.

Content is designed for persons involved in software development, principally at the project leader and manager level. Other software team members will gain an understanding of the current trends in design processes.

For detailed information on Tektronix Microcomputer Development Workshops and Seminars, contact your local Tektronix Sales Engineer.

# LOGIC ANALYZERS

LOGIC ANALYZERS



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### DAS 9100 Digital Analysis System

#### 132 state-of-the-art logic analyzers in one.

Now you can have a single logic analysis system that is configurable, affordable and easy-to-use. The DAS 9100 contains your selected configuration of acquisition and pattern generation modules, allowing you up to 104 input channels, up to 80 pattern generation channels, up to 330 MHz synchronous acquisition and up to 660 MHz asynchronous acquisition!

The DAS also sets a new standard in human engineering and ease of use with its straightforward keyboard and menus, and now that standard is raised again with the industry's first use of color in the man-machine interface; for fast, easy operation.

Tektronix logic analyzers provide you with the unprecedented speed and versatility of the DAS 9100, the microprocessor analysis capability of the 7D02 and a combination of features in the portable 308 Data Analyzer. You'll find that a Tektronix logic analyzer can save you time and money.

Companion instruments include the 7D11 Digital Delay for 7000 Series Oscilloscopes (page 281), and the WR 501 Word Recognizer for TM 500 Series (page 365).

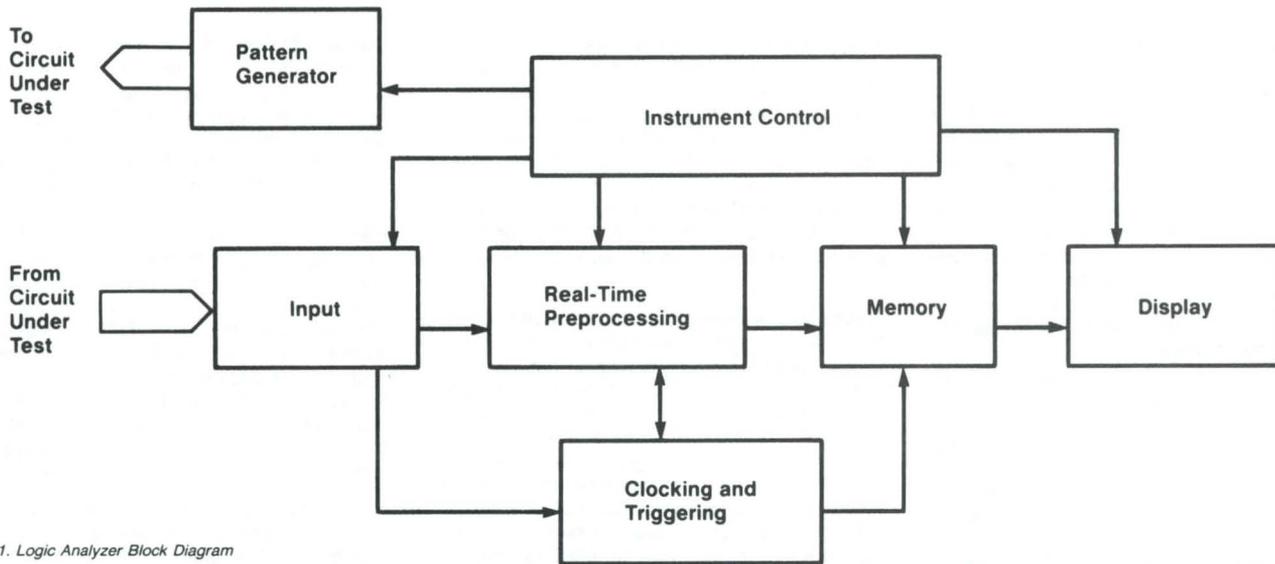


Figure 1. Logic Analyzer Block Diagram

Tektronix offers a broad range of logic analyzers for use in design, manufacturing, and service. This section of the catalog includes descriptions of these products and appropriate accessories.

Although the products differ somewhat, depending upon the specific applications for which they were designed, there are some basic architectural components of logic analysis described below.

Also a selection guide is provided to help you locate the best set of features for your specific application.

**WHY LOGIC ANALYZERS?**

As electronic designers have moved from primarily analog designs to circuit designs with many digital signals, the requirements for test and measurement equipment have also changed. For digital circuits the logic analyzer has assumed a role similar to that of the oscilloscope for analog circuits. Like the scope it is a highly flexible instrument that can be connected to many different circuit points relatively easily, and it provides a clear visual display for the user.

Logic analyzers come in a variety of sizes and shapes to fulfill different requirements. There are portable, light-weight logic analyzers for field service and larger, more versatile benchtop units for use in laboratories and manufacturing areas.

The logic analyzer is continuing to evolve as new applications are identified and new features are required. As you can see from reviewing the Tektronix logic analyzer descriptions, we are committed to providing you outstanding value in the form of performance today and flexibility for the future.

**ARCHITECTURE OF LOGIC ANALYZERS**

The basic parts of a logic analyzer, as shown in figure 1. There are six main sections in conventional analyzers: input, real-time preprocessing, memory, clocking and triggering, display, and control. In the new DAS 9100 Tektronix has introduced a seventh basic section, pattern generation. A description of each section is given in the following paragraphs.

**Input**

Today logic analyzers have from 8 to more than 100 parallel inputs. Typically the inputs are grouped in 8 or 16 channels per probe. The threshold voltage for the inputs is variable to allow for the wide variety of logic devices available. Each pod also includes an external clock input and/or a qualifier input, as well as ground reference lines.

Because of the special needs for various signal types, a variety of probe and accessory hardware has been developed. For very high speed signals, short leads are connected to hybrid input circuits for maximum signal fidelity. To analyze complex parts such as microprocessors, personality modules monitor the device and decode the binary patterns into meaningful mnemonics.

**Real-Time Preprocessing**

Because of the large amount of data in a digital system it is often necessary to preprocess it. Clock qualification is the process of sorting data in real time, based on the state of a control signal. Clock qualification sorts the data according to the time relationships to other bus signals. Data qualification is the process of sorting the data in real time based on the content of the data. Clock and data qualification increase the effective size of the acquisition memory and reduce analysis time. Personality modules often contain hardware to synthesize clocks, predict instruction fetches, and decode control lines.

**Memory**

Logic analyzers can have three separate memories. The acquisition memory stores the data acquired from the circuit under test. Data is acquired and loaded into memory continuously, writing over previous data until a trigger event terminates the acquisition.

For asynchronous timing measurements the acquisition memory may be a dual memory. One memory stores acquired data while the other stores glitch information.

Reference memory is used to store a pattern for comparison. Such a pattern could either be acquired from a circuit operating properly or from an off-line source such as a simulator. When the contents of the acquisition memory are compared with the contents of reference memory, the differences are highlighted to enable the operator to see the errors easily.

## Clocking And Triggering

The clocking and triggering area contains word recognizers and qualifiers that define the trigger event. The trigger event stops the data acquisition and serves as a reference point in the acquired data. This part of the analyzer also contains circuitry to clock the data acquisition. In logic analyzer terminology there are two modes of clocking, synchronous and asynchronous. In synchronous mode the analyzer is clocked from the circuit under test. Since, in most digital systems today, events in the circuit are driven by a system clock, the logic analyzer must also be able to use the system clock in order to know when to detect events. In asynchronous mode the analyzer clock is provided by the analyzer, so there is no synchronization (except the trigger event) with the circuit under test. Asynchronous clocking allows the logic analyzer to sample the data at faster rates than the system data rate and thereby provide time resolution of events occurring faster than the system clock rate. Synchronous clocking is usually used for watching state flow related to software. Asynchronous clocking is usually used to acquire hardware timing information.

There are four types of word recognition: simple, sequential, nested, and non-sequential.

Simple word recognition is the ability to recognize a single event defined by a word made up of selected input channels. For example, a 64-channel logic analyzer can have a word recognizer register of up to 64 bits that describe an event.

Sequential word recognition is the natural extension of simple word recognition. Simple events are combined sequentially to define a compound event. For example, if you expect events A, B, and C to occur in that order, you can set the trigger to look for a valid output from word recognizer A, followed by a valid output from word recognizer B, followed by a valid output from word recognizer C to trigger and end the acquisition. The trigger will occur only after all three events have occurred in the proper order.

Nested word recognition introduces the ability to monitor conditional branching. For example, event A might occur, followed by event B, followed by either event C or event D. Program flow might often include events A and B, with the choice between C and D determining the next sequence of events. The branching must be monitored, since the flow of the program depends on it.

Non-sequential word recognition is similar to sequential and nested word recognition except that the trigger can follow a software algorithm where the next event depends upon the result of a test. For example, a command passing algorithm is non-sequential.

Event counters and delay timers increase the versatility of the logic analyzer trigger. An event counter counts the number of occurrences of an event. Using the event counter, you instruct the logic analyzer to trigger only after the nth occurrence of the event. A delay timer works similarly, except that the trigger is delayed a given length of time rather than waiting for the nth event.

Trigger arming allows a logic analyzer to acquire data based on two different clocks. One section of the analyzer monitors data lines at the system clock rate until a trigger event is found. It then arms another section of the analyzer running at a high asynchronous clock rate to allow it to trigger and acquire high speed timing information. The event that triggers it could be a trigger event detected independently or it could be a programmed delay from the arming signal, or a combination of both.

An example of arming is when you want to investigate high-speed-hardware phenomena such as control pulses to a microprocessor but you want to monitor address lines to determine when to investigate the control lines. When the analyzer section monitoring the address lines at slower speed finds the proper trigger event, it enables the other analyzer section running at higher speed to take a high-resolution look at the control lines. Note that the analyzer section monitoring the address lines must be clocked synchronously, while the other section is clocked asynchronously.

## Display

If you think for a moment about how much data you can acquire with a logic analyzer, you will quickly realize that it is extremely important to manipulate and display the data carefully to be able to find the significant points quickly and reliably. Tektronix logic analyzers give you considerable flexibility, so that you can see the data you need the way you want to see it.

There are three basic types of output display: timing diagram, state table, and mnemonic disassembly. For the timing diagram the data stored in memory are used to construct a multi-trace waveform drawing which looks a lot like a multi-channel display on an oscilloscope. The timing diagram is usually the preferred method to observe data acquired asynchronously at high speeds. It helps the user locate hardware faults.

The state table allows the user to observe data describing the state of the circuit under test in tabular form. It is the preferred output for data acquired synchronously. The data is much more readable if it can be grouped into fields and displayed in octal or hexadecimal format, as well as in binary. Also the ability to group the data in fields relating to the circuit under test rather than to the logic analyzer probes makes it easier to understand what is really happening.

Mnemonic disassembly allows the user to observe the data in the state table in much more readable form. For example, it is much easier to understand the event flow of a microprocessor when the instruction codes are shown rather than the numerical machine code. That is also true for messages in a character code such as ASCII and for transactions on a bus such as the GPIB. Some mnemonic disassembly tables may be built into the hardware of the logic analyzer as you purchase it, but it is also helpful if you can define your own mnemonics.

## Instrument Control

As you can appreciate from the descriptions above, the logic analyzer offers you great flexibility. To use this flexibility you must set up the instrument to acquire data in the manner you desire and you must be able to display it the way you want. To do all this with conventional knobs and switches would be very cumbersome. So Tektronix has provided the ability to deal with each logic analyzer in the optimum way for the application. Since the 7D01 is intended for hardware oriented people, it looks more like a hardware controlled box. The 7D02 programming is optimized to allow you to follow the program flow of a microprocessor. Through extensive use of menus the DAS 9100 allows you to specify a large number of parameters quickly and easily. The 308 is four instruments in one, compact in size, useful in both design and service.

An important aspect of the control of logic analyzers is the interface to external controllers and peripherals. The user of instrumentation can save significant time as intelligent instruments talk to each other to speed up the testing process. Also, the ability to work with controllers allows the same instrument to be used in both design and manufacturing.

## Pattern Generation

The traditional logic analyzer observes the circuit under test. Obviously, to observe the circuit and acquire meaningful data, something meaningful must be happening at the circuit. In the past the user has had to set up a separate stimulus instrument to drive the circuit in some known way in order to collect meaningful data. Often a lot of effort and time is expended in developing a suitable fixture. This is true especially during the early stages of design when the circuit to be tested cannot be tested in the environment of other known good circuitry.

The DAS 9100 is the first logic analyzer to have both stimulation and observation capability in the same instrument. It saves significant time for the designer, since he can set up a program to stimulate his circuit in the same way that he sets up the rest of the logic analyzer — with prompted menus. Since the pattern generator allows algorithmic generation of data, a relatively short program can create a much larger sequence of data to drive the circuit under test. The pattern generator can be programmed to behave like the environment in which the circuit is to be used, so that the designer can test parts of a circuit design before all the prototypes are ready.

In addition, the tests created for the pattern generator can ultimately form the basis for evaluation and manufacturing tests. The pattern generator stimulates the circuit under test, the data is acquired in the acquisition memory and then compared to the contents of the reference memory to identify errors.

**LOGIC ANALYZER SELECTION GUIDE**

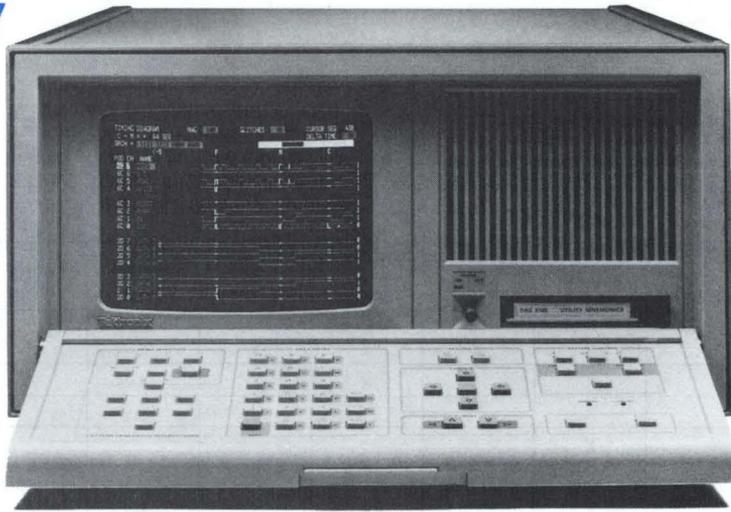
The following guide will help you determine which Tektronix logic analyzer features are best suited to your specific application needs. The guide is a summary of the most salient considerations. Additional information is available in the individual product descriptions that follow or, call your Tektronix representative for assistance.

APPLICATION/FEATURE	308	7D02	Preconfigured Digital Analysis Systems*				9129 9109	7D01 DF2 DL2
			9121 9101	9122 9102	9123 9103	9124 9104		
<b>Bus Measurements:</b>								
Trigger on simple program execution	X	X	X	X	X	X	X	X
Trigger on complex program execution		X		X	X	X	X	
Measure execution time interval and state count		X						
Data qualification		X						
Stimulate bus transfers					X	X	X	
Relate program execution to data		X		X	X	X	X	
Relate program execution to asynchronous control		X		X	X	X	X	
Analyze serial data transfers/communications interface	X							
Simultaneous state & timing		X			X	X	X	
Time aligned state & timing					X	X	X	
Analyze asynchronous timing and glitches	X	X	X		X	X	X	X
Microprocessor mnemonics		X		X	X	X	X	
User defined mnemonics			X	X	X	X	X	
Analyze GPIB transactions			X	X	X	X	X	X
<b>Stimulation Capabilities:</b>								
Pattern compression				X	X	X	X	
Synchronous clock output				X	X	X	X	
Programmable strobe outputs				X	X	X	X	
External control lines				X	X	X	X	
Tri-state capability				X	X	X	X	
Level swings selectable by pod				X	X	X	X	
<b>Service:</b>								
On-site	X							
Depot level	X		X	X	X	X	X	
Remote control			Opt 02	Opt 02	Opt 02	Opt 02	X	
<b>Hardware Debugging:</b>								
Glitch capture	X	X	X		X	X	X	X
Glitch triggering		X	X		X	X	X	
Synchronous acquisition speed	20 MHz	10 MHz 20 MHz clock	100 MHz	25 MHz	100 MHz	100 MHz	25 MHz 100 MHz 330 MHz	50 MHz
Asynchronous acquisition speed	20 MHz	50 MHz	100 MHz	25 MHz	100 MHz	100 MHz	25 MHz 100 MHz 330 MHz 660 MHz	100 MHz
1.5 ns sampling resolution							X	
Simultaneous state & timing acquisition with time alignment					X	X	X	
Test fixture elimination				X	X	X	X	
<b>System Capabilities:</b>								
Mass storage			Opt 01	Opt 01	Opt 01	X	X	
Programmable via RS-232C			Opt 02	Opt 02	Opt 02	Opt 02	X	
Programmable via GPIB			Opt 02	Opt 02	Opt 02	Opt 02	X	
Display hard copy			X	X	X	X	X	
Trigger output	X	X		X	X	X	X	X
Trigger input	X	X		X	X	X	X	X
Modular and expandable			X	X	X	X	X	X
7000 Series compatible		X						X

\*Additional feature combinations may be obtained using options or by adding modules.

LOGIC ANALYZERS

**NEW**



LOGIC ANALYZERS

**DAS 9120 Digital Analysis System**

**An Industry First From Tektronix**

**Color-Coded CRT Display Significantly Enhances Ease of Use**

**Faster Setups, Quicker Data Interpretation**

**Reduced Human Error Rate**

**Easily Learned, Menu-Driven Operating System**

**All The Flexibility and Performance Features of the DAS 9100 Series**

With the Color DAS, Tektronix brings the benefits of a color-coded display to a logic analyzer for the first time. This innovative achievement represents a new level of human engineering in the field of test and measurement instrumentation. At the same time, it demonstrates Tektronix' commitment to improving the productivity of the design engineer through advances in man/machine interface.

**Color Makes The Difference**

Because their displays are complex and contain a high information density, logic analyzers are ideal for color coding. Extensive research by both government and industry has shown that color can be a highly effective tool in organizing, locating and analyzing large amounts of displayed data.

Tek's research arm, the Technology Group conducted a series of tests to evaluate the use of color with typical logic analyzer displays. The results demonstrated that color was clearly superior to other types of coding. Not only were user response times improved, but error rates also were reduced by as much as 80 percent.

The Color DAS display is coded in yellow, green and red set against a black background. The spectral distribution of these colors is wide enough to make them easily distinguishable, yet close enough to prevent unnecessary focal shifts by the eye. The color-coded display is produced

by a custom CRT that employs yellow, green and red phosphors, whose light emissions fall within a common focal depth.

Each color has a dedicated function in the display coding format. Because it stands out, yellow is used for high priority display items such as acquired data and frequently changed menus fields. Green is a quieter color and is used for background information and descriptive labels. Red demands immediate attention and is used for tasks such as error messages and highlighting data differences during memory comparisons.

The Color DAS display format presents several immediate benefits to a user. Instrument setups can be entered faster because all important menu fields are assigned a uniform color, which makes them easy to locate. Acquired data can be analyzed faster because its color differentiates it from other display information. Also, important discrepancies within the acquired data are highlighted in a separate color to call the user's attention to them. For instance, differences between acquisition and reference memories are highlighted in red. Color also acts as a deterrent to operator fatigue and boredom, a psychological advantage that boosts productivity.

**Superior Human Engineering**

Besides color, the Color DAS 9100 includes many other important human engineering features. Its menu-driven, user interface is easy to learn and self-documenting, so there is no need to constantly refer to manuals. All menu fields are graphically arranged into logical groups that present the user with a self-explanatory path through instrument setup. Error recovery is simplified through error prompt messages that give the user an alternative course of action.

To complement the menu-driven displays, there is a color-coded keyboard organized specifically to enhance user programming. All keys are arranged into logical groups that correspond to the display elements they service.

For timing measurements, there is a delta time feature that allows fast measurements of the number of sample intervals between points selected by the user.

For permanent storage and recall of instrument setups, the Color DAS has an optional, built-in DC-100 tape drive unit. It is operated through a

simple, menu-driven file system that allows either full or partial instrument setups to be entered into a directory and stored on tape for later recall.

For state measurements of software flow, the Color DAS has Define Mnemonics, that converts acquired state data into mnemonics defined by the user. The "New" Define Mnemonics: Allows you to enter your own mnemonic disassembly for custom microprocessors and gate arrays as new as bit slice and popular 8, 16 and 32-bit microprocessors. The disassembler is powerful enough to handle processors with prefetched instruction queues, but is simple to operate. Disassembly tables are entered in a format similar to tables found in the microprocessor databook. They even allow you to highlight selected mnemonics in programmable color for fast analysis of software.

In addition, individual mnemonic sets for different processors can be loaded into the table through the tape drive I/O.

**State-Of-The-Art-Performance and Flexibility**

To back up its superior, human engineering, the Color DAS has a performance capability unmatched by any other logic analyzer currently available. Data widths can span up to 104 channels, and timing sampling resolution is available up to an unprecedented 660 MHz (1.5 nanoseconds). Full pattern generation facilities up to 80 channels at 25 MHz is provided. All this capability is made possible by the Color DAS's modular architecture which is identical to that of other DAS 9100 Series instruments. The Color DAS accepts up to eight modular data acquisition and/or pattern generation modules at a time. You can choose from a variety of modules to configure exactly the system you need to match your application. And when you're ready to expand, it's simply a matter of adding new modules.

Data acquisition modules allow both synchronous and asynchronous data acquisition. Speeds may range from 25 MHz to 660 MHz depending on the combination of modules in use. Other features include split clocking, qualification, and multi-level triggering. There is also a special "Arms" mode that allows a 32-channel module to run synchronously and when triggered, arm the trigger on an 8-channel module, set to acquire asynchronously. In this manner software flow can be used to pinpoint areas where hardware logic needs to be examined.

Pattern generation includes a powerful, concise instruction set including symbolic branching and nested subroutines. Pattern output can also include up to 10 programmable strobes for sophisticated logic control simulation. In addition, the pattern generator accepts several different types of signals originating from the prototype circuitry, including a tri-state and an interrupt.

The Color DAS can be easily integrated into a larger system through its external communication capability, that includes both GPIB and RS-232C. Using the Color DAS with the Tektronix 8560 Multi-User Software Development Unit results in an automated digital-design tool of unprecedented dimension. The designer can now control all aspects of both microcomputer software development and hardware/software integration from a single CRT terminal.

**DAS 9100 Digital Analysis System**

Up to 104 Acquisition Channels

Synchronous Acquisition to 330 MHz

Asynchronous Acquisition to 660 MHz

Up to 80 Channels of Pattern Generation to 25 MHz

An Architecture for Future Growth

Easy to Learn and Easy to Use

Affordable

The digital evolution, especially microprocessor technology, has touched every facet of electronic instrumentation. Bus structures have become wider, faster, and more complex. This has led to an increase in total hardware and software design complexity. These events created a need for a new state-of-the-art general purpose logic analyzer.

**The DAS 9100 — A New Standard in Logic Analysis**

Modularity is the key to the DAS 9100. DAS mainframes accommodate plug-in card modules, (DAS 9129 Color Mainframe, 9109 Monochrome Mainframe, 9119 ATE Mainframe) chosen by you according to your specific needs. Configurable capabilities of the DAS 9100 allow for data acquisition, stimulation and remote programmable control, for optimum performance in a broad range of test situations.

For high speed data acquisitions, the DAS 9100 provides clock rates to 330 MHz synchronous and 660 MHz asynchronous, sampling resolution to 1.5 ns. Data storage can be up to 4096 bits per channel to capture the data you want.

To accommodate wider, more complex bus applications, the DAS 9100 provides up to 104 channels of data acquisition. Also, glitch capture, split clocking, up to seven clock qualifiers, and multiple levels of sequential triggering help you pinpoint problem areas in your system. For extra difficult problems, the Trigger Arms mode provides the capability to look at address/data bus transactions and asynchronous handshaking events simultaneously. And, the DAS 9100 goes one step further by displaying the data time aligned in both timing and state table displays.

If you're doing prototype debugging, the DAS 9100 combines data acquisition with pattern generation. With pattern generation you can stimulate the prototype with a known pattern up to 80 channels wide exercise control lines with up to ten plus programmable strobes, and truly analyze the results.

And, best of all, it's easy to use. A straight forward menu-driven user interface let's you concentrate on solving your problem, not on learning how to operate the DAS 9100.



LOGIC ANALYZERS

**TABLE I. SUMMARY OF DATA ACQUISITION MODULE CHARACTERISTICS**

Characteristics	*91A32	91A08	91A04 & 91AE04**	
			Full Channel Mode	High Resolution Mode
Number of Channels Per Module	32	8	4	2
Sampling Resolution/ Sample Frequency	40 ns/25 MHz	10 ns/100 MHz	3 ns/330 MHz	1.5 ns/660 MHz
Modules Per System	3	4	1 91A04 3 91AE04	1 91A04 3 91AE04
Channels Per System	96	32	16	8
Memory Depth	512	512	2048	4096
Triggering	***nA→B≠C	1 level, Arms Mode, Glitch Trigger	1 level plus arms mode	
Multiple Clocks	3	With 91A32		
Synchronous	YES	YES	YES	NO
Asynchronous	YES			
Qualifiers Per Board	2	1	0	
Set-up Times				
Hold Times	29 ns/0 ns	9 ns/0 ns	2 ns/0 ns	2 ns/0 ns
Number of Probes	4	1	1	1

\*Data and clock thresholds selected independently.

\*\*The 91A04 is a master card, channel expansion requires one or more 91AE04's.

\*\*\*n occurrences of A followed by B, reset on C.

## DAS 9100 — Select YOUR Configuration

The DAS 9100 has four different data acquisition modules. Each has its own data width and maximum speed: 32 channels at 25 MHz; 8 channels at 100 MHz with glitch memory; 4 channels at 330 MHz or two channels at 660 MHz. Modules can be combined to give you the logic analyzer you need.

Need high speed performance? One module can track your system clock (synchronously) at speeds to 330 MHz or provide asynchronous sampling to 660 MHz. The 8-channel module provides *both* synchronous and asynchronous sampling at 100 MHz. And the 32-channel module can be used to arm the trigger on those modules with higher acquisition rates.

To back it all up, there's powerful triggering, clock and trigger qualification, programmable reference memory and multiple clocks. There is glitch triggering, with a separate glitch memory for unambiguous glitch detection and our unique, new "arms mode" that allows precise timing correlation between synchronous and asynchronous data.

Arms mode allows the DAS 9100 to capture synchronous and asynchronous data simultaneously. The data is displayed in the correct time relationship for easy analysis in either Timing or State Display mode. To obtain the data width and speed your application requirements, simply select the appropriate combination of modules and add on later as your needs change.

To complete the tool set, the define mnemonics menus allow the user to build disassembly tables to support proprietary and other non-supported chips. Up to 64 tables with 256 entries per table can be nested to provide the capability to support complex 16-bit processors, with room left over!

At last you can have the tool that covers your digital system debugging needs. By combining pattern generation and data acquisition modules, you can stimulate your prototype while simultaneously analyzing its operation; allowing you to enter a whole new dimension of design analysis and verification.

Pattern generation makes it possible to start debugging hardware before your software, or all of your hardware, is available.

Pattern generation capability is built around a 16-channel, 25 MHz controller module. Through additional expansion modules, you can increase the total to 48 or 80 channels while maintaining full system speed. The pattern generator allows interaction with the prototype through clock outputs, data strobes, an external clock, and external control inputs, including an interrupt line. And, the pattern generated can even be changed, based on the data acquired by the logic analyzer, through the external control lines.

Table 2 summarizes capabilities of the two Pattern Generator Modules.

**TABLE 2. PATTERN GENERATOR SUMMARY**

Characteristics	Pattern Generator Modules	
	91P16 (Controller)	91P32
Modules Per System	1	2
Channels Per Module	16	32
Strobes Per Module	2	4
Clock Frequency	25 MHz	25 MHz
Number of Probes per Modules	2 8 Channels/ Probe	4 8 Channels/ Probe
Number of Program Steps	254	254

*Note: Maximum number of channels is 80.*

To make good use of an instrument, it needs to be easy to use. The logical grouping of the keyboard on the DAS 9100 simplifies the operator's task considerably. The Menu Selection and Pattern Generator keys are used to set up a specific task. The Data Entry keys are used to enter values. The operator uses the Editing, Cursor and Scroll keys to interact with the display. The System Control keys allow control of overall system operation.

The DAS 9100 also offers you powerful I/O options, including a built-in magnetic tape cartridge drive (Option 01) to create files of instrument set ups, pattern sequences, mnemonics and reference memory. The Option 02 RS-232 and GPIB interface offers complete remote programmability. A hard copy interface is also included.

### DAS 9100 — Versatile Performance for All Applications

The DAS 9100's modular performance provides capabilities for a variety of applications. Data acquisition modules offer unsurpassed performance in high-speed timing analysis and bus analysis. And now, the integration of pattern generation modules opens up a new realm of logic analysis applications in design and manufacturing.

### DAS 9100 — High-Speed Timing Analysis

The trigger specification menu (Figure 1) lets you choose either synchronous or asynchronous timing acquisition. Normally, you will be using asynchronous sampling to see control signal operations (handshaking, interrupts, read/write) which do not occur synchronously with the same edge of the master clock. For tracing timing bugs, the DAS 9100 combines flexible triggering with glitch triggering to capture and display rapidly changing data.

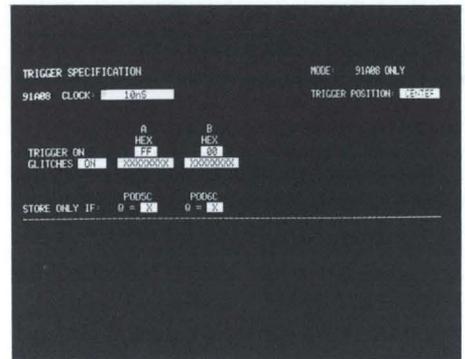


Figure 1. Trigger Specification Menu

For high-speed timing, your mode would be 91A08 only or 91A04 only. More complex triggering may be used for simply selecting one of the several other triggering modes. Modes and parameters are selected via the trigger spec menu.

A typical example (Figure 1) is for 100 MHz sampling on 16 channels of data using the two 91A08 modules plugged into mainframe slots five and six. The glitch trigger is enabled and the sample rate is set to 10 ns using the internal clock. The trigger event is shown and the desired trigger position is centered to view data on both sides of the trigger event. The qualifiers, "store only if", are all set to X (don't care.) Also, the threshold is set for TTL on both modules. Hexadecimal radix is selected for state table viewing.

When the trigger event is recognized, acquisition is completed and the data recorded in memory is displayed.

In the timing diagram display (Figure 2) the information can be easily analyzed. The channels are labeled for convenient identification and the trigger event is displayed at the top and highlighted in the display by the vertical line labeled **T**. The glitches display is on and the glitches are presented. If there is any concern about differentiating glitch from data, simply turn the glitch field to off to remove glitches. Also, the cursor location (labeled **C**) is displayed at the top of the screen.

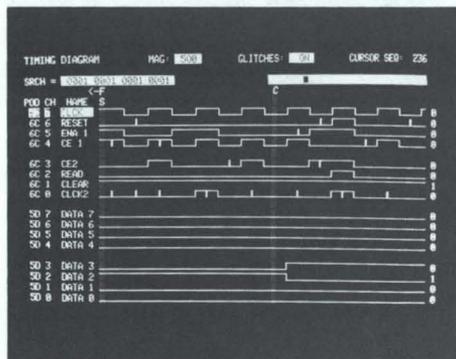


Figure 2. Timing diagram with glitches

The 91A08 module samples up to 100 MHz and uses glitch triggering to capture narrow pulses.

In time-critical applications, the DAS 9100's Delta Time feature allows precise measurements of the time intervals between selected display points (Figure 3). The negative or positive difference between the stationary marker "M" and movable cursor "C" is automatically shown in the upper left-hand area of the display. This particular display has a sampling resolution of 1.5 ns, or 660 MHz.

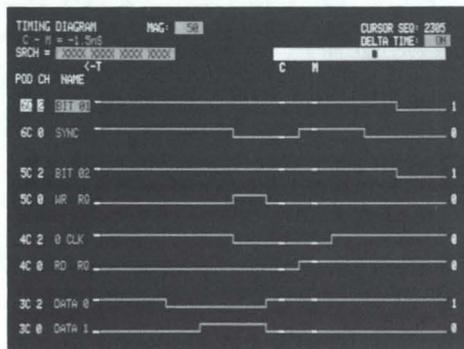


Figure 3. Delta Time timing diagram w/1.5 ns measurement

The 91A04/91AE04 is a high-speed module that synchronously samples to 330 MHz and asynchronously to 660 MHz. By using the 91A04/91AE04 module, you can view glitches with 1.5 ns resolution and truly analyze where those errant pulses originated.

As a timing analyzer, the DAS 9100 is unsurpassed in performance. You can label all sixteen timing channels with signal names of your choice, thereby taking the guesswork out of data identification. Data sampling resolution can be selected from 5 ms to an unprecedented 1.5 ns to help you isolate very high-speed digital transactions on synchronous and asynchronous data lines.

**DAS 9100 — Bus Analysis**

When the DAS 9100 is used to analyze a bus structure, the synchronous mode will normally be used. The 91A32 module with 32 channels and up to a 25 MHz sample rate, is ideal for bus analysis. If 91A08 or 91A04 modules (which are ideal for asynchronous acquisition) are added, the DAS 9100 will provide synchronous and asynchronous data acquisition simultaneously to uncover asynchronous faults while monitoring synchronous execution (Arms Mode). The data are then displayed in a time correlated format for easy analysis.

When looking at data/address bus transactions, it is convenient to be able to group channels to allow for display formatting of acquired data.

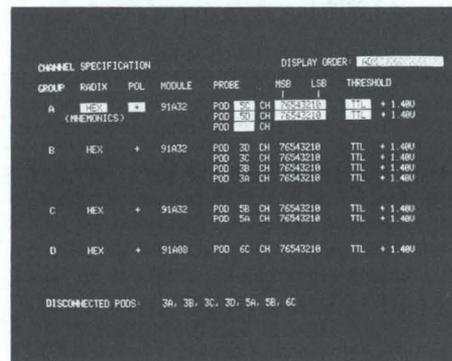


Figure 4. Channel Specification Menu

The Channel Specification Menu (Figure 4) is used to group the probe channels into logical display groups in any order for convenient analysis. You can also select thresholds, logic polarity, radix, and the order in which the groups should be displayed.

When the PMA 100 Personality Module Adaptor and DC 100 tapes are used, all channel specification parameters can be automatically configured to conform with the microprocessor under test.

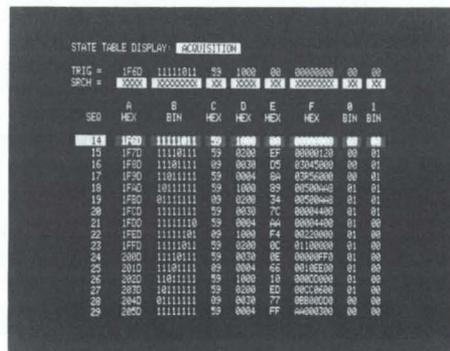


Figure 5. State Table Display

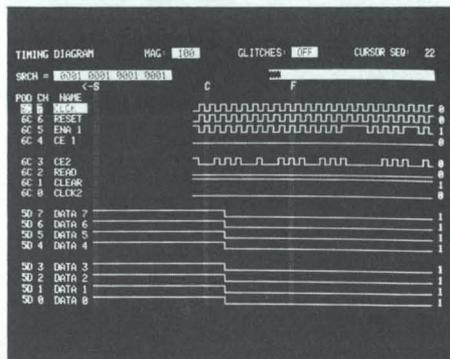


Figure 6. Timing diagram of data acquired in Arms Mode

In the State Table (Figure 5), as in the Timing diagram (Figure 6), the trigger word is displayed. The memory location or sequence numbers that correspond to the recorded events are also listed. To look at different sections of memory, either use the scroll keys or enter the sequence number you want.

The State Table lets you easily follow synchronous transactions that occurred on the bus around a specified event. With the Arms Mode, (Figure 6) you can also observe control signal transactions to determine if their asynchronous activity is proceeding correctly.

**Define Mnemonics**

To make data easy to interpret, Define Mnemonics 1 lets you define your own language of events, this may be as simple as a lookup table for special purpose microcomputer control functions or as capable as a full mnemonic disassembler for a 68000 microprocessor system.

You can even define the color of a display element.

There is also a set of optional mnemonics tapes for use in conjunction with the DAS 9100's tape drive unit. These tapes provide full mnemonic tables for many popular 8 and 16-bit microprocessors. They can be used in conjunction with the PMA 100 unit to provide full disassembly of software flow as executed on the bus of the system under test.

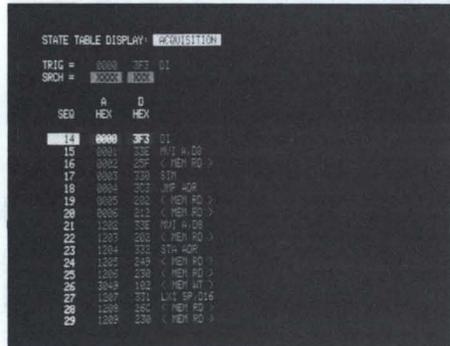


Figure 7. State Table with user defined mnemonics

**Reference Memory**

For intermittent problems, the reference memory provides the means to track down unwanted random transitions. By pressing the Store key, acquisition memory from the State Table is copied into reference memory. To track down an intermittent, press Compare ≠ and the DAS 9100 will begin acquiring data, based on the specified parameters, and compare it with known correct reference memory data. If the data is different, the DAS 9100 halts.

By selecting the Acquisition and Reference Memory, the intermittent will be shown as a highlighted difference and also a flag ≠ will be present beside the sequence number where the intermittent occurred (Figure 8).

A programmable compare window is provided to allow the DAS 9100 to help uncover specific intermittents within a small number of events. With the data masking plus the compare window, comparison testing can be done on as little as a single bit.

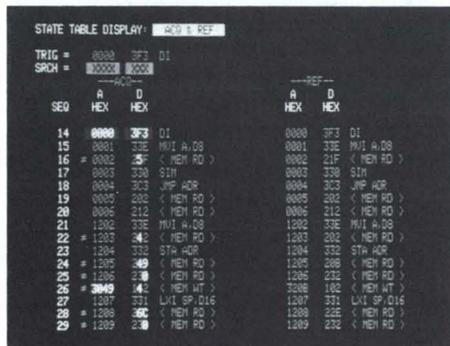


Figure 8. Acquisition and Reference Memory



With versatile software and hardware analysis and stimulus capabilities, the DAS is complete design engineers tool.

**DAS 9100 — Pattern Generation**

The DAS 9100 Pattern Generator provides up to 80 data signals and 10 programmable strobes at data rates up to 25 MHz. You can use these signals to stimulate your circuit either directly or with a minimal fixture of your own design. By stimulating the circuit from the pattern generator, you can start debugging parts of your circuit before all the other parts are ready. The ability to use a single logic analyzer to both stimulate and acquire data from a digital circuit is truly a new dimension in logic analysis.

The Pattern Generator is controlled by seven powerful instructions (Table 3). Each of the instructions is a familiar word with a logical function performed by the DAS 9100.

**TABLE 3. PATTERN GENERATOR INSTRUCTION SUMMARY**

Instruction	Action
COUNT	Increase Pattern by one clock cycle (256 maximum)
REPEAT	Repeat pattern output at this step up to 256 clock cycles
HOLD	Hold pattern and clock outputs at this step up to 256 clock cycles
HALT	Stop
GO TO	Go to designated label
CALL	Jump to designated subroutine label
RETURN	Return from subroutine

The program menu allows a pattern to be entered as a sequentially executed program. Instruction steps may be labeled for either program looping or comments, and a strobe or group of strobes can be output at each instruction execution. With pattern depth of 254 vectors, coupled with looping and 16 levels of subroutine nesting, a complex digital circuit can be effectively stimulated without on-board firmware.

To connect the pattern generator output signals to your circuit, you use the P6455 Probe for TTL or MOS signals and the P6456 Probe for ECL signals. Thus, data levels and strobes are programmable over a wide range of values to cover all logic families.

The clocking can be provided either internally from the time base module or externally via the External Clock probe.

To use the generator patterns, you may need to synthesize control signals to strobe the information into the circuit under test. The DAS Pattern Generator provides up to 10 independently programmable strobes that can be delayed in 40 ns increments from the system clock to provide gating signals.

The DAS 9100 Pattern Generator can also be controlled externally by the test circuit in any of three ways. Three external signals from the External Clock probe allow the pattern generator to be made to PAUSE, INHIBIT (tri-state) or INTERRUPT the program sequence and transfer execution to a subroutine pattern.

One of the best features of the DAS 9100 Pattern Generator is that it's easy to use. Since it is contained in your DAS 9100 Mainframe and you program it using the same menu approach as the rest of your DAS 9100 functions, you save time and money in getting your designs up and running. Moreover, you can easily save a complete stimulation acquisition test sequence on tape for later use in evaluation, manufacturing, or service.

**DAS 9100 — Tape Storage Option**

The DAS 9100 includes several optional storage and I/O capabilities. Using these features you can easily store and retrieve instrument set-ups and reference patterns, and remotely control the instrument.



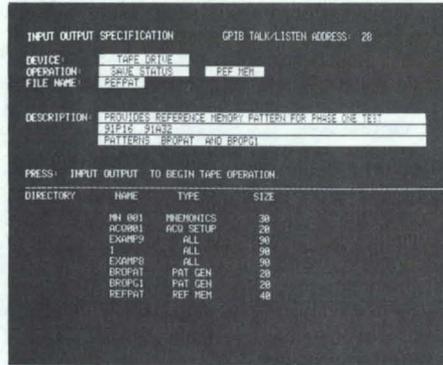
Figure 9. Magnetic Tape Option

The DC 100 magnetic tape storage system, Option 01, (Figure 9) can store a variety of status files from the DAS 9100, as shown in Table IV.

**Table 4. MAGNETIC TAPE FILES**

File Type	Description
Patgen	Pattern Generator Menu and Memory
Define	Define Mnemonics Menu And Mnemonic Tables
Ref Mem	Reference Memory Contents
Data Acq	Channel Spec., Trigger Spec And Timing Diagram Menus
All	All of The Above

The file directory (Figure 10) allows 32 files per cartridge. Each tape can hold 6 ALL files with some space left for other files. Each file includes a header (Figure 10) of up to 180 characters, which you can use for file description or usage instructions.



Figures 10. I/O Menu and File Directory

**DAS 9100 — External Communications Options**

The DAS 9100 Option 02 includes a GPIB interface, RS-232C interface and a composite and remote hard copy video output. These I/O ports provide a variety of useful possibilities for interfacing your DAS 9100.

**GPIB**

The GPIB interface port on the DAS 9100 conforms to the IEEE Standard 488-1978 and to the Tektronix *Standard Codes and Formats*.

Using the English-like commands of the *Codes and Formats*, you can remotely control all of the capabilities of your DAS 9100.

Menus can be programmed, output patterns generated, data acquired and compared with reference patterns, and any results (acquisition memory for example) returned to the controller for further analysis.

The DAS 9100 operates via the GPIB port as either a talker or a listener, and is compatible with controllers such as the Tektronix 4041, 4051, 4052, 4052A 4054, or 4054A.

The controller commands the DAS 9100 to perform all the functions that can be accessed from the DAS 9100 keyboard. LEARN mode allows the user to send individual keystroke sequences to the controller. This mode can be a real timesaver to modify previously stored DAS 9100 setup programs when just a few changes are needed.

**RS-232C**

The first mode using the RS-232C port is essentially the same as the GPIB mode. The controller commands the DAS 9100 to perform the desired functions using the same commands as for GPIB. The RS-232C hardware interface works with standard modems.

**Master-Slave**

The second mode using the RS-232C port is master-slave operation. Using the DAS 9100 console (designated as Master), you can completely control a remote DAS 9100 (designated as Slave).

**Master/Slave**

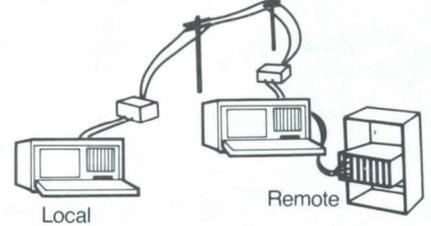


Figure 11. Master/Slave Mode

Any keystroke command that is executed by the Master is transmitted to the Slave and implemented as if the remote user entered it on the Slave's keyboard. Screen contents on the Slave are transmitted automatically to the Master DAS 9100 screen.

For instance, you can use a Master in your engineering lab to control a Slave via telephone lines, thus saving travel and/or time to analyze a tough problem at a remote location.

**Composite Video Output**

The video out jack (Figure 12) is part of Option 02 and provides a composite video signal to drive a video hardcopy unit or an external video monitor.

Recommended hardcopy units are Tektronix 4612 and 4632 Video Copiers, which provide crisp, clear permanent copies of DAS 9100 screen contents.

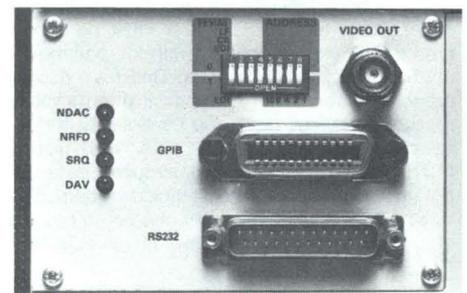
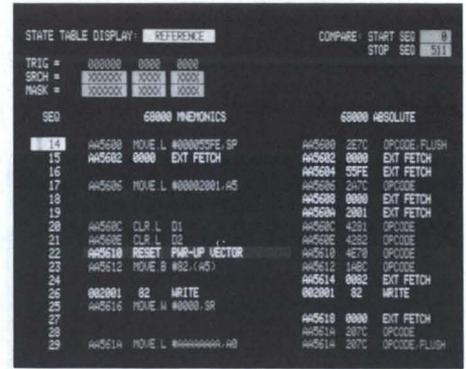


Figure 12. Rear I/O panel Option

**DAS 9100— The Logic Analysis System for You**

The DAS 9100 Digital Analysis System combines powerful data acquisition and pattern generation modules with an easy-to-use human interface to create a unique, state-of-the-art logic analysis system. You select the proper configuration for your present application today and select additional capability for future needs when the need occurs. The optional magnetic tape provides easy storage and recovery of instrument set-ups. And flexible I/O interfacing allows the DAS 9100 to be configured optimally in your environment.



**Software Mode:**  
68000 instructions disassembled and reordered in the order they're executed with unnecessary information suppressed.

**SYSTEM CHARACTERISTICS**

**Dedicated Support**

Twelve Personality Modules in all, supporting processors from three key vendors: Motorola, Intel, and Zilog. Pre-defined disassembly tapes are available for each family of microprocessors.

**Proprietary Support/User Definable Mnemonics**

Up to 64 tables with 256 entries per table, nestable to 16 levels. Multi-byte instructions, extension words, relative addressing, and other processor variables are accommodated. Everything may be stored on a DC 100 tape.

**Three Types of Disassembly**

**Absolute:** Displays all bus information.

**Hardware Disassembly:** Applies mnemonics to all of the bus activity.

**Software Disassembly:** Displays the data as its executed and throws out multiple fetches giving a display just like the original source code.

**Ease of Use**

Labels may be added to specific addresses and/or instructions. Comments may be added to all mnemonics.

**Programmable Color**

Users may define color to all constituents of the disassembly. For example, reads and writes may be colored green, all instructions yellow, and special cases, or illegal opcodes, as red (yellow characters on red background). Color capability requires a color DAS.

**Microprocessor Support**

Support for proprietary microprocessors, bit-slice, gate arrays, and newly announced micros is quickly and easily added by using the DAS 9100's Define Mnemonics capabilities.

**DEDICATED MICROPROCESSOR SUPPORT USING PMA 100**

Vendor	Microprocessor	Personality Module
Motorola	6800	PM 102
Motorola	6802	PM 103
Motorola	6809	PM 111
Motorola	68000	PM 109
Intel	8085	PM 104
Intel	8086	PM 106
Intel	8088	PM 107
Intel	MULTIBUS	PM 112
Zilog	Z80	PM 105
Zilog	Z8001	PM 110
Zilog	Z8002	PM 108
	General Purpose	PM 101

**NEW**

**PMA 100 Personality Module Adaptor**

Links DAS 9100 with the Worlds most Complete Proven Microprocessor Support

Streamlines Microprocessor Software Acquisition and Disassembly for most 8 and 16 Bit Processors

Compatible with all Tek Logic Analyzer PM 100 Personality Modules

Simplifies Probe Connection and Analysis of Data

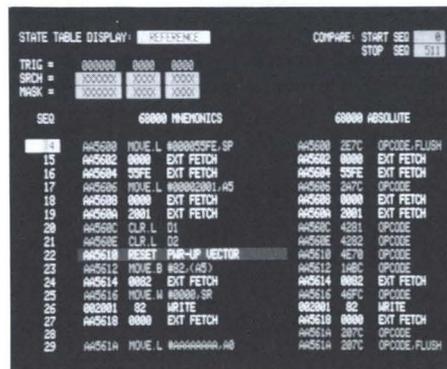
A great many logic analyzer applications involve the analysis of real-time software flow as executed by a microprocessor-based system. In such applications, the logic analyzer must be configured by the user to conform with the parameters of the processor under test. Besides ensuring proper pin connections, this task often involves monitoring various clock and control lines associated with the processor's instruction fetch/execute cycle, so that acquired data can be translated into disassembled mnemonics. When accomplished manually, this setup process often consumes large amounts of valuable labor time.

The new Tektronix PMA 100 Personality Module Adaptor now gives you a highly streamlined setup and disassembly method when testing the software of many popular microprocessors. It links the DAS 9100's data acquisition section with any of Tektronix PM 100 Series personality modules, which fully support a wide variety of 8-and 16-bit processors. Each module plugs directly into the vacant processor socket of the system under test, eliminating the need for individual probe connections. Through the PMA 100 Adaptor, the

personality module configures the DAS 9100 to handle specific software-oriented, data acquisition from the processor under test. This includes items such as bus demultiplexing, clock synthesis, fetch prediction, etc.

Working with the PM 100 Series personality modules, the PMA 100 Adaptor provides the industry's broadest and most thorough support for microprocessor software data analysis. For instance at the 16-bit level, instructions entering the processor's internal queue, but not actually executed, are all flagged when displayed. In addition, each module provides one word of data qualification, which can be specified via the DAS trigger menu.

Once the software test data has been properly acquired and formatted by the personality module, it is transferred to the DAS 9100 acquisition memory through the PMA 100. Here it is fully disassembled using the Define Mnemonics Table, which is set up through data originating from the local DC 100 tape drive. Tektronix has mnemonics tapes available that support all processors covered by the PM 100 Series Personality Modules.



**Hardware Mode:**  
68000 instructions disassembled in order of appearance on the bus displayed simultaneously with absolute data.

## DAS 9100 CHARACTERISTICS

### DATA FORMATTING

**Group Designations** — Up to 16 groups (1 to 32 channels per group).

**Display Order** — Designate group display order for state table.

**Channel Order** — Designated channel order within a group.

**Radix** — Octal, Binary, or Hexadecimal.

**Polarity** — Positive or negative (complement).

**Threshold** — Select TTL or variable.

### USER DEFINABLE MNEMONICS

Up to 64 nestable tables with 256 entries per table. More than sufficient to completely disassemble 8086 and 68000 type processors.

### TRIGGERING

**Trigger** — Synchronous or Asynchronous.

**Trigger Word Position** — Begin, Center, End of Memory.

**Trigger Delay** — 1 to 32,767 clock samples.

**Trigger Word Display** — Hex, Binary, Octal, or mixed radix; any bits allowed as don't care (X).

### Trigger Modes (Word Recognition)

Three Word recognizers

Word one (N) times

Word one FOLLOWED BY word two

Word one THEN NOT word two

RESET on word three

External Trigger Enable (TTL)

Word Recognizer Output (TTL)

91A32 arms 91A08 or 91A04/91AE04

Compare until equal or not equal

### Glitch Recognizer (91A08 only)

Enable by channel

OR'ed with 91A08 trigger word

**Clocks** — Up to four split clocks (multiple 91A32 modules).

**Clock Qualifiers** — Up to seven.

### DATA ACQUISITION DISPLAY MODES

**Screen Size** — 229 mm (9 in) diagonal, displays 24 lines of 80 characters.

### Timing Diagram Features

Simultaneous display of 16 user selectable channels

User definable six-character trace labels for each displayed channel

Data magnification factors from X1 to X10,000

Cursor position and word readout in binary

Search word

Time aligned data display for arming mode

Glitch display select (91A08 only)

Horizontal data scrolling

Memory display window

### State Table Features

Hex, Binary, Octal, or mixed radix

User definable mnemonics displayed by group in acquisition/reference memory displays

Search word

Time-aligned data display for arms mode

Vertical or block scrolling

Cursor position

Up to 512 bits by 96 channels reference memory display, with or without data acquisition display

Reference memory editing

Programmable compare window

Reference memory mask word capability

Compare mode — highlighted and flagged for differences

### KEYBOARD

The DAS 9100 keyboard is divided into four sections for ease of use and functionality. Menu keys, data entry keys, edit and cursor control, and system control keys provides total control at your fingertips.

### DATA ACQUISITION MODULES

#### 91A32 DATA ACQUISITION MODULE

**Maximum Number of Inputs** — 32 data channels, expandable to 96 channels with three modules.

**Maximum Sampling Rate** — 25 MHz with internal or external clock (40 ns cycle time).

**Memory Depth** — 512 bits/channel.

**Data Set-Up Time** — (Period data valid prior to external clock edge) 29 ns, minimum.

**Data Hold Time** — 0 ns, minimum.

**Clock Qualifiers** — Two per module, six maximum, selectable polarity.

**Qualifier Set-Up Time** — 29 ns, minimum.

**Qualifier Hold Time** — 0 ns, maximum.

**Clock** — Internal: 5 ms to 40 ns  $\pm 1\%$   $\pm 1$  ns. External: Up to three external sources. Selectable rising or falling edge.

**Trigger** — 1, 2 and 3 level word recognition arms 91A08 or 91A04.

**Sequence Comparison** — Compare until equal or not equal.  
**Probe** — P6452, four per module. See the Data Acquisition Probes Table.

#### 91A08 DATA ACQUISITION MODULE

**Maximum Number of Inputs** — Eight data channels expandable to 32 channels data with four modules.

**Maximum Sampling Rate** — 100 MHz with internal or external clock (10 ns cycle time).

**Memory Depth** — 512 bits/channel.

**Glitch Storage** — 5 ns minimum glitch width.

**Data Set-up Time** —  $\leq 9$  ns using one 91A08.

$\leq 10$  ns using multiple 91A08 Modules.

**Data Hold Time** — 0 ns, maximum.

**Clock Qualifiers** — One per module, four maximum.

**Qualifier Set-up Time** —  $\leq 9$  ns using one 91A08.

$\leq 10$  ns using multiple 91A08 modules.

**Qualifier Hold Time** — 0 ns, maximum.

**Clock** — Selectable from two internal and two external sources. Internal: 5 ms to 10 ns,  $\pm 1\%$ ,  $\pm 1$  ns. External: Selectable rising or falling edge.

**Trigger** — Word Recognition: Single-level data or glitch word, externally armable (from 91A32 trigger using arms mode).  
Word Width: Up to 32 bits using four modules. Sequence Comparison — Compare until equal or not equal.

**Probes** — P6452, one per module. See Data Acquisition Probes Table.

P6454, one per DAS 9100; external clock for one to four 91A08 modules.

#### 91A04 AND 91AE04 DATA ACQUISITION MODULE

**Maximum Number of Inputs** — Four data channels expandable to 16 channels with four modules; in high resolution mode two channels expandable to eight.

**Maximum Sampling Rate** — 330 MHz with internal or external clock. 660 MHz with internal clock.

**Memory Depth** — 2048 words; 4096 words in high resolution mode.

**Clock** — Internal: 3 ns to 5 ns,  $\pm 5\%$ ; 10 ns to 5 ms.  $\pm 1\%$ . External: From P6453 probe, 330 MHz maximum (1 channel moving), 300 MHz all channels moving. Set Up Time: 3 ns (4 channels or more), 2 ns (single channel). Hold Time: 3 ns (4 channels or more), 0 ns (single channel).

**Trigger** — Word recognition or pattern sequence comparison  
Word Recognition: Single-level data word, externally armable (from 91A32 trigger). Delay: Selectable from 60 to 65541 sample periods after trigger. Pattern-Sequence Comparison: Compare until equal or not equal.

**Probe** — P6453. See Data Acquisition Probes Table.

### DATA ACQUISITION PROBES

CHARACTERISTIC	P6452	P6453	P6454
Module used with	91A32, 91A08 Trigger/Time Base	91A04/91AE04	91A08
INPUTS	8 Data 1 Qualifier 1 GND or Reference	4 Data 1 Clock 5 Reference	1 Clock 1 Reference
Input Impedance without lead set	1 M $\Omega$ $\pm$ 1% 5 pF (NOM)	1 M $\Omega$ $\pm$ 5% 5 pF (NOM)	1 M $\Omega$ $\pm$ 5% 5 pF (NOM)
Operating Input Range	-40 to threshold voltage +10 V not to exceed 40 V (dc + peak ac)	-2 V to +5 V (dc + peak ac)	-2.5 V to +5 V (dc + peak ac)
Threshold Range (Programmable)	-2.5 V to +5 V - TTL -10 V to +20 V - MOS	-2.5 V to +5 V	-2.5 to +5 V
Threshold Accuracy (Ref to Programmed Threshold)	$\pm$ 100 mV $\pm$ 2% - TTL $\pm$ 160 mV $\pm$ 4% - MOS	$\pm$ 50 mV $\pm$ 3%	$\pm$ 50 mV $\pm$ 3%
Sensitivity (Centered on Threshold)	500 mV p-p	700 mV p-p	700 mV p-p
Maximum Non-destructive	$\pm$ 40 V	$\pm$ 25 V	$\pm$ 25 V

\* Lead set adds  $\approx$  5 to 10 pF.

### PATTERN GENERATOR PROBES

CHARACTERISTIC	P6455	P6456
Modules used with	91P16, 91P32	91P16, 91P32
Outputs	8 Data 1 Clock 1 Strobe	8 Data 1 Clock 1 Strobe
Inputs	V <sub>H</sub> - high user supply rail voltage V <sub>L</sub> - low user supply rail voltage	V <sub>H</sub> - high user supply rail voltage V <sub>L</sub> - low user supply rail voltage
Maximum user supply levels	V <sub>H</sub> - $\pm$ 20 V V <sub>L</sub> - -20 V to +5 V V <sub>DIFF</sub> - 25 V	V <sub>H</sub> - $\pm$ 15 V V <sub>L</sub> - $\pm$ 15 V V <sub>DIFF</sub> - 10 V
Output drive current minimum source or sink	3 V <sub>DIFF</sub> to 5 V = 20 mA 5 V to 25 V = 10 mA	50 $\Omega$ load to V <sub>H</sub> - 2 V
Leakage (output inhibited)	<100 $\mu$ A	ECL output in low state
Capacitance	10 pF nominal (lead set adds $\approx$ 10 pF)	10 pF nominal (lead set adds $\approx$ 10 pF)
User current drain maximum	120 mA	V <sub>H</sub> 130 mA V <sub>L</sub> 130 mA V <sub>DIFF</sub> = 5.2 V $\pm$ 5%
Output logic levels	V <sub>OH</sub> > +1.6 V @ 20 mA V <sub>OL</sub> < +0.5 V @ 10 mA; +0.6 @ 20 mA	V <sub>OH</sub> -0.6 V to -1 V V <sub>OL</sub> -1.65 to -2 V with 50 $\Omega$ load to V <sub>H</sub> - 2 V
Logic Family	TTL - MOS	ECL only

**91P16 AND 91P32 PATTERN GENERATOR MODULES**

**Up to 80 Programmable Data Output Channels.**  
**Instruction Set**  
 Count(N) — Increment N values.  
 Goto — Label and output vector (pattern).  
 Hold(N) — Hold output and inhibit clock for N cycles.  
 Repeat(N) — Hold output while generating N clock cycles.  
 Call — Call subroutine.  
 Return — Return from subroutine.  
 Halt — Output vector and inhibit clock.  
**External Control Lines** — From trigger-time/base probe.  
**Interrupt** — Jump to subroutine.  
 Interrupt Input — External clock probe selectable rising or falling edge.  
 Interrupt Setup Time — 7 ns minimum relative to EXT Clock In. 72 ns minimum relative to clock output.  
 Interrupt Processing Delay — Four clock cycles (Response Time).  
**Pause** — Hold temporarily while asserted.  
 Pause Input — Selectable high or low true.  
 Pause Holdtime — 14 ns after pattern external clock transition.  
 Pause Pulse Width — 19 ns, minimum.  
**Inhibit** — Tri-state all outputs while asserted.  
 Inhibit Input — Selectable high or low true.  
 Inhibit Delay Time — 70 ns maximum.

**Pattern Data Width**  
 91P16: 16 parallel channels (two 8-channel probes).  
 91P32: 32 parallel channels (four 8-channel probes).  
 Expandable: 80 ch (one 91P16, two 91P32's & 10 probes).  
**Operating Rate** — 25 MHz maximum (40 ns cycle time).  
**Output Data Skew** — ≤10 ns.  
**Pattern Memory Depth** — 254 instructions or words (virtually unlimited pattern length).  
**Number of Nested Subroutines** — 16 maximum.  
**Number of Labels** — 32 maximum.  
**Number of Strokes** — One stroke per probe, expandable to 10 strokes (three modules, 10 probes).  
**Stroke Start Time** — Selectable from 70 ns to 40.91 μs in 40 ns steps.  
**Stroke Pulse Width** — Selectable from 40 ns to 40.880 μs in 40 ns steps.  
**Stroke Pulse Polarity** — Selectable: positive or negative.  
**Clock Output** — One clock line per probe (rising edge signifies beginning of cycle).  
**Skew Between Different Probe Output Clocks** — ± 5 ns.  
**Clock** — Selectable external or internal.  
 Internal Clock: 40 ns to 5 ms ± 1% ± 1 ns.  
 External Clock: 40 ns min. Cycle time; selectable rising or falling edge.  
 1 clock output per probe.  
**Pause Input** — Selectable high or low true.  
**Probes**  
 P6455 TTL/MOS Pattern Generator Probe.  
 P6456 ECL Pattern Generator Probe. See Pattern Generator Probes Table on previous page.

**TAPE DRIVE OPTION 01 (DC 100 TAPES)**

**Over 160k Bytes**  
 Stores 6 full configuration instrument set-ups  
 Stores 30 full acquisition set-ups  
 Stores 30 pattern generator files  
 Stores 30 define mnemonics files  
 Stores 15 reference memory files  
 Directory space for 32 files

**I/O INTERFACE OPTION 02  
 RS-232**

**Selectable Baud Rates** — 300, 600, 1200, 2400, 4800, 9600.  
**Inputs** — Pin three Received Data.  
 Pin 5 Clear to Send  
 Pin 6 Data Set Ready  
 Pin 8 Data Carrier Detect  
**Outputs** — Pin 2 Transmitted Data.  
 Pin 4 Request to Send  
 Pin 20 Data Terminal Ready  
**Other** — Pin 1 Ground.  
 Pin 7 Signal Ground

**Master/Slave**  
 Remote control of DAS 9100 by a DAS 9100.  
 Full duplex, asynchronous via RS-232 to 9600 baud.

**GPIB**

The Option 02 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*. (Talker and Listener only).

**Capacitive Load Due to this Device** — 100 pF per signal line maximum.  
**Lockout and Remote Lights Provided on Keyboard**  
**Selectable Address**  
**Selectable Controller Type**  
**4 Rear-Panel LED's Provide Observable Handshake Lines**  
 — SRQ, NDAC, NRFID, DAV

**COMPOSITE VIDEO OUTPUT**

**VON** — 1.4 V to 1.6 V.  
**VOFF** — 0.3 V to 0.7 V.  
**VSYNC** — 0 V to 0.1 V.  
**THSYNC** — 63.5 μs ± 0.1 μs.  
**TVSYNC** — 16.5 ms ± 0.1 ms.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	432	17.0
Height	241	9.5
Depth	597	23.5
Weight	kg	lb
Net (without accessories)	22.0	48.0

**Power** — 1,000 VA maximum.  
**Temperature Range** — Operating: 0°C to +50°C. Storage: -40°C to +65°C.  
**Altitude** — Operating: 3000 m (10,000 ft) maximum. Storage: 15 000 m (50,000 ft) maximum.

**ORDERING INFORMATION  
 STANDARD CONFIGURATIONS**

**DAS 9101 Digital Analysis System ... \$12,800**  
 (16 channels at 100 MHz)  
**DAS 9102 Digital Analysis System ... \$14,480**  
 (32 channels at 25 MHz, 16 channels of pattern generation)  
**DAS 9103 Digital Analysis System ... \$18,900**  
 (32 channels at 25 MHz, 8 channels at 100 MHz, 16 channels pattern generation)  
**DAS 9104 Digital Analysis System ... \$30,755**  
 (64 channels at 25 MHz, 16 channels at 100 MHz, 16 channels of pattern generation)  
**Color DAS 9121 Digital Analysis System ... \$15,700**  
 (16 channels at 100 MHz)  
**Color DAS 9122 Digital Analysis System ... \$17,380**  
 (32 channels at 25 MHz, 16 channels of pattern generation)  
**Color DAS 9123 Digital Analysis System ... \$21,800**  
 (32 channels at 25 MHz, 8 channels at 100 MHz, 16 channels pattern generator)  
**Color DAS 9124 Digital Analysis System ... \$33,655**  
 (64 channels at 25 MHz, 16 channels at 100 MHz, 16 channels of pattern generation)

**NOTES:**  
 1 All data acquisition modules, pattern generator modules, and mainframe options are also available for the standard configurations with the exception of those already included in the configuration; i.e. DAS 9104 includes the Option 01 Tape Drive.  
 2 If standard configurations are ordered with additional modules, check that the correct number of power supplies are included.  
 3 The 91A04 modules can share a +5 V power supply only with a 91A32 data acquisition module or an empty bus slot.

**MAINFRAMES**

**DAS 9109 Mainframe ... \$5,500**  
**DAS 9119 Mainframe ... \$5,950**  
 (ATE Version) (Deletes CRT and keyboard; adds Option 02)  
**DAS 9129 Color Mainframe ... \$8,400**

**OPTIONS**

**Option 01** — Tape Drive ..... +\$1,450  
**Option 02** — RS-232C, GPIB and Hardcopy Interface ..... +\$1,150  
**Option 03** — Additional Power Supply ..... +\$800  
**Option 04** — Two Additional Power Supplies ..... +\$1,600  
**Option 05** — Rackmount Hardware ..... +\$200  
**Option 88** — Mainframe shipped with modules installed and checked out as part of the mainframe ..... NC

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC  
**Option A2** — UK 240 V/13A, 50 Hz ..... NC  
**Option A3** — Australian 240 V/10A, 50 Hz ..... NC  
**Option A4** — North American 240 V/15A, 60 Hz ..... NC  
**Option A5** — Switzerland 220 V/10A, 50 Hz ..... NC

**FIELD INSTALLABLE OPTIONS**

**DAS 91F1** — Field Installed Option, DC 100 Tape Drive (Includes installation in Service Center) ..... **\$1,700**  
**DAS 91F2** — Field Installed Option, GPIB Interface, RS-232 Hard copy ..... **\$1,300**

**MODULES**

**91A32 Data Acquisition Module ..... \$4,990**  
 (32 channels at 25 MHz, including probes)  
**91A08 Data Acquisition Module ..... \$4,250**  
 (Eight channels at 100 MHz, including acquisition probes, P6454 Clock Probe required with first module for synchronous operation)  
**91A04 Data Acquisition Module ..... \$7,950**  
 (Four channels at 330 MHz, including probes)  
**91AE04 Data Acquisition Module ..... \$4,950**  
 (Four additional channels at 330 MHz, including probe. Requires 91A04)  
**91P16 Pattern Generator Module ..... \$3,990**  
 (16 channels at 25 MHz, including probes)  
**91P32 Pattern Generator Module ..... \$6,990**  
 (32 channels at 25 MHz, including probes. Requires 91P16)

See Table on page 72 for available PM's.  
**NOTES:**

1. When selecting modules, check that you do not exceed the following maximum numbers of modules or channels per instrument:

TOTAL PER INSTRUMENT	QTY	SPECIAL REQUIREMENTS
Modules	6	
91A32	3	
91A08	4	
91A04	1	
91AE04	3	Requires 91A04
91P16	1	
91P32	2	Requires 91P16
Data Acquisition CH's	104	

2. When adding modules, check that the correct number of power supplies are also selected. The mainframe includes sufficient power for two modules. One additional power supply (Option 03) is required for three or four modules. Two (Option 04) additional power supplies are required for a total of five or six modules.

**PMA 100 Personality Module Adaptor \$3,550**  
 (Includes Motorola tape.)  
**Option 01** — Delete Motorola Disassembly Tape ..... -\$175  
**Option 02** — Delete Motorola Disassembly Tape, add Intel Tape (062-8589-00) ..... NC  
 Additional Intel Tape  
 Order 062-8589-00 ..... **\$225**  
**Option 03** — Delete Motorola Disassembly Tape, add Zilog Tape (062-8591-00) ..... NC  
 Additional Zilog Tape  
 Order 062-8591-00 ..... **\$225**

**ADDITIONAL PROBES**

**P6452 Eight Channel Data Acquisition Probe.**  
 Order 010-6452-01 ..... **\$730**  
**P6453 Four Channel 330 MHz High Speed Data Acquisition Probe.** Order 010-6453-01 ..... **\$1,560**  
**P6454 100 MHz Clock Probe.** Order 010-6454-01 ..... **\$265**  
**P6455 Eight Channel Pattern Generator Probe for TTL/MOS.** Order 010-6455-01 ..... **\$575**  
**6456 Eight Channel ECL Pattern Generator Probe.**  
 Order 010-6456-01 ..... **\$575**

**OPTIONAL ACCESSORIES**

**100A Certified Data Cartridge** from Tektronix (pkg of five).  
 Order 119-1350-01 ..... **\$120**  
**GPIB Cable, two meter.** Order 012-0630-03 ..... **\$90**  
**GPIB Cable, four meter.** Order 012-0630-04 ..... **\$150**  
**RS-232 Cable, two meter.** Order 012-0815-00 ..... **\$55**  
**Hard Copy Unit Cable, 75 ohm, 42 in Coax, BNC.**  
 Order 012-0074-00 ..... **\$17**  
**Hardcopy Unit Cable, 75 ohm, 10 in Coax, BNC.**  
 Order 175-2753-00 ..... **\$13.50**  
**Additional Power Supply.** Order 020-0707-00 ..... **\$750**  
**DAS Set-Up and Hold Calibration Fixture**  
 Order 067-1037-00 ..... **\$1,200**  
**Carrying Case for Probes.** Order 016-0672-00 ..... **\$80**  
**Rackmount Hardware** Order 016-0463-00 ..... **\$200**

For DAS 9100 Series training and other training information, contact your local Sales Office or request a copy of the Tektronix Customer Training Catalog on the return card.

## 308

## Four Analyzers in One

Up to 25 Channels of Word Recognition  
Triggering

Ultra-Portable

Easy to Use

Cost Effective

The 308 is a 20 MHz, four-in-one portable Data Analyzer. It provides parallel timing, parallel state, serial state and signature analysis in an easy to use convenient package.

With the color-coded keyboard you can easily control all the functions of the 308 Data Analyzer.

The 308's unique menu readout displays all of the status and operator mode information on its self-contained CRT. The status information is always displayed as the first line in all modes of operation to provide you with instant identification of what you're doing before, during, and after data acquisitions.

The 308 Data Analyzer provides data acquisition via one eight-channel high-impedance probe (1 M $\Omega$ , 5 pF) for parallel timing and parallel state modes. For serial and signature acquisitions, a single-channel high-impedance probe (10 M $\Omega$ , 13 pF) is used. All four modes are provided with a selectable threshold, TTL or Variable (+12 to -12 V), to allow data acquisitions from any digital logic family.

Input formats are selectable between Hexadecimal, Binary, Octal or Decimal. For the parallel state mode, direct display of acquisition memory is provided in Hex, Binary and Octal simultaneously.

In the Serial State mode the display provides readout in Hex, Binary and ASCII simultaneously, plus parity error indication.

In the parallel timing mode, a unique selectable memory window is provided to allow you to select the section of acquisition memory you wish to view. The window size is programmable for 42, 84, or 168 bits of display width.

A cursor mode is provided for parallel timing, parallel state and serial state that gives word position information with respect to the delayed trigger word. For parallel timing the cursor provides decoding of the timing diagram in any one of the four formats.

The 308 Data Analyzer comes with an 8 x 252 bit reference memory to provide compare and "Restart If" functions. The reference memory "Restart If" function can be used in both parallel modes and the Serial State mode.

The 308 can have up to 16 bits of external word recognition with an optional probe. It provides a word recognizer trigger out signal (TTL) to trigger other external equipment. An external qualifier



DATA ANALYZER

input, selectable for trigger or clock, is provided. When used in conjunction with the eight-channel data probe, plus the word recognizer probe, a total of 25 bits of word recognition for triggering is provided.

The 308 signature analysis portion gives signatures in two different modes, Repeat and Hold. In the Repeat mode, a signature is taken and displayed; once displayed, the 308 takes another signature. This process repeats until the stop key is pressed. In the Hold mode, the 308 allows the acquisition of signatures manually. By pushing the Hold key, the 308 will acquire and simultaneously display up to eight signatures on the screen.

## CHARACTERISTICS

## SIGNAL INPUTS

**Parallel Timing and State** — Multiline probe-tip, eight data lines, one clock and one ground lead.

**Maximum Number of Inputs** — Eight.

**Input Impedance** — 1 M $\Omega$ , 5 pF.

**Logic Swing** — Minimum: 500 mV + 2% of threshold voltage peak-to-peak centered on threshold voltage. Maximum:  $\pm 40$  V or less, to at least threshold voltage. Maximum Nondestructive Input Voltage: -40 V to +40 V.

**Width of Data Input** — Minimum 10 ns, with 400 mV overdrive from threshold voltage.

**Threshold Voltage** — Selectable.

**TTL** — +1.4 V to +0.2 V.

**VAR** — -12 V to +12 V.

**Input Mode** — Selectable.

Sample or Latch (to 5 ns with 500 mV overdrive voltage).

**Serial State** — Single channel probe input.

**Input Impedance** — 10 M $\Omega$ , 13 pF. Nondestructive maximum input voltage 500 V peak at probe tip, 250 peak at BNC input connector.

**Logic Swing** — Minimum: 500 mV + 2% of threshold voltage, peak-to-peak centered about the threshold. Maximum:  $\pm 30$  V peak.

**Selectable Parity** — Odd, Even or None.

**Selectable Bits Per Character** — 5, 6, 7 or 8 bits (includes parity if active).

**Selectable Input Logic** — Positive or negative (at probe tip).

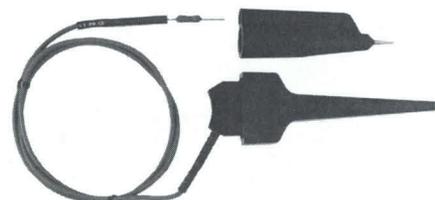
**Synchronizing Word (Synchronous mode only)** — Programmable to require two equal words. If not programmed defaults to ASCII word SYN.

**Hunt Word (Synchronous Mode only)** — Programmable to require one word. If not programmed, defaults to "XXXXXXXX" (Not defined). One Hunt word is equal to three Hexadecimal "FF"s (Line idles).

**Stop Bits (ASYNCR Only)** — Responds to one or more.

## Signature Analyzer

Single channel data input via probe 10X — 10 M $\Omega$ ; 13 pF Clock start, and stop inputs provided by Data Acquisition Probe. Slip-on tip to allow characterization of tri-state bus lines.



## CLOCK

### Parallel Timing and State

**External Clock Period** — 50 ns minimum.

**Pulse Width** — High-Logic Level: 24.5 ns minimum. Low-Logic Level: 24.5 ns minimum.

**Data Setup Hold Time** — 25 ns minimum.

**Data Hold Time** — 0 ns minimum.

**Internal Clock Frequency** — 20 MHz.

**Sample Intervals** —  $\geq 50$  ns to 200 ns/sample in 1-2-5 sequence.

**Data Pulse Width to Ensure Sampling** — 1 sample interval + 10 ns minimum.

### Qualifier Input

#### Selectable-Trigger or Clock

**Input Threshold** — TTL Level +1.4 V  $\pm$  0.2 V.

**Maximum Input Voltage** — -5 V to +10 V peak.

**Serial State** — Synchronous or Asynchronous

**Internal Clock for Asynchronous Mode Selectable Via Keyboard** — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800 and 9600 bits per second (baud rate).

**Internal Clock Accuracy** —  $\pm 0.02\%$ .

**External Clock for Asynchronous Mode** — Up to 9600 baud.

**External Clock for Synchronous Mode** — Up to 9600 baud.

## MEMORY

8 X 252 bits Data Acquisition Memory.

8 X 252 bits Reference Memory.

## TRIGGER

### Parallel Timing & State

Synchronous or Asynchronous.

External Qualifier.

**Data Word Recognizer** — Eight channel, programmable in Hex, Binary, Octal or Decimal.

**External Word Recognizer Probe** — 16 channel, programmable in Hex, Binary, Octal or Decimal.

**Input Threshold** — TTL (+1.4 V +0.2 V).

**Word Recognizer Trigger Out** — TTL level (+1.4 V  $\pm$  0.20).

**Trigger Delay** — Programmable from 0-65535 delay by clocks.

**Data Position** — Selectable in Pretrigger or Posttrigger Positions, First Trigger Mode (Internal Select).

### Serial State

**Data Word Recognizer** — Programmable to require a sequence of two words (or characters).

**External Trigger** — Programmable for one bit 0, 1, or "X".

**Trigger Delay** — Programmable from 0 to 65535 delay by word count (character).

**Data Position** — Selectable for Pretriggering or Posttriggering.

**Framing Error Detection** — When a valid stop bit is not detected, data acquisition is stopped.

## DISPLAY

Status information of the 308 is always displayed at the top of the screen. Also, the menu of the 308 is displayed with all fields visible. In the Serial State the 308 provides an extended menu for additional Serial capabilities.

### Timing Diagram

Programmable Window Memory Size.

Cursor Position Pointer and Word Decode.

Positive or Negative Display Logic.

### Parallel State

Displays Hex, Binary & Octal simultaneously for quick decode. 12 Word Display Table.



**Search Mode** — Inverse video highlighting.

**Compare Mode** — Inverse video highlighting of differences. Positive or Negative Display Logic.

### Signature

Displays the edge selects for clock, start and stop. Also displays each signature taken simultaneously.

Displays a four digit signature.

**Displays Characters** — 0 - 9, A, C, F, H, P, U.

### Serial State

Displays Hex, Binary, & ASCII simultaneously.

12 Word or Character Display.

Search Mode, Inverse Video Display of Word.

Compare Mode; Inverse Video Display of Differences.

Positive or Negative Display Logic.

## PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	237	9.3
Heights	117	4.6
Depth	359	13.9
Weights	kg	lb
Net without probes	3.7	8.0
Net with probes	4.5	10.0

## OTHER CHARACTERISTICS

**Line Voltage Ranges** — 90 V to 132 V ac, 180 V to 250 V ac.

**Line Frequency Range** — 48 to 440 Hz.

**Power** — 40 W maximum.

**Temperature Range** — 0°C to 50°C, operating.

## INCLUDED ACCESSORIES

Accessory pouch (016-0654-00); P6107 Serial Data Probe (016-6107-03); P6451 Active Probe (R Angle Connector), (016-6451-05); power cord (161-0104-00).

## ORDERING INFORMATION

**308 Data Analyzer** ..... \$3,950

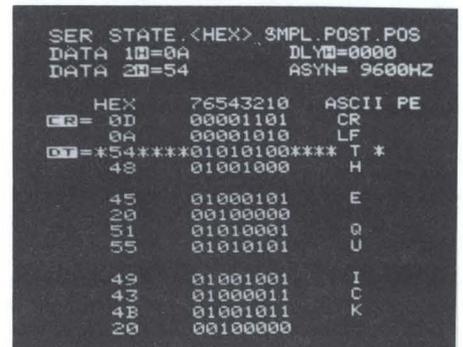
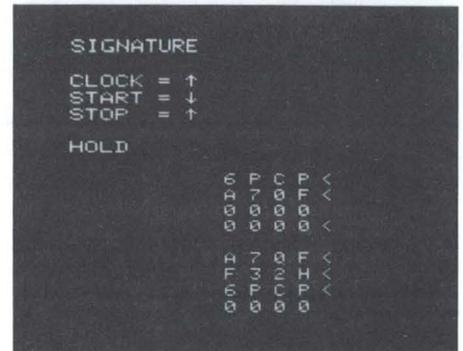
**Option 01** — P6406 Word Recognizer Probe ..... +\$420

**1105 Battery Power Supply** ..... \$1,375

1105 Power Supply provides 1.5 to 2 hours of nominal operation.

**Option 01** — 230 V Operation ..... NC

The SONY®/TEKTRONIX® 308 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo Japan. Outside of Japan the 308 is available from Tektronix, Inc., its marketing subsidiaries and distributors.



Tektronix offers service training classes on the 308 Data Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

## 7D02 Microprocessor Analyzer

Unprecedented Triggering Power in Both the State and Timing Modes of Data Acquisition

Disassembled Mnemonics for Fast, Simplified Interpretation of State Information

Up to 52 Data Channels

A Unique Configurable Menu to Enhance Testing Power

Synchronous (External Clock) and Asynchronous (Internal Time Base) Operation

Configurable to Individual 8 and 16 Bit Microprocessors

The 7D02 Logic Analyzer plug-in can acquire up to 52 channels of state information in the synchronous mode, using the clock of the system under test. The basic instrument contains 28 channels, with an expansion option (03) increasing this to 44. A timing option (01) provides eight additional channels for a total of 52 synchronous channels. Alternatively, the timing option provides eight channels of asynchronous information, using the 7D02's own clock. The state and timing sections can be operated independently, or used as a trigger source for one or the other.

All the 7D02's data acquisition resources are under the control of a unique user language, which allows them to be configured according to the needs presented by a particular situation. Through user programming, almost any combination of resources can be employed to construct specific triggers or data qualifiers.

Synchronous resources include four independent word recognizers up to 48 bits each, two universal time/event counters which can interact with each other and may be reset on the fly, and several modes of clock qualification. Asynchronous resources include a word recognizer, and an 8-channel glitch recognizer with an independent memory.

A series of Personality Modules can adapt the 7D02 to the specific characteristics of individual processors, both 8- and 16-bit. Once data is acquired, it can be displayed in the disassembled mnemonics of the processor in use, as well as Hex, Octal, ASCII and Binary formats. Also available will be a general purpose Personality Module which will enable the user to support those microprocessors not specifically supported by the 7D02, or for other general purpose logic analysis tasks.

### CHARACTERISTICS

#### DISPLAY

**Type** — State Table, raster scan.  
**Format** — 32 characters/line, 24 lines.  
**Channels Displayed**  
 Basic 7D02: 28; (8 Data, 16 Address, 4 Control).  
**Acquisition Memory Locations Displayed** — 19 maximum.  
**Radices Available**  
 Data: ASCII, Hex, Binary, Octal.  
 (Mnemonic disassembly for each supported microprocessor).  
 Address: ASCII, Hex, Binary, Octal.  
 Control: Binary, Mnemonic Disassembly.

#### SIGNAL INPUTS

Signal inputs for the 7D02 are obtained through optional Personality Modules which (along with Option 03) determine the number of input channels available.  
**Input Channels, Basic 7D02** — 35; (8 Data, 16 Address, 10 Control, 1 External Trigger).  
**Input Impedance** — Determined by Personality Module used.  
**External Trigger**  
 Input Impedance: 1 M $\Omega$   $\pm$  2% (compatible with 10X Coded Probe).  
 Threshold: 1.4 V.  
 Setup Time: 10 ns (at BNC).  
 Hold Time: 18 ns (at BNC).

#### CLOCK SYNCHRONOUS ONLY

**Raw Clock Input** — 20 MHz maximum.  
**Time Between Qualified Clocks** —  $\geq$  100 ns.



LOGIC ANALYZERS

**Setup/Hold Time** — Determined by Personality Module used.  
**Number of Qualifiers** — Six maximum (can shift or divide qualified clocks by up to four positions or times).

#### DATA QUALIFICATION

Complex Data Qualification allows the acquisition memory to be turned on and off at any time using Word Recognizers and Counters. This process simulates a large acquisition memory and pattern search capability.

#### MEMORY SIZE (BASIC 7D02)

**Acquisition Memory** — 28 X 256 bytes.  
**Storage Memory** — 28 X 256 bytes.

#### COUNTERS

**Universal Counters** — Two.  
**Counting Mode**  
 Resolution, Time Mode: 1 ms or 1  $\mu$ s.  
 Accuracy:  $(\pm 1 \text{ count}) \times (\text{number of start/stop cycles}) \pm 0.01\%$  of value.  
 Maximum Count: 65,534.  
**Events Mode** — Maximum Count = 65,534.  
**Control Mode**  
 Resolution, Time Mode: 1 ms or 1  $\mu$ s.  
 Minimum Interval Generated: Two.  
 Maximum Interval Generated: 65,534.  
 Generating Interval Accuracy:  $(-0, +1 \text{ count}) \times (\text{number of start/stop cycles}) \pm (0.01\% \text{ of value}) + (0 \text{ to } 0.2 \mu\text{s})$ .  
**Events Mode**  
 Minimum Interval Generated: Two.  
 Maximum Interval Generated: 65,534.

#### WORD RECOGNIZERS

**Word Recognizers:** Four.  
**Channels, Basic 7D02:** 31 (32 if timing option (01) is installed).

#### TRIGGERING

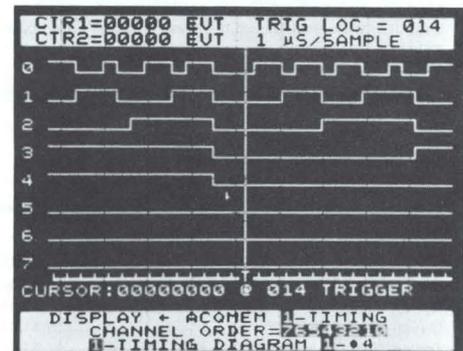
Can be triggered from any of the word recognizers or from either of the counters, in the control mode. (Has ability to track and trigger on very complex program flows).  
**Trigger Position (Number of qualified clocks displayed after the trigger point)**  
 Trigger Before Data: 240.  
 Trigger Centered: 128.  
 Trigger After Data: 16.  
 Zero Delay: Zero.  
**Trigger Output** — TTL compatible (capable of driving a 50  $\Omega$  unterminated transmission line).  
**Accuracy** — One qualified clock + 86 ns  $\pm$  35 ns after event at probe tip.

#### PROCESSOR HALT

The Processor can be halted when the 7D02 stops acquisition.  
**Processor Halt Delay** — Two qualified state clocks after the 7D02 stops acquisition plus Personality Module delay time.

#### OTHER CHARACTERISTICS

**Ac Power**  
 Line Voltage Ranges: Determined by 7000 Series mainframe.  
 Power Consumption: 49 W maximum at nominal line voltage (all options).  
**Size** — Three wide 7000 Series plug-in.  
**Weight** — 3.6 kg (8 lb).  
**Temperature Range** — Operating: 0°C to 50°C. Nonoperating: -55°C to +75°C.  
**Altitude Ranges** — Operating: Sea level to 4500 m (15,200 ft). Nonoperating: 15,000 m (50,000 ft).



7D02 Option 01 Timing Display

Tektronix offers service training classes on the 7D02 Microprocessor Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

**OPTION 01 — TIMING OPTION**

The Timing Option provides the 7D02 user with eight additional channels of asynchronous data acquisition at sample rates of up to 50 MHz.

**SIGNAL INPUTS**

**Number of Channels** — Eight (using a P6451 Data Probe). Input Impedance: 1 MΩ shunted by ≈5 pF.

**Logic Swing** — Minimum: 500 mV +2% of threshold voltage centered on threshold voltage. Maximum: -15 V to at least threshold voltage +10 V. Maximum Nondestruct Input Voltage: -40 V to at least +40 V.

**Threshold Voltage** — Programmable from -6.35 to +6.35 in 50 mV increments.

**Data Setup/Hold Time** — Data Setup: 20 ns. Data Hold: 2 ns.

**CLOCK**

**Asynchronous** — Sample Rates: 20 ns to 5 ms in a 1-2-5 sequence. Accuracy: ±0.01%.

**Synchronous** — Maximum raw input clock frequency: 20 MHz. (Obtained from system under test via the Personality Module). Minimum Time Between Qualified Clocks: 100 ns.

**MEMORY SIZE**

**Acquisition Memory** — 8 X 255 bytes.

**Glitch Memory** — 8 X 255 bytes.

**WORD RECOGNIZERS**

**One Data Word Recognizer** — Eight channels (ANDed together).

**One Glitch Word Recognizer** — Eight channels (ORed together but ANDed with the Data Word Recognizer).

**External Trigger In** — Can function as a word recognizer.

**TRIGGERING**

**Sources** — Timing Option Data Word Recognizer; Timing Option Glitch Word Recognizer; Main Section (7D02) Word Recognizers; External Trigger In.

**DIGITAL DELAY**

**Maximum Delay** — 65,534 sample clocks.

**GLITCH LATCH**

**Pulse Width** — >5 ns. Asynchronous Mode only.

**DISPLAY**

**Timing Diagram Mode** — Number of Channels: Eight. Window Size: 124 words in X1 mode or 31 words in X4 mode. (Data channels can be relocated by the user). Numeric Formats: Hex, Octal, Binary, ASCII. Glitch displayed as a \* in the table beside DATA. Timing Display: Glitches are displayed by an ↑ above the line where the glitch occurred. Maximum Number of Words Displayed: 19. Numeric Formats: Hex, Binary, Octal ASCII. Number of Words Scrolled: 255. Trigger Position Accuracy: ±1-bit (Asynchronous Mode).

**MISCELLANEOUS**

The P6451 Data Acquisition Probe comes standard with an Option 01.

**OPTION 03 — EXPANSION OPTION**

The Expansion Option provides the 7D02 with the ability to support most 16-bit microprocessors.

**SIGNAL INPUTS**

Adds an additional 16 bits to the 7D02. 8 Data, 8 Address.

**WORD RECOGNITION**

**Maximum Number of Channels** — 48; (16 Data, 24 Address, 6 Control, 1 External Trigger, 1 Timing Option (if timing option installed)).

**DISPLAY**

**Maximum Number of Channels** — 44; (16 Data, 24 Address, 4 Control).

**MEMORY SIZE**

**Acquisition Memory** — 44 X 256 bytes.

**Storage Memory** — 44 X 256 bytes.

**ORDERING INFORMATION**

7D02 Logic Analyzer .....	\$4,800
Option 01 — Timing .....	+\$2,000
Option 7D02F01 — Timing, Field-Installed .....	\$2,350
Option 03 — Expansion .....	+\$1,300
Option 7D02F03 — Expansion, Field-Installed .....	\$1,500

**OPTIONAL ACCESSORIES**

Hardware Kit, electrical equipment (fits any 7600 or 7400 mainframe). Order 016-0669-00 .....	\$10
Service Maintenance Kit Order 067-0939-00 .....	\$750

The 7D02 has a configurable menu. This example, useful for Debugging Real-Time μP Programs, will trigger if Address F820 is NOT FOUND within 100 ms of the occurrence of Address B000.

All test parameters supplied by prompts.

IF clause defines a data stream event, which may be either single or compound.

The 7D02 may simultaneously monitor up to 4 Word Recognizers and 2 Counters.

THEN clause defines a response to the event, in this case, setting counter #1 to zero and then incrementing every millisecond.

At the same time the counter is set, branch to the second test (bracketing allows simultaneous actions).

```

TEST 1
1 IF
1 WORD RECOGNIZER # 1
1 DATA=XX
1 ADDRESS=B000
1 /NMI=XX /IRO=XX FETCH=XX R/W=XX
1 BA=XX INUAL OP=XX EXT TRIG IN=XX
1 TIMING WR=XX
1 THEN DO
1 COUNTER # 1 2-MS
1 2-RESET AND RUN
1 GOTO 2
1
END TEST 1
TEST 2
1 IF
1 WORD RECOGNIZER # 2
1 DATA=XX
1 ADDRESS=F820
1 /NMI=XX /IRO=XX FETCH=XX R/W=XX
1 DISPLAY ← PROGRAM
    
```

Sequential Activities are monitored using multiple "tests".

The 7D02 now monitors the data stream for an event to satisfy the second test's IF clause.

If the event occurs, then branch back to test #1 and start the program over. Concurrent measurements are in the same test.

Or if counter #1 has reached 100 ms, then activate the trigger.

```

END TEST 1
TEST 2
3 IF
3 WORD RECOGNIZER # 2
3 DATA=XX
3 ADDRESS=F820
3 /NMI=XX /IRO=XX FETCH=XX R/W=XX
3 BA=XX INUAL OP=XX EXT TRIG IN=XX
3 TIMING WR=XX
3 THEN DO
3 GOTO 1
OR IF
3 COUNTER # 1 = 00100 2-MS
3 THEN DO
3 TRIGGER 0-MAIN
3 0-BEFORE DATA
3 0-SYSTEM UNDER TEST CONT.
3 0-STANDARD CLOCK QUAL.
END TEST 2
DISPLAY ← PROGRAM
    
```

By using the proper personality module, software flow can be displayed using the mnemonics of the chip under test, here the Motorola MC6802.

LOC	ADDRESS	OPERATION	/IRO/NMI
0010	F8004	BNE	\$F820 11
0011	F8005	FB	READ \$F820 11
0012	F8000	INC	\$0006 11
0013	F8000	00	READ 11
0014	F8000	00	READ 11
0015	00000	00	READ 11
0016	00006	03	WRITE 11
0017	F8000	BEQ	\$F865 11
0018	F8000	04	READ 11
0019	F8001	TST	\$0004 11
0020	00000	00	READ 11
0021	F8000	04	READ 11
0022	F8004	07	READ 11
0023	F8004	BNE	\$F820 11
0024	F8005	FB	READ 11
0025	F8000	INC	\$0006 11
0026	F8000	00	READ 11

DISPLAY ← ACQMEM 0-MAIN  
 1-MNEMONIC  
 0 ABSOLUTE  
 1 MNEMONIC

## DAS 9100 And 7D02 MICROPROCESSOR SUPPORT

Tektronix will support all popular microprocessors with the DAS 9100 (using the PMA 100) and 7D02. The following support is now available.

Microprocessor Type	Support Features*	Personality Module Available
<b>8-BIT</b>		
8080	FM, DM	PM 101 OPT 01
8085	FM, P-C, DM	PM 104
Z80	FM, P-C, DM	PM 105
6800	FM, P-C, DM	PM 102
6802/6808	FM, P-C, DM	PM 103
6809/6809E	FM, P-C, DM	PM 111
6502	FM, DM	PM 101 OPT 02
1802	STD, DM	PM 101 and 062-6001-00 (Application Manual)
8031	STD, DM	PM 101 and 062-6003-00 (Application Manual)
8039/8035	STD, DM	PM 101 and 062-5999-00 (Application Manual)
8048/8049	STD, DM	PM 101 and 062-5999-00 (Application Manual)
8051	STD, DM	PM 101 and 062-6003-00 (Application Manual)
8748	STD, DM	PM 101 and 062-5999-00 (Application Manual)
8751	STD, DM	PM 101 and 062-6003-00 (Application Manual)
6801/6803	STD, DM	PM 101 and 062-6000-00 (Application Manual)
<b>16 BIT</b>		
8086	FM, P-C, DM	PM 106
8088	FM, P-C, DM	PM 107
Z8001	FM, P-C, DM	PM 110
Z8002	FM, P-C, DM	PM 108
68000	FM, P-C, DM	PM 109
9900 TMS/SBP MULTIBUS*	STD, DM CM, STD, P-C, DM	PM 101 and 062-6002-00 (Application Manual) PM 112

\*FM — Full Mnemonic Disassembly      P-C — Pre-Configured,      STD — Standard Radices  
 CM — Control Mnemonics              Single Plug, Interconnection      (Hex, Binary, Octal)  
 DM — Mnemonics may be developed using DAS Define Mnemonics

For those 8-Bit and 16-Bit microprocessors not currently supported by specific personality modules, and for general purpose applications, the PM 101 General Purpose Personality Module or DAS Define Mnemonics capabilities are available. See Data Sheet AX-4489 for details on PM 101.

\* MULTIBUS is a registered trademark of Intel Corp.

### PM 100 Series

#### Microprocessor Personality Modules

The PM 100 Personality Modules are high performance data acquisition modules designed to interface specific microprocessors to the 7D02 and PMA 100/DAS 9100 Digital Analysis System.

PM 102 through PM 112 interface with the system under test through a single plug for error free connection. The interface to the logic analyzer is also a single plug for easy change of processor type.

The modules, operating synchronously with the system under test, demultiplex busses, synthesize signals necessary to track processor status, and transfer data to the logic analyzer memory. A synthesized control function allows triggering or data qualification on instruction fetches. The Personality Module also provides full mnemonic disassembly and formatting for the display.

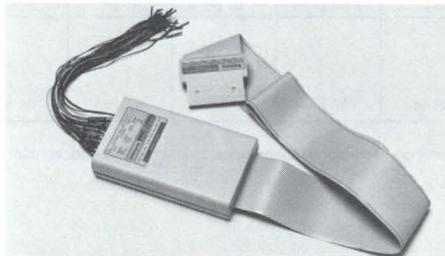
When used with the 7D02, word recognizer displays are formatted in the mnemonics of the processor control signals. The processor may be halted by the personality module when the 7D02 triggers.

#### COMMON CHARACTERISTICS

**Operating Temperature** — -15°C to +55°C except for PM 109 which is 0°C to +50°C.  
**Storage Temperature** — -62°C to +85°C except for PM 109 which is -55°C to +75°C.  
**Operating Altitude** — 4.5 km (15,000 ft).  
**Storage Altitude** — 15 km (50,000 ft).

	PHYSICAL CHARACTERISTICS					
	PM 101,102,103 104,105,108		PM 106,107 109,111		PM 112	
<b>Dimensions</b>	mm	in	mm	in	mm	in
Width	120	4.7	120	4.7	170	6.7
Height	170	6.7	48	1.9	157	6.2
Depth	203	8.0	203	8.0	305	12.0
<b>Weights</b>	kg	lb	kg	lb	kg	lb
Net	1.2	2.6	1.2	2.6	1.2	2.6

**Cable Lengths from Module to 7D02** — 1.22 m ± 25 mm.  
**Module to μp** — 330 mm ± 12 mm. (Except for PM 101 which is 350 mm ± 13 mm and PM 111 which is 470 mm ± 1.3 mm).  
 PMA 100 or DAS 9100



### PM 101 General Purpose Personality Module

#### Data Acquisition and Display Formatting for any Type of 8- or 16-bit Microprocessor

The PM 101 Personality Module offers data acquisition capabilities designed to fit any type of synchronous digital system including those with 8- or 16-bit microprocessors.

### SYSTEM CHARACTERISTICS SETUP/HOLD TIMES\*

**Clock/Qualifier Inputs** — Setup: 55 ns maximum. 35 ns typical. Hold: 0 ns maximum.

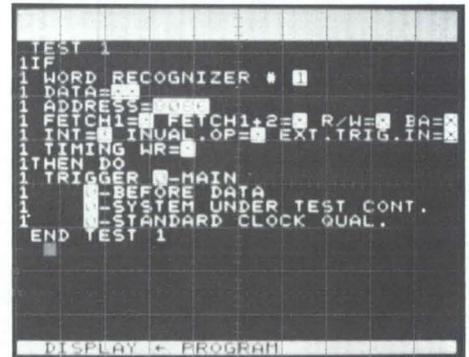
**Address and Data Inputs** — Setup: 45 ns maximum. 25 ns nominal. Hold: 0 ns maximum.

\*PMA 100 adds 5 ns maximum to setup time.

### ORDERING INFORMATION

PM 101 ..... \$1,400  
 Option 01 — 8080 Mnemonics ..... +\$300  
 Option 02 — 6502 Mnemonics ..... +\$300

### PM 102 6800 Personality Modules PM 103 6802 Personality Modules



PM 103 Default Trigger Menu



PM 103 Mnemonic Display

### SYSTEM CHARACTERISTICS SETUP AND HOLD TIMES

**Data Inputs** — Setup: 40 ns maximum. Hold: 0 ns maximum.

### ORDERING INFORMATION

PM 102 ..... \$1,400  
 PM 103 ..... \$1,400

**MICROPROCESSOR PERSONALITY MODULE SPECIFICATION SUMMARY**

MODULE	PM 101	PM 102	PM 103	PM 104	PM 105	PM 106	PM 107	PM 108	PM 109	PM 110	PM 111	PM 112
<b>Processors Supported</b>	<b>General Purpose Logic Analysis Including 8 &amp; 16 Bit <math>\mu P^{*1,2}</math></b>	<b>6800 68A00 68B00</b>	<b>6802 68A02 6808</b>	<b>8085 8085A 8085A-2</b>	<b>Z-80 Z-80A Z-80B</b>	<b>8086 8086-2 8086-4</b>	<b>8088</b>	<b>Z8002</b>	<b>68000L4 68000L6 68000L8 68000L10</b>	<b>Z8001 Z8001A</b>	<b>6809, 68A09 68B09 6809E 68A09E 68B09E</b>	<b>MULTIBUS<sup>6</sup></b>
Required number of Channels DAS 9100		28	28	28	28	44	44	44	44	44	28	44
Required 7D02 Option 03	44 Stored Channels 7D02 w/Option 03 28 without	NO	NO	NO	NO	YES	YES	YES	YES	YES	NO	YES
<b>SIGNAL INPUTS</b>	w/Option 03											
Address	24	16	16	16	16	20	20	16	24	16	8	7D02 w/Opt 05 24 max
Data	16	8	8	8	8	16	8	16	16	16	16	24 max
Control	10	9	9	10	10	15	15	15	10	17	9	16 max 16
Impedance (nominal)	1/2 LSTTL 25 pF	1/2 LSTTL 40 pF	1/2 LSTTL 40 pF	1/2 LSTTL 40 pF	1/2 LSTTL 40 pF	1/2 LSTTL 40 pF	1/2 LSTTL 40 pF	1/2 LSTTL 37 pF	1 LSTTL 70 pF	1/2 LSTTL 40 pF	1/2 LSTTL 40 pF Except PHALT 1-LSTTL	1/2 LSTTL 35 pF
$V_{in}$ low min/max	0 V/ 0.5 V	0 V/ 0.6 V	0 V/ 0.6 V	0 V/ 0.6 V	0 V/ 0.6 V	-0.5 V/ +0.5 V	-0.5 V/ +0.5 V	0 V/ 0.5 V	-0.5 V/ +0.5 V	0 V/ 0.5 V	0 V/ 0.6 V	-0.5 V/ 0.6 V
$V_{in}$ high min/max	2.4 V/ 7 V	2.0 V/ 7.0 V	2.0 V/ 7.0 V	2.0 V/ 7.0 V	2.0 V/ 7.0 V	2.0 V/ 7.0 V <sup>*3</sup>	2.0 V/ 7.0 V <sup>*3</sup>	2.4 V/ 7.0 V	2.0 V/ 5.5 V	2.0 V/ 7.0 V	2.0 V/ 7.0 V	2.0 V/ 5.5 V
Maximum Input Non-destructive	-7 V to +15 V	$\pm 15$ V	$\pm 15$ V	-7 V to +15 V	-7 V to +15 V	-5 V to +7 V <sup>*4</sup>	-5 V to +7 V <sup>*4</sup>	-7 V to +15 V	-7 V to +15 V	$\pm 7$ V	-7 to +15 V	-0.5 to 5.5 V
Threshold Voltage Hysteresis (nominal)	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V	1.4 V
DISPLAYED CHANNELS	7D02 w/Option 03											
Address	24	16	16	16	16	20	20	16	24	16	16	7D02 w/Opt 03 24 max
Data	16	8	8	8	8	16	8	16	16	16	8	24 max
Control	4	R/W, NMI, IRQ, FETCH	R/W, NMI, IRQ, FETCH	R/W, I/O MEM, INTRQ (any interrupt) IFC (FETCH)	R/W, (INTER REQ), I/O MEM, FETCH	(see text)	(see text)	R/W, I/O MEM, INTREQ, IFC, (FETCH)	(see text)	(see text)	R/W, /IFC, (/IFC + IFC2), INT	16 max 4
<b>CLOCK</b>												
Maximum Input Frequency	20 MHz (100 ns min between Qualified Clocks)	2 MHz	6 MHz	10 MHz	6 MHz	8 MHz	5 MHz	4 MHz	10 MHz	6 MHz	8 MHz	5 MHz
Minimum Pulse Width-High/Low	25 ns/ 25 ns	180 ns/ 180 ns	180 ns/ 180 ns	70 ns/ 40 ns	70 ns/ 70 ns	1/3 Clock Period + 2ns/ 2/3 Clock period - 15 ns		105 ns/ 105 ns	44 ns/ 44 ns	70 ns/ 70 ns	220 ns/ 210 ns	50 ns/ 50 ns
Input Impedance (nominal)	50 k $\Omega$ 15 pF	50 k $\Omega$ 35 pF	50 k $\Omega$ 35 pF	50 k $\Omega$ 40 pF	50 k $\Omega$ 40 pF	50 k $\Omega$ 40 pF	50 k $\Omega$ 40 pF	50 k $\Omega$ 37 pF	50 k $\Omega$ 70 pF	50 k $\Omega$ 40 pF	50 k $\Omega$ 35 pF	1/2 LSTTL 35 pF
<b>PROCESSOR HALT DELAY</b>												
2 Qualified Clock Cycles Plus ....	58 ns	90 ns	90 ns	63 ns	60 ns	80 ns <sup>*5</sup>	80 ns <sup>*5</sup>	65 ns	50 ns	73 ns	73 ns	58 ns <sup>*5</sup>

For complete information and data sheets on microprocessor analysis products described, contact your nearest Tektronix Sales Office.

\*1 Option 01 8080 mnemonics

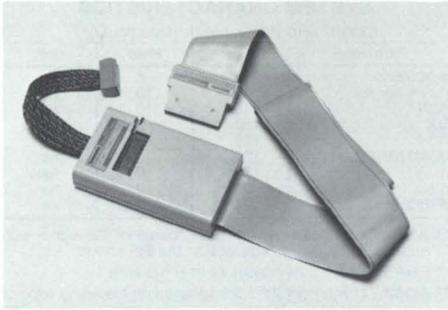
\*2 Option 02 6502 mnemonics

\*3 Except minimum/maximum, HOLD, Reset, 2.0 to 5.5 V.

\*4 Except minimum/maximum, HOLD, Reset, -1 to +5.5 V.

\*5 Requires user modification to enable.

\*6 MULTIBUS is a registered trademark of Intel Corp.



**PM 104 8085 Personality Module**

**SYSTEM CHARACTERISTICS**  
SETUP/HOLD TIMES\*

**Data and Address Inputs** — Setup: 50 ns maximum. Hold: 0 ns maximum.

**ALE Input** — Setup: 40 ns maximum. Hold: 0 ns maximum.

**HOLD Input** — Setup: 120 ns (measured to trailing edge of CLK, t<sub>2</sub>, or TWAIT). Hold: 0 ns.

**READY Input** — Setup: 135 ns maximum (referenced to rising edge of T<sub>2</sub>). Hold: 0 ns.

\*PMA 100 adds 5 ns maximum to setup time.

Order PM 104 ..... \$1,400

**PM 105 Z-80 Personality Module**

**SYSTEM CHARACTERISTICS**  
SETUP AND HOLD TIMES (MAXIMUM)

Parameter	Setup*	Hold	Units
Address 0-15	50	5	ns
Data 0-7	35*1	10*1	ns
M1	39	18	ns
MREQ	22*2	0*2	ns
IORQ	22*2	0*2	ns
WR	90*1	5*1	ns
BUSAK	46	4	ns
HALT	46	4	ns
INT	35*3	4*3	ns
NMI	74	0	ns
WAIT	50*4	0*4	ns

\*PMA 100 add 5 ns maximum to setup time.

\*1 Relative to rising edge of clock on T3 for M1 cycle or to the trailing edge of T3 for memory or I/O cycles.

\*2 Relative to rising edge of clock on T1 for MREQ and to rising edge of clock on TW for IORQ.

\*3 Relative to rising edge of the clock of the last T state prior to an M1 cycle.

\*4 Relative to trailing edge of the clock of T2 state for a memory cycle or to TW for an I/O cycle.

Order PM 105 ..... \$1,400

**PM 106 8086 Personality Module**

**PM 107 8088 Personality Module**

When used with the Tektronix 7D02 Logic Analyzer, the PM 106/PM 107 solves the major problem encountered when debugging an 8086/8088 based design; that is understanding what is happening in the instruction queue. The logic analyzer acquires all the information transmitted across the data bus. Queue status is decoded to determine which instructions were actually executed and which were fetched but not executed.



This 8086 mnemonic display shows disassembled instructions entering the 8086 queue. In this illustration instructions that enter the queue but are not executed are flagged with question marks. Operands for which there is no data (as when the instruction is flushed before the operand is retrieved) are marked with asterisks. (7D02 Display)



8086 State Table Display (7D02 Display)

**SYSTEM CHARACTERISTICS**

MAXIMUM SETUP AND HOLD TIMES  
(Minimum and Maximum Modes)

Parameter	Setup	Hold	Units	Notes
Address	45	20	ns	Relative to falling edge of ALE
Data	30	0	ns	Relative to falling edge of clock on T <sub>4</sub> state
Ready	80	0	ns	Relative to falling edge of clock at T <sub>3</sub> or T <sub>4</sub> TRYLCL, TRYHCH, TCHRYX

All Maximum Mode Status Lines, Series Resistance: 10 Ω additional.

\*PMA 100 add 5 ns maximum to setup time.

SIGNAL TIMING, MINIMUM MODE (Synthesized)

Parameter*	Typical	Max	Min	Units
ALE falling edge (TCHLL)	40	55*1	-	ns
ALE width (TLHLL)	-	-	60	ns
M/I/O (TCHCTV)	33	110	-	ns
INTA (TCHCTV)	68	110	-	ns
DT/R (TCHCTV)	*2	*3	-	ns
DEN (TCVCTV) (TCVCTX)	63	80	-	ns
WR (TCVCTV) (TCVCTX)	45	80	-	ns
HLDA	*4	*5	-	ns

\*Names given by Intel 8086 Users Manual.

\*1 0 ns after falling edge of clock for T2 cycle.

\*2 Clock high width plus 33 ns.

\*3 Clock high width plus 100 ns.

\*4 Equal to or greater than 1 clock width plus 33 ns.

\*5 Greater than 1 clock width plus 100 ns.



8086 Default Trigger Menu (7D02 Display)

Control Name and Function	Stored	Word Recog	Clock Qualifier
C0 R/W [LST-F]. When C2 is low, C0 indicates R/W status - when C2 is high C0 denotes when the last byte out of the instruction queue was the first byte of an executed instruction.	X	X	
C1 M/I/O [2LS F]. When C2 is low, C1 indicates whether present operation is a memory or input-output access. When C2 is high, C1 goes high, when the second to the last byte of the instruction queue was the first byte of an executed instruction.	X	X	
C2 Code fetch goes to a high whenever an instruction is being fetched.	X	X	
C3 IRQ - is the combination of INTR and NMI	X	X	
C4 Min/max indication		X	X
C5 HOLD Acknowledge		X	X
C6/Code fetch			X
C7 HOLD acknowledge line provides visual indication of a HOLD acknowledge condition on the screen when 7D02 is running			X
C8 Machine state (T1)			X
C9/Wait			X

A20-23 provide queue level information and BHE.

**ORDERING INFORMATION**

PM 106 ..... \$1,800  
Option 01 — With Service Test Unit ..... +\$500

PM 107 ..... \$1,800  
Option 01 — With Service Test Unit ..... +\$500

Or Service Test unit may be ordered separately:  
without power supply Order 067-1024-00 ..... \$500

**PM 108 Z8002 Personality Module**

**SYSTEM CHARACTERISTICS**

SETUP AND HOLD TIMES (MAXIMUM)

Parameter	Setup*		Hold		Units
	Min	Max	Min	Max	
Address 0-15	—	34*3	—	0	ns
Data 0-15	—	40*1	—	0	ns
READ/WRITE	—	40*1	—	0	ns
IO/MEM	—	40*1	—	0	ns
INTREQ	160*2	—	—	—	ns
IFC	—	40*1	—	0	ns
/BUSAK	—	40*1	—	0	ns
/MREQ	—	40*1	—	0	ns
/RESET	—	40*1	—	0	ns
/PHALTED*	—	40*1	—	0	ns
/AS	—	40*1	—	0	ns
/WAIT	—	—	—	—	ns

\*PMA 100 adds 5 ns maximum setup time.

\*1 Referenced to falling edge of T3.

\*2 Latched at falling edge of T2. Held until cleared by interrupt acknowledge cycle.

\*3 Latched at rising edge of /AS.

\*The "OR" of Z8002 stopped and 7D02 HALT.

Order PM 108 ..... \$1,800

### PM 109 68000 Personality Module

The PM 109 solves the major problem in debugging 68000 based systems by flagging prefetched but unexecuted instructions.

#### SYSTEM CHARACTERISTICS SETUP AND HOLD TIMES (MAXIMUM) (With Respect to Falling Edge of Clock)

Parameter	Setup*	Hold	Units
Address	45	20	ns
Data	25	20	ns
/UDS	45	20	ns
/IPL0/IPL1/IPL2	50	0	ns
/DTACK	30	20	ns
/HALT	40	0	ns
/AS	30	20	ns
/BGACK	40	20	ns
/Reset	20	20	ns
R/W	15	20	ns

\*PMA 100 adds 5 ns maximum to setup time.

Control Name and Function	Stored	Word Recog	Clock Qualifier
C0 (FL-IACK) LDS	X	X	
C1 (OPC/EXT) R/W	X	X	
C2 (Fetch)	X	X	
C3 SUPER/USER	X	X	
C4 /BGACK	X	X	X
C5 /INTR		X	*
C6 /AS			X
C7 /HALT			X
C8 /DTACK			*
C9 /AS sampled			X

\* Not recommended that these lines be used for clock qualification.

#### ORDERING INFORMATION

PM 109 .....	\$2,000
Option 01 — With Service Test Unit .....	\$1,200
Or the Service Test Unit can be ordered separately: Order 067-1025-00 .....	\$1,200

### PM 110 Z8001 Personality Module

#### SYSTEM CHARACTERISTICS SETUP AND HOLD TIMES (MAXIMUM)

	Setup* <sup>1</sup>	Hold	
Data	32 ns	3 ns	Relative to the falling edge of clock at T3
Address	15 ns	23 ns	Relative to rising edge of AS
SN0-SN6 (segment inputs)	25 ns	25 ns	Relative to rising edge of AS
N/S (normal /system)	86 ns	0 ns	Relative to the falling edge of the clock at T3
AS	78 ns	* <sup>2</sup>	Relative to the rising edge of the clock at T2
R/W	65 ns	0 ns	Relative to the rising edge of the clock at T2
ST0 - ST3	65 ns	0 ns	Relative to the rising edge of the clock at T2
Wait	55 ns	24 ns	Relative to the trailing edge of the clock at T2 or TWA for memory or I/O cycles, and at TWA3 or TWA5 for acknowledge cycles
MO,BUSAK	85 ns	0 ns	Relative to the trailing edge of the clock at T3
VI,NVI	110 ns	0 ns	Relative to the trailing edge of the clock at T3
SEGT	85 ns	0 ns	Relative to the trailing edge of the clock at T3
NMI	110 ns	* <sup>3</sup>	

<sup>1</sup> PMA 100 adds 5 ns maximum to setup time.

<sup>2</sup> Minimum pulse width = 42 ns.

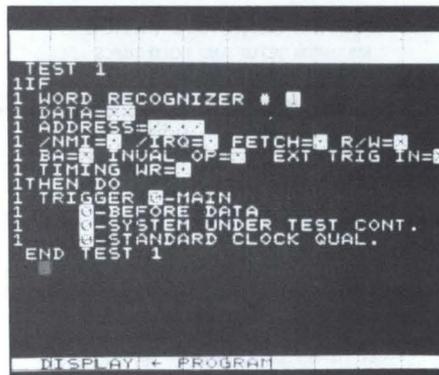
<sup>3</sup> Minimum pulse width = 28 ns.

Control Name and Function	Stored	Word Recog	Clock Qualifier
N/S Normal/System	X	X	
C0 Encoded - Read/Write - Low on writes, refresh and Interrupt ACK cycles	X	X	
C1 Encoded - High on I/O, Interrupt ACK and Fetch n. Low on memory, Fetch 1, EPA transfer, reserved internal operation and refresh cycles	X	X	
C2 Encoded - High on Fetches, Interrupt ACK and refresh cycles	X	X	
C3 Interrupt request - combined NMI, VI, NVI and SEGT(active high)	X	X	
C4 Low on EPA, EPN and /MO read or write cycles		X	X
C5 True Z8001 R/W signal		X	X
C6 Low on internal operations, refresh and bus acknowledge cycles			X
C7 Halt-Low indicates the processor is halted. The PM 110 uses the processor/stop signal and the Z8001 continues to execute refresh cycles			X
C8 /Wait - used to qualify out wait states			X
C9 General clock qualifier - generated by the PM 110 (active high)			X

Order PM 110 ..... \$1,800

### PM 111 6809/6809E Personality Module

The Tektronix PM 111 Personality Module is a dedicated acquisition module designed for use with 6809 microprocessor-based systems. By using the convenient Tektronix Low Profile Dip Clip Adaptor, the PM 111 will also support the 6809E-based systems.



6809 Default Trigger Menu (7D02 Display)



6809 Mnemonic Display (7D02 Display)

### SYSTEM CHARACTERISTICS

#### SETUP AND HOLD TIMES (MAXIMUM)\*<sup>1</sup>

Parameter	Setup* <sup>2</sup>	Hold	Unit
ADDRESS	220	0	ns
DATA	40	10	ns
R/W	140	0	ns
BA	190	0	ns
BS	160	0	ns
/(BMA/BREQ)	120	0	ns
/NMI	155* <sup>3</sup>	0	ns
/IRQ	95* <sup>3</sup>	0	ns
/FIRQ	95* <sup>3</sup>	0	ns

\*<sup>1</sup> All lines are measured from the source of the signal with respect to the falling edge of E at the ZIF socket.

\*<sup>2</sup> PMA 100 adds 5 ns maximum to setup time.

\*<sup>3</sup> All PM 111 Interrupt lines are sampled on the falling edge of E in contrast to the Motorola spec of sampling on the falling edge of Q.

Control Name and Function	Stored	Word Recog	Clock Qualifier
C0 READ/WRITE	X	X	
C1 /IFC	X	X	
C2 /(IFC + IFC2)	X	X	
C3 INT	X	X	
C4 BA	X	X	X
C5 /IOCO		X	*
C6 /VMA			X
C7 (HALT) • (DMA/BREQ)			X
C8 DMA + DEAD			X

\* This line useful for word recognition only; not recommended for clock qualification purposes.

#### ORDERING INFORMATION

PM 111 .....	\$1,600
40 Pin Low Profile Dip Clip Adaptor 100 mm Version Order 015-0339-00 (Recommended) .....	\$42
Female Adaptor Order 380-0647-01 .....	\$30
40 Pin Dip Socket Order 136-0623-00 .....	\$2.40

**NEW**

### PM 112 MULTIBUS Personality Module

The PM 112 plugs into the MULTIBUS\* card cage. It supports up to 16-bit data transfers and up to 24-bit addresses. Eight user-defined control lines allow monitoring of all significant signals on or off the bus. When the bus is making an 8-bit transfer, the upper eight bits of the data word are used to store user strappable data, address, or control functions. A manual clock allows acquisition of the state of a "stuck" bus. The built-in extender function allows use on a "full" card cage. PM 112 conforms to IEEE Standard P796.

\* MULTIBUS is a registered trademark of Intel Corporation.

#### SYSTEM CHARACTERISTICS

##### SYSTEM WORST-CASE SETUP HOLD TIMES WITH 7LD02

Parameter	Setup* <sup>1</sup>	Hold	Units	Notes
Data	0	35	ns	* <sup>2</sup>
Address	-5	55	ns	* <sup>2</sup>
UDC lines	-5	55	ns	* <sup>2</sup>
/MRDC,/MWTC /IORC,/IOWC /INTA	0	35	ns	* <sup>2</sup> , 30 ns, typ
/BHEN	-5	55	ns	* <sup>2</sup>
/INT0-/INT7	50	45	ns	* <sup>2</sup>
/INH1,/INH2	10	50	ns	* <sup>2</sup> , Word Rec
/INH1,/INH2 /LOCK, ACLO	30	35	ns	* <sup>2</sup> , Clock Qual
CBRQ	25	35	ns	* <sup>3</sup>
Timing Option	-5	65	ns	* <sup>2</sup> ,* <sup>3</sup>

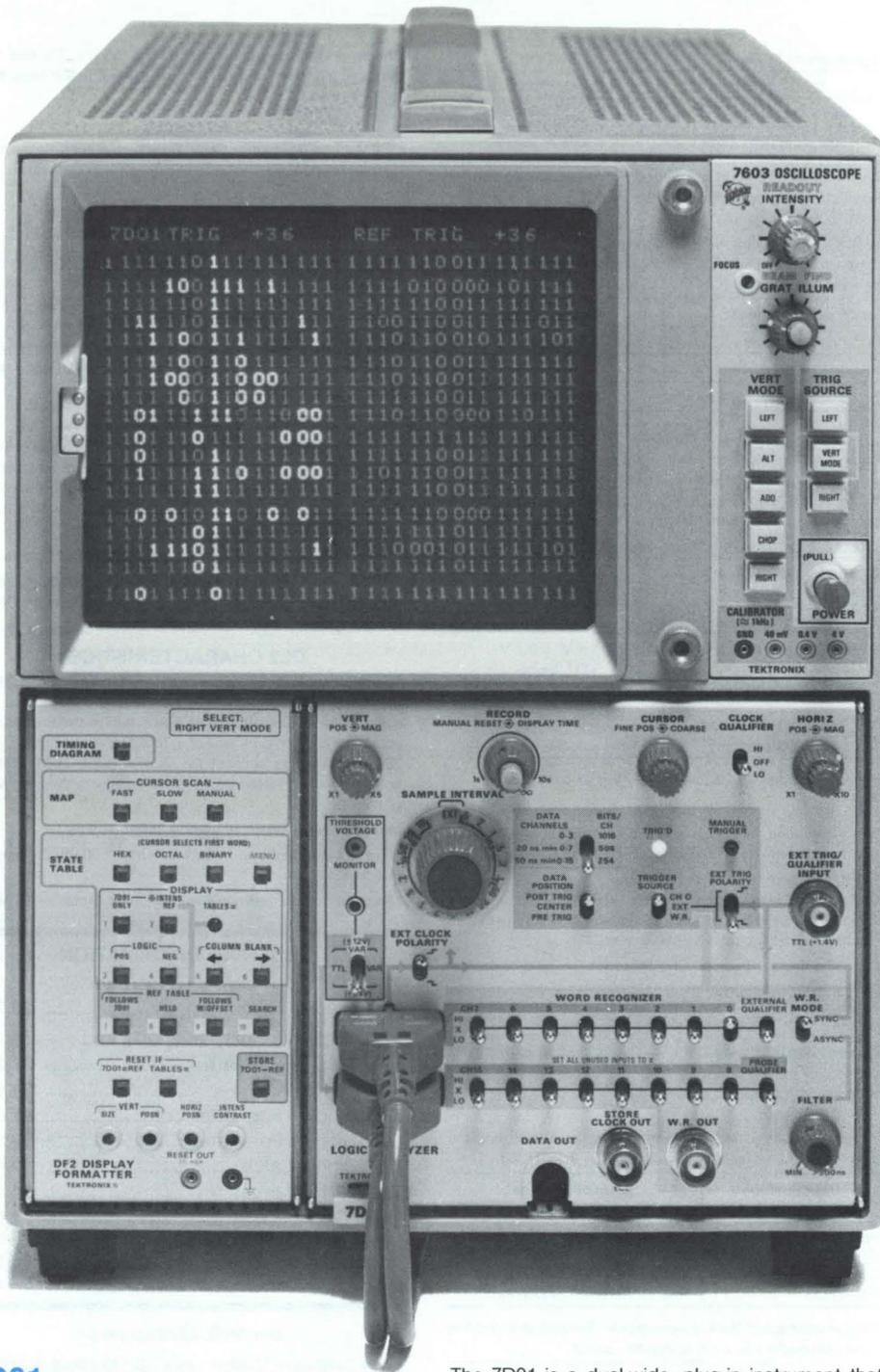
<sup>1</sup> PMA 100 add 5 ns maximum to setup time.

<sup>2</sup> With respect to falling edge of XACX.

<sup>3</sup> With respect to rising edge of BUSY.

#### ORDERING INFORMATION

PM 112 .....	\$1,400
Set of 10 leads with Pomona Grabbers. Order 012-0670-00 .....	\$65



**7D01 General Purpose Logic Analyzer**

- 16 Stored Channels**
- Up to 1024 Words Deep**
- State or Timing**
- Up to 100 MHz Sample Rate**
- High Impedance Probes**
- 18 Bit Word Recognizer**
- Clock Qualifier**

The 7D01 is a dual-wide, plug-in instrument that occupies one vertical amplifier compartment and an adjacent time base compartment in 7000 Series oscilloscope mainframes. With this compatibility, you can configure a total logic analysis system. Using a four-wide mainframe oscilloscope, you can combine your logic analyzer with your analog oscilloscope and display the outputs of both at the same time.

**Display Formatters**

There are two Display Formatters available with the 7D01 Logic Analyzer—the DF1 and DF2. Both offer timing, mapping, and state table displays in Binary, Hexadecimal and Octal formats. The DF2 offers additional formats for IEEE Standard 488/GPIB and ASCII.

The Display formatters are dedicated for use with the 7D01. They provide complete alphanumeric character generation, so that the logic analysis package can be used in mainframes without CRT readout (mainframe Option 01).

There are also two modes of automatic data acquisition in the DF1 and DF2 that compare the entire 7D01 memory to the reference memory. If a difference is detected, the difference and location will be intensified in the display read out at the top of the CRT, and the number of resets required to find the error will be displayed. This function, called RESET IF 7D01 = REF, allows full comparison of stored and newly acquired data. To compare only the tables selected by the cursor control, use RESET IF TABLES = .

7D01 TRIG	+2 4	REF TRIG	+1 9
C563			793E
2564			F93F
A565			0560
6566			8561
E567			4562
1568			C563
9569			2564
556A			A565
056B			6566
356C			E567
856D			1568
756E			9569
F56F			556A
0D70			D56B
8D71			356C
4D72			856D
CD73			756E
D12B	TRIG		D12B

**Digital Latches**

The DL2 and DL 502 Digital Latches extend the 7D01 Logic Analyzer's measurement capabilities by detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. Operating in an asynchronous mode, the 16 channel Digital Latches can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

LOGIC ANALYZERS

**7D01 CHARACTERISTICS**

The 7D01 acquires 4, 8, or 16 CH of data and stores the data in a 4k memory. Data storage format is selectable as 4 CH X 1016 bits, 8 CH X 508 bits, or 16 CH X 254 bits.

Data sampling can be asynchronous (internal clock) or synchronous (external clock). In asynchronous modes, sampling rates can be selected up to 100 MHz in the 4 CH mode, up to 50 MHz in the 8 CH mode, or up to 20 MHz in the 16 CH mode. External sampling clocks up to 50 MHz can be used in the 4 and 8 CH modes, and up to 25 MHz in the 16 CH mode.

**SIGNAL INPUTS**

Clock, Qualifier, and Data Input Source — Two multilead P6451 Probes provide connections for 9 CH (9 input and ground) each. CH 0-7 and clock are through probe 1, and CH 8-15 and qualifier are through probe 2. Each probe attaches through a 25-pin connector at the 7D01 front panel.

Clock Qualifier	Setup	Hold
P6451	20 ns	0 ns
External*	11 ns	7 ns

\*Measured at external BNC jack. For 0 ns hold time, 42 inch BNC coaxial cable is recommended.

**Input Impedance** — 1 MΩ paralleled by 5 pF (at probe head).

**Threshold at Probe Tips** — Front panel switch selects fixed TTL (+1.4 V ± 0.2 V), variable (± 12 V) or split (variable for top probe, TTL for bottom probe). Front panel jack monitors variable threshold only.

**Minimum Logic Swing** — 500 mV plus 2% of threshold voltage p-p or less, centered on the threshold voltage.

**Maximum Logic Swing** — -40 V or less, to at least threshold voltage plus 10 V. (Maximum nondestructive input ± 40 V.)

**MEMORY**

**Storage** — 4096 bits.

**Format** — Front panel selectable.

Data Channels Displayed	Bits per Channel
0-3	1016
0-7	508
0-15	254

**SAMPLING RATE**

**Asynchronous (internal clock)** — Sampling Intervals are selectable from 10 ns to 5 ms in 18 steps using a 1-2-5 sequence.

Data Channels Displayed	Maximum Sampling Rate	Minimum Sampling Interval*	Minimum Data Pulse Width*
0-3	100 MHz	10 ns	15 ns
0-7	50 MHz	20 ns	25 ns
0-15	20 MHz	50 ns	55 ns

\*Minimum data pulse width to insure recording is one sample interval + 5 ns.

**Synchronous (external clock)** — + or - edge of clock pulse can be selected to initiate sample.

Data Channels Displayed	Maximum Clock Freq	Minimum Clock Width*	Data Set-up Time Required	Data Hold Time Required
0-3	50 MHz	10 ns	20 ns	0
0-7	50 MHz	10 ns	20 ns	0
0-15	25 MHz	20 ns	23 ns	0

\*High and low clock width.

**WORD RECOGNIZER**

**Word Recognizer** — 16 data inputs, Probe Qualifier and External Qualifier. Output is true when input conditions match settings (HI, X, LO).

**Asynchronous Mode**

Format	Minimum Input Pulse Width (Asynchronous Mode)
Any Single Channel	10 ns or less
Channels 0-3	15 ns or less
Any Other Combination	20 ns or less

**Synchronous Mode**

Characteristic	Requirement
Minimum Setup Time	12.5 ns or less
Minimum Hold Time	8.5 ns or less

**Async Filter** — Rejects recognized words that remain true for less than an operator selected time period. Period is variable from 10 ns to 300 ns.

**W.R. Out Connector** — A recognized word produces a displayed trigger marker and a front panel output for triggering external circuitry.

Characteristic	Requirement
HI Level	≥ 1.9 V
LO Level	≤ 0.1 V
Impedance (Rising Edge)	50 Ω ± 10%

**TRIGGER**

**Source** — Three-position switch provides selection of trigger source from among channel 0, external (External Trigger/Qualifier Input), or internal word recognizer. A display can also be obtained with front panel MANUAL TRIGGER pushbutton.

**Channel 0** — Triggers on rising edge of CH 0 data.

**External Trigger/Qualifier Input Connector (EXT TRIG-/QUALIFIER INPUT)**

Characteristics	Requirement
Threshold	+1.4 V, ± 0.2 V (TTL Level)
Minimum Pulse Width	15 ns
Maximum Safe Input Voltage	-5 V or less, to at least +10 V

**Triggered Light** — Indicates display trigger has occurred.

**CURSORS**

**Word Selection** — Cursor appears as a movable second intensified spot on the CRT display. It is used to select and mark a word.

**Coarse and Fine Position Controls** — Coarse control moves cursor in increments of 16 sample intervals. Fine control moves cursor in increments of 1 sample interval.

**Cursor to Trigger Position CRT Readout** — The difference in sample interval bits between cursor position and trigger position is displayed by the CRT readout at the top, right-hand portion of the CRT graticule (e.g., TRIG ± XXX).

**Cursor Position Binary Data** — The logic state of each displayed channel coincident with the cursor position is displayed in Binary by the readout at the bottom of the CRT (HI = 1, LO = 0).

**Trigger Intensified Marker** — Intensified zone indicating the trigger point, selectable by a switch (DATA POSITION).

Data Position Switch Setting	Intensified Zone Location
Pretrigger	Near extreme right of display
Centertrigger	Near center of display
Posttrigger	Near extreme left of display

**Trigger Intensified Marker Accuracy** — Position of intensified zone with respect to word recognizer output.

Sample Interval Control Setting	Maximum Bit Error
10 ns	± 4 bits
20 ns	± 3 bits
50 ns to 5 ms	± 1 bit

**ENVIRONMENTAL**

**Temperature** — Operating: 0°C to +40°C. Nonoperating: -40°C to +75°C.

**Altitude** — Operating: To 4500 m (15,000 ft). Nonoperating: To 15 200 m (50,000 ft).

**Vibration** — With the 7D01 and DF1 or DF2 combined, frequency swept from 10 to 50 cps at one minute per sweep. Vibrate for 15 minutes along each of the 3 major axes at 0.015 inch total displacement. Hold 3 minutes at any major resonance, or if none, at 50 cps. Total time, 54 minutes.

**Shock** — Operating and nonoperating: 30 g's, 3 1/2 sine 11 s duration, 2 shocks in each direction along 3 major axes, for a total of 12 shocks.

**AC POWER**

**Line Voltage Ranges** — Determined by the 7000 Series oscilloscope mainframe.

**Power Consumption** — 32 W at nominal line voltage.

**INCLUDED ACCESSORIES**

Two, P6451 Data Input Probes (010-6451-03).

**DF1 CHARACTERISTICS**

The DF1 reformats the output of the 7D01 in a choice of five display formats including Timing, Mapping and state table displays in Binary, Hexadecimal and Octal. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

**DF2 CHARACTERISTICS**

The DF2 reformats the output of the 7D01 in a choice of seven display formats including Timing, Mapping and state table displays in Binary, Hexadecimal, Octal, ASCII and IEEE Standard 488/GPIB. It imposes no significant electrical characteristics on the 7D01 that affect measurement parameters.

**INCLUDED ACCESSORIES**

GPIB Probe Adaptor for the P6451 (103-0209-00). (A 24 pin IEEE Standard Connector with quick connection to the P6451 Probe Head.)

**DL2 CHARACTERISTICS**

The 16 channel DL2 aids the 7D01 measurement capabilities by detecting narrow asynchronous pulses of less than one sample interval or as narrow as 5 ns in a data stream. The DL2 plugs into any compartment of a 7000 Series mainframe. Two 25 pin connectors connect the DL2 with the 7D01. Data is acquired via two P6451 Probes which plug into the front panel of the DL2.

**Minimum Pulse Width to Initiate Latch** — 5 ns.

**Minimum Amplitude to Initiate Latch** — 500 mV centered at threshold.

**Minimum Sample Interval Asynchronous Clock** — 50 ns.

**ORDERING INFORMATION**

7D01F Logic Analyzer (7D01 and DF1 Display Formatter) .....	<b>\$6,700</b>
7D01F2 Logic Analyzer (7D01 and DF2 Display Formatter) .....	<b>\$7,250</b>
7D01 Logic Analyzer .....	<b>\$4,650</b>
DF1 Display Formatter .....	<b>\$2,050</b>
DF2 Display Formatter .....	<b>\$2,600</b>
DL2 Digital Latch .....	<b>\$2,000</b>
DL 502 Digital Latch .....	<b>\$1,800</b>
7603 Oscilloscope* .....	<b>\$2,700</b>
Option 01 — (Deletes one readout board) .....	<b>-\$300</b>
7704A Oscilloscope* .....	<b>\$4,260</b>
Option 01 — (Deletes one readout board) .....	<b>-\$300</b>

**OPTIONAL ACCESSORIES**

**Clock Qualifier** — Modifies earlier 7D01 to include clock qualifier feature (installation not included).

Order 040-0891-00 .....

**\$170**  
\*See pages 237 through 257 in this catalog for details on these and additional 7000 Series mainframes. See pages 267 through 290 for details on complementary 7000 Series plug-ins.

Tektronix offers service training classes on the 7D01 General Purpose Logic Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

ACQUISITION PROBES



- P6406 Word Recognizer Probe**, replacement for SONY/TEKTRONIX 308 Option 01 only.  
Order 010-6406-01 ..... **\$541**
- P6107 Serial Data Probe**, replacement for SONY/TEKTRONIX 308.  
Order 010-6107-03 ..... **\$117**
- P6451 Parallel Data Probe**, replacement for 7D01, 7D01F, 7D01F2, 7D02 Option 01, WR 501 (Two probes required for 16-channel operation).  
Order 010-6451-03 ..... **\$545**
- P6451 Active Probe (Right Angle Connector)**, replacement for SONY/TEKTRONIX 308 only.  
Order 010-6451-05 ..... **\$545**
- P6452 8-Channel Data Acquisition Probe**, for DAS 9100.  
Order 010-6452-01 ..... **\$730**
- P6453 4-Channel Data Acquisition Probe**, for 91A04/91AE04 300 MHz High Speed.  
Order 010-6453-01 ..... **\$1,560**
- P6454 100 MHz Clock Probe**, for 91A08.  
Order 010-6454-01 ..... **\$265**

OPTIONAL ACCESSORIES

- Flying Lead Set**, 5 inch for P6452.  
Order 012-0987-00 ..... **\$40**
- Flying Lead Set**, 10 inch for P6452.  
Order 012-0746-00 ..... **\$15**
- Diagnostic Lead Set**, for P6452, P6455, P6456.  
Order 012-1000-00 ..... **\$75**
- Sense Leads**, package of 10 ground (or VL) 5 inch, black with Pomona hook tip for P6452, P6455, P6456.  
Order 012-0989-01 ..... **\$100**
- Sense Leads**, package of 10 ground (or VH) 5 inch green with Pomona hook tip for P6455, P6456.  
Order 012-0990-01 ..... **\$50**
- Leads with Grabber Tips**, package of 2 for P6454.  
Order 195-3659-00 ..... **\$15**
- Leads with Grabber Tips**, package of 12 for P6451, P6452, P6455, P6456.  
Order 020-0720-00 ..... **\$33**
- High Speed Grippers**, package of 10, flat pack for P6453, P6454.  
Order 195-1943-06 ..... **\$75**
- High Speed Grippers**, package of 10 dip pack for P6453, P6454.  
Order 195-2234-06 ..... **\$75**
- BNC Cable**, 50  $\Omega$ , 8 inch (connect 7D01 to DL2).  
Order 012-0076-00 ..... **\$17**

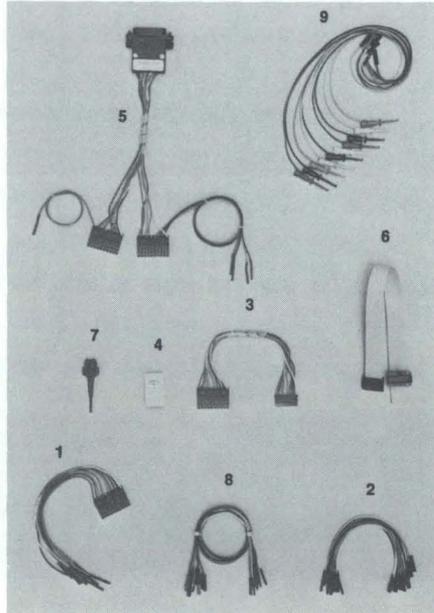
PATTERN GENERATOR PROBES

- TTL/MOS Pattern Generator Probe** for P6455, 8-Channel.  
Order 010-6455-01 ..... **\$575**
- ECL Pattern Generator Probe** for P6456, 8-Channel.  
Order 010-6456-01 ..... **\$575**
- Pattern Generator Lead Set**, 9 inch for P6455, P6456.  
Order 012-0926-00 ..... **\$100**
- Pattern Generator Lead Set**, high speed 5 inch harmonica for P6455, P6456.  
Order 012-1001-00 ..... **\$50**

DIP CLIP ADAPTORS

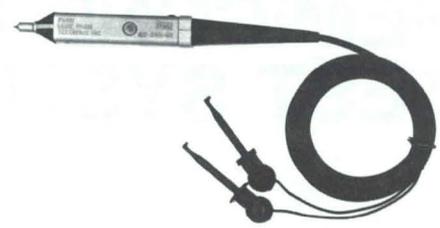
- 40-Pin-Low Profile Dip Clip**, 100 mm cable (order M/F adaptor below).  
Order 015-0339-00 ..... **\$42**
- 40-Pin-Low Profile Dip Clip**, 300 mm cable (order M/F adaptor below).  
Order 015-0339-02 ..... **\$42**
- Male Adaptor for 40-Pin-Low Profile Dip Clip**, for use with PM 101 7D02 General Purpose Personality Module or with individual leads such as the 10-wide comb set 012-0747-00.  
Order 380-0560-05 ..... **\$15**
- Female Adaptor for 40-Pin-Low Profile Dip Clip**, for use with dedicated 7D02 Personality Modules.  
Order 380-0647-01 ..... **\$30**

SPECIAL PURPOSE LEAD SETS



- 1. 10 Wide Comb**, 10 in leads — grabbers not included.  
Order 012-0747-00 ..... **\$50**
- 2. 200 mm Individual Connectors**, grabbers not included.  
Order 012-0655-02 ..... **\$70**
- 3. 10 Wide Comb**, with harmonica connector.  
Order 012-0800-00 ..... **\$30**
- 4. Clothes Pin IC Clip** Order 003-0709-00 ..... **\$31**
- 5. GPIB Connector** Order 103-0209-00 ..... **\$180**
- 6. Low Profile Dip Clip**, 16 pin can be used with 14- or 16-pin IC's.  
Order 015-0330-00 ..... **\$35**
- 7. Grabber Tip** Order 206-0222-00 ..... **\$3.25**
- 8. Color Coded Replacement Lead Set\***, 400 mm for the P6450 Probe or the P6451 Probe. Ten leads per set connects probe lead to 0.025 inch, square pins.  
Order 012-0655-01 ..... **\$40**
- 9. Individual Connector\***, 400 mm 10 wire with Pomona Grabbers.  
Order 012-0670-00 ..... **\$65**
- Probe Holder**, clip-on holder accommodates probe pod for P6451.  
Order 352-0473-01 ..... **\$3.15**
- BNC Cable**, used with the Digital Latch.  
Order 012-0118-00 ..... **\$16**

\* EMI can exist with the 400 mm length. This can be a problem if using a digital latch.



P6401 Logic Probe

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

CHARACTERISTICS

- Logic Level Thresholds**  
0 or Low (Lamp Extinguishes):  $+0.7 \pm 0.1$  V dc.  
1 or High (Lamp Illuminates):  $+2.15 \pm 0.15$  V dc.
- Minimum Recognizable Pulse Width** — 10 ns.
- Impedance** —  $\approx 7.5$  k $\Omega$  paralleled by  $\approx 6$  pF.
- Minimum Circuit Resistance for Open Circuit Indication** — 10 k $\Omega$ .
- Maximum Safe Input** —  $\pm 150$  V (dc or RMS).
- Minimum Recognizable Strobe Pulse Width** — 20 ns.
- Maximum Safe Strobe Input** —  $\pm 30$  V (dc or RMS).
- Strobe Input Impedance** — 5.6 k $\Omega$  within 20%.

INCLUDED ACCESSORIES

Hook tip (206-0114-00); probe tip to 0.025 in square pin adaptor (206-0137-01); two alligator clips (344-0046-00); strobe lead (175-0958-01); strobe lead (175-0958-00); white plug (348-0023-00); accessory pouch (016-0537-00).

**P6401 Logic Probe** Order 010-6401-01 ..... **\$148**

OSCILLOSCOPE PROBE

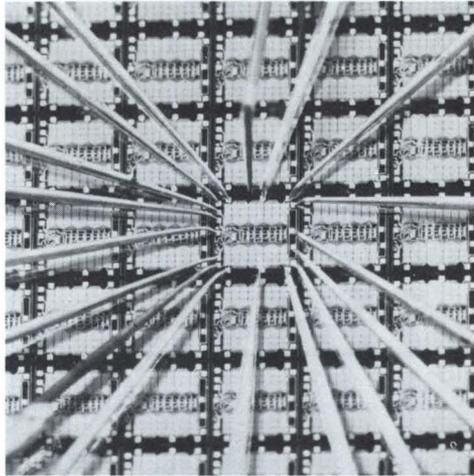
ACCESSORIES

Accessories to aid in probing digital circuits with standard oscilloscope probes may be found on pages 442 and 443.

# SEMICONDUCTOR TEST SYSTEMS

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At Tektronix, we've been planning for the future for years. Since the early 70's Tektronix has designed and built semiconductor test systems that have more than kept pace with the rapidly advancing semiconductor device technology. We knew that it would become increasingly difficult to test these new devices with their increased complexity, speed, and pin count, and that functional testing would become more and more important to the success of the semiconductor electronics industry.

Our testing technology has progressed in advance of industry need. Marking the beginning of Tektronix' state-of-the-art test-technology development, the first S-3200 system was designed to characterize and test LSI devices and microprocessors. Subsequent systems provided improved device characterization and were designed for quality control in production test environments. Then we tackled the challenge of testing high-speed logic devices and solving unique problems associated with sub-nanosecond technologies. Our testing expertise has advanced so rapidly, in fact, that we have announced six new S-3200 Series systems in the past four years — a phe-

nomenal pace unmatched in the semiconductor test industry. All of our test systems, from the first system announced a decade ago to the recent introduction of our S-3295, are backed by Tektronix' commitment to excellence.

Tektronix provides the hardware, software, training, and applications support to solve today's testing problems, and tomorrow's as well. New and unusual device parameters are viewed as a challenge to our resources not as insurmountable problems. The field-proven hardware and software in every S-3200 system provides the versatility to get the job done.

Every S-3200 system uses the same highly advanced software — TEKTEST®. So there's only one language to learn. Using TEKTEST, a test engineer can easily and quickly generate and debug programs for device testing or characterization and then transfer these programs from one system to another. And, using our foreground/background capability, up to four users can program or compile data in the background while testing continues uninterrupted in the foreground. A powerful debugging tool, Terminal Control Mode, gives the test engineer interactive control of the test program.

All of the S-3200 systems feature highly sophisticated data reduction and graphics, which make the test results manageable and easy to understand.

We offer analog and digital capability to meet the unique test requirements presented by new and increasingly complex devices. In fact, most manufacturers of captive devices use Tektronix systems for just this reason. Tektronix is also a device manufacturer and has been testing its own ICs and hybrids for years. We have developed expertise and in-depth understanding of complex testing.

At Tektronix, we've built on our past experience and knowledge about device testing to create a total, compatible line of LSI/VLSI test systems that can help solve your test problems — today and in the future.



## **NW** S-3295

**State-of-the-Art Performance in VLSI  
Development and Evaluation**

**256 Channels, 128 I/O Pins**

**State-of-the-Art Driver/Receiver**

**Programmable Dynamic Loads**

**128 Kilobit Local Pattern Memory**

**Automatic De-skew**

**DEC PDP-11/44 CPU**

**Dynamic Time-Set Selection**

**Advanced Color Graphics and Data  
Reduction**

### **To meet your changing test requirements — Tektronix announces tomorrow's solution**

State-of-the-art yesterday, today, and tomorrow. From simple to complex, small scale integration to very large scale integration, common integrated circuits to microprocessors, the evolution of Tektronix systems continues to meet your test needs. Tektronix semiconductor test systems not

only keep pace with what you're developing today, but also provide solutions for the test requirements of the future. The Tektronix S-3295 is the newest generation in our system technology evolution developed to handle tomorrow's complex, high pin count devices.

The S-3295 was designed to meet VLSI engineering evaluation needs in the computer, aerospace, and telecommunications industries, as well as in semiconductor manufacturing. The S-3295 is yet another industry-leading step forward for the S-3200 Series. It offers significant performance increases in real-time pattern generation/recognition, timing flexibility/accuracy, resolution, and functional pin capability. This system supports 256 independent pins (128 I, 128 O), offering greater capacity and flexibility in accommodating high pin count devices.

Subsystems within the S-3295 include the 2952 Pattern Processor, with its unique and powerful capabilities, and the 2945 Clock Generator, which provides 16 sets of 16 timing phases, accurate 125 ps edge-timing resolution, and split-cycle operation at all clock speeds. These two subsystems provide uncompromised 20 MHz test rates within the S-3295.

The S-3295 has been redesigned with all new high performance pin electronics drivers and receivers. The new pin electronics cards provide increased capabilities and performance in driver

and comparator formatting, clock phase distribution, signal transition times, and edge position accuracy for optimized fidelity at high speeds. Automatic de-skew of driver, comparator, and inhibit phase circuits enhance measurement certainty. Programmable dynamic loads eliminate complex load boards. Local pattern memory of 128 kilobits per I/O pin can accommodate very large patterns and minimize CPU transfers. Data and clock channel multiplexing provides 40 MHz real-time functional data rate on a reduced set of pins. A Digital Equipment Corporation (DEC) PDP-11/44 offers up to 1 megabyte of main memory. Color graphics enable easier reporting and interpretation of engineering data.

The S-3295 is based on the proven S-3200 architecture that has been delivering test results worldwide over the last decade. Proven features like S-STMS (Single-Shot Time Measurement Subsystem), 50-ohm switching matrix, a waveform digitizer, optional stimulus and measurement subsystems (GPIB instrumentation), and compatible peripherals. And like all S-3200 testers, it features TEKTEST system software — the industry leader in test languages for engineering evaluation and characterization. Tektronix is committed to hardware and software compatibility.

Device technology is changing — the new Tektronix S-3295 System meets these changes head-on.



**NEW**  
**S-3220**

**Full Capability 20 MHz Test System**

**Vertically-Oriented Pin Electronics  
Simplifies Prober/Handler Interface**

**Minimal Floor Space Requirements**

**Cost-Effective For High-Throughput  
Production Applications**

**Enhanced 1 k Pattern RAM Supplements  
4 k per Pin Stored Memory**

**Single-Shot Timing Measurement**

**Uses TEKTEST®, Allowing Device  
Characterization Programs to be Condensed  
and Used in Production Testing**

**Up to 128-pin Test Capability**

The Tektronix S-3220 is a versatile computer-controlled automated test system designed for testing and verifying the performance of the wide variety of integrated circuits in use today. The S-3220 is an ideal test system for users with requirements that range from SSI through LSI. In addition to high-speed digital circuits, this system accommodates analog devices and dual-family hybrids such as CODECs and ADCs.

The S-3220 is offered as a production-oriented complement to the Tektronix S-3270 Test System. Since the S-3220 uses the TEKTEST control software used in all S-3220 systems, programs originally developed for engineering use can easily be condensed and employed in a high volume production or incoming inspection environment. The essential test related features of the larger systems are retained in the S-3220, allowing (with no loss in speed or accuracy) functional or pattern testing as well as dc parametric and single-pass ac parametric testing.

The S-3220 is the first S-3220 Series system with a vertical pin-electronics package that is integrated with the control/stimulus equipment rack. This feature eases prober/handler mechanical interface and reduces floor space requirements — an important consideration in most production areas.

**S-3275**

**Independent I/O Control on a Cycle-by-Cycle Basis at Each Pin**

**16 Programmable Driver/Compare Phases**

**16 Programmable Timing Sets, Each Available on a Cycle-by-Cycle Basis (Split-Cycle)**

**Full Functional Data (Force, Inhibit, Compare, Mask) to All Pin Electronics Cards at 20 MHz Test Speed**

**Versatile Driver Formats**

**Tests Devices With Up to 128 Pins**

**Single-Shot Timing**

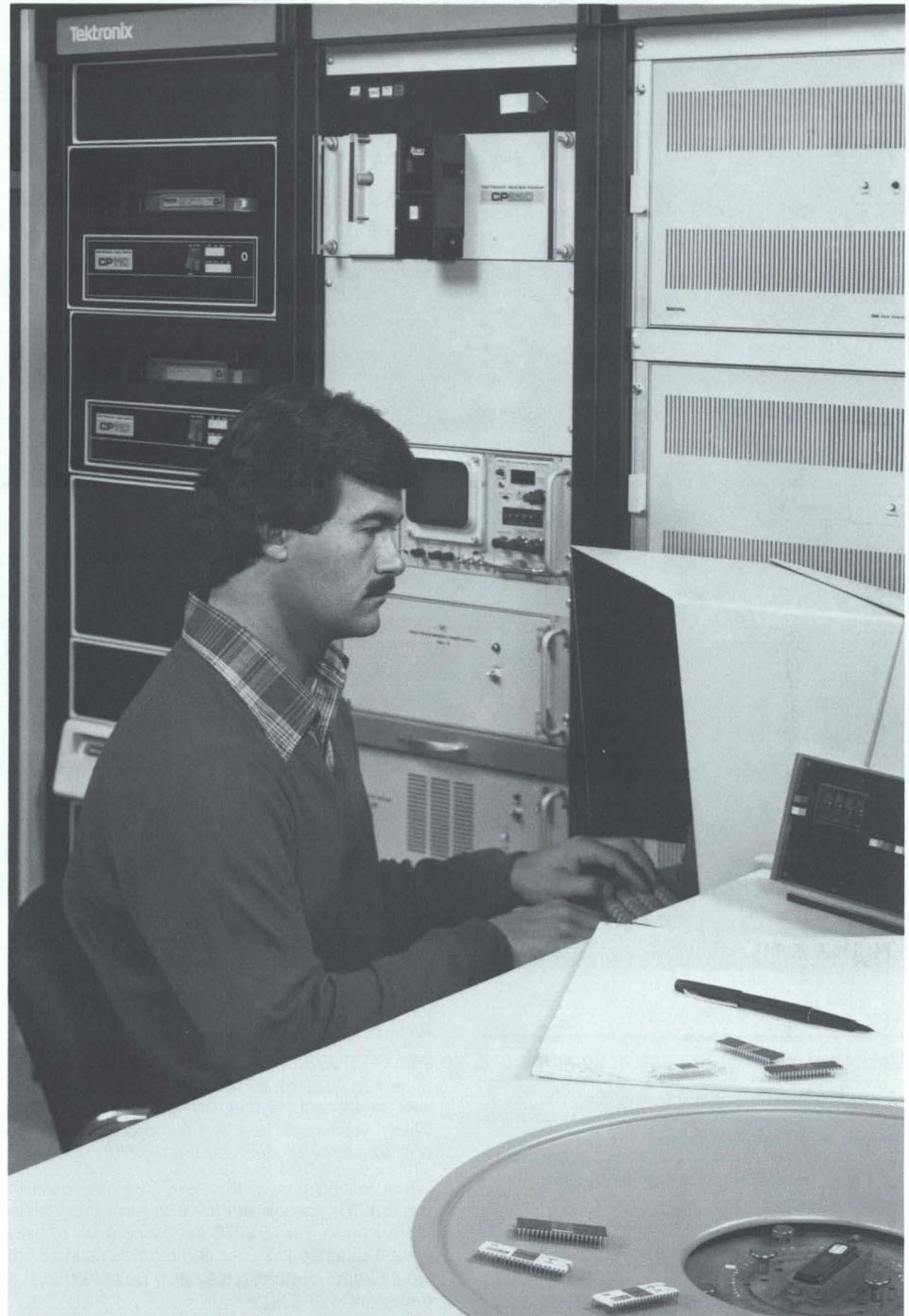
**Advanced Graphics and Data Reduction**

**Uses TEKTEST®, a Device-Oriented Test Language With Networking Capability**

Using a powerful set of testing features, the S-3275 is more than able to measure the characteristics of today's complex LSI/VLSI devices, single-chip microcomputers, 16-bit processors, memories, hybrids, analog LSI and others. The S-3275 gives both the speed and data width demanded by such devices, and combines them with advanced software for effective data management and control.

An integral part of the S-3275, the 2952 Pattern Processor can send all four data bits to each pin-electronics card during each test cycle. These four bits (force, inhibit, mask, and compare) provide nine distinct test states to each pin card resulting in 64 inputs and 64 outputs at clock rates up to 20 MHz for true 128-pin test capability.

The 2952 combines the functions of pattern sequencing and algorithmic pattern generation. As a pattern processor, it allows sophisticated control of pattern sequence programming. Loops, subroutines, conditional branching, nesting, and list pointers can all be used to control program flow. Interrupts can be initiated from a number of sources to start new pattern sequences (and then return to the original). Phantom clock cycles



can be invoked to execute multiple processor steps during a single cycle at the test head.

In the algorithmic pattern generation mode, the processor controls the output of the X and Y address generators, each 12 bits wide. This address output may then be scrambled by a 4 k topological memory. A 12-bit control (Z-axis) generator provides signals to manipulate control lines to the device under test. A data generator produces 16 force data bits and 16 compare data bits. Refresh algorithms are initiated by interrupts to the pattern controller.

The 2945 Clock Generator is also part of the system and exhibits performance to match almost any testing requirement. Cycle periods range from 500 Hz to 20 MHz, with time resolution to 8 ns. Up to 16 phases are available during each cycle, with a phase-edge resolution of 125 ps and a pulse width down to 4 ns. 16 sets of these phases can be programmed and then selected on a cycle-by-cycle basis during testing. The clock can be operated in a free-running mode, or synchronized to a signal from the device under test. These two modes are interchangeable from one test cycle to the next.



## S-3270

Uninterrupted Error Storage at 20 MHz

Multiple Pattern Sources

Versatile Driver Formats

14 Programmable Channels of Timing Information

Test Devices With Up to 128 Pins

Single-shot Timing

Advanced Graphics and Data Reduction

Uses TEKTEST®, a Device-Oriented Test Language

Easy to Program and Edit

True Foreground/Background Timesharing

The S-3270 system tests LSI, microprocessors, analog and digital hybrids, peripheral interface circuits, RAMs, ROMs, and more. Designed to deliver test results on the devices you see every

day. It is also built to deliver results when new devices appear.

With the S-3270, you can perform functional tests at speeds up to 20 MHz. In some cases, the system will test devices that operate at 40 MHz. When you must test a microprocessor at its optimum speed, you need the S-3270.

When testing one of the new, fast devices with the S-3270, you will not have to stop the test to log an error. The S-3270 keeps right on testing while it catches the error and records its location. Input/Output switching may also be performed at a clock rate of 20 MHz.

The fully integrated waveform digitizer allows you to perform linear and analog tests. The system has 64 pin-electronic cards, each with input and output capability, so you can test a device with up to 128 pins. The 14-phase clock gives you many programmable channels of timing information, to properly and effectively test devices.

For total flexibility, the S-3270 features independent control of logic level definition at each driver and receiver. You set the logic level on every input and output channel, so you are not bound by the limits of the system.

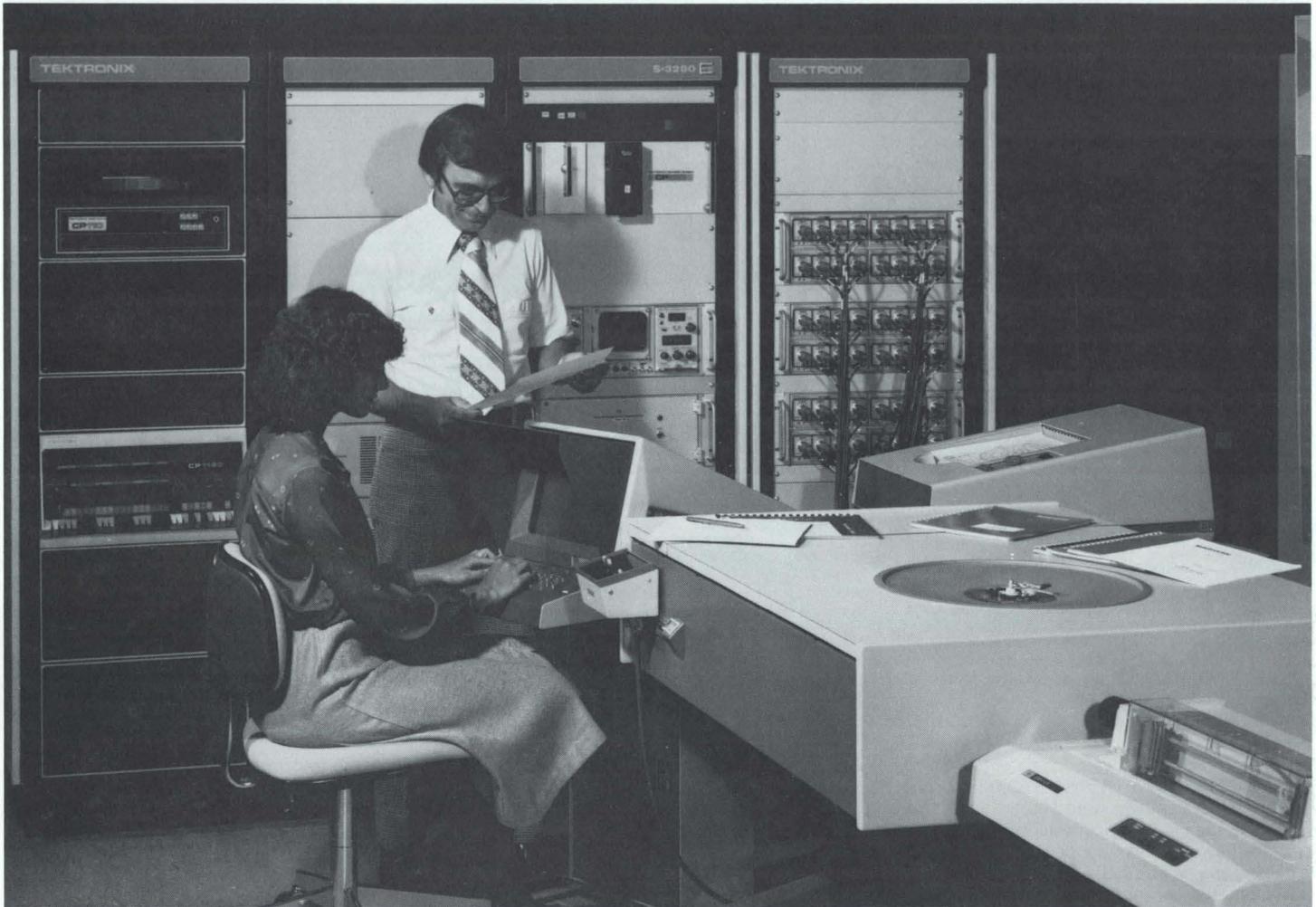
When device complexity dictates highly advanced patterns, the S-3270 gives you multiple ways to produce those patterns — programming on the disk or mag tape, toggling, using the 2942 Memory Pattern Generator, the PRAM and/or shift registers. The S-3270 is equipped with 4 k of shift register memory behind each pin, and it can be increased to 8 k of memory.

### High Performance Drivers (30 V swing) Allow Versatility in Testing

The unique Single-Shot Time Measurement technique allows you to make a measurement with 50 ps resolution in one iteration. Dynamic measurements can also be made by moving strobes (iteration) or by using the optional waveform digitizer.

The basic system makes differential voltage measurements on your device with a resolution of 50  $\mu$ V. It also features sub-nanoamp current measuring, especially important in testing CMOS devices. Kelvin sensing increases the accuracy of the forced voltage, insuring that the levels at the DUT will be exactly what you ordered.

When you are characterizing devices that are fast, complex, and unfamiliar, you need a system that is both capable and flexible, the Tektronix S-3270.



## S-3280

100k ECL Testing

Precision Fixturing

Sub-nanosecond Measurements

Full Graphics and Data Reduction Package

High-Speed Drivers

Sampling for Waveform Analysis

Uses TEKTEST®

Simple to Program and Edit

Tests High-Speed Logic

CML Capability

Testing sub-nanosecond logic devices requires extremely fast pulses, clean edges, precise control of pulse levels, and highly accurate time measurement capability. The S-3280 is designed to meet the testing requirements of high-speed logic devices.

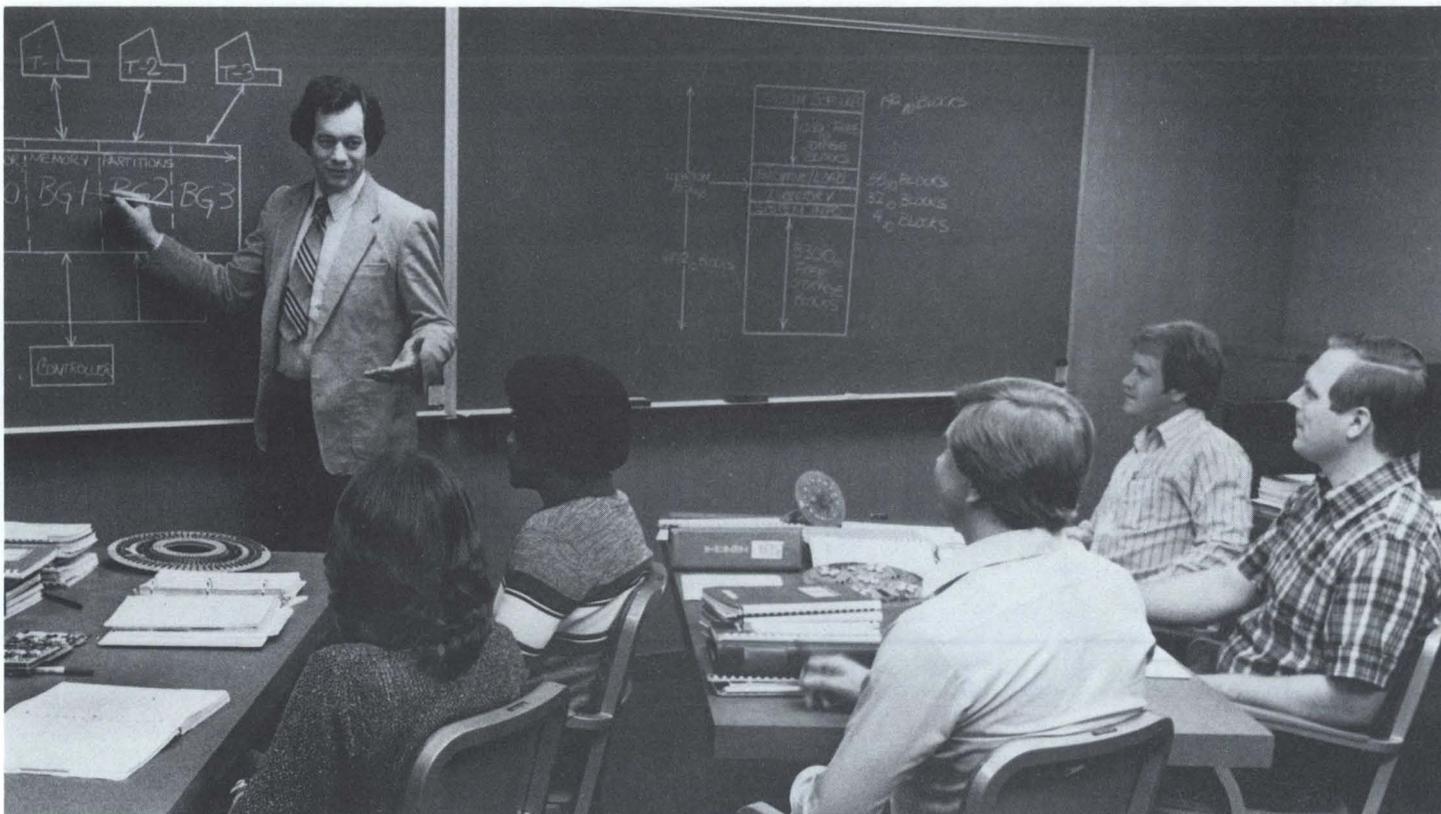
This system is based on the proven architecture of the Tektronix S-3200 LSI test systems. The S-3280 has the same advanced pattern generation capability and features multiple pattern sources, from algorithmic patterns to memory patterns to simple fixed or toggled bits. The S-3280 also features a 20 MHz data rate with interrupted error storage at that speed. Like all other S-3200 systems, the S-3280 uses a device-oriented, English-like test language, TEKTEST.

The S-3280 was designed specifically to solve ECL testing problems. Featuring sub-nanosecond time measurement capability, the high-speed hardware gives the S-3280 the ability to test ECL devices to their fullest.

One of the more important features of an ECL test system is its ability to make accurate timing measurements. The S-3280 features three methods of making dynamic measurements. First, Delta-T provides measurements with 50 ps resolution on any test vector, at 20 MHz data rate, in a single pass. Second, our Waveform Digitizing (sampling) capability provides 1 ps resolution to digitize and store any waveform for further analysis. Third, for functional testing, the system's strobed comparators will make tests on any or all test vectors at 20 MHz. The system features 1 mV programming resolution with dual-level comparators on every channel.

Because no multiplexing is necessary the system uses the shortest possible path to deliver clean, accurate signals to the device, thus minimizing waveform degradation.

The S-3280 will measure the parameters of today's ECL devices and will continue to be able to test the more advanced high-speed logic devices that are being developed. The S-3280's advanced, high-speed measurement characteristics make it a superior ECL testing solution.



**Training and Support**

When you purchase a Tektronix S-3200 Semiconductor Test System, we want you to be able to use that system to the fullest extent of its capabilities. We have an entire support staff dedicated to helping you do just that. And an integral part of that support is our professional training for your test engineers and service technicians. Before you purchase a system, a training specialist works with you and your Tektronix Sales Specialist to identify your training requirements and recommend an appropriate training schedule.

With the purchase of your system, you receive credits for up to ten weeks of training in our S-3200 System Basic Applications and Basic Maintenance classes. We also offer advanced training in test applications and maintenance as well as tailor-made training seminars in special interest areas. Additional training credits for the basic courses may be purchased to allow for staff expansion and turnover.

The courses are fast-paced, performance-oriented, and individualized. Instruction time in all classes is equally divided between classroom lecture and hands-on laboratory experience. Each student is expected to choose specialized lab projects which will meet individual job requirements, so your unique system applications become the focus of training.

Our instructors have extensive experience in test system applications and maintenance. And they stay abreast of modern instructional techniques, advanced system applications, and hardware operation. Class size is limited to maintain a balance of one instructor for every four students during lab sessions.

For further information on class schedules, course content, or your special training requirements, contact your Tektronix Sales Specialist or the STS Training Coordinator at (503) 629-1187.

**TEKTEST Software**

The language of S-3200 Series systems, TEKTEST, is a device-oriented language, easy to read and understand since it is very close to English. System architecture was designed so that programming, editing and debugging all use TEKTEST. When making corrections in a program, there is no need to use a "bridge" language between the source language and the machine language. Everything is written in TEKTEST. This capability, that we call Terminal Control Mode, gives the test engineer total control of the program. When editing program material during a test, the test engineer can hold power to the device, make the changes, and continue the test. There is no need to re-sequence the program. And, since these systems also feature true foreground/background operation, up to four test engineers can be using terminals interfaced to a system, and the system will continue to test devices without any throughput loss. Terminal Control Mode and true foreground/background make the S-3200 Series simple and fast to program and debug.

The more complex a device, the more information you need about that device. But with complexity can come confusion...unless your test system makes the picture clearer.

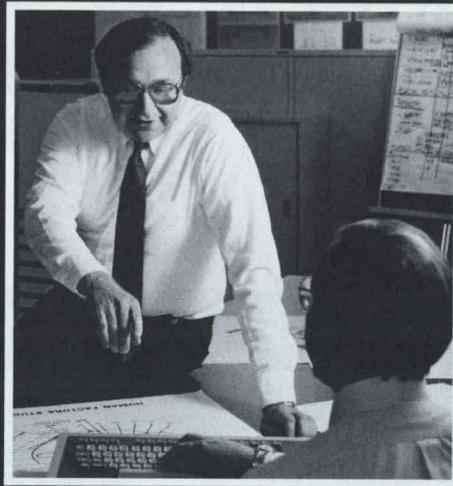
The S-3200 Series systems provides you with the graphics capability to reduce testing data to manageable, usable form.

**For More Information**

For more information about the S-3200 Semiconductor Test Systems, contact the Test Systems Specialist located in the office nearest you.

- Portland, OR
- Los Angeles, CA
- Boston, MA
- Philadelphia, PA
- St. Louis, MO
- Tektronix U.K., Ltd.  
Harpenden, England
- Tektronix  
Orsay, France
- Tektronix AB  
Solna, Sweden
- Tektronix Holland, B.V.  
Badhoevedorp, The Netherlands
- Tektronix BmbH.  
Munich, Germany
- Sony/Tektronix Corporation  
Tokyo, Japan
- Tektronix Canada, Inc.  
Montreal, Canada
- Tektronix Europe B.V.  
Amstelveen, The Netherlands

# INFORMATION DISPLAY DIVISION



Computer Graphics help make computer-based information more accessible and understandable. And as the volume of information to be processed in industry expands rapidly, the need for greater access and understanding grows too. To help meet this need, the Information Display Division of Tektronix offers a wide range of products, from display terminals and desktop computers to hard copy units, digital plotters and other peripherals.

Jon Reed, vice-president and general manager of the Information Display Division (inset) reviews human factor considerations that are being designed into future products.



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COMPUTER GRAPHICS PRODUCTS



### “The Graphics Standard”

Tektronix has set the standard in computer graphics for the past 14 years. The introduction of new products like the 4110 Series continues this tradition. Designed to be compatible with existing product lines, the 4110 Series offers enhanced communications and local intelligence for maximum efficiency. These new products complement

a broad line of graphics equipment including color and monochrome display terminals, desktop computers, hard copy units, graphics software and peripherals.

For additional product information and details on software and accessory support, please indicate your interest on the reply card enclosed in your catalog.



**4006-1**

**Low Cost**

**Flicker-free High Resolution**

**Graphic and Alphanumerics**

The 4006-1 Computer Display Terminal makes interactive, high-resolution flicker-free graphics affordable to cost-conscious disciplines and departments. Priced competitively with many alphanumeric (only) terminals, the 4006-1 makes graphic capability practical for the stock room, the classroom and the conference room as well as for other graphic applications.

The 4006-1 connects readily to most mainframes, thanks to its RS-232C Interface. A screen capacity of 2590 alphanumeric characters in addition to its graphics capability allows the 4006-1 to operate in association with existing alphanumeric terminals to interpret statistical data and transform it into meaningful charts, tables, graphs and diagrams.

The 4006-1 is shipped with a Standard Data Communication Interface conforming to EIA RS-232C, asynchronous full duplex only. Option 01 is a full- or half-duplex interface.

PLOT 10 Software packages designed to be used with the 4006-1 Computer Display Terminal include: Terminal Control System, Advanced Graphing-II, Easy Graphing, Interactive Graphing Package, Preview Routines for CalComp Plotters, Character Generation System, and the Interactive Graphics Library.

**CHARACTERISTICS**

**DISPLAY**

**CRT Type** — Direct View Bistable Storage.  
**Dimensions** — 190 mm x 142 mm (7.5 in x 5.6 in).

**ALPHANUMERIC MODE**

**Format** — 35 lines; 74 character/line; 2590 character full screen.  
**Character Set** — 63 character (TTY ANSI Code).  
**Character Generation** — 5 x 7 dot matrix.  
**Cursor** — 8 x 8 dot matrix.

**GRAPHICS DISPLAY MODE  
(Vectors only)**

**Vector Drawing Time** — 3.6 ms ± 0.2 ms.  
**Graphics Matrix** — 1024 X x 1024 Y addressable points; 1024 X x 780 Y viewable points.  
**Baud Rate (Transmit and Receive)** — 75 to 4800 baud.

**ORDERING INFORMATION**

**4006-1 Computer Display Terminal ..... \$3,900**  
**Option 01** — Optional Data Communications Interface ..... **+\$385**

COMPUTER GRAPHICS TERMINALS



COMPUTER GRAPHICS TERMINALS

## 4012

**High-Resolution, Flicker-Free Graphics**

**Full Upper and Lower Case ASCII Character Set**

**Conventional Bus Structure For Peripheral Add-On**

The 4012 Computer Display Terminal combines the world's leading graphics with complete alphanumeric. Alphanumerics can tabulate computer data, but graphics can amplify that data into usable, immediately meaningful information. High-resolution graphic presentations and the full ASCII alphanumeric, upper and lower case, are available.

The flicker-free screen provides up to 1024 X by 780 Y displayed graphic points or as many as 2590 alphanumeric characters per display. The TTY-style keyboard simplifies input while the thumbwheel controlled crosshair cursor enhances graphic interactivity. Using thumbwheel control, the operator can direct the X-Y cursor to make additions or deletions of data on the display screen.

PLOT 10 Software packages designed to be used with the 4012 Computer Display Terminal include: Terminal Control System, Advanced Graphing-II, Easy Graphing, Interactive Graphing Package, Preview Routines for CalComp Plotters, Character Generation System, and the Interactive Graphics Library.

Basic Data Communication Interface included with the 4012 is EIA RS-232C compatible (full duplex only). The Optional Data Communication Interface includes convenient switch-selectable functions, independent transmit and receive baud rates, and full- and half-duplex operation.

### CHARACTERISTICS

#### DISPLAY

**CRT Type** — Direct View Bistable Storage.

**Dimensions** — 203 mm x 152 mm (8 in x 6 in).

#### ALPHANUMERIC MODE

**Format** — 74 character/line; 35 lines/display; 2590 character/display.

**Alphanumeric Cursor** — Pulsating 7 x 9 dot matrix.

**Character Set** — 94 character (Full ASCII).

**Character Size** — 85 x 105 mils.

**Character Generation** — 7 x 9 dot matrix (with MOS ROM.)

**Character Generation Rate** — 1,000 characters.

#### GRAPHIC MODE

(Vectors only)

**Vector Drawing Time** — 2.6 ms.

**Graphic Matrix** — 1024 X x 1024 Y addressable points; 1024 X x 780 Y viewable points.

**Cursor** — Thumbwheel controlled cross-hair Graphics Matrix; 3 through 1023 X; 0 through 780 Y.

#### OPTION 01 DATA COM INTERFACE

**Functions** — Local/remote echo, full duplex and half duplex.

**Data Rates** — 110, 150, 300, 600, 1200, 2400, 4800, and 9600 baud.

#### AC POWER

**Line Voltage** — 110 or 220 (high, med, low) V ac, strappable.

**Line Frequency** — 48 to 440 Hz.

**Power** — 110 W.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	1054	41.5
Depth	737	29.0
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	40.9	90.0

**Operating Temperature** — 10°C to 40°C.

#### INCLUDED ACCESSORIES

RS-232 Data Communications Interface (021-0065-00).

### ORDERING INFORMATION

**4012 Computer Display Terminal** ..... **\$6,200**

**Option 01** — Optional Data Communications

Interface ..... **+\$525**

**Option 02** — DEC PDP-11 w/KL-115 Controller ..... **+\$525**

**Option 04** — Data General NOVA Interface ..... **+\$525**

**Option 06** — HP 2100-Series (12531 Card)

Interface ..... **+\$525**

**Option 16** — DEC PDP-11 w/DL-11, PDP 11/05 ..... **+\$525**

**Option 23** — 2741 Correspondence Code

Interface ..... **\$1,325**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**

**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**

**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**

**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**



**4014-1/4015-1**

**483 mm (19 in) Direct-View Storage Display**

**Selectable Formats in Alphanumeric and Graphic Modes**

**High-Resolution, Interactive Graphics Capability**

**Plug-In Intelligence Options**

**APL Character Set Available**

The most effective way to display a large data base is high resolution, big screen graphics. The 19-inch, flicker-free 4014-1 and APL-language 4015-1 Computer Display Terminals offer a multitude of capabilities for mapping, design, manufacturing, medicine, energy exploration and many other diverse applications.

Firmware options provide up to 26k of graphics memory for local symbols, stroke-drawn characters, overlays, or background graphics, all of which can be redisplayed on command from the host or keyboard. Reduce data transmission as you redraw portions of your graphics from local memory and generate circles and arcs by a single command. Add local scaling, rotation, and clipping of graphics. Buffer communications between the host and keyboard. Reduce CPU connect-time through local control of graphic tablets, plotters, and tape and disk storage. A

variety of optional intelligence is available to help you keep up with new methods in mapping, process layout, financial graphing and much more.

The 4014-1 and 4015-1 offer 1024 X by 780 Y displayable points standard and up to 4096 X by 3120 Y displayable points with the optional Enhanced Graphics Module. Its 12 million point capability is more than sufficient to solve most complex mapping and design tasks. Full 94-character ASCII includes four program-selectable alphanumeric formats that display up to 8512 characters at once.

Tektronix PLOT 10, a versatile modular software provides a library of proven graphics packages for all levels of users. PLOT 10 Software includes: Interactive Graphics Library (IGL), a system of I/O device drives primary commands and advanced feature support for device independent applications: Terminal Control System (TCS) for linking to existing applications, PLOT 10 Easy Graphing for rapid generation business or scientific graphs and much more.

Interactive previewing on the 4014-1 can considerably reduce time involvement in plotter trial-and-error graphic development. As a cartographer's tool, for instance, the 4014-1 will draw precise maps of cities states, and land formations, and isolate and enlarge those areas you choose.

**CHARACTERISTICS**

**DISPLAY**

**CRT Type** — Direct View Bistable Storage.  
**Dimensions** — 483 mm (19 in) diagonal.  
**Display Area** — 381 x 279 mm (15 x 11 in).

**ALPHANUMERIC MODE**

**Character Set, 4014-1** — Full ASCII (94 printing characters).  
**Character Set, 4015-1** — Full ASCII and APL (188 printing characters).  
**Character Formats** — Four, program-selectable  
74 character/line by 35 lines; 81 character/line by 38 lines; 121 character/line by 58 lines; 133 character/line by 64 lines.  
**Alphanumeric Cursor** — 7 x 9 dot pulsating.

**KEYBOARD**

**Normal Keyboard** — Typewriter paired upper and lower case with automatic repeating keys (4015-1 adds APL character set).

**GRAPHICS MODE**

**Vector Drawing Time** — 127 m/s (5,000 in/s).  
**Addressable Points** — 1024 X x 1024 Y (10 bits).  
**Viewable Points** — 1024 X x 780 Y.

**INTERACTIVE GRAPHIC MODE**

**Addressable Points** — 3 X through 1024 X; 0 Y through 780 Y.  
**Cross-hair Cursor** — Thumbwheel controlled.

**COMPUTER INTERFACES**

**Basic Data Communication Interface** — EIA RS-232C compatible, full duplex.

**AC POWER**

**Line Voltage** — 110/220 V ac (high, med, low).  
**Line Frequency** — 48 to 440 Hz.  
**Power** — 350 W.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	508	20.0
Height	1105	43.5
Depth	825	32.5
Weight	kg	lb
Net	68.0	150.0

**INCLUDED ACCESSORIES**

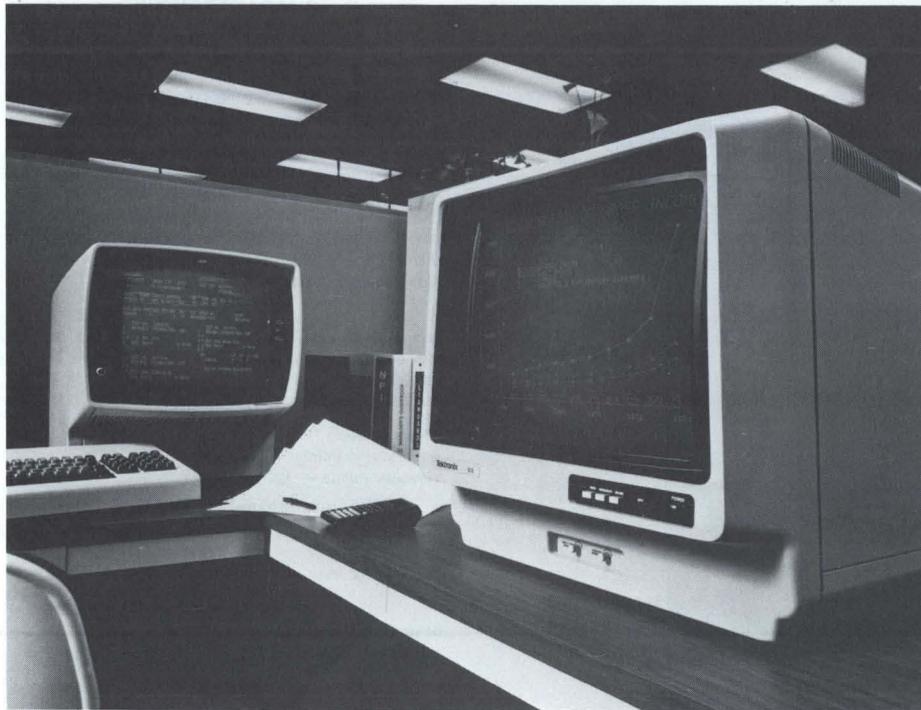
RS-232 Data Communications Interface (021-0065-00).

**ORDERING INFORMATION**

- 4014-1 Computer Display Terminal ... \$15,750**
- 4015-1 Computer Display Terminal ... \$16,900**
- Option 01** — Optional Data Communications Interface +\$525
- Option 02** — DEC PDP-11 w/KL-11 Teletype Control Interface ..... +\$525
- Option 04** — Data General NOVA Interface ..... +\$525
- Option 05** — Peripheral Control Interface ..... +\$790
- Option 06** — HP 2100 Series (HP 12531 Card) Interface ..... +\$525
- Option 16** — DEC PDP-11, -11/05 w/DL-11 Control (M7800) Interface ..... +\$525
- Option 23** — Correspondence Code Interface +2k Output Buffer ..... +\$1,325
- Option 27** — Additional 32k of Graphics Memory ..... +\$200
- Option 30** — Minibus Extender ..... +\$135
- Option 31** — Display Multiplexer ..... +\$640
- Option 34** — Enhanced Graphics Module. (Factory installed only) ..... +\$1,100
- Option 36** — Dual Interface Capability ..... +\$1,120
- Option 40** — Programmable Keyboard ..... +\$1,780
- Option 41** — Expanded Symbol/Character Package . +\$155
- Option 48** — 220 V, 50 Hz ..... NC

Tektronix offers service training classes on the 4014 Computer Display Terminal. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

COMPUTER GRAPHICS TERMINALS



STORAGE DISPLAY MONITOR

**618**

High Resolution Graphics

Combined Stored and Write Thru Mode

19 Inch Diagonal CRT

**Simultaneous stored graphics and refresh information**

An extra feature on the 618 is the Write Thru Mode — a technique by which refreshed data appears on the screen at the same time as stored graphics. The stored portion of the screen presents high resolution, high density graphic and alphanumeric information, while the refresh portion of the display adds the benefits of selective erase, interactivity, and dynamic motion, without any loss of resolution.

High Speed Interactive Graphics adds a New Dimension to the IBM 3277 Display Station. The Tektronix 618 Storage Display Monitor can be used with an IBM 3277 Model 2 Display Station that is equipped with a 3277 Graphics Attachment. The Graphics Attachment (RPQ 7H0284 from IBM) allows the 618 Monitor to add a wide range of graphic capabilities to the station. A dual display station is thus configured with the IBM monitor displaying alphanumeric data and the 618 displaying graphic information and special symbols.

Software support for the Graphics Attachment includes basic routines for drawing lines, placing text, and coordinate transformation. Advanced routines for geometric structures and 3-dimensional displays are also provided.

The 618 offers the benefits of low-cost, high-resolution graphics on a storage screen with excellent interactivity. Two line widths can be selected by software.

The 618 features a 19-inch diagonal CRT driven as an X-Y directed beam display, using analog inputs. The display is horizontally oriented, with the X-axis as the long axis.

**CHARACTERISTICS**

**DISPLAY**

- CRT Type** — Direct View Storage.
- Dimensions** — 48 cm (19 in) diagonal.
- Display Area** — 267 X 356 mm (10.5 x 14 in).
- Stored Writing Speed** — 150 m/s.
- Refreshed Writing Speed** — 500 m/s.
- Write-Thru Contrast Ratio** — 4:1. (Written to background.)
- Maximum Z-Axis Repetition Rate** — 1 MHz.
- Stored Luminance** — 5 fL.
- Resolution, Center Screen** — 40 line pairs/in.
- Resolution, Screen Edges** — 35 line pairs/in.
- Positional Accuracy** — ± 1.25. (Percent of long axis.)
- Stored Dot Writing Time** — 5 μs or less.
- Settling Time** — 5 μs + 5 μs/cm to within one spot diameter.
- Viewing Time** — ≈ 2 minutes until hold mode; ≈ 30 minutes until AUTO ERASE.
- Erase Cycle Time** — 1.5 s, ± 20%.

**AC POWER**

- Line Voltage Ranges** — 90 to 110 V ac, 108 to 132 V ac, 198 to 242 V ac, 216 to 264 V ac (jumper selectable).
- Line Frequency** — 48 to 66 Hz.
- Power** — 220 W maximum at 115 V ac, 60 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	572	22.5
Height	533	21.0
Depth	647	25.5
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net	46.0	100.0
Shipping	55.0	120.0

**INCLUDED ACCESSORIES**

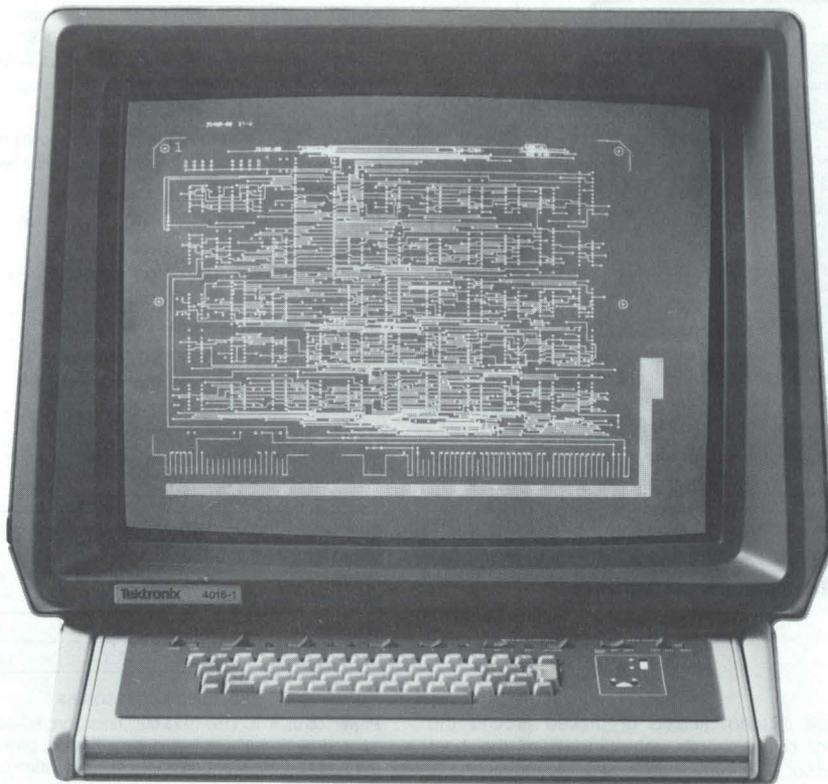
Power cord (161-0066-00).

**ORDERING INFORMATION**

**618 Storage Display Monitor** ..... **\$11,445**  
**Option 30** — Interconnecting Cable, ..... **+\$155**  
 (618 to IBM 3277 For use with IBM Graphics Attachment, IBM RPQ 7H0284)

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**
- Option A2** — UK 240 V/13A, 50 Hz ..... **NC**
- Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**
- Option A4** — North American 240 V/15A, 60 Hz ..... **NC**



**4016-1**

**636 mm (25 in) Direct-View Storage Display**

**High-Resolution, Flicker-Free Graphics**

**Selectable Formats in Graphic and Alphanumeric Modes**

**Plug-In Intelligence Options**

The 4016-1 features a high-resolution, 25-inch display screen that allows designers of electronic circuit boards, utility networks, automotive components, schematic diagrams, street maps or similar applications to work with fine detail while maintaining the total picture perspective.

Using a Direct View Storage Tube (DVST) display, 4016-1 graphic lines are sharp, stable and flicker-free, simplifying the study of fine details. Its 4096X by 3120Y viewable points, and finely etched 10-mil wide vectors are uniquely suited to display highly complex graphics. Thumbwheel-controlled crosshair cursor makes it easy to interactively manipulate the display.

**Over 15,000 Displayable Characters**

Besides enabling display of more high density graphic information than any other terminal available, the 4016-1 provides high density alphanumerics for applications, from graphic labeling to newspaper page layout. Over 15,000 characters may be displayed simultaneously and may be formatted as 179 alphanumeric characters per line, like a line printer, or in two 85 character columns, like an open book.

Three other larger character formats are standard with the 4016-1, the largest of which is suitable for group viewing.

**Complete Tektronix 4014-1 Compatibility**

The 4016-1 is compatible with 4014-1 application software, communication support, and other Tektronix peripheral devices. The 4016-1 is supported by the family of PLOT 10 Software products.

**Plug-in Intelligence**

Using the modular 4010 bus structure, add-on low-cost options include up to 26k of usable graphics display memory, scaling, relative graphics, clipping, circular arc generation, rotation by one degree increments, user definable stroke characters, programmable keyboard, GPIB interfacing to the intelligent 4924 Digital Cartridge Tape Drive, 4907 File Manager, and 4662 and 4663 Interactive Digital Plotters, plus the 4953 or 4954 Graphics Tablet.

Commands also allow a user to digitize data with distance, time, or gradient filtering; edit graphics from a host computer, local 4907, 4924 storage device or Option 40 programmable keys, and implement off-line plotting by accessing data via local storage devices.

**Added Enhancements**

The 4016-1 includes a convenient detachable keyboard and detachable display.

Other standard enhancements include hardware generated solid, dashed, and dotted lines; point plotting with software controllable point sizes and incremental "relative graphics" plotting.

**CHARACTERISTICS**

**DISPLAY**

**CRT Type** — Direct View Bistable Storage.  
**Written Image** — Bright green on green background.  
**Dimensions** — 635 mm (25 in) diagonal.  
**Display Area** — 454 x 340 mm (18 x 13.5 in).

**ALPHANUMERIC MODE**

**Character Set** — Full ASCII (94 printing character).  
**Standard Character Formats** — 74 character/line by 35 lines; 81 character/line by 38 lines; 133 character/line by 64 lines; 179 character/line by 86 lines.  
**Optional Character Formats** — 74 character/line by 35 lines; 81 character/line by 38 lines; 121 character/line by 58 lines; 133 character/line by 64 lines.  
**Alphanumeric Cursor** — 7 x 9 dot pulsating.

**KEYBOARD**

**Normal Keyboard** — Typewriter paired upper and lower case with automatic repeating keys.

**GRAPHICS MODE**

**Drawing Time/Resolution Vector Drawing Time** — 200 m/s (8,000 in/s).  
**Addressable Points** — 4096 X x 4096 Y (12 bits).  
**Viewable Points** — 4096 X x 3120 Y.  
**Vector Formats** — Five (straight, dotted and dashed lines).

**INTERACTIVE GRAPHIC MODE**

**Addressable Points** — 0 X through 1023 X; 0 Y through 780 Y.  
**Cross-hair Cursor** — Thumbwheel controlled.

**COMPUTER INTERFACES**

**Basic Data Communications Interface** — EIA RS-232C compatible, full duplex.

**AC POWER**

**Line Voltage** — 110/220 V ac (high, med, low).  
**Line Frequency** — 48 to 66 Hz.  
**Power** — 450 W.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	680	27.0
Height	1278	50.7
Depth	756	30.0
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	113.0	250.0

**INCLUDED ACCESSORIES**

Wheel kit (040-0714-00); RS-232 Data Communications Interface (021-0065-00).

**ORDERING INFORMATION**

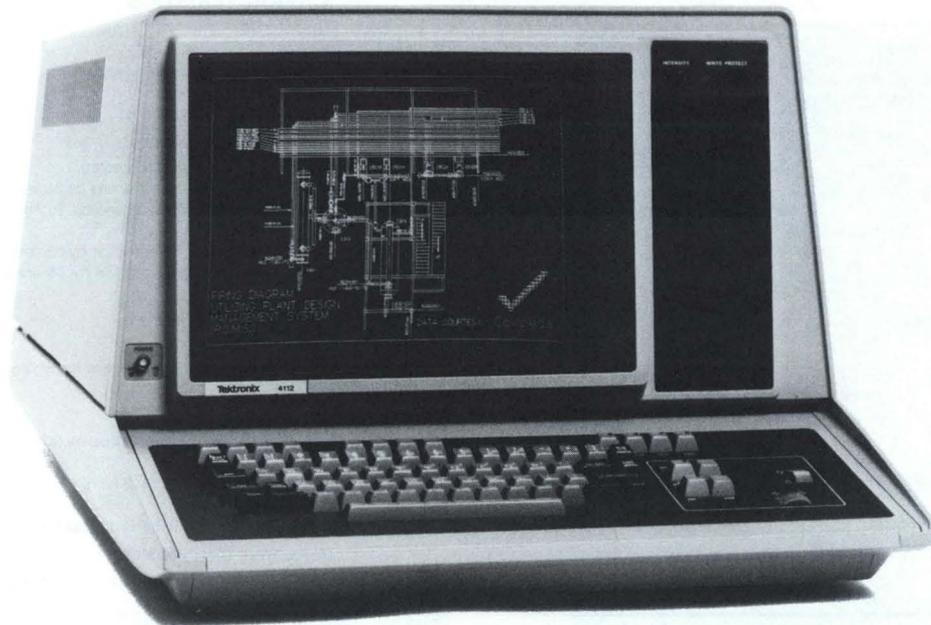
**4016-1 Computer Display Terminal ... \$19,500**

- Option 01** — Optional Data Communications Interface ..... + \$525
- Option 02** — DEC PDP-11 w/KL-11 Teletype Control Interface ..... + \$525
- Option 04** — Data General NOVA Interface ..... + \$525
- Option 05** — Peripheral Control Interface ..... + \$790
- Option 06** — HP 2100 Series (HP 12531 Card) Interface ..... + \$525
- Option 16** — DEC PDP-11, -11/05 Control (M7800) Interface ..... + \$525
- Option 23** — Correspondence Code Interface +2k Output Buffer ..... + \$1,325
- Option 27** — Additional 32k of Graphics Memory ..... + \$200
- Option 31** — Display Multiplexer ..... + \$640
- Option 32** — 4014 Character Set ..... NC
- Option 35** — Dual Interface Capability ..... + \$935
- Option 40** — Programmable Keyboard ..... + \$1,780
- Option 41** — Expanded Symbol/Character Package . . . + \$155

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC
- Option A2** — UK 240 V/13A, 50 Hz ..... NC
- Option A3** — Australian 240 V/10A, 50 Hz ..... NC
- Option A4** — North American 240 V/15A, 60 Hz ..... NC

COMPUTER GRAPHICS TERMINALS



## NEW 4112A

**Raster Scan Monochrome Display with Local Picture Segments**

**2-D Transforms, True Zoom and Pan up to Three Memory Planes**

**Compatible with Tektronix 4010 Series**

Designed to satisfy a broad range of evolving needs, from basic line graphs to high density design, the 4112A Computer Display Terminal provides access to an unusually wide assortment of graphics capabilities. Its powerful local intelligence keeps user interactivity high and host dependency low.

The 4112A offers a bright, flicker-free 15-inch (diagonal) raster scan display. Eight user definable programmable function keys are provided.

The 4112A is compatible with the popular Tektronix 4010 Series of Computer Display Terminals. Programs developed for the 4012 or 4014, for example, may require only minor software revisions to run on the 4112A. Updating existing programs for the new 4112A features is a simple process using the modular device drivers and advanced feature support of the Tektronix PLOT 10 Interactive Graphics Library (IGL).

### Local Picture Segments

A local picture segment is a group of graphic primitives that describes a portion of a picture. These primitives are retained in the terminal's memory to be redrawn and manipulated at any time. Schematic components, symbols, titles and text can be defined as segments, for example, then stored in local memory and redrawn when needed, with minimal computer time and communications traffic required. Local segments may

also be rotated, scaled or moved around the screen, by a simple command from the host processor (2-D Transforms).

### Zoom and Pan

An addressable display space of 4096 by 4096 points is accessible locally by simple, key-actuated zoom and pan or via the host. The thumbwheel controls are used to pan the display with a rectangular cursor and to set the viewport dimensions of the magnified image.

### Multiple Display Memory Planes

Two additional memory planes may be added to the 4112A, via Option 20, to provide as many as three display surfaces. This optional capability enables a number of effects, including overlays of text and/or graphic information.

### Definable Dialog Area

At any time, the user can specify the size and position of the region where communications between terminal and host are displayed. This dialog area is scrollable by the thumbwheels, allowing for easy recall of previous communications.

### Local Programmability

Optional 4110 Series Local Programmability includes a Fortran 86 compiler. Low-level Terminal Interface subroutines, a local version of PLOT 10 IGL and is implemented with CPM-86. (See page 105).

## CHARACTERISTICS

### DISPLAY

**CRT Type** — Raster scan.

**Dimensions** — 220 x 254 mm (8.6 x 11.5 in) 381 mm (15 in) diagonal.

**Scan Type** — 50 or 60 Hz, non-interlaced.

**Phosphor Type** — White P4.

### MEMORY

**Standard Display Memory** — 72k bytes.

**Standard Graphics Memory** — 32k bytes (expandable to 672k bytes).

### KEYBOARD

**Normal Keyboard** — 72 typewriter paired, upper and lower case, programmable and autorepeating (seven lighted).

**User-Definable Programmable Function Keys** — Eight, Four terminal control, four special function.

### ALPHANUMERIC MODE

**Character Set** — 94 (full ASCII) or 128 in "snoopy mode".

**Character Format** — 80 columns, 34 rows, 7 x 9 dot matrix.

### GRAPHICS MODE

**Resolution** — 640 horizontal x 480 vertical pixels.

**Addressability** — 4096 x 4096 points.

**Command Syntax** — PLOT 10 compatible.

**Line Types** — Solid, dashed, erase.

**Graphic Primitives** — Vectors, polygons, text.

### COMPUTER INTERFACES

**Basic Data Communications Interface** — EIA RS-232C compatible, full- or half-duplex.

### AC POWER

90 to 132 V ac, 6.25A maximum, 48 to 62 Hz or 180 to 250 V ac, 3A maximum, 48 to 62 Hz.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	546	21.5
Height	404	15.9
Depth	849	32.0
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	46.3	102.0

### INCLUDED ACCESSORIES

Power cord, 8 ft, (161-0123-00); host port RS-232 Cable, 12 ft, (012-0911-00); re-legendable key caps, package of 8, (366-1882-00); function key overlays, package of 6, (334-3290-01).

### ORDERING INFORMATION

**4112A Computer Display Terminal ..... \$9,600**

**Option 01** — Extended Communications ..... +\$950

**Option 02** — Current-Loop Interface ..... +\$250

**Option 4A** — United Kingdom Keyboard ..... NC

**Option 4C** — Swedish Keyboard ..... NC

**Option 4E** — APL Keyboard ..... +\$750

**Option 4F** — Danish/Norwegian Keyboard ..... NC

**Option 10** — Three-Port Peripheral Interface ..... +\$950

**Option 11** — External Video Output ..... +\$800

**Option 13** — 11 x 11 In Graphic Tablet with pen .... +\$3,300

**Option 14** — 30 x 40 In Graphic Tablet with pen .... +\$5,500

**Option 20** — (2) Display Memory Planes ..... +\$2,600

**Option 24** — Additional 32k bytes of RAM ..... +\$300

**Option 25** — Additional 64k bytes of RAM ..... +\$600

**Option 26** — Additional 96k bytes of RAM ..... +\$875

**Option 27** — Additional 128k bytes of RAM ..... +\$1,150

**Option 28** — Additional 256k bytes of RAM ..... +\$2,300

**Option 29** — Additional 512k bytes of RAM ..... +\$4,600

**Option 42** — Single Flexible Disk ..... +\$1,700

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... NC

**Option A2** — UK, 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian, 240 V/10A, 50 Hz ..... NC

**Option A4** — North American, 240 V/15A, 60 Hz ..... NC



## 4114A **NEW**

**Direct View Storage Tube with Local Picture Segments**

**2-D Transforms, Refresh Support and Fast Redraw**

**Compatible with Tektronix 4010 Series**

The 4114A Computer Display Terminal satisfies the needs of graphics users for faster, more versatile throughput in high density graphics applications. Its local intelligence and expandable memory can significantly reduce the delays and costs associated with over-dependence on a host computer. The 4114A has a resolution high enough for the most complex engineering and scientific graphics.

The 4114A is compatible with Tektronix 4010 Series Computer Display Terminals. Using the modular device drivers and advanced feature support of Tektronix PLOT 10 Interactive Graphics Library (IGL) makes updating existing programs a simple process.

A local picture segment is a group of graphic primitives describing a portion of a picture, retained as a unit in local memory to be redrawn or manipulated at any time. Schematic components, symbols, titles, and text can be defined as segments, then stored and recalled without using a string of commands. Local segments can be rotated, scaled or moved around the screen, with only a simple command from the host (2-D Transforms).

### Refresh Support

Local generation of more than 1500 cm or approximately 3000 short vectors of flicker-free refresh. Option 31 provides color enhanced (amber) refresh for easy recognition of refresh information.

## 4114A30 Desk Configuration **NEW**

Computer display terminal operators can improve their performance with the efficiency, convenience and comfort of the 4114A Model 30, modular Desk Configuration.

The pedestal module contains the power supply and circuit board cage, and also houses one or two optional flexible disk drives for convenient local storage. Supporting the display at eye level the table module can be installed on the left or the right side of the pedestal. The keyboard for the 4114A30 can be detached from the table module for positioning in the lap, on the pedestal, or underneath the display screen.

### Local Programmability

Optional 4110 Series Local Programmability includes a Fortran 86 compiler, Low-level Terminal Interface subroutines, a local version of PLOT 10 IGL and is implemented with CPM-86. (See page 105).

## CHARACTERISTICS

### DATA TRANSMISSION

**Data Rate** — 50 to 19,200 b/s.

**Data Type** — 7-bit asynchronous serial ASCII, plus parity bit.

**Block Mode** — Option 01 Extended Communications.

**Communications Interface** — RS-232C.

### DISPLAY

**CRT Type** — Direct View Storage Tube; 4096 x 4096 addressable points; 4096 x 3120 displayable points; enhanced refresh; fast redraw.

**Dimensions** — 368 mm x 277 mm (14.5 in x 10.9 in); 483 mm (19 in) diagonal.

### MEMORY

**Standard** — 56k bytes ROM and 32k bytes RAM (expandable to 800k).

### KEYBOARD

**Normal Keyboard** — 72 typewriter paired, upper and lower case, programmable and auto repeating, (five lighted).

**User Definable Programmable Function Keys** — Eight.

**Graphic Cursor Control** — Thumbwheels.

**Alpha Cursor Position** — Key control.

**Scrolling** — Thumbwheels.

### GRAPHICS MODE

**Addressability** — 4096 x 4096.

**Line Types** — Solid dashed, defocused.

**Drawing Speed (Storage)** — 134 m/s.

**Drawing Speed (Refresh)** — 537 m/s.

**Graphic Command Syntax** — Tektronix PLOT 10 compatible.

### ALPHANUMERIC MODE

**Standard Displayable Character Set** — 94 character (full ASCII).

### AC POWER

**Line Voltage** — 90 to 132 V ac, 11 A maximum or 180 to 250 V ac, 5.5 A maximum.

**Line Frequency** — 48 to 62 Hz.

### PHYSICAL CHARACTERISTICS, 4114A

Dimensions	mm	in
Width	597	23.5
Height	1290	51.0
Depth	813	32.0
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	107.5	237.0

### PHYSICAL CHARACTERISTICS, 4114A30

Dimensions	Monitor		Pedestal	
	mm	in	mm	in
Width	584	23.0	565	22.3
Height	425	16.8	762	30.0
Depth	582	22.9	851	33.5
	Keyboard		Table	
Width	508	20.0	1219	48.0
Height	70	2.8	692	27.2
Depth	229	9.0	762	30.0
<b>Weight</b>	<b>kg</b>		<b>lb</b>	
Net	165.9		364.9	

### INCLUDED ACCESSORIES

Power cord, 8 ft, (161-0123-00); power cable, pedestal to display, 21 in, (161-0145-00); host port RS-232 Cable, 12 ft, (012-0911-00); re-legendable key caps, pkg of 8, (366-1882-00); function key overlays, pkg of 6, (334-3290-01).

### ORDERING INFORMATION

**4114A Computer Display Terminal ... \$17,900**

**4114A30 Computer Display Terminal:**

**Desk Configuration ..... \$21,400**

**Option 01** — Extended Communications ..... **+\$950**

**Option 02** — Current Loop Interface ..... **+\$250**

**Option 4A** — United Kingdom Keyboard ..... **NC**

**Option 4C** — Swedish Keyboard ..... **NC**

**Option 4E** — APL Keyboard ..... **+\$750**

**Option 4F** — Danish/Norwegian Keyboard ..... **NC**

**Option 10** — Three - Port Peripheral Interface ..... **+\$950**

**Option 13** — 11 x 11 Inch Graphic Tablet w/Pen .... **+\$3,300**

**Option 14** — 30 x 40 Inch Graphic Tablet w/Pen .... **+\$5,500**

**Option 24** — Adds 32k bytes of RAM ..... **+\$300**

**Option 25** — Adds 64k bytes of RAM ..... **+\$600**

**Option 26** — Adds 96k bytes of RAM ..... **+\$875**

**Option 27** — Adds 128k bytes of RAM ..... **+\$1,150**

**Option 28** — Adds 256k bytes of RAM ..... **+\$2,300**

**Option 29** — Adds 512k bytes of RAM ..... **+\$4,600**

**Option 31** — Color Enhanced Refresh ..... **+\$2,000**

**Option 40** — Ten-Slot Peripheral Bus Extender;

Nominal line voltage ..... **+\$350**

**Option 41** — Ten-Slot Peripheral Bus Extender;

90-110 line voltage ..... **+\$350**

**Option 42** — Single Flexible Disk and Disk

Controller ..... **+\$1,700**

**Option 43** — Dual Flexible Disk and Disk

Controller ..... **+\$2,600**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... **NC**

**Option A2** — UK, 240 V/13A, 50 Hz ..... **NC**

**Option A3** — Australian, 240 V/10A, 50 Hz ..... **NC**

**Option A4** — North American, 240 V/15A, 60 Hz ..... **NC**

**Option A5** — Switzerland 220 V/10A, 50 Hz ..... **NC**



**4113A** *NEW*

Raster Scan Color Display

Local Picture Segments

2-D Transforms, True Zoom and Pan

Compatible with Tektronix 4010 Series

**New Capabilities of Color Combined With Local Intelligence**

The 4113A Computer Display Terminal continues the evolution of the 4110 Series of intelligent display terminals by adding color raster features while maintaining compatibility with the 4112A and the 4114A.

The 4113A features true zoom and pan, and multiple viewports. In addition, three memory planes display any eight colors at one time (or 16 colors via Option 21).

**Local Picture Segments**

A local picture segment is a group of graphic primitives that describe a portion of a picture. Schematic components, symbols, titles, and text can be defined as segments, then stored in local memory and redrawn in a specified color as needed, with minimal host time. Local segments may also be scaled, rotated, or moved around the screen, by a single command from the host (2-D Transforms).

**Zoom and Pan**

An addressable 4096 X x 4096 Y display space is accessible by key-actuated zoom and pan or via the host. Thumbwheel controls pan the display with a rectangular cursor and set dimensions of the magnified image.

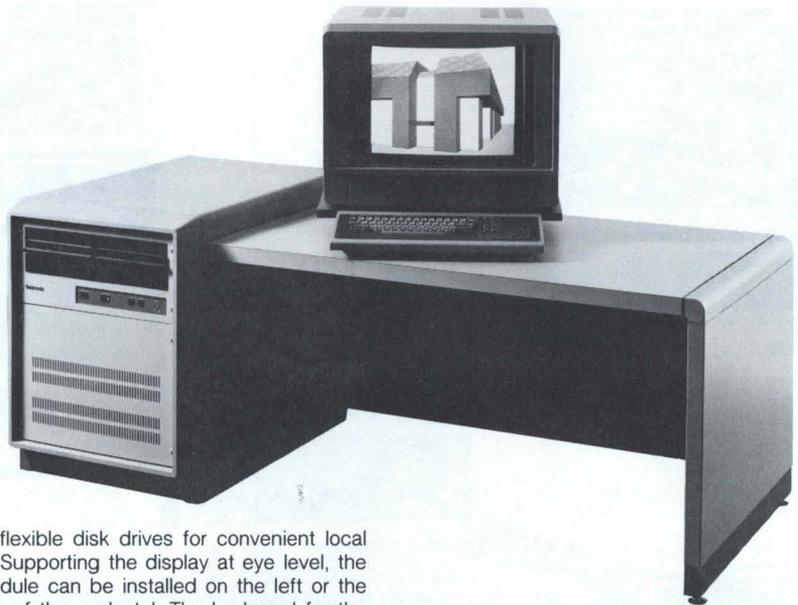
**Multiple Display Memory Planes**

Besides being used to specify colors, the memory (bit) planes provide for overlaying text and/or graphic information, useful in the preparation of multi-layer pictures.

**4113A30 Desk Configuration** *NEW*

Computer display terminal operators can improve their performance with the efficiency, convenience, and comfort of the 4113A30, modular Desk Configuration.

The pedestal module contains the power supply, circuit board cage and also houses one or two



optional flexible disk drives for convenient local storage. Supporting the display at eye level, the table module can be installed on the left or the right side of the pedestal. The keyboard for the 4113A30 can be detached from the table module for positioning, in the lap, on the pedestal, or underneath the display screen.

**Local Programmability**

Optional 4110 Series Local Programmability includes a Fortran 86 compiler, Low-level Terminal Interface subroutines, a local version of PLOT 10 IGL and is implemented with CPM-86. (See page 105).

**CHARACTERISTICS**

**DATA TRANSMISSION**

**Data Rate** — 9600 baud.  
**Block Mode** — Option 01.  
**Communications Interface** — RS-232C.

**MEMORY**

**Standard** — 88k bytes ROM, 32k bytes RAM expandable to 800k.

**DISPLAY**

**Medium** — Shadow-mask color raster tube.  
**Size** — 483 mm (19 in) diagonal.  
**Refresh Rate** — 60 Hz, noninterlaced.

**KEYBOARD**

**Normal Keyboard** — 72 typewriter paired upper and lower case, programmable, auto repeating (seven lighted).  
**User Definable Programmable Function Keys** — Eight.  
**Terminal Control Keys** — Four.  
**Zoom and Pan Keys** — Four.  
**Graphic Cursor Control** — Thumbwheels.

**GRAPHICS MODE**

**Addressability** — 4096 X x 4096 Y points.  
**Resolution** — 640 x 480 pixels.  
**Line Types** — Solid, dashed.  
**Graphic Command Syntax** — PLOT 10 compatible.  
**Graphics Primitives** — Vectors, panels, text.  
**Colors (Three-Bit Plane)** — Eight.  
**Colors (Four-Bit Plane)** — 16.  
**Palette Selection** — 4096.

**ALPHANUMERIC MODE**

**Character Set** — 94 (full ASCII).  
**Character Format** — 80 columns, 34 rows, 7 x 9 matrix in 8 x 14 (pixel) area.

**AC POWER**

90 to 132 V ac, 10 A maximum or 198 to 250 V ac, 5 A maximum; 50 or 60 Hz.

**PHYSICAL CHARACTERISTICS, 4113A**

Dimensions	mm		in	
Width	584		23.0	
Height	1350		53.0	
Depth	787		31.0	
Weight	kg		lb	
	Net	125.0		275.0

**PHYSICAL CHARACTERISTICS, 4113A30**

Dimensions	Monitor		Pedestal	
	mm	in	mm	in
Width	584	23.0	565	22.3
Height	425	16.8	762	30.0
Depth	582	22.9	851	33.5
Weight	kg		lb	
	Net	166.1		365.4

**ORDERING INFORMATION**

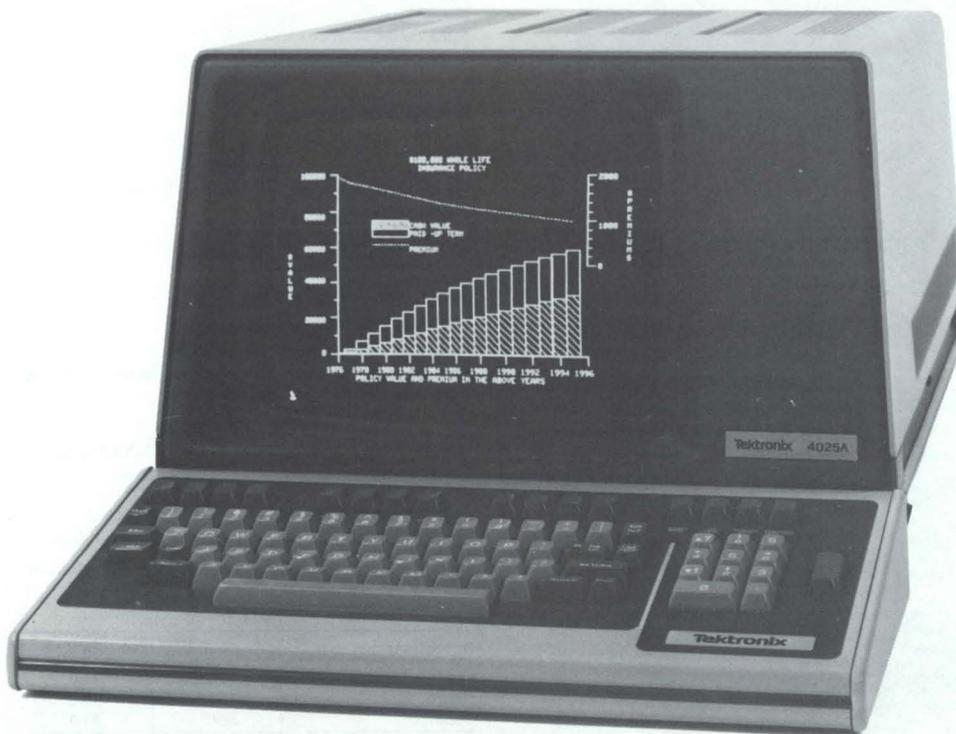
**4113A Computer Display Terminal ... \$16,500**

**4113A30 Computer Display Terminal Desktop Configuration ..... \$20,000**

- Option 01** — Extended Communications ..... +\$950
- Option 02** — Current Loop Interface ..... +\$250
- Option 4A** — United Kingdom Keyboard ..... NC
- Option 4C** — Swedish Keyboard ..... NC
- Option 4E** — APL Keyboard ..... +\$750
- Option 4F** — Danish/Norwegian Keyboard ..... NC
- Option 10** — Three-Port Peripheral Interface ..... +\$950
- Option 12** — External Video Output ..... +\$1,150
- Option 13** — 11 x 11 Inch Graphic Tablet w/Pen .... +\$3,300
- Option 14** — 30 x 40 Inch Graphic Tablet w/Pen .... +\$5,500
- Option 21** — Display Memory Plane ..... +\$1,500
- Option 24** — Adds 32k bytes of RAM ..... +\$300
- Option 25** — Adds 64k bytes of RAM ..... +\$600
- Option 26** — Adds 96k bytes of RAM ..... +\$875
- Option 27** — Adds 128k bytes of RAM ..... +\$1,150
- Option 28** — Adds 256k bytes of RAM ..... +\$2,300
- Option 29** — Adds 512k bytes of RAM ..... +\$4,600
- Option 42** — Single Flexible Disk and Disk Controller ..... +\$1,700
- Option 43** — Dual Flexible Disk and Disk Controller ..... +\$2,600

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... NC
- Option A2** — UK, 240 V/13A, 50 Hz ..... NC
- Option A3** — Australian, 240 V/10A, 50 Hz ..... NC
- Option A4** — North American, 240 V/15A, 60 Hz ..... NC
- Option A5** — Switzerland, 220 V/10A, 50 Hz ..... NC



## 4025A

### Alphanumerics And Graphics

### PLOT 10 Compatible

### ASCII Character Set and Finger Tip Editing

### Forms Ruling Option Available

The 4025A provides a marriage of alphanumerics and optional graphics. You can create and store multiple graphs in memory, create multiple graphs per page, and scroll graphics along with alphanumeric information.

The Standard 4025A Forms Mode and Ruling option can duplicate essentially any form. Visual attributes include enhanced, blinking, inverted and underlined fields. Logical attributes include protected fields, alphanumeric unprotected or numeric only.

To make data entry and editing easier, you can divide the display screen into two separate display areas, each with independent scrolling. The monitor area is used to communicate with the host and the workspace area for the form or graphic display. Hard copy output is standard.

The PLOT 10 Easy Graphing Software package lets you interactively create bar charts with multiple shadings, histograms, log plots, pie charts and period axes, all with a wide variety of labeling options.

The PLOT 10 Interactive Graphics Library provides all the tools needed for the most demanding graphics application developer. Plot 10 IGL is modeled after the ANSI/SIGGRAPH proposal for a graphics programming standard.

The keyboard, an office typewriter configuration, is immediately familiar to new users. Pre-defined editing keys simplify insertion, deletion and input of lines and characters. Sixteen user-definable keys, plus nearly all other keys on the keyboard can be redefined to generate a command or character string at the touch of a finger.

A 16k display memory is standard with the 4025A, expandable to 32k, allowing buffering and scrolling of many pages. Graphic capability is added, with 32k memory, by Option 26.

### CHARACTERISTICS

#### DATA TRANSMISSION

**Data Rate** — Programmable to 9600 baud.

**Communications Interface** — RS-232C, full duplex standard.

#### DISPLAY

**Medium** — Raster scan CRT, 640 x 480 points.

**Dimensions** — 229 x 163 mm (9 x 6.4 in) 300 mm (12 in) diagonal.

**Type** — Dot Matrix.

**Refresh Rate** — Dot and Frame-30/s; Field-60/s.

**Raster Lines** — Standard 525 line scan with 480 lines displayed.

**Display Memory** — 16k bytes standard.

### KEYBOARD

**Normal Keyboard** — 86 typewriter (4 lighted).

**Programmable Keys** — 81.

### ALPHANUMERIC MODE

**Character/Line** — 80.

**Line/Display (Rows)** — 34.

**Character Full Screen** — 2720.

**Standard Displayable Character Set** — 128 upper and lower case (full ASCII); optional character sets available.

**Character Size** — 7 x 9 in and 8 x 14 dot matrix (graphic cells are 8 x 14 matrix).

**Cursor Type** — Wide underscore.

### GRAPHICS MODE

**Resolution** — 28 addressable points/cm.

**Line Types** — Solid, dashed, points, dark vectors (erasing).

### AC POWER

**Standard** — 115 V ac, 3 A, 49 to 63 Hz.

**Power** — 295 W maximum at 125 V ac.

**Ranges** — 90 to 100 V ac; 105 to 125 V ac; 112 to 136 V ac.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	445	17.5
Height	317	12.5
Depth	540	21.2
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	27.2	60.0

### INCLUDED ACCESSORIES

Keyboard overlay, blank, (334-3290-00); blank key cap, 1:2, (366-1748-00); key cap cover, 1:2, (200-2163-00); blank key cap, 1:1, (366-1749-00); key cap cover, 1:1, (200-2164-00); power cord, (161-0066-00).

### ORDERING INFORMATION

**4025A Computer Display Terminal** ..... **\$5,900**

**Option 01** — Half/Full Duplex Interface ..... **+\$160**

**Option 02** — Current Loop Interface ..... **+\$250**

**Option 03** — RS-232C Peripheral Interface\* ..... **+\$330**

**Option 04** — GPIB Peripheral Interface\* ..... **+\$440**

**Option 4A** — United Kingdom Keyboard ..... **NC**

**Option 4B** — French Keyboard ..... **NC**

**Option 4C** — Swedish Keyboard ..... **NC**

**Option 22** — 32k bytes of Display Memory ..... **+\$100**

**Option 26** — Graphics, 32k bytes Memory ..... **+\$800**

**Option 31** — Character Set Expansion ROMs ..... **+\$450**

**Option 36** — Peripheral ROM ..... **+\$165**

**Option 38** — Keyboard Graphic Input Interface\*\* ..... **+\$400**

\*Requires Option 36.

\*\*Requires Option 26.

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... **NC**

**Option A2** — UK, 240 V/13A, 50 Hz ..... **NC**

**Option A3** — Australian, 240 V/10A, 50 Hz ..... **NC**

**Option A4** — North American, 240 V/15A, 60 Hz ..... **NC**

Tektronix offers service training classes on the 4020 Raster Scan Terminal Series. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



## 4027A

Full Color Graphics and Alphanumerics

PLOT 10 Compatible

Fully Supported Color Capability

Dynamic Displays Easily Created

### Adding a Color Dimension to Graphics

The 4027A adds full-color graphics to a compact, high performance computer terminal. Colors are selected from a 64-color palette with up to eight colors simultaneously displayable. When selecting colors with the Lightness, Saturation and Hue controls, you'll find the 4027A system as easy to use as it is versatile.

Local capabilities include colored vectors, characters, symbols, and polygon fill. Firmware enables a second color to border the polygon, and allows user selection of up to 120 different patterns or color combinations for polygon or pie fill. Because these capabilities are initiated by firmware, not software, 4027A operation makes minimal demands on host computer communications.

### Easy-to-use Graphic Software

For graphic representation, the 4027A uses color-enhanced PLOT 10 Easy Graphing Software. Easy Graphing simplifies even non-programmer construction of line graphs with special symbols and dashed lines, legends, titles, and grids, and up to six curves or colored bar charts.

The PLOT 10 Interactive Graphics Library provides all the tools needed for the most demanding graphics application developer. PLOT 10 IGL is modeled after the ANSI/SIGGRAPH proposal for a graphics programming standard.

### Graphic Input

Graphic input capability consists of a graphic crosshair cursor controlled by graphic cursor keys. In addition to reporting the coordinates back to the host, the terminal also reports the color of the designated coordinate.

### Memory

The standard 16k bytes of display memory (optional 32k), and 48k to 192k bytes of graphic memory (optional 192k bytes) allow scrolling, dual screen and multiple field formatting featured in the 4025A Terminal.

The Standard RGB and video signal outputs allow connection of the 4027A to external video displays for group viewing and presentations.

## CHARACTERISTICS

### DATA TRANSMISSION

**Data Rate** — 9600 baud, receiving and transmitting, independently selectable.

**Communications Interface** — RS-232C full duplex. (Option 01 for half and full duplex.)

### DISPLAY

**Medium** — Shadow mask, raster scan, 640 x 480 points.

**Colors Displayable At Once** — Eight.

**Color Palette** — 64.

**Dimensions** — 191 mm x 254 mm (7.5 in x 10 in) 330 mm or 13 in diagonal.

**Patterns** — 120 user definable.

**Dot/Frame Refresh Rate** — 30/s.

**Field Refresh Rate** — 60/s.

**Type** — Dot matrix (each character position has 14 rows of eight dots each).

### Cursor Types

Alphanumeric — Wide underscore.

Graphic — Full screen cross-hair.

### MEMORY

**Standard Display Memory** — 16k bytes.

**Standard Graphics Memory** — 48k bytes.

### KEYBOARD

**Normal Keyboard** — 86 typewriter (four lighted).

**Programmable Keys** — 81.

**Cursor Position** — Key control.

**Terminal Functions** — Key control.

**Scrolling** — Key control.

**Numeric Pad** — Key control.

### GRAPHIC MODE

**Resolution** — 26 addressable points/cm.

**Line Types** — Solid (one of eight colors), dashed, PLOT 10 compatible.

### ALPHANUMERIC MODE

**Standard Displayable Character Set** — 128 (full ASCII).

**Character/Line** — 80.

**Lines/Display (Rows)** — 34.

**User Definable Character Sets** — Up to 31 fonts.

### AC POWER

90 to 120 V ac, 6A maximum or 108 to 132 V ac, 6A maximum; 550 W maximum at 125 V ac 48 to 63 Hz.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	584	23.0
Height	482	19.0
Depth	584	23.0
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	45.4	100.0

### INCLUDED ACCESSORIES

Keyboard overlay, blank, (334-3290-00); blank key cap, 1:2, (366-1748-00); key cap cover, 1:2, (200-2163-00); blank key cap, 1:1, (366-1749-00); key cap cover, 1:1, (200-2164-00); power cord, (161-0066-00).

## ORDERING INFORMATION

**4027A Color Graphics Terminal** ..... **\$10,900**

**Option 01** — Half/Full Duplex Interface ..... +\$160

**Option 02** — Current Loop Interface ..... +\$250

**Option 03** — RS-232C Peripheral Interface\* ..... +\$330

**Option 04** — GPIB Peripheral Interface\* ..... +\$440

**Option 4A** — United Kingdom Keyboard ..... NC

**Option 4B** — French Keyboard ..... NC

**Option 4C** — Swedish Keyboard ..... NC

**Option 22** — 32k bytes of Display Memory ..... +\$100

**Option 29** — 192k bytes of Color Graphics Memory . . . +\$900

**Option 31** — Character Set Expansion ..... +\$450

**Option 36** — Peripheral ROM Interface ..... +\$165

\* Requires Option 36.

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... NC

**Option A2** — UK, 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian, 240 V/10A, 50 Hz ..... NC

**Option A4** — North American, 240 V/15A, 60 Hz ..... NC

Tektronix offers service training classes on the 4020 Raster Scan Terminal Series. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



## 4051

**GPIB  
 IEEE-488**

The 4051 is designed to support other products that comply with IEEE Standard 488-1978.

**Powerful, Easy-to-Use Desktop Computing with Extended BASIC**

**High Resolution Graphics and Alphanumerics**

Desktop computing for a whole spectrum of problem solving, data analysis, and decision making applications. The 4051 is stand-alone computing power that is approachable, affordable, and able to grow as your applications grow. It includes integrated computing, peripherals, and a GPIB interface.

### Friendly Graphics

Commands like DRAW and ROTATE built into the 4051 give you full graphics flexibility while working in your units, not machine or raster units.

The magnetic cartridge tape drive is built into the 4051 hardware and language. File management commands like FIND, OLD, READ, and WRITE, retrieve or store programs and data. A comfortable typewriter keyboard is integrated into the system with a 36-character buffer that eliminates lost entries.

Extended BASIC language provides both power for the sophisticated programmer and simplicity for the beginner. Input and output can be as simple as INPUT or PRINT or can have FORTRAN-like power with PRINT, DELETE and IMAGE commands.

Data Communications Interface (Option 01) permits data exchange with a host computer. Option 01 also enables the 4051 to emulate a terminal

with direct host-to-terminal data transfer. Terminal modes provide local intelligence and direct data transfer between the built-in cartridge tape drive and host computer.

The GPIB is built-in and easy to program with the 4051 BASIC I/O commands. As the industry's choice for connecting instrumentation it is our choice for the 4051 and its many available peripherals.

### GPIB Extender

The General Purpose Interface Bus Extender provides a cost-effective way to interconnect remotely located, IEEE Standard 488 compatible instruments, allowing GPIB communication over distances of up to 500 meters (1650 feet).

GPIB Extenders are always used in pairs: Two 4932 units or one 4932 and one 4909F02. The 4932 is compatible with any instrument that has a GPIB interface, and is compatible with the 4909F02 via the coaxial "link" cable. See page 26 for more information.

## CHARACTERISTICS

### DATA TRANSMISSION

**Data Communications Interface (Option 01)** — Full or half duplex.

**Data Type** — Asynchronous.

**Data Rate** — Up to 2400 baud.

**Printer Interface (Option 10)** — EIA RS-232 and RS-244A compatible up to 2400 baud.

**GPIB Conformance** — IEEE Standard 488-1978 (byte serial, bit parallel).

### DISPLAY

**CRT Type** — Direct View Storage.

**Graphic Resolution** — 1024 x 780 displayable points.

**Dimensions** — 192 x 162 mm (7.5 x 5.5 in).

**Character Set** — Full ASCII upper/lower case. (Also includes Scandinavian, German, Central European, Spanish, special graphic symbols.)

**Character Format** — 72 character/line, 35 lines.

### KEYBOARD

**Normal Keyboard** — 128 upper and lower case (full ASCII) with auto repeat.

**User Definable Function Keys** — 10-shiftable to 20. Keys for single-step program execution, auto numbering, rewinding tape, autoloading/execute first program.

**Calculator Key Pad** — Five math functions.

**Numeric Keys** — Ten.

### CENTRAL PROCESSING UNIT

**Type** — LSI 8-bit microprocessor.

**Standard Memory Workspace** — 16k bytes (32k with Option 22).

**Programming Language** — BASIC with extensions.

**Dynamic Range** —  $\pm 10^{-308}$  to  $\pm 10^{308}$ .

**Numeric Accuracy** — 14 decimal digits (12 displayed).

### TAPE DRIVE

**Cartridge** — Magnetic.

**Type** — 300A, 300XL, and 600A Certified Data Cartridges from Tektronix.

**Rewind Speed** — 90 ips.

**Search/Read Speed** — 30 ips.

**Structure** — 256 bytes w/header.

### AC POWER

**Voltage Ranges ( $\pm 10\%$ )** — 100, 110, 120 V ac; or 200, 220, 240 V ac.

**Line Frequency** — 48 to 66 Hz.

**Power** — 200 W maximum.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	465	18.3
Height	345	13.6
Depth	826	32.5
Weight	kg	lb
Net	29.5	65.0

**Operating Temperature** — 10°C to 40°C.

### INCLUDED ACCESSORIES

System software tape (020-0160-04); system software backup tape (020-0161-03); power cord (161-0066-00); blank user definable key overlays, pkg of 10, (334-2630-02).

### ORDERING INFORMATION

**4051 Desktop Computer** ..... **\$6,295**  
**Option 01** — Data Communications Interface ..... **+\$900**  
**Option 10** — Printer Interface ..... **+\$550**  
**Option 22** — 32k Bytes Total Memory ..... **+\$150**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

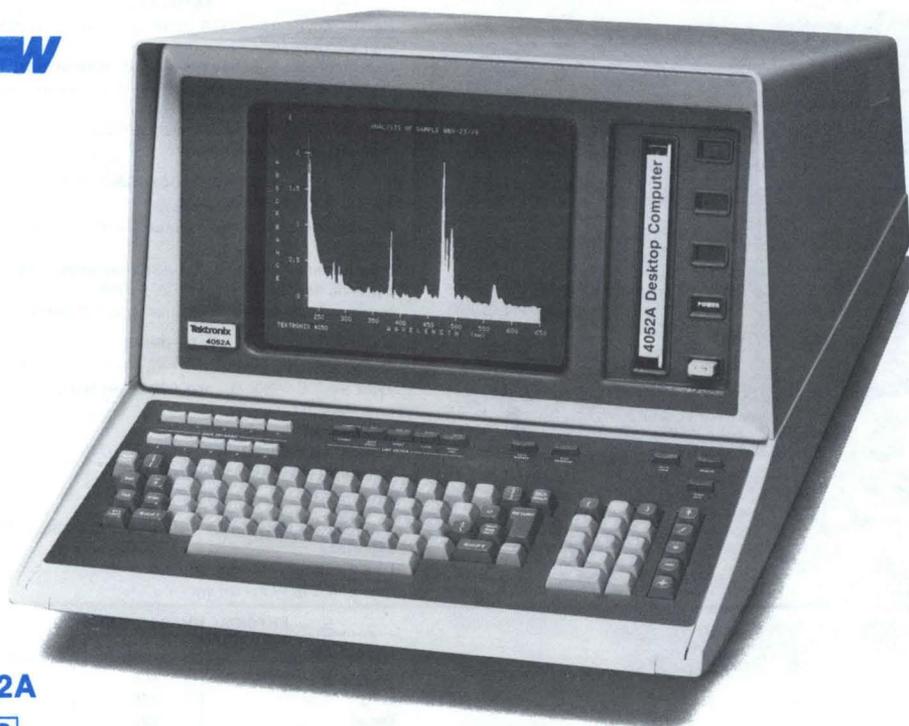
**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK, 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian, 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American, 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland 220V/10A, 50 Hz ..... **NC**

### OPTIONAL ACCESSORIES FOR 4932

**4932 GPIB Extender** ..... **\$1,195**  
**GPIB Cable, 2 m, double shield.**  
 Order 012-0630-03 ..... **\$90**  
**GPIB Cable, 4 m, double shield.**  
 Order 012-0630-04 ..... **\$150**  
**Coaxial Link Cable, 50 ft, RG 6/U.**  
 Order 012-1051-00 ..... **\$50**  
**Coaxial Link Cable, 250 ft, RG 6/U.**  
 Order 012-1052-00 ..... **\$105**

Tektronix offers service training classes on the 4050 Graphic System Series. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

**NEW**



**4052A**

**GPIB  
 IEEE-488**

The 4052A is designed to support other products that comply with IEEE Standard 488-1978.

**Fast Processing**

**High Level BASIC**

**Extended Memory File Manager (Option)**

The 4052A Desktop Computer provides computation and communications for a whole spectrum of problem solving, data analysis, and decision making applications. It offers high performance stand-alone computing power, flexible data communications, and easy-to-learn, extended BASIC. These features, combined with high resolution graphics, make the 4052A an excellent choice for scientific and statistical research, forecasting, data acquisition, and analysis.

For rapid calculation, the 4052A has a fast processor with microcode floating point. Fast processing coupled with simultaneous display of text and graphics meets the needs of most application requirements.

A magnetic cartridge tape drive is built-in, allowing both ASCII and binary programs or data to be easily stored and retrieved using simple file management commands in BASIC.

New extended BASIC provides the simplicity desired by the beginner and the flexibility and power required by the experienced programmer.

Device independent keywords such as INPUT and PRINT make programming input and output operations easy. Fast matrix functions such as multiply, inverse, transpose, identity and determinants are built into BASIC.

**Friendly Graphics**

Commands like MOVE, DRAW and ROTATE in BASIC allow graphic displays to be created on the 4052A using user defined units, not machine or raster units.

**GPIB Extender**

The General Purpose Interface Bus Extender provides a cost-effective way to interconnect remotely located, IEEE Standard 488 compatible instruments, allowing GPIB communication over distances of up to 500 meters (1650 feet).

GPIB Extenders are always used in pairs: Two 4932 units or one 4932 and one 4909F02. The 4932 is compatible with any instrument that has a GPIB interface, and is compatible with the 4909F02 via the coaxial "link" cable. See page 26 for more information.

**CHARACTERISTICS**

**DATA TRANSMISSION**

- Data Type** — Asynchronous.
- Data Rate** — Up to 9600 baud.
- Data Communications Interface (Option 01)** — Full or half duplex.
- Printer Interface (Option 10)** — EIA RS-232 or RS-244A compatible.
- GPIB Conformance** — IEEE Standard 488-1978 (byte serial, bit parallel).

**DISPLAY**

- CRT Type** — Direct View Storage.
- Dimensions** — 192 mm x 141 mm (7.5 in x 5.5 in) 282 mm (11 in) diagonal.
- Graphic Resolution** — 1024 x 780 viewable points; 1024 x 1024 addressable points.
- Character Set** — Full ASCII (German, Swedish, Danish/Norwegian, British, Spanish, Graphic and Business font selectable under program control).
- Character Format** — 72 character/line, 35 lines.

**KEYBOARD**

- Normal Keyboard** — 128 ASCII, upper/lower case (full ASCII) with auto repeat.
- User Definable Function Keys** — 10 shiftable to 20. Keys for single-step program execution auto-numbering, rewinding tape, autoload/execute first program.
- Calculator Key Pad** — Five math functions.
- Numeric Keys** — Ten.

**CENTRAL PROCESSING UNIT**

- Type** — LSI, bipolar, 16 bit.
- Standard Memory Workspace** — 32k bytes total (64k with Option 24).
- Programming Language** — High level BASIC with extensions.
- Dynamic Range** —  $\pm 10^{-308}$  to  $\pm 10^{308}$ .
- Numeric Accuracy** — 14 decimal digits (12 displayed).

**TAPE DRIVE**

- Cartridge** — Magnetic.
- Type** — 300A, 300XL, and 600A Certified Data Cartridge from Tektronix.
- Rewind Speed** — 90 ips.
- Search/Read Speed** — 30 ips.
- Structure** — 256 bytes w/header.

**AC POWER**

- Voltage Ranges ( $\pm 10\%$ )** — 100, 110, 120 V ac or 200, 220, 240 V ac.
- Line Frequency** — 48 to 66 Hz.
- Power** — 300 W maximum.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	465	18.3
Height	345	13.6
Depth	826	32.5
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	30.8	68.0

**Operating Temperature** — 10°C to 40°C.

**INCLUDED ACCESSORIES**

System software tape (020-0160-04); system software back-up tape (020-0161-03); power cord (161-0066-00); blank user definable key overlays, pkg of 10, (334-2630-02).

**ORDERING INFORMATION**

- 4052A Desktop Computer** ..... **\$9,900**
- Option 01** — Data Communications Interface ..... **+\$1,400**
- Option 02** — Four Slot ROM Backpack ..... **+\$400**
- Option 03** — Four Slot Data Communications Interface ..... **+\$1,700**
- Option 10** — RS-232 Printer Interface ..... **+\$550**
- Option 24** — 64k Bytes Total Memory ..... **+\$290**
- Option 27** — 256k Bytes Extended Memory File Manager ..... **+\$3,500**
- Option 28** — 512k Bytes Extended Memory File Manager ..... **+\$4,500**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... **NC**
- Option A2** — UK, 240 V/13A, 50 Hz ..... **NC**
- Option A3** — Australian, 240 V/10A, 50 Hz ..... **NC**
- Option A4** — North American, 240 V/15A, 60 Hz ..... **NC**
- Option A5** — Switzerland 220V/10A, 50 Hz ..... **NC**

**OPTIONAL ACCESSORIES FOR 4932**

- 4932 GPIB Extender** ..... **\$1,195**
- GPIB Cable, 2 m, double shield.**
- Order 012-0630-03 ..... **\$90**
- GPIB Cable, 4 m, double shield.**
- Order 012-0630-04 ..... **\$150**
- Coaxial Link Cable, 50 ft, RG 6/U.**
- Order 012-1051-00 ..... **\$50**
- Coaxial Link Cable, 250 ft, RG 6/U.**
- Order 012-1052-00 ..... **\$105**

Tektronix offers service training classes on the 4050 Graphic System Series. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

DESKTOP COMPUTERS

NEW



4054A

GPIB  
 IEEE-488

The 4054A is designed to support other products that comply with IEEE Standard 488-1978.

19 In, High Resolution Display

Dynamic Graphics (Option)

Extended Memory File Manager (Option)

Color Enhanced Graphics (Option)

Unequaled graphics and powerful, fast computations, the 4054A is the only integrated desktop computer that combines easy-to-learn, extended BASIC with the unique features of a large-screen, high resolution display. For rapid calculation, the 4054A has a fast processor with microcoded floating point.

The 4054A has a long list of proven peripheral products. GPIB (General Purpose Interface Bus) and RS-232C interfacing coupled with easy-to-program BASIC I/O commands allow considerable versatility in designing your own system.

The General Purpose Interface Bus Extender provides a cost-effective way to interconnect remotely located, IEEE Standard 488 compatible instruments, allowing GPIB communication over distances of up to 500 meters (1650 feet).

GPIB Extenders are always used in pairs: Two 4932 units or one 4932 and one 4909F02. The 4932 is compatible with any instrument that has a GPIB interface, and is compatible with the 4909F02 via the coaxial "link" cable. See page 26 for more information.

The 4054A features software compatibility with the rest of the 4050 Series of desktop computers. Programs developed on the 4051 and 4052A will operate on the 4054A, giving its users access to a wealth of PLOT 50 Software, already written and debugged, thus reducing program development costs often associated with new systems.

The Dynamic Graphics Option adds increased interactivity to the graphics of the 4054A and brings the user closer to the solution by providing the graphic power to work directly with the graphic elements of the design problem. Complicated displays can be constructed quickly and easily with movable user-defined objects.

**Superior Graphic and Alphanumeric Display**  
With 4096 X and 3120 Y resolution — 12 million displayable points the 4054 has all the graphics capability you will need for even the most complex display. With stroke-generated characters programmable in four sizes and eight fonts, the 4054A has the tools to alphanumerically dress up your output to suit any professional requirement. The large screen permits previewing of 132 column line printer output.

For your graphing needs there are 36 distinct dot-dash patterns, selectable under program control, providing for maximum effect of represented data. For interaction the 4054A has a thumbwheel driven, true crosshair cursor. All of these features are implemented using the extended BASIC of the 4054A.

New powerful extended BASIC provides the simplicity desired for the beginner together with the flexibility and power required by the experienced programmer. Device independent keywords make program and data input/output operations easy. Fast, built-in BASIC functions such as SINE, LOG, SQR, etc., plus a complete set of matrix functions provide powerful computation at your fingertips.

CHARACTERISTICS

DATA TRANSMISSION

**Data Communications Interface (Option 01)** — Full or half duplex.  
**Data Type** — Asynchronous.  
**Data Rate** — Up to 9600 baud.  
**Printer Interface (Option 10)** — EIA RS-232 or RS-244 Compatible up to 9600 baud.  
**GPIB Conformance** — IEEE Standard 488-1978, (byte serial, bit parallel).

**Processor** — LSI bi-polar 16 bit.  
**Memory Workspace** — 32k bytes or 64k with Option 24.  
**Dynamic Range** —  $\pm 10^{-308}$  to  $\pm 10^{308}$ .  
**Numeric Accuracy** — 14 decimal digits (12 displayed).  
**Programming Language** — High level BASIC with extensions.

DISPLAY

**CRT Type** — Direct View Storage.  
**Graphic Resolution** — 4096 x 3125 viewable points; 4096 x 4096 addressable points.  
**Dimensions** — 385 mm x 282 mm (15 in x 11 in); 482 mm (19 in) diagonal.  
**Visibility** — Flicker-free.  
**Alphanumeric** — Up to 132 character/line, 64 lines, four sizes.  
**Special fonts** — Selectable under program control—Swedish, German, British, Spanish, Danish/Norwegian, Graphic and Business.  
**Graphics** — Vector drawing time — 15k cm/s.  
**Addressable Resolution** — 4096 X x 3120 Y Dot-dashed vectors, programmable in 36 visibly distinct patterns.

KEYBOARD

**Normal Keyboard** — 128 characters (full ASCII) upper and lower case with auto repeat.  
**User Definable Function Keys** — 10 shiftable to 20.  
**Numeric Function Keys** — Ten.  
**Line/Character Editor Keys** — Five.  
**Cursor Position Control** — Thumbwheels.  
**Cursor Type** — Cross-hair.

TAPE DRIVE

**Cartridge** — Magnetic.  
**Type** — 300A, 300XL, and 600A Certified Data Cartridges from Tektronix.  
**Rewind Speed** — 90 ips.  
**Search/Read Speed** — 30 ips.  
**Structure** — 256 bytes w/header.

AC POWER

**Voltage Ranges** — 100, 110, 120 V ac or 220, 240 V ac.  
**Line Frequency** — 48 to 66 Hz.  
**Power** — 360 W maximum.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	674	26.3
Height	513	20.0
Depth	840	32.7
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	65.8	145.0

Operating Temperature Range — 10°C to 40°C.

INCLUDED ACCESSORIES

System software tape (020-0160-04); system software backup tape (020-0161-03); power cord (161-0066-00); blank user definable key overlays, (pkg of 10) (334-2630-02).

ORDERING INFORMATION

**4054A Desktop Computer** ..... \$20,100  
**Option 01** — Data Communication Interface ..... +\$1,400  
**Option 02** — Four Slot ROM Backpack ..... +\$400  
**Option 03** — Data Communications Interface,  
Four Slot ..... +\$1,700  
**Option 10** — RS-232 Printer Interface ..... +\$550  
**Option 24** — 64k Bytes Total Memory ..... +\$290  
**Option 27** — 256k Bytes Total Memory ..... +\$3,500  
**Option 28** — 512k Bytes Extended Memory  
File Manager ..... +\$4,500  
**Option 30** — Dynamic Graphics ..... +\$3,315  
**Option 31** — Color Enhanced Dynamic Graphics .... +\$5,315

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**  
**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... NC  
**Option A2** — UK, 240 V/13A, 50 Hz ..... NC  
**Option A3** — Australian, 240 V/10A, 50 Hz ..... NC  
**Option A4** — North American, 240 V/15A, 60 Hz ..... NC  
**Option A5** — Switzerland, 220V/10A, 50 Hz ..... NC

OPTIONAL ACCESSORIES FOR 4932

**4932 GPIB Extender** ..... \$1,195  
**GPIB Cable**, 2 m, double shield.  
Order 012-0630-03 ..... \$90  
**GPIB Cable**, 4 m, double shield.  
Order 012-0630-04 ..... \$150  
**Coaxial Link Cable**, 50 ft, RG 6/U.  
Order 012-1051-00 ..... \$50  
**Coaxial Link Cable**, 250 ft, RG 6/U.  
Order 012-1052-00 ..... \$105

OEM terms available on this product.

DESKTOP COMPUTERS

## Editor ROM Pack (4051 only)

Allows general ASCII file editing of data or programs or text (including FORTRAN, BASIC and COBOL programs) offline. Includes 29 commands such as COPY, INSERT, MOVE, SEARCH and SORT for creating, manipulating and storing ASCII text.

Order 4051R06 ..... \$650

## Editor ROM Pack (4052/4052A and 4054/4054A only)

Same capability as 4051R06.

Order 4052R06 ..... \$650

## Signal Processing ROM Pack #1 (4051 only)

Adds seven new functions which can be applied to one dimensional data arrays; integration, differentiation (2 and 3 point), fast graphing, locating minimum and maximum, and crossing over a threshold. Functions operate 2-10 times faster than equivalent BASIC routines.

Order 4051R07 ..... \$350

## Signal Processing ROM Pack #1 (4052/4052A and 4054/4054A only)

Same capability as 4051R07.

Order 4052R07 ..... \$350

## Signal Processing ROM Pack #2 (4051 only)

Extends array handling capabilities by adding commands that perform Fast Fourier Transform (FFT), its inverse (IFT), convolution, correlation, windowing and related utility functions. Functions execute 7-20 times faster than BASIC routines.

Order 4051R08 ..... \$700

## Signal Processing ROM Pack #2 (4052/4052A and 4054/4054A only)

Same capability as 4051R08.

Order 4052R08 ..... \$700

## Real Time Clock ROM Pack (4052/4052A and 4054/4054A only)

Provides five time related functions for date and timekeeping, elapsed time measurement and a time programmable 4050 BASIC level interrupt. All functions may be executed directly from the keyboard or may be used within a program.

Order 4052R09 ..... \$500

## Advanced File Manager ROM Pack (4051 only)

Provides easy access to advanced file management offered by the 4909 Multi-User File Management System. Accessible using commands in BASIC, capabilities such as indexed or "keyed" files, variable length records and dynamic file allocation are supported.

Order 4051R10 ..... \$750

## Advanced File Manager ROM Pack (4052/4052A and 4054/4054A only)

Same capability as 4051R10.

Order 4052R10 ..... \$750

## Character and Symbol ROM Pack (4052/4052A or 4054/4054A only)

Generates high resolution stroked characters that can be scaled, rotated and slanted to user's specifications. In addition to the over one-hundred standard characters, users can construct unique custom symbols. The degree of smoothness is selectable for quick screen previews before final plotter copy. Additional commands are provided to extend Dynamic Graphic capabilities.

Order 4052R11 ..... \$900

## GPIB Enhancement ROM Pack (4051 only)

Improves the performance of the 4051 as an instrument controller using forty-one commands; twelve to facilitate standard GPIB commands using direct call statements; twelve to improve GPIB polling by adding parallel polling, control of SRQ sensing, automatic serial polling and decoding of *Tektronix Codes and Formats* for standard error messages. Seventeen additional commands expand binary data acquisition and automated data manipulation.

Order 4051R14 ..... \$650

## GPIB Enhancement ROM Pack (4052/4052A or 4054/4054A only)

Improves the performance of the 4052 and 4054 as instrument controllers using thirty-nine commands; twelve to facilitate standard GPIB commands using direct call statements; twelve to improve GPIB polling by adding parallel polling, control of SRQ sensing, automatic serial polling and decoding of *Tektronix Codes and Formats* for standard error messages. Fifteen additional commands expand binary data acquisition and automated data manipulation.

Order 4052R14 ..... \$650

## ROM Expander (4051, 4052/4052A and 4054/4054A)

Permits connecting up to eight ROM Packs to the 4050 Series Desktop Computer. Utilizes one slot of existing twos lot backpack.

Order 4050E01 ..... \$1,450

## Data Communications Interface (4051, 4052/4052A and 4054/4054A)

Allows asynchronous bit serial communications between 4050 Series Desktop Computer and any external device conforming to EIA RS-232 standard. Ease of use is facilitated by a special overlay and added language commands that make communication parameters and communications programmable.

Order Option 01 (4052/4052A, 4054/4054A) ..... +\$1,400  
Order Option 01 (4051) ..... +\$900

## Backpack (4052/4052A and 4054/4054A only)

Optional four-slot backpack.

Order Option 02 ..... +\$400

## Backpack (4052/4052A and 4054/4054A only)

Optional four-slot backpack with Option 01 Data Communications Interface built-in.

Order Option 03 ..... +\$1,700

## Printer Output Interface (4051, 4052/4052A and 4054/4054A)

Enables 4050 Series system to output alphanumeric to any printer or output device conforming to the RS-232C or RS-244A Standard for EIA Numerical Machine Control. Data rates are switch-selectable up to 2400 baud with the 4051, and 9600 baud with the 4052 or 4054.

Order Option 10 ..... +\$550

## Extended Memory File Manager (4052/4052A or 4054/4054A only)

Integrated-RAM-based peripheral with command structure similar to 4907. Provides storage of data files and programs with high speed transfers.

Order 4052F27 256k bytes ..... \$3,600

Order 4052F28 512k bytes ..... \$4,600

## Dynamic Graphics (4054/4054A only)

Permits complex graphic objects to be created, saved, and recalled with simple BASIC language commands. These objects, saved in a Dynamic Graphics memory can be displayed, blinked, moved anywhere on the screen, and removed without affecting the rest of the display.

Order Option 30 ..... +\$3,315

## Color Enhanced Dynamic Graphics (4054/4054A only)

Contains Option 30 Dynamic Graphics (see above) with the addition of the latest technology, two color DVST. Refreshed graphics appear in an orange color while stored graphics are displayed in the familiar green. Distinguishability between refreshed and stored graphics are improved with the additional color.

Order Option 31 (factory option only) ..... +\$5,315

PLOT 50

Graphics Software Library

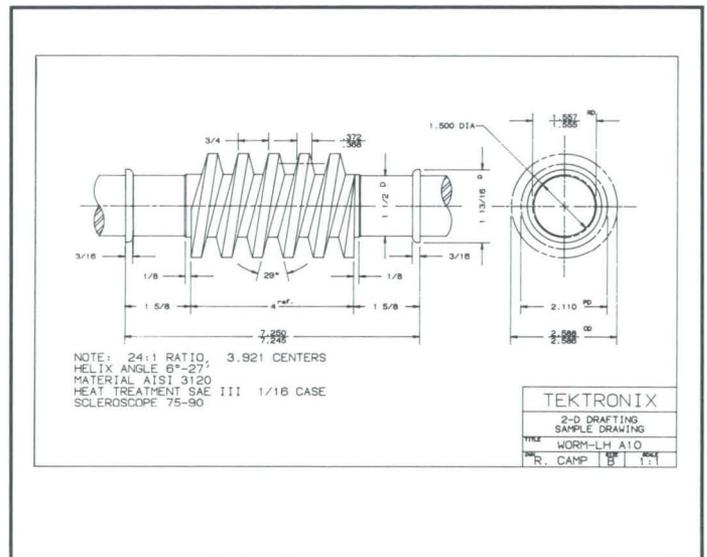
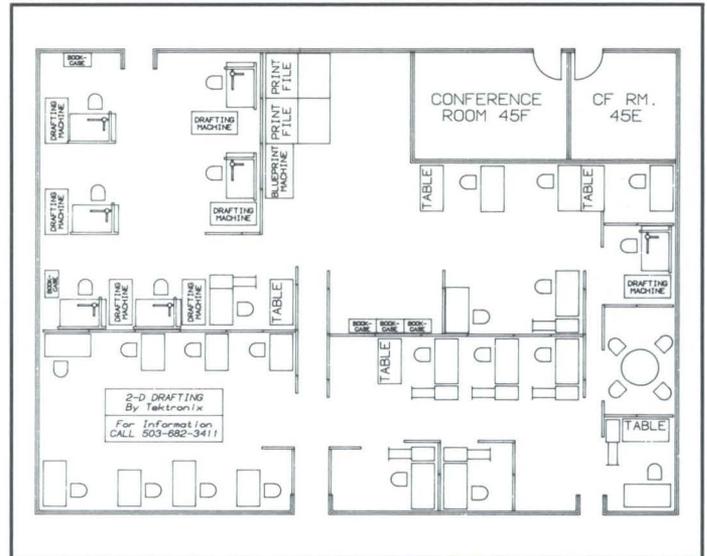
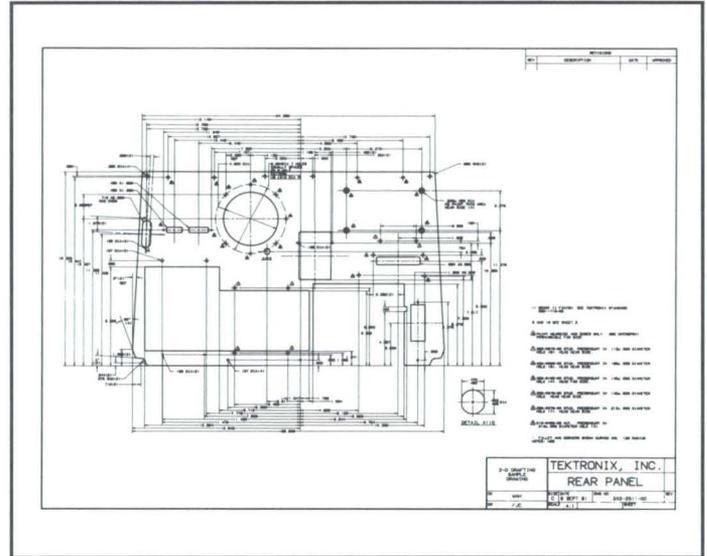
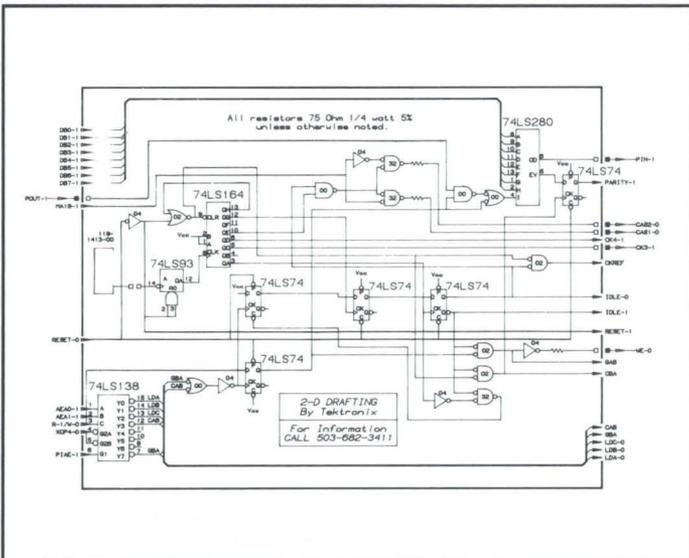
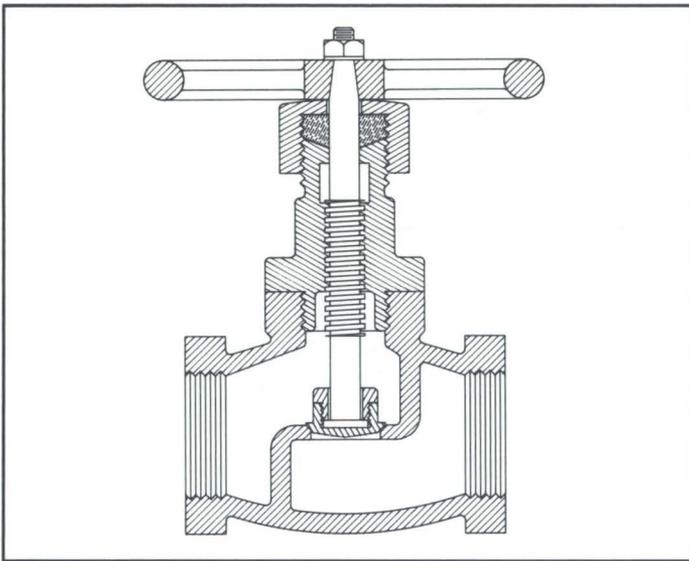
PLOT 50 software supports the 4050 Series Desktop Computers. The PLOT 50 software provides flexible, interactive programs that aid the user in scientific, engineering and management applications through easy-to-use high quality graphics.

Tektronix has developed an extensive library of software to assist users with their multiple applications.

2-D Drafting

At the heart of the PLOT 50 software library is the 2-D Drafting package, which represents a state-of-the-art alternative to manual drawing. The 2-D Drafting software contains flexible routines for creating geometry, annotation, dimensioning, and symbol manipulation.

The 2-D Drafting software provides significant productivity gains in the creation of engineering drawings in mechanical, electrical, structural and facilities disciplines. The speed and accuracy of the package is unmatched by other similar offerings in the market. Compliance with ANSI Y14 and ISO standards means a short learning curve exists for new users.

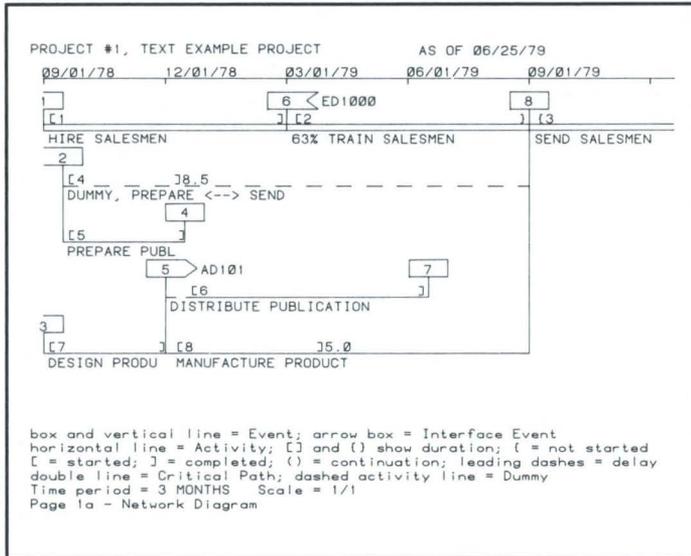


SOFTWARE

**MicroPERT 2 - Project Management**

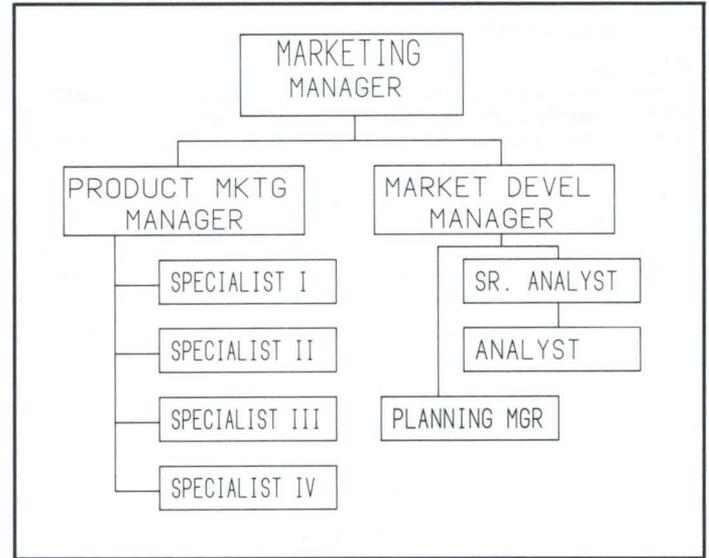
This (tape or disk based) software package represents an innovative approach to understanding changes in complex projects. PERT and CPM (Critical Path Method) techniques are employed as well as many options for graphic reports, responsibility coding and resource utilization and management.

Project managers can obtain faster turn-around when making project changes and graphically understanding the results of those changes.



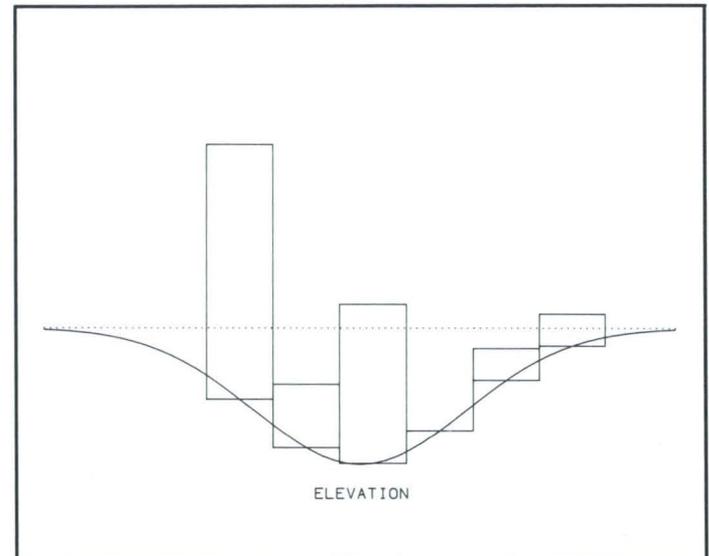
**Picture Composition and Document Preparation**

Picture Composition allows the user to create simple or complex illustrations without being a programming expert. The Document Preparation Software is a powerful text formatting package, especially useful for creating and editing large, technical documents. Together, Picture Composition and Document Preparation provide unusual power for creating technical documents, including composition and graphics.



**Statistics**

The Tektronix Statistics Library contains the very latest plus traditional methods employed for Tests and Distributions, Analysis of Variance, Multiple Regressions, and Nonlinear Estimations. This well-rounded portfolio includes a special user interface and exploratory graphs to aid in faster analysis and understanding. The Statistics software is available as separate volumes or at discount as a Library.



**Technical Data Representation**

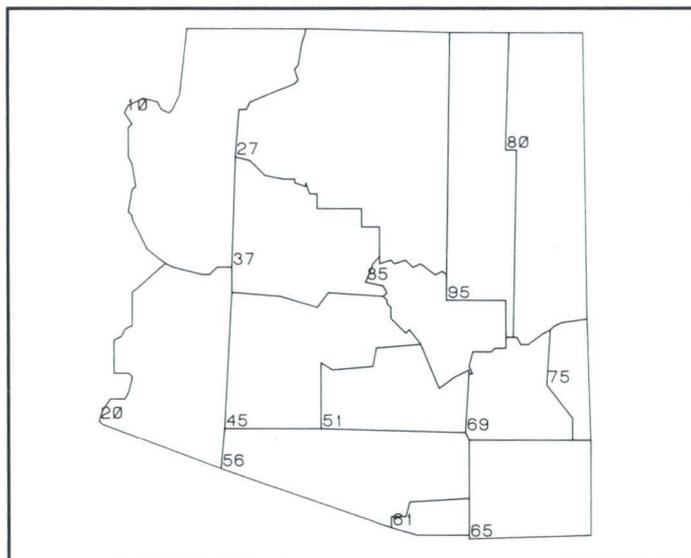
To assist managers in creating presentation quality graphs, a number of various software packages are available. Easy graphing provides simple methods of constructing Line, Pie, and Bar charts. Presentation Aids assists users in creating management style graphs directly on overhead projector film (included with the software package).

SOFTWARE

**Interactive Digitizing**

This sophisticated software package is intended for users in "production" digitizing environments. Users can quickly create and edit digitized files for analysis and processing. The software is tablet menu driven with assisting prompts on-screen to guide users through basic operations.

Users can quickly manipulate objects (points, polygons, lines, text, symbols) and modify objects (insert, move, delete). Flexible routines exist for users to attach a rich amount of attribute data to digitized objects. Symbol creation, reference grids, user-defined object names and attributes, length, area, and centroid calculations are but a few of the many features available.



**Other PLOT 50 Software**

Other software support in the PLOT 50 Library includes:

- Modeling and Reporting
- Math I & II
- Electrical Engineering
- Graph Plot
- Utilities
- Business Planning & Analysis I & II

At the heart of the software library is Tektronix graphics; more kinds of interactive graphics and more meaningful graphics than any competitive software on the market. Access to information is of little value if the keys to understanding and communicating are not there, too. PLOT 50 supports the unequalled graphics capability of the 4050 Series.

The displays are not only sharper — thanks to each 4050 Series computer's high-resolution display — they're more complete, too, with features like automatically labeled data points. Or the capability to easily transform the same data into different kinds of graphs.

4054, PLOT 50 Software can perform routines many times faster than competitive packages — and offers many capabilities simply unavailable elsewhere.

Most PLOT 50 Software is compatible with the entire 4050 Series, so you can change computers or exchange data quickly and easily.

Most importantly, PLOT 50 packs tremendous power into the fewest possible keystrokes. Combined with the processing speed of the 4052 or PLOT 50 lets you sit down at the computer, load the program, and proceed to the solution. Even complete newcomers to computers can put most volumes to use in less than an hour! With PLOT 50's multiple menus, help files and tutorials, continual prompting and graphic output, even operators unskilled in the application itself can perform many common tasks.

**Common Data Exchange Formats**

Tektronix has developed common data across programs very easy. Standard File Formats (SFF) allow sharing of numeric data across programs and the Graphic Model Exchange Format (GMX) allows sharing of graphic data across program. These common exchange formats represent significant productivity gains for desktop computing graphics users.

**ORDERING INFORMATION**

4052D07 — PLOT 50 Interactive Digitizing .....	\$1,600
4050A17 — PLOT 50 MicroPERT 2 Project Management (tape) .....	\$4,000
4050D02 — PLOT 50 Test and Distributions .....	\$900
4050D03 — PLOT 50 Statistics of Variance .....	\$900
4050D04 — PLOT 50 Statistics: Multiple Linear Regression .....	\$900
4050D05 — PLOT 50 Statistics: Nonlinear Estimation .....	\$900
4050D11 — PLOT 50 MicroPERT 2 Project Management (disk) .....	\$4,000
4050A16 — PLOT 50 Presentation Aids .....	\$900
4052D10 — PLOT 50 Document Preparation .....	\$900
4054D06 — PLOT 50 Picture Composition .....	\$2,200
4054D08 — PLOT 50 2-D Drafting .....	\$12,000

**The Technical Assistance Services (TAS) and Software Subscription Services support PLOT 10 and PLOT 50 Software. These services are available throughout the U.S. and many countries around the world.**

**TECHNICAL ASSISTANCE SERVICES**

Tektronix Technical Assistance Services (TAS) supplement your own resources and provide short-term consultative assistance to aid your Tektronix software implementation, training and problem solving. TAS exists to help you gain maximum benefit from your Tektronix products.

TAS is a general program making Tektronix' System Analyst resources available at your site and is available for Tektronix hardware and licensed software products. Your requirements will be defined and agreed upon before action is taken or cost is incurred. Most cases will be satisfied on a "time and materials" basis. Tektronix will make every effort to respond in a timely and efficient manner to help you more quickly achieve or increase productive capability.

**FEATURES**

While TAS is a general program, typical services include:

**Installation Assistance**

Provides preinstallation counseling, assisting in installation of software on a host computer, and installation validation.

**Familiarization Training**

Training modules are presented to individuals or groups on the operational aspects of Tektronix products. Introduction or overview training on hardware or software explains system interaction and use of software. Generally, less than one day of presentation is required.

**Custom Training**

Includes developing and presenting training modules to satisfy a specific user need.

**Problem Definition**

Provides debugging help, and tracing a problem in a hardware/software system.

**Product Interfacing Assistance**

Advises as to special interface requirements where intimate knowledge of Tektronix hardware and software is required.

**Application Interfacing Assistance**

Provides graphics expertise to customers integrating Tektronix hardware and software into their specific application.

**SERVICE HOURS AND CHARGES**

**Hours of Coverage**

Normal working hours are 8:00 a.m. to 5:00 p.m., five days per week (excluding Tektronix holidays).

**Charges**

On-site labor charges are on an hourly basis, as quoted by your local Tektronix office. The minimum time charges is three hours.

Travel charges are on a zone basis, depending on your distance from the designated Tektronix support office.

**SOFTWARE SUBSCRIPTION SERVICES**

The Tektronix Software Subscription Service (SSS) provides subscribers with current releases of Tektronix licensed software products, updates to software documentation, plus information on applications, utilization and enhancements.

With SSS, Tektronix provides updated products on the same media as the original product. Updated products are available on a periodic basis as required to maintain a currently released version. SSS coverage includes licensed PLOT 10 and PLOT 50 software products in Category A or B (see Software Warranty and Software Support statements on pages 7-8).

Software product updates are supplemented by documentation changes to software reference manuals, application articles, and programming hints.

During the one year period of the Warranty or SSS, Software Performance Reports may be submitted to Tektronix. When your diagnosis indicates a software defect, complete a Software Performance Report and send it to Tektronix. Tektronix will respond via code correction, by-pass procedure, or include the correction in the next update of the product.

**CONDITIONS AND CHARGES**

**License Required**

Customer/User must have a valid license for licensed Tektronix software products.

**Recipient**

A person and/or department responsible for maintaining the software's integrity at the user's site must be identified as the update recipient.

**SSS Prerequisite**

All Tektronix software products at the customer/user site must be current before the SSS can be initiated.

**Software Interaction**

The SSS must be purchased for all options and prerequisite software packages.

**Hardware Maintenance**

All Tektronix hardware and firmware must be maintained at the latest level to ensure hardware/software compatibility.

**Charges**

Annual product Use Fee (includes the SSS for one year). Use Fee is payable in advance.

Tektronix offers OEM Software Licensing Agreements. See your Tektronix OEM representative for full details.

## PLOT 10

### Graphics Software Library

PLOT 10 provides tools for easy use of the graphic and alphanumeric capabilities of Tektronix terminals including the 4110 and 4010 Series terminals, 4006-1, 4025A and 4027A Color Display.

PLOT 10 is the world's leading commercial graphics library. Versatile, modular, and fully documented, it lets you start with only the code you need to do your job, then expand with modules and utilities to develop more sophisticated or specialized applications. PLOT 10 builds to unique high-level solutions such as English-like commands for business applications and other non-programmer environments.

### PLOT 10 Includes the Following Packages

#### Terminal Control System (TCS)

A composite of FORTRAN IV subroutines, TCS contains the basic building blocks for all graphic operations. Anything that can be displayed graphically can be managed by TCS. Its proven uses range from simple business graphs and forecast diagrams to contour maps of electron densities, interactive design of electrical circuit boards, and complex architectural renderings. Several sets of graphs and data can be displayed on-screen at once by using the system's windowing functions, or graphs can be superimposed in the same screen area. It permits modular as well as system independent programming, and supports such basic graphic functions as windowing, clipping and rotation for DVST terminals and 4660 Series Plotters. Data scaling is automatic.

#### Plotter Utility Routines

These routines link your data base, terminal and Tektronix 4660 Series plotters to enable easy, powerful command of multicolored graphs, charts, maps and renderings. Digitizing is just as versatile by using the built-in joystick.

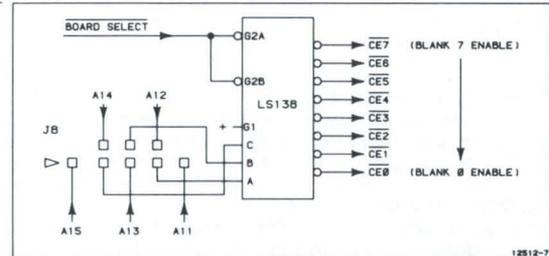
#### Advanced Graphing II Package

Versatile Terminal Control System software to graph your data using a powerful set of Fortran IV subroutines. AG-II combines simplicity of use with highly flexible subroutines to let a programmer tailor the size, shape and format of graphs, by specifying more than 40 graphic elements. But AG-II is as much a boon to the new user as to the expert. By using the system's built-in default determinations, you can supply as few as two subroutine calls to produce a full-screen graph properly scaled and annotated.

#### Interactive Graphing Package

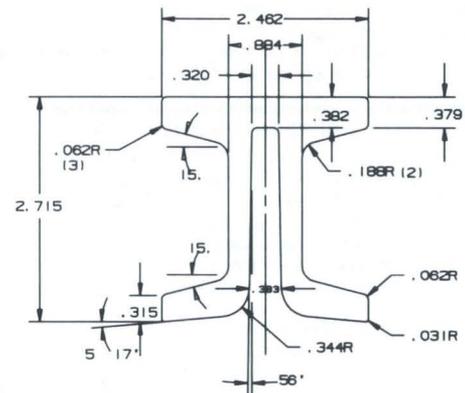
Powerful graphing through English language commands for the non-programmer. By using a library of HELP and error messages, plus step-by-step computer guidance, the beginner can launch into a straightforward system of data base management. IGP simplifies the task of graph storage, editing, recall and updating, so a user with little or no programming experience can create a presentation quality graph, on DVST terminals.

## LOGIC DESIGN AND MAINTENANCE

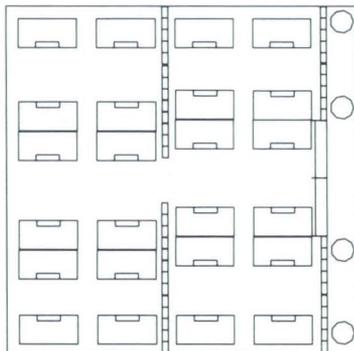


MANUAL: BUS TEST FIX. SECT/FIG.: 2-4		
WRITER:	ARTIST: GROSSAND	
SIZE: 17 x 36	CAM SET: 100X	
PHOTO INST.: LINESHOT.		
DISK: GREEN FILE: 12512/7		
LAYER# 2,3,4	FONT SIZE# 8,9	ORIG# 58

## LIBRARIES of BASIC OBJECTS



## OFFICE & SITE PLANNING



TITLE  
ADD  
CHANGE  
DELETE  
REDRAW  
SAVE  
EXIT

OBJECT  
MOVE  
ROTATE

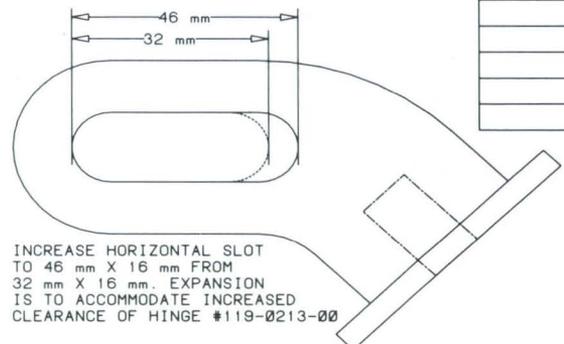


## DESIGN DOCUMENTATION

ENGINEERING CHANGE ORDER

TITLE: BRACKET #119-0110-00

PROJ ENGR:



GRAPHICS TEXT COMPOSER  
Many quality character fonts

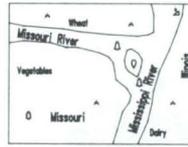
English

Tektronix  
Informatic  
Display

Math

$$A = \int_a^b e^{-\sigma t} dt$$

Cartographic



Special

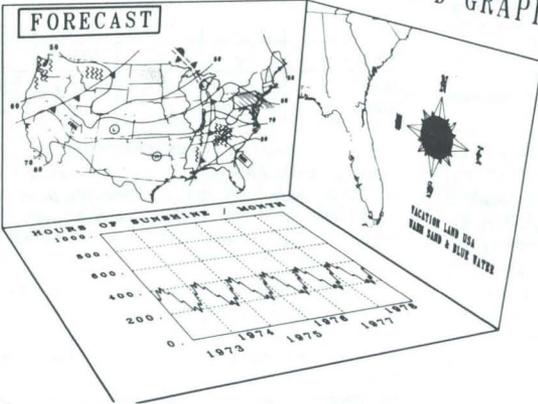


European & Latin American

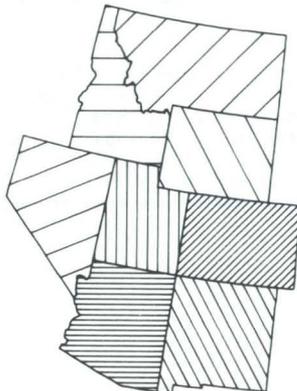
¡Señor, mire  
presentado  
4014, de Tek

Diese Vorgänge  
automatisch ge  
Welches ist d

4010C01 PLOT 10 IGL 3-D GRAPHICS



Panel Support



Clipped Panels



CALL FILPAN  
CALL EDGE  
CALL PANEL

Rocky Mountain/Plateau State Population

Easy Graphing

A straight forward English language command structure that gives the non-programmer wide-ranging command of graphics in business and engineering decision-making tasks. For those with programming experience, commands are provided to call user-written subroutines for customized graphical displays or for unique data handling requirements. The standard PLOT 10 Easy Graphing package offers support for up to six curves or shaded bar charts, line graphs with special symbols and dashed lines, legends, titles, grids, hard copy, plotter control, and much more. PLOT 10 Easy Graphing offers high quality color graphing even on minicomputers.

Interactive Graphics Library

IGL's state-of-the-art software is transportable from CPU to CPU, and from operating system to operating system.

IGL is a uniquely modular system of I/O, device drivers, primary commands and advanced feature support that lets the user move at will among any Tektronix display devices or technology. The structure of PLOT 10 Interactive Graphics Library follows the concepts suggested in the ACM/SIGGRAPH study on a core standard for computer graphics, and is the world's best selling implementation of the SIGGRAPH core concept. Though conformance of PLOT 10 IGL is neither guaranteed nor implied to exactly match the evolving core recommendation, it is offered in support of the recognized need for consistency in fundamental computer graphics concepts. Advanced options such as Line Smoothing, Color Panel Filling, Graphics Text composer, Segments and 3-D graphics may be added. Segments support lets an application programmer build the automated drafting board.

BASE PRODUCT LISTING\*

"A" Series, Matching Software for DVST Terminals.

- 4010A01 — PLOT 10 Terminal Control System.
- 4010A02 — PLOT 10 Advanced Graphing II.
- 4010A04 — PLOT 10 Preview Routines for CalComp Plotters.
- 4010A05 — PLOT 10 Character Generation System.
- 4010A06 — PLOT 10 Graphic Tablet Utility Routines.
- 4010A10 — PLOT 10 Terminal Control System, Implementation for IBM with TSO.

"B" Series, Office Machine Simplicity for Producing the Most Popular Formats in Graphing.

- 4010B0x — PLOT 10 Easy Graphing.
- Option 33 — 4010 Series Support.
- Option 43 — 4025A Terminal Support.
- Option 48 — 4027A Color Support.

"C" Series, The Graphic Standard in Device Independence.

- 4010C01 — PLOT 10 Interactive Graphics Library.

\* A complete listing of PLOT 10 software, availability and prices can be obtained from your Tektronix Sales Office.

NEW 4110 SERIES LOCAL PROGRAMMABILITY

Tektronix 4110 Local Programmability provides direct, local access to all 4110 Series Computer Display Terminal features. Local Programmability reduces, or in some cases eliminates, dependence on host computers.

Local Programmability supplies all the elements required to locally write, edit, compile, link, debug, and run programs; to access all the graphic and alphanumeric features resident in the 4110 Series firmware; and, to control peripherals connected to the terminal.

The package consists of a disk-based CP/M-86\* operating system, a FORTRAN-86\*\* compiler, utility programs and a library of Low-level Terminal Interface (LTI) subroutines. A local version of Tektronix PLOT 10 Interactive Graphics Library (IGL) and a macro assembler are also available.

Older 4110 Series terminals are easily upgraded to Local Programmability. The recommended system configuration includes a minimum of 256k bytes of RAM. The user can expand local memory up to a total of 800k bytes on the 4114 and 4113 and up to a total of 672k bytes on the 4112.

\* A registered trademark of Digital Research, Inc.

\*\* A registered trademark of Intel Corp.

\* Contact your local Tektronix Sales Office for price and ordering information.



4662 Option 31

## 4662

**Intelligent B-size (A3) Plotter**

**Multi-color Capability**

**Built-in RS-232 and GPIB Interface**

The 4662 is the first plotter with built-in processing power. It has the capability to operate independently, without bogging down computational operations. Input data is internally buffered so you can optimize data transfer from your host processor, or move on to your next computation while the 4662 is plotting. Incorporating state-of-the-art technology, it provides an accuracy and repeatability that no other plotter can approach for the price.

When turned on, the 4662 automatically adjusts for its nominal plot size regardless of how the last plot was set up. To set a different plotting area or adjust to a new paper size, you simply use the SET control buttons on the front panel to define the area. The 4662 plots on paper, vellum, mylar, acetate-film and preprinted forms.

The 4662's digital stepping motors and internal vector generator operate at high speed, with microprocessor-controlled acceleration and deceleration.

### Excellent Repeatability

There is no servo hysteresis and no drift as in potentiometric feedback systems. There are no slidewires to clean, no moving electrical contacts, and no servo adjustments to be made.

Up to four 4662s can be configured in series, and up to 15 4662s can be used with one GPIB device like the Tektronix 4050 Series of desktop graphic computers. Each plotter can perform its own job simultaneously while the host processor turns to other tasks. A simple, unique code activates each plotter.

## 4662 Option 31

**Intelligent B-Size (A3) Plotter**

**8-pen Turret Version**

**Compatible in RS-232C ASCII Environments**

**Supported by PLOT 10 and PLOT 50 Software**

The 4662 Option 31 adds the convenience of an automatic 8-pen turret to the built-in processing and feature-packed performance of the world's most versatile small plotter. With the Option 31, you can insert any eight pens and program the 4662 to make the selection for you. Mix and match hard-nib, fiber-tip and wet-ink pens. Include fine line widths for the most precise plots, or for drawing several plots on a single page. Work with nine available colors to add greater clarity and appeal to presentations and camera-ready plots.

Retrofit your present 4662 with the Option 31 turret. It can be installed quickly by any Tektronix service engineer. Updating existing programs to include programmed pen selection requires the addition of just a few lines of code.

### Operating Modes

The 4662 Option 31 has two input modes in RS-232C: Alphanumeric (Alpha) and Graphic Plot (Graphic). The 4662 Option 31 also has Graphic input (GIN) to the host. A GPIB interface is also standard.

## CHARACTERISTICS

**Plotting Area** — X-axis, >381 mm (15 in); Y-axis, >254 mm (10 in).

**Repeatability** — ±0.06 mm (±0.0025 in); Option 31 - ±0.06 mm w/same pen, ±0.25 mm w/pen exchanged.

**Time to Maximum Velocity** — ≈120 ms.

**Resolution** — 0.127 mm (0.005 in).

**Plotting Rate** — 406 to 559 mm/s (16 to 22 ips) vector dependent.

**Plotting Rate, Option 31** — User programmable from 10 to 570 mm/s in 10 mm/s increments.

**Point Plotting Rate** — Ten points/s maximum.

**Character Set** — Full ASCII.

**Pen Control** — Software or front panel Pen button; manually disabled.

**Writing Method** — Fiber-tipped pen, nylon tipped pen, or wet ink drafting pens.

**Paper Size** — 279 x 432 mm (11 x 17 in) maximum.

**Paper Retainer** — Electrostatic holddown.

**Drive Characteristics** — Two four-phase stepping motors, each operating a pulley/cable system to propel the pen in that motor's respective axis.

### AC POWER

**Voltage Ranges** — 105, 116, 210, 232 ±14% V ac.

**Line Frequency** — 48 to 66 Hz.

**Power** — 60 W typical, 90 W maximum.

### PHYSICAL CHARACTERISTICS

	4662		4662 Option 31	
	mm	in	mm	in
<b>Dimensions</b>				
Width	517	20.4	654	25.7
Height	203	8.0	203	8.0
Depth	495	19.5	495	19.5
<b>Weight</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net	13.8	30.0	16.0	35.0
Shipping	20.8	46.0	21.0	46.0

### INCLUDED ACCESSORIES 4662

Power cord (161-0066-00); digitizing sight (214-2409-01); RS-232 Interface Cable, 15 ft, (012-0829-00); paper, 10 x 10 in, 100 sheets, (006-1698-00); fiber tip pens for paper, pkg of 3, red (016-0589-00); green (016-0589-01); black (016-0589-02); blue (016-0589-03).

### INCLUDED ACCESSORIES (4662 OPTION 31)

Power cord (161-0066-00); digitizing sight (119-1432-01); RS-232 Interface Cable, 15 ft, (012-0829-00); paper, blank, 100 sheets (006-2410-00); fiber tip pens for paper, 9-pen multi-color packs for paper (016-0687-00).

## ORDERING INFORMATION

**4662 Interactive Digital Plotter ..... \$4,800**

**Option 01** — GPIB I/F Cable instead of

RS-232C I/F Cable ..... **NC**

**Option 20** — 8k Buffer ..... **+\$495**

**Option 31** — Eight Pen Turret ..... **+\$1,000**

**4662A01** — PLOT 10 Utility routines software ..... **\$460**

**021-0339-00** — Option 31 Field Retrofit

kit for std 4662 ..... **\$1,500.00**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**

**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**

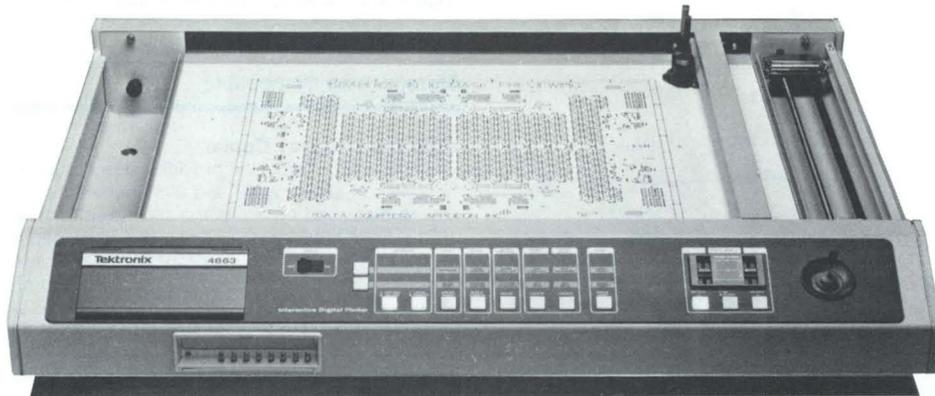
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**

**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**

**Option A5** — Switzerland 220 V/10A, 50 Hz ..... **NC**

Tektronix offers service training classes on the 4662 Interactive Graphic Plotter. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

OEM terms available on these products.



**4663**



The 4663 is designed to support other products which comply with IEEE Standard 488-1978.

**Intelligent C-size Plotter**

**Dual Programmable Pen Control**

**Nine Character Fonts**

**RS-232 and GPIB Product**

The 4663 is the first high speed, C-size plotter with built-in processing power and 5.5k buffer memory to free the host from many routine computations. This intelligent plotter saves time without sacrificing flexibility.

The 4663 can handle either European A-2 drafting size or American C-size paper, mylar or acetate. Fiber tip, hard-nib, or wet ink pens give you crisp, clean camera-ready copies or overhead transparencies.

A sprocket feed paper advance (Option 36) is available for roll stock, with form feed remotely or locally programmable. This option allows the 4663 to operate unattended with a variety of form sizes.

The plotter features dual programmable pen control with interchangeable multicolor pens and is capable of producing dotted or dashed lines from local firmware. A built-in joystick allows easy manual positioning of the pen carriage crosshairs for digitizing or page scaling adjustments.

**Unique Parameter Entry Device**

This front panel device lets you quickly identify or select operating parameters without resorting to binary switches, straps, status display devices, and volumes of operator manuals. It allows you to quickly program baud rate, pen type, acceleration, plotting speed, aspect ratio, page size and many other parameters.

**Excellent Penmanship**

Nine character fonts come standard with the 4663, including the full ASCII character set. All characters can be scaled, slanted, rotated and may be centered when used as pilot symbols.

**Local Functions**

Various graphic functions are implemented via firmware. Page scaling, windowing, viewporting and clipping are typical.

Hardware loop through RS-232C interface is standard and optional GPIB is available. The 4663 is designed to support other GPIB products that comply with IEEE Standard 488-1978.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 26 for additional information.

**CHARACTERISTICS**

- Maximum Plotting Area** — X-axis, 569 mm (22.4 in) Y-axis, 432 mm (17 in).
- Repeatability** — ±0.064 mm (±0.0025 in).
- Resolution** — ±0.025 mm (±0.001 in).
- Maximum Plotting Speed** — 406 to 559 mm (16 to 22 ips) vector dependent.
- Point Plotting Rate** — Ten points/s maximum.
- Character Generator** — 95 ASCII, 15 x 7 matrix, seven special fonts standard.
- Paper Size** — 420 x 594 mm (European A2), 17 x 22 in (US C-size).
- Paper Retention** — Electrostatic hold down.
- Media Types** — Paper, mylar or acetate.
- Drive Characteristics** — Microprocessor controlled stepping motors controlling cable system connected to pen arm.
- Baud Rate** — 110 to 9600 baud.
- Standard Interface** — RS-232C, full duplex, loop-through.

**AC POWER**

- Voltage Ranges** — 90 to 132 V ac and 180 to 250 V ac.
- Line Frequency** — 48 to 440 Hz.
- Power** — 180 W typical.

**4663S**



**Intelligent C-Size Plotter**

**RS-232 and GPIB Product**

**High Performance Features**

As the first interactive digital plotter to combine large plotter capabilities with C-size workstation convenience, the 4663S typically does most of the work relegated to the largest flatbeds and drums at a tremendous savings in time and cost. Using its dual-programmable pens, unique push-button parameter entry card, and the other high-performance features, you can enjoy easy command over many of the most sophisticated plotting tasks.

**Features**

In addition to the capabilities of the 4663, the 4663S offers the following high performance features as standard:

**Integral GPIB and RS-232 Interface**

This interface provides flexible plotter configurability with a variety of host computers, terminals and displays.

**Circular Interpolation and Programmable Macros**

These features allow the precise drafting of circles and arcs, and for quick drafting of stored graphics and symbols.

**Added Default Parameters**

These parameters permit as many as four groups of set-up instructions to be entered in plotter memory, with single-key recall.

**Downloadable Math and Character Sets**

These sets permit alphanumeric versatility with reduced host dependency.

**PHYSICAL CHARACTERISTIC, 4663/4663S**

Dimensions	mm	in
Width	995	37.6
Height	173	6.8
Depth	752	29.6
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	386.0	85.0
Shipping	454.0	100.0

**INCLUDED ACCESSORIES**

Power cord (161-0066-00); RS-232 Interface Cable, 15 ft, (012-0829-00); fiber tip pen, pkg of 3, black, (016-0414-00); red, (016-0415-00); blue, (016-0416-00); green, (016-0417-00); paper translucent, white, No 1 sulfite, 17 x 22 in, box of 100 sheets, (006-3150-00); 4663S only, GPIB Cable, 2 m (012-0630-03).

**ORDERING INFORMATION**

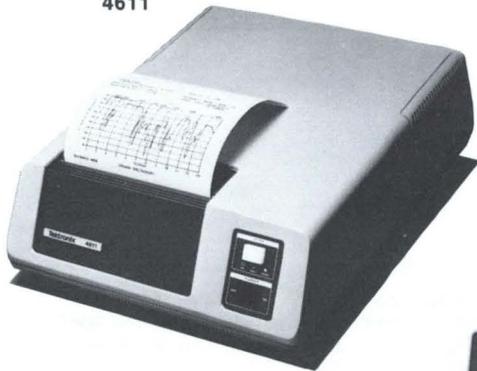
- 4663 Interactive Digital Plotter** ..... **\$9,990**
- 4663S Interactive Digital Plotter** ..... **\$10,900**
- Option 04** — GPIB only (deletes RS-232C for 4663) ..... **NC**
- Option 36** — Paper advance ..... **+\$1,050**
- 4663A01** — PLOT 10 Utility Routines Software ..... **\$750**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**
- Option A2** — UK 240 V/13A, 50 Hz ..... **NC**
- Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**
- Option A4** — North American 240 V/15A, 60 Hz ..... **NC**
- Option A5** — Switzerland 230 V/10A, 50 Hz ..... **NC**

Tektronix offers service training on the 4663 Interactive Digital Plotter. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

4611



4631



**4611**

**Low Copy Cost**

**High Contrast, Permanent Images**

**Electrostatic Process**

**Storage Tube Compatible**

**A Storage Display Copier**

The 4611 provides low cost, high quality copies of complex graphics and alphanumeric from storage tube displays at the press of a button. The 4611 is based on electrostatic (charge transfer) technology, and uses electrostatic paper for high contrast, permanent copies at an economical per-copy cost.

The 4611's high addressability and dot overlap result in uniquely dark, smooth lines for optimum electrostatic copy quality. The dry toning system employed by the 4611 is cleaner, more convenient and more consistent than liquid toning systems. Images are permanently fused and made from safe ingredients. Typical user applications include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records.

Copies are vertically oriented in the standard 4611. However, an option offering a 73 percent larger horizontally oriented image is available. The 4611 is compact and lightweight, and can be easily moved from desk to desk. It also can be multiplexed to copy up to four terminals and/or display monitors. Warm up lights and paper-out indicators are provided.

The 4611 is compatible with the Tektronix 4010 Series of Computer Display Terminals, the 4114A and the 4025A Terminals, the 4050 Series of Graphic Computing Systems, and the 4081 Interactive Graphics Terminal. The 4611 is also compatible with Tektronix 11 and 19 inch computer display modules.

**CHARACTERISTICS**

**Warm-up Time** — Two minutes.  
**Copy Time** — 24 s (vertical format).  
**Paper Type** — Electrographic (dielectric).  
**Image Size** — Vertical Format: 190 x 147 mm (7.5 x 5.8 in).  
 Horizontal Format: 190 x 254 mm (7.5 x 10 in). Option 31: 190 x 226 mm (7.5 x 8.9 in).  
**Addressability** — Vertical: 171 dots/in. Horizontal: 256 dots/in.  
**Toner** — Dry Carbon.

**AC POWER**

**Voltage Range** — 90 to 128 V ac and 180 to 250 V ac. (High range requires Options A1, A2, A3 or A4).  
**Line Frequency** — 48 to 62 Hz.  
**Power** — Warm-up: 300 W nominal, 370 W maximum. Operating: 215 W nominal, 290 W maximum. Idle: 120 W nominal, 185 W maximum.

**PHYSICAL CHARACTERISTICS**

	Dimensions				Weight	
	Width	Height	Depth		kg	Net
mm	425	181	525	kg	20.0	
in	16.7	7.1	20.6	lb	45.0	

**INCLUDED ACCESSORIES**

Power cord (161-066-00); hard copy cable, 15-pin, 10 ft, (012-0547-00); electrographic paper, 2 rolls, (006-2838-00); 4.9 oz, dry copy toner, (006-2990-00).

**ORDERING INFORMATION**

**4611 Hard Copy Unit** ..... **\$4,550**  
**Option 01** — Landscape Image Format ..... **+\$150**  
**Option 02** — Four-Channel Multiplexer ..... **+\$600**  
**Option 31** — Compatible with 4025A Terminal.  
 (Not required if Option 01 is ordered) ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK, 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian, 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American, 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland, 220 V/10A, 50 Hz ..... **NC**

For ordering Hard Copy Paper see page 115.

**4631**

**High Image Quality, Copies in Seconds**

**Fiber Optic Process**

**Storage Tube Compatible**

**A Storage Display Copier**

The 4631 Hard Copy Unit provides superior quality copies of any graphic and alphanumeric information displayed on a storage tube display. The 4631's fiber optic process uses dry silver paper for the fine detail and photographic quality image needed when copying complex graphics and alphanumeric. It requires no toners or chemical additives of any kind. Copies can be made in either vertical or horizontal format. A special "slow scanning" mode allows horizontal format images to be made at even higher resolution and quality.

The 4631 can be multiplexed to copy up to four storage tube terminals and/or display monitors. It is compatible with the Tektronix 4010 Series of Computer Display Terminals, the 4114 Terminal, the 4025A Terminal, the 4050 Series of Graphic Computing Systems, and the 4081 Interactive Graphics Terminal. The 4631 is also compatible with Tektronix 11 and 19 inch computer display modules.

**CHARACTERISTICS**

**Warmup Time** — Ten minutes.  
**Normal Scan** — 18 s first copy; 9 s subsequent.  
**Slow Scan** — 36 s first copy; 16 s subsequent.  
**Paper Size** — 216 x 277 mm (8.5 x 11 in).  
**Paper Type** — Tektronix Standard Dry Silver Paper, (Type 7770), 500 ft roll.  
**Addressability, Normal Scan** — Vertical: 79 dots/cm (200/in).  
 Horizontal — 67 dots/cm (170/in).  
**Slow Scan** — Vertical: 118 dots/cm (300/in).  
 Horizontal: 134 dots/cm (340/in).  
**Image Size** — Vertical Format: 180 x 137 mm (7.1 x 5.4 in).  
 Horizontal Format: 225 x 170 mm (8.85 x 6.7 in).  
 Option 31: 163 x 190 mm (6.4 x 7.5 in).

**AC POWER**

**Voltage Range, Standard** — 104 to 126 V ac.  
**Strappable Low Range** — 90 to 110 V ac.  
**Strappable High Range** — 108 to 132 V ac.  
**Line Frequency Range** — 48 to 62 Hz.  
**Power, Warmup** — 620 W nominal; 750 W on high range.  
**Power, Copy Process** — 200 W nominal; 240 W on high range.

**PHYSICAL CHARACTERISTICS**

	Dimensions				Weight	
	Width	Height	Depth		kg	Net
mm	406	295	648	kg	29.5	
in	16.0	11.6	25.5	lb	65.0	

**INCLUDED ACCESSORIES**

Interconnect cable, 15-pin, 10 ft, (012-0547-00); Standard Dry Silver Paper, (Type 7770), 500-ft roll, (006-1603-00).

**ORDERING INFORMATION**

**4631 Hard Copy Unit** ..... **\$5,950**  
**Option 01** — Copy Counter ..... **+\$120**  
**Option 02** — Four Channel Multiplexer ..... **+\$660**  
**Option 31** — Compatible with Tektronix 4025A Terminal . **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**  
**Option A1** — Universal Euro 220 V/16A 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A 60 Hz ..... **NC**  
**Option A5** — Switzerland 220V/10A 50 Hz ..... **NC**

Tektronix offers service training classes on the 4631 Hard Copy Unit. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

4612



## 4612

**Low Copy Cost**

**High Contrast, Black and White Images**

**Electrostatic Process**

**Video Source Compatible**

### A Video Display Copier

Hard copy units such as the 4612 provide quick and convenient copies of complex information that has been displayed on a screen. These devices are essential to the use of graphic terminals, desktop computing systems, and video image processing systems. To fulfill a variety of user needs, graphic and alphanumeric information is permanently recorded on paper at the press of a button. These needs include quick preview copies before final plotting, copies of intermediate steps during interactive work sessions, and final output copies for reports, presentations, and file records.

The 4612 provides permanent black-and-white copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. Based on electrostatic technology, the 4612 uses electrographic paper for high contrast copies at an economical copy cost. The 4612 is compatible with the Tektronix 4025A Terminal, the 4112A Option 11 Terminal, and with a wide variety of raster scan terminals and video signal sources including DEC VT100 Series terminals, DEC MINC Systems, AT & T Gemini 100 Systems and those sources that produce RS-170, RS-330 or RS-375A type signals.

The 4612 is compact and lightweight, and can easily be moved from desk to desk. Its unique dry toning process is convenient, non-messy and superior to liquid toner systems. Images are permanently fused and made from safe ingredients. Warm-up lights and paper-out indicators are provided. All copies are vertically oriented. The 4612 can be multiplexed to copy up to four terminals and/or display monitors.

The standard 4612 unit is prepared for use with 525 line, 60 Hz sources. Adjustment for 625 line, 50 Hz is provided as an option.

4632



### CHARACTERISTICS

**Warm-up Time** — Two minutes.  
**Copy Time** — 24 s.  
**Paper Type** — Electrographic (dielectric).  
**Image Size** — 7.5 x 5.8 standard (525 line, 60 Hz signals).  
**Addressability** — 256 dots/in horizontal, 171 dots/in vertical.  
**Toner** — Dry carbon.

#### AC POWER

**Voltage Range** — 90 to 128 V ac and 180 to 250 V ac. (High range requires Options A1, A2, A3 or A4.)  
**Line Frequency Range** — 48 to 62 Hz.  
**Power, Warm-up** — 300 W nominal, 370 W maximum.  
**Power, Copy Process** — 215 W nominal, 290 W maximum.  
**Power, Idle** — 120 W nominal, 185 W maximum.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	425	16.7
Height	181	7.1
Depth	525	20.6
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net	20.0	45.0

#### INCLUDED ACCESSORIES

Power cord (161-0066-00); electrographic paper, 2 rolls, (006-2838-00); 4.9 oz, dry copy toner, (006-2990-00); BNC Interconnect Cable, 10 ft, (175-2753-00).

### ORDERING INFORMATION

**4612 Video Hard Copy Unit** ..... **\$4,400**  
**Option 02** — Four-Channel Multiplexer ..... **+\$600**  
**Option 03** — Setup for 625/50 Hz Scanning Std ..... **NC**  
**Option 15** — Video Input 15-pin Connector ..... **NC**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro, 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK, 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian, 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American, 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland 220 V/10A, 50 Hz ..... **NC**

## 4632

**High Image Quality**

**Gray Scale Capability**

**Copies in Seconds**

**Video Source Compatible**

### A Video Display Copier

The 4632 provides permanent copies of graphic and alphanumeric information from raster scan terminals and other video signal sources. All copies are horizontally oriented. Eight distinct shades of gray can be copied with a special gray scale enhancement option. The standard 4632 can clearly show six different shades of gray, for polygon fill-in, bar charts, and many other applications.

The 4632 can be multiplexed to copy up to four raster scan terminals, and can accept remote copy signals. The 4632 is compatible with the Tektronix 4025A 4027, 4027A, 4112A, 4113A Terminals and with a wide variety of raster scan terminals and video signal sources, including those that produce RS-170, RS-330, RS-375A, RS-343A and RS-412A type signals. The 4632 is also compatible with DEC MINC Systems and VT100 Series Terminals, with the HP 2640 Series, and the AT&T Gemini 100 Systems.

The standard 4632 is prepared for use with 525 line, 60 Hz sources. Many other adjustments are provided as options, including adjustments for 625 line, 50 Hz and for high resolution 1029 line, 60 Hz.

### CHARACTERISTICS

**Warmup Time** — Ten minutes.  
**Copy Time** — 18 s first copy; 9 s subsequent copies.  
**Paper Size** — 216 x 277 mm (8.5 x 11 in).  
**Paper Type** — Tektronix Standard Dry Silver Paper, (Type 7770), 500 ft roll.  
**Addressability** — Incoming signal dependent.  
**Image Size** — 203 x 152 mm (8 x 6 in).  
**Gray Levels** — Six minimum (8 with Option 06).

#### AC POWER

**Voltage Range, Standard** — 104 to 126 V ac.  
**Strappable Low Range** — 90 to 110 V ac.  
**Strappable High Range** — 108 to 132 V ac.  
**Line Frequency Range** — 48 to 62 Hz.  
**Power, Warmup** — 620 W nominal, 750 W maximum.  
**Power, Copy Process** — 200 W nominal; 240 W maximum.  
**Power, Idle** — 120 W nominal, 185 W maximum.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	406	16.0
Height	295	11.6
Depth	648	25.5
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net	29.5	65.0

#### INCLUDED ACCESSORIES

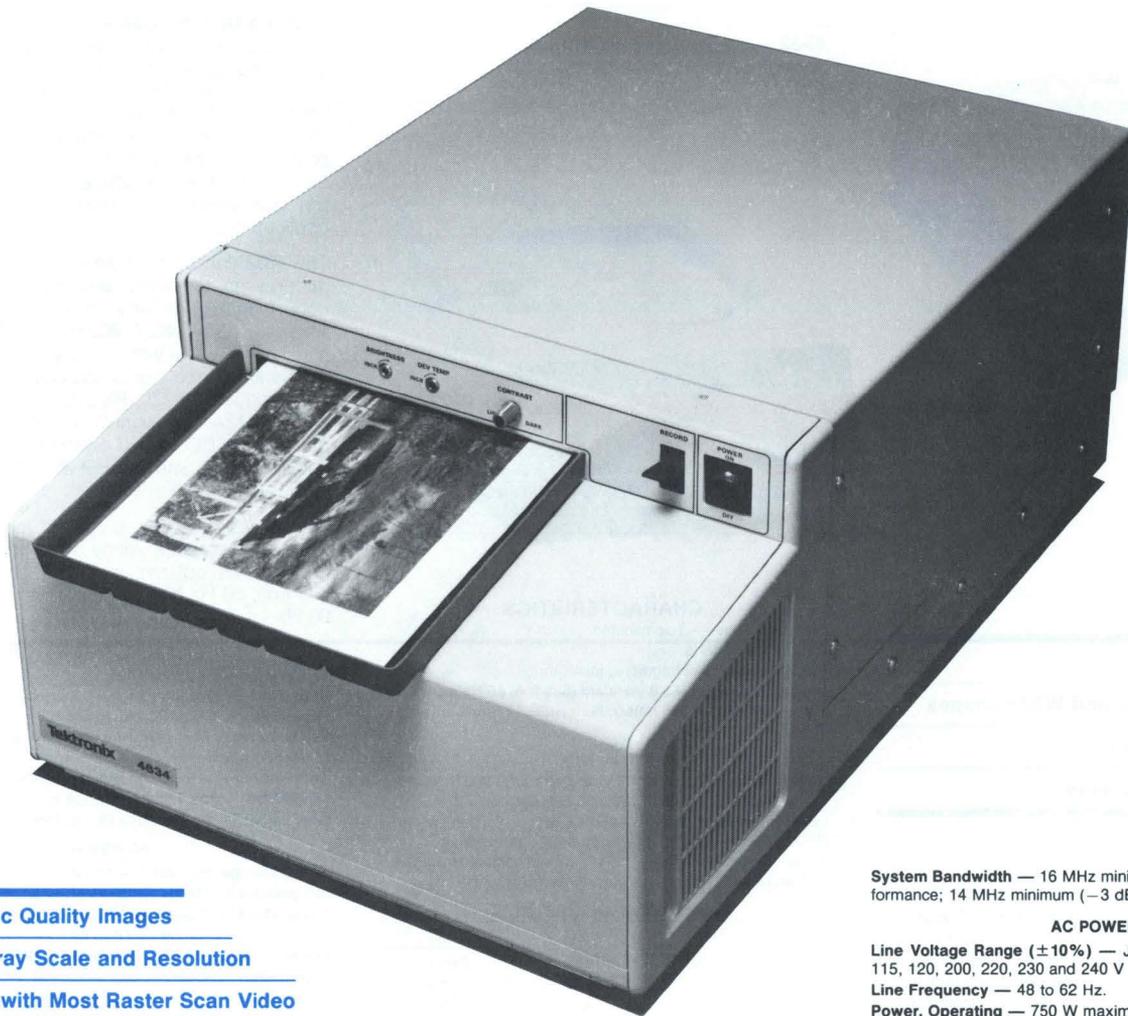
Standard Dry Silver Paper, Type 7770, 500 ft roll, (006-1603-00); BNC Terminator 75 Ω (011-0102-00).

### ORDERING INFORMATION

**4632 Video Hard Copy Unit** ..... **\$6,050**  
**Option 01** — Copy Counter ..... **+\$120**  
**Option 02** — Four Channel Multiplexer ..... **+\$660**  
**Option 03** — Setup for 625 Line/50 Hz ..... **NC**  
**Option 04** — Setup for 1029 Line/60 Hz ..... **NC**  
**Option 05** — Setup for Tektronix 4023 Terminal ..... **NC**  
**Option 06** — Enhanced Gray Scale ..... **+\$840**  
**Option 07** — Compatible with HP 2640 Series Terminals ..... **+\$125**  
**Option 08** — Compatible with DEC VT100 Terminals ..... **+\$125**  
**Option 09** — Setup for AT&T GEMINI 100 Systems ..... **+\$125**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A 60 Hz ..... **NC**  
**Option A5** — Switzerland 220 V/10A 50 Hz ..... **NC**



**4634**

**Photographic Quality Images**

**Excellent Gray Scale and Resolution**

**Compatible with Most Raster Scan Video Systems**

**Dry, Quick, Convenient Process**

**Large, File-Sized Image**

**Low Copy Cost**

The 4634 Imaging Hard Copy Unit records images of photographic quality from raster scan video sources. It is easily coupled to video sources, both analog and digital.

The 4634 can be quickly adjusted to accommodate a wide variety of line rates, interlaced and non-interlaced, for both 50 Hz and 60 Hz systems.

The 4634 uses a CRT to expose the recording material, a high quality dry silver paper. A fiber optic faceplate efficiently couples the light output to the paper and provides an image of high quality and fine detail.

Video information is input through rear panel connectors. If the signal input to the 4634 is composite video, hookup is a simple BNC connection to a video loopthrough. The loopthrough requires a 75-ohm terminator at the end of the video chain, whether that be the 4634 or some other video device.

The 4634 is available as either a rackmount or benchtop model.

**CHARACTERISTICS**

**Paper** — Tektronix High-Performance Dry Silver Paper, (Type 7772), or switch selectable to Tektronix Standard Dry Silver Paper, (Type 7770).

**Paper Packaging** — Rolls of paper encased in light-sealed cylindrical cassettes.

**Paper Dimensions** — 216 mm x 152 m (8.5 in x 500 ft).

**Shelf Life of Tektronix Paper** — 12 months at 20°C with 50% relative humidity.

**Recording Technique** — Raster scan video with fiber optic CRT.

**Developing Technique** — Heat via internal processor.

**Warmup Time** — 20 minutes.

**Copy Time** — 26 s.

**Exposure Time (11 in Copy)** — 8.5 s.

**Copy Repetition Rate** — ≈ 12 s.

**Copy Length Range** — 178 to 279 mm (7.0 to 11.0 in) in 19 mm (¾ in) increments.

**CRT Spot Size** — ≤ 0.15 mm (0.006 in) at 10 V grid drive.

**Luminance Variation** — ≤ 1.3 to 1.

**Horizontal Image Size Range** — 127 to 203 mm (5 to 8 in) for 60 Hz field rate; 152 to 203 mm (6 to 8 in) for 50 Hz field rate.

**Vertical Image Size Range** — Adjusts for correct aspect ratio.

**Image Format** — Horizontal scan lines in direction of exiting paper motion.

**Optical Density when used with High Performance Paper** — 1.45 maximum; 0.2 minutes.

**Gray Shades** — 12 with Tektronix 7772 paper; Six with Tektronix 7770 paper.

**Resolution** — At least 4.92 lines/mm (125 lines/in) with Tektronix 7772 paper; at least 3.94 lines/mm (100 lines/in) with Tektronix 7770 paper.

**System Bandwidth** — 16 MHz minimum (−3 dB) in High Performance; 14 MHz minimum (−3 dB) Standard.

**AC POWER**

**Line Voltage Range (±10%)** — Jumper selectable for 100, 115, 120, 200, 220, 230 and 240 V ac.

**Line Frequency** — 48 to 62 Hz.

**Power, Operating** — 750 W maximum.

**Power, Standby** — 240 W maximum.

**Heat Dissipation** — 820 BTU/hour average; 2560 BTU/hour maximum.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	425	16.8
Height	266	10.5
Depth	686	27.0
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net	30.5	67.0

**Rackmount Requirements** — 266.7 mm (10.5 in) of vertical front panel space in standard. 482.6 mm (19 in) cabinet, 440.4 mm (17.34 in) depth behind rack panel; 246.0 mm (9.68 in) in front of rack.

**INCLUDED ACCESSORIES**

High Performance Dry Silver Paper, (Type 7772), 500 ft roll, (006-2432-00); terminator, 75 ohm (011-0131-00).

**ORDERING INFORMATION**

**4634 Imaging Hard Copy Unit** ..... **\$7,900**  
**Option 30** — Delete Rackmount Hardware ..... **−\$85**  
**Option 45** — End-User set-up ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**

For ordering Hard Copy Paper see page 115.

OEM terms available on this product.



4642

**60 Characters/Second Print Speed Standard RS-232C Interface**

The 4642 Printer provides 60-character per second output along with a variety of print alternatives. This table top unit is compatible with the Tektronix 4020 Series Computer Display Terminals and 4050 Series Graphic Systems. Interface is standard RS-232C.

**A Variety of Type Faces**

The 4642 provides a varied selection of upper and lower case type faces. The standard format prints in 80 columns, and provides a choice of regular and elongated characters. A condensed character set, selectable from a front panel switch, gives 132 column output, with a choice of regular or elongated characters.

**Compact, Easy to Use**

The 4642 is a table top unit, requiring minimum space for operation. The standard printer employs a friction paper feed and uses inexpensive roll paper. A tractor feed paper drive (Option 01) can be used with both fan-fold paper and multi-part forms.

**A Choice of Features**

A complete selection of features and accessories can make the 4642 Printer even more versatile; for example, a printer stand is available to convert the 4642 to a floor unit. The 4642-1 is the 220 V ac, 50 Hz version of the 4642. All options and accessories are identical.

**CHARACTERISTICS**

- Printing Speed** — 60 characters.
- Printing Width** — 203 mm (8.0 in) maximum.
- Character Density**
  - Condensed — 65 mm (16.5, chars/in).
  - Standard — 40 mm (10, chars/in).
- Elongated (Double Width) — Software selectable.
- Character Set** — 96 Standard ASCII.
- Printing Matrix** — 5 x 7 dot matrix.
- Paper Type** — Roll (fan-fold optional).
- Paper Size (Width)**
  - Roll — 250 mm (9.8 in) maximum.
  - Fan Fold — 102 mm to 305 mm (4 in to 12.1 in).
- Ribbon Type** — Cartridge, film ribbon.

**AC POWER**

- 4642 — 115 V ac + 10 to 15% at 60 Hz.
- 4642-1 — 220 V ac + 10 to 15% at 50 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	495	19.5
Height	241	9.5
Depth	495	19.5
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	27.0	60.0

**Operating Temperature Range** — 4.4°C to 37.7°C (40°F to 100°F).

**ORDERING INFORMATION**

- 4642 Printer ..... **\$2,900**
- 4642-1 Printer ..... **\$2,900**
- Option 01 — Rear Feed Tractor Paper Drive ..... **+\$280**



4643

**4643**

- Low Cost Printing**
- Flexible for Many Applications**
- Crisp, Matrix Quality Printing**
- Easy to Use**
- International Characters**
- High Reliability**

A low cost alternative to conventional line printing, the Tektronix 4643 Printer provides fast, high-quality, impact printing that is suitable for most data processing applications. With high reliability built in, the 4643 is a convenient and economical choice requiring no preventive maintenance and infrequent servicing.

Fast but not expensive, the 4643 Printer uses bi-directional operation to print 340 characters per second. With a full 132 character line, speeds of 125 lines per minute are nominal. The 4643 Printer rivals the speed of many line printers but is available for the modest price of a matrix printer.

The 4643 provides three type faces: standard, condensed, and expanded. All three can be program selected, allowing users to mix the various fonts for greater reading impact.

**Compatibility**

The printer of choice for high technology systems, the standard Tektronix 4643 can be interfaced with most standard RS-232 data processing instruments and systems. Option 01 provides a parallel interface. The 4643 is compatible with the following Tektronix products: 4010 and 4110 Series Terminals, 4020 Series Terminals, and 4050 Series Desktop Graphic Computing Systems; the 8001 and 8002A Microprocessor Labs and 8550 Microcomputer Development Lab; the S-3250, S-3270 and S-3280 Semiconductor Test Systems; and the 4041 Controller.

**CHARACTERISTICS**

- Printing Speed** — 340 characters.
- Condensed Character Density** — 219 character/line.
- Standard Character Density** — 132 character/line.
- Expanded Character Density** — 72 character/line.
- Throughput Rate**
  - 132 Columns Wide — 125 lines/minute.
  - 72 Columns Wide — 200 lines/minute.
  - 40 Columns Wide — 300 lines/minute.
- Paper Slew Rate** — 254 mm/s (10 in/s) minute.
- Character Set** — 128 (96 ASCII plus 32 international).
- Vertical (Line) Spacing** — 24 lines/mm (6 lines/in).
- Horizontal (Standard Character) Spacing** — 39 characters/cm (10 or 5 characters/in).
- Printing Matrix** — 14-wire, 7 x 7 half-dot matrix.
- Paper Type** — Continuous fanfold, edge perforated.
- Paper Width** — 76.2 to 406.4 mm (3 to 16 in) at 0.7 mm (0.028 in) maximum thickness.
- Ribbon Type** — Fabric, continuous loop cassette.
- Ribbon Life** — Five million characters.

**AC POWER**

- Line Voltage** — 90 to 136 V ac or 187 to 257 V ac.
- Line Frequency** — 50 or 60 Hz.
- Power, Idle** — 150 W maximum.
- Power, Printing** — 275 W maximum.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	671	26.4
Height Closed	213	8.4
Height Open	571	22.5
Depth	594	23.8
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	30.0	67.0

**INCLUDED ACCESSORIES**

Ribbon cassette (118-1314-00).

**ORDERING INFORMATION**

- 4643 Printer (2400 Baud Standard) ..... **\$4,200**
- Option 01 — Parallel Interface (Cannot be ordered with Option 02) ..... **NC**
- Option 02 — Specify Baud Rate 110, 150, 300, 600, 1200, 4800, 9600, (Requires Option 61) ..... **NC**
- Option 03 — 8500 Series Interface ..... **NC**
- Compatibility ..... **NC**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1 — Universal Euro, 220 V/16A, 50 Hz ..... **NC**
- Option A2 — UK, 240 V/13A, 50 Hz ..... **NC**
- Option A3 — Australian, 240 V/10A, 50 Hz ..... **NC**
- Option A4 — North American, 240 V/15A, 60 Hz ..... **NC**
- Option A5 — Switzerland 220 V/10A 50 Hz ..... **NC**



## 4909

Shared Access up to 10 Users

Public and Private File Workspaces for Operational Flexibility/File Protection

32 or 96 Megabyte Drive Capacity

Expandable up to 8 drives (768 Megabytes)

Indexed and Dynamically Allocated Files

Variable Length Records

Concatenated Volumes

English Command Operation Over High-Speed GPIB

Time of Day Clock with Battery Backup

File Names up to 100 Characters Long

Multiple Level Library Names

The 4909 Multi-User File Management System is a high performance mass storage system based on a controller that provides advanced file management between up to ten desktop computers and large capacity hard-disk drives. Flexible file management and a multiple level library structure provides multiple file access levels, indexed (keyed) file support, directly addressable bytes within records, expandable records and files, and enhanced data storage and retrieval. Permitting host interfacing flexibility, plug-in options include additional disk drives for expanded capacity.

### Mass Storage Expandability

The 4909 offers 32 megabytes of data storage capacity as standard. Optionally, 96 megabytes of storage capacity are available. Each drive comes with a 16 megabyte removable disk cartridge allowing data transportability and fast backup. For increased capacity, additional disk drives can be added by acquiring the 4909AC Auxiliary Cabinet. This cabinet will hold one or two additional disk drives of either 32 or 96 megabyte capacity. Interconnection with the 4909 is by a plug-in disk interface that can support two hard disk drives. A maximum of four disk interface plug-ins can be used on the 4909, supplying a maximum of 768 megabytes of online mass storage capacity.

### File Security

Several levels of file security are provided by the 4909. The removable disk cartridge allows large collections of files to be completely removed from the 4909 and placed in a physically secure place. For archival storage, the removable cartridge is highly effective.

Files cannot be affected at the volume level unless a master password is known. If a master password was specified when the original disk volume was formatted, subsequent reformatting cannot take place unless the master password is known, thus prohibiting the modification of existing files.

For security, users permitted to use a file within other private file workspaces can be given different levels of access, ranging from read-only to write and delete.

Within a multi-user environment, access to files within a private file workspace is controlled by an access list assigned to each file.

### Multi-User Access

The cost effectiveness and contribution to productivity of a mass storage system is enhanced when two or more users are allowed to share information simultaneously. The 4909 allows the sharing and updating of files by up to ten users. Private file access is permitted after users supply a User-ID and password. Access is permitted to a private file workspace if the user entry matches a pre-defined User-ID list maintained by the 4909.

Users who do not provide a User-ID and password when "signing-on" are automatically placed into a public file workspace. All users utilizing the public file workspace have access to the same files, each of which is collectively subject to operations currently taking place by other users within the public file workspace. With public file workspaces, users of dedicated 4909 systems are not burdened by multi-user "sign-on" constraints.

### Superior File Management

Designed for ease of use and superior file management flexibility, the 4909 lets you manage your files; they don't manage you! File names, for example, can be up to 100 characters long. Multiple levels of files called libraries are provided, allowing files to be grouped according to any particular criteria or need. When files are created, users need not worry about how big a file should be, nor what to do if they write more information than the file can hold. The 4909 provides for dynamic allocation or automatic expansion of files, eliminating this "book-keeping" task by the user.

### Indexed Files

For users requiring faster, more flexible access to record information stored in files, the 4909 provides indexed or keyed files. Each record can be stored and retrieved on the basis of an alphanumeric key. The key used might be an employee's name or a product reference number. With indexed files, information can be better organized, and quickly retrieved. A variety of useful commands are provided to allow complete control of indexed files. Indexed files don't have to be treated differently from regular files, as they are on some systems that support this capability.

### True Concatenated Volumes

The 4909 introduces the concept of "concatenated" volumes. File size is no longer constrained by the capacity of the drive on which it is located. Multiple drives can logically be configured together to appear as one. Any individual file can assume the size of the total configured drive capacity. Fixed as well as removable disk cartridges can be configured together, or kept separate to allow removable cartridges to be transported between other 4909 hard disk systems. Also, when drives are configured together, users need not be concerned with specifying on which of the volumes a particular file is stored.

### Variable Length Records

Variable length records are supported by the 4909 to provide additional flexibility in creating and updating files. This allows records to change in accordance with user requirements.

### Interfacing Flexibility

The 4909 controller has eleven plug-in slots allowing a variety of special purpose interfaces to be supported. In addition to hard disk interfacing, access to desktop computers is provided using a GPIB (IEEE Standard 488-1978) plug-in interface. Assuming the 4909 Controller contained only a single disk interface, up to ten GPIB interfaces could be supported. A maximum data transfer rate of 240,000 bytes/second is possible per GPIB interface, with some performance degradation depending on the number of users, and the amount of disk access taking place.

### ROM Pack Operation

Access to the 4909 from the 4050 Series of desktop computers will be via GPIB interfacing used in conjunction with a ROM pack to provide file management operation. ROM packs for the 4050 Series include the 4051R10 for use with the 4051, and the 4052R10 for use with the 4052/4054.

### English Command Operation

Without a ROM pack, devices supporting any IEEE Standard 488-1978. Compatible interface can communicate directly with the 4909, using English commands. The 4909 will respond to ASCII command strings sent over the bus, and can therefore be used by a variety of non-Tektronix desktop computers or controllers.

### Realtime System Clock

The 4909's realtime clock, once set, automatically assigns the time and date to a file, allowing users to keep track of when files were created or updated. Files can be manipulated on the basis of their time/date "stamps," e.g. a user may want to delete all files that have not been accessed since a particular date.

### GPIB Extender

The General Purpose Interface Bus Extender provides a cost-effective way to interconnect remotely located, IEEE Standard 488 compatible instruments, allowing GPIB communication over distances of up to 500 m (1650 ft).

GPIB Extenders are always used in pairs: Two 4932 units or one 4932 and one 4909F02. The 4932 is compatible with any instrument that has a GPIB interface, and is compatible with the 4909F02 via the coaxial "link" cable. See page 26 for more information.

## CHARACTERISTICS

Capacity Per Drive — 32 or 96 megabytes (16 removable).

Disk Data Transfer Rate\* — 1.2 megabytes/s.

GPIB Data Transfer Rate\* — 240k bytes/s maximum burst.

Average Access Time — 30 ms.

Average Latency Time — 8.33 ms.

Recoverable Error Rate — Two in 10 Bits.

Number of Tracks/Inch — 384.

\*Actual transfer rates are application and computer dependent.

### AC POWER

Line Voltage and Frequencies — 120 V ac at 60 Hz, 240 V ac at 50 Hz, 100 V ac at 50 Hz or 60 Hz.

Power — 1150 W maximum at 120 V ac, 60 Hz.

### PHYSICAL CHARACTERISTICS

	Dimensions			Weight	
	Width	Height	Depth	kg	Net
mm	565	760	850		137
in	22.2	30.0	33.5	lb	302.0

### INCLUDED ACCESSORIES

GPIB Interface cable, 4 m (012-0630-04); cartridge disk, 16 megabyte (119-1462-00).

## ORDERING INFORMATION

4909 Multi-User File System ..... \$22,900

### OPTIONS/FIELD UPGRADES

Option 33 — 96 Megabytes Disk ..... +\$4,900  
 4909AC — Auxiliary Cabinet ..... \$13,000  
 4909F01 — GPIB Interface ..... \$1,600  
 4909F02 — GPIB Extender ..... \$2,095  
 4909F03 — Disk Interface ..... \$1,600  
 4909F10 — Controller Expansion ..... \$1,000

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16A, 50 Hz ..... NC  
 Option A2 — UK, 240 V/13A, 50 Hz ..... NC  
 Option A3 — Australian, 240 V/10A, 50 Hz ..... NC

4907 Option 31



## 4907 File Manager

### 4050 Series Compatible

### Built-in File Manager

The 4907 File Manager is a direct-access, flexible-disk device with a double density read/write feature. Its advanced multiple-level, file-by-name system includes a directory that maintains the user files, passwords and available space. Several drives may be connected to the 4907 for additional storage capacity.

Built-in ROMs and special 4050 Series ROM Packs contain the 4907 operating system software. No 4050 Series memory is required to support the operating system. The 4907 can also be used with some of the 4010 Series of graphic terminals and its compact size lets it fit on a desktop or lab bench.

### CHARACTERISTICS

User-Available Storage Per Disk — 630k bytes.  
Tracks Per Disk — 77 maximum.  
Sectors Per Track — 32.  
Bytes Per Sector — 256.  
Rotational Speed — 360 rpm.  
Average Access Time — 340 ms.  
Transfer Time — 4.2 ms/sector.

### AC POWER

Line Voltage — 100 to 240 V ac.  
Line Frequency — 50 to 60 Hz.  
Power — 200 W at 120 V ac, 60 Hz maximum.

### PHYSICAL CHARACTERISTICS

Dimensions				Weight	
	Width	Height	Depth		Net
mm	520	195	640	kg	27.5
in	20.3	7.7	25.7	lb	60.0

### INCLUDED ACCESSORIES

4051 File Manager ROM Pack (020-0279-00); power cord (161-0066-00); GPIB interface cable, 2 m, (012-0630-03); cleaning pads, box of 10, (006-2398-00); label set, 0 to 9, (334-3340-00).

### ORDERING INFORMATION

4907 File Manager ..... **\$4,620**  
Option 30 — Two Disk Drives Total ..... +2,500  
Option 31 — Three Disk Drives Total ..... +\$3,675  
Option 40 — 4052/4054 Interface ..... NC

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal Euro, 220 V/16A, 50 Hz ..... NC  
Option A2 — UK, 240 V/13A, 50 Hz ..... NC  
Option A3 — Australian, 240 V/10A, 50 Hz ..... NC  
Option A4 — North American, 240 V/15A, 60 Hz ..... NC

4924



4923



## 4923/4924 Tape Recorder/Drive

### RS-232C Compatible (4923)

### Easy-to-Use Data Storage/Retrieval

The 4923 Digital Cartridge Tape Recorder provides reliable, easy-to-use data storage and retrieval for the Tektronix 4006 and 4010 Series Terminals. The 4924 Digital Cartridge Tape Drive supports the Tek 4050 Series Desktop Computers. Up to 15 tape drives can be multiplexed to a 4050 acting as a controller on the GPIB. A single 4924 drive allows concurrent handling of merge operations, and input/output transactions.

### CHARACTERISTICS

Cartridge Type — 300A, 300XL Certified Data Cartridges from Tektronix.  
Usable Tape Length — 91.44 m (300 ft).  
Storage Capacity — 200,000 bytes, nominal for 4923. 300,000 bytes, nominal for 4924.  
Characters/Record — 128 eight-bit bytes for 4923. 128/256 eight-bit bytes for 4924.  
Recording Density — 1600 bpi.  
Data Transfer Rate — Standard, 9600 baud; Option 01, 110 to 9600 baud (4923 only).  
Data Format — 8-bit binary or 8-bit ASCII.  
Number of Data Tracks — One.  
Recording Format — NRZ two-track, self-clocking.  
Read/Write Speed — 762 mm/s (30 ips).  
Skip Forward/Reverse — 762 mm/s (30 ips).  
Fast Forward/Rewind — 2.286 m/s (90 ips).

System Error Rate — 1 in 10<sup>7</sup> for 4923. 1 in 10<sup>7</sup> or less for 4924.

Start Time Read/Write — 25 ms.  
Start Time Fast Forward/Rewind — 75 ms.

### AC POWER

Line Voltage Range — 100 to 240 V ac (jumper selectable).  
Line Frequency — 50 to 60 Hz.  
Power — 62 W at 115 V ac.

### PHYSICAL CHARACTERISTICS

Dimensions				Weight	
	Width	Height	Depth		Net
mm	220	152	438	kg	7.7
in	8.7	6.0	17.2	lb	17.0

### INCLUDED ACCESSORIES

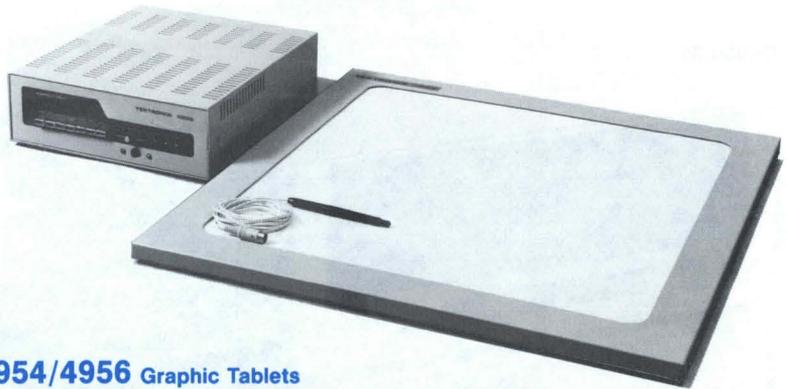
Power cord (161-0066-00); GPIB Interface cable, 2 m, 4924 only, (012-0630-01).

### ORDERING INFORMATION

4923 Digital Cartridge Tape Recorder ..... **\$2,600**  
Option 01 — Full Duplex (RS-232C) ..... **NC**  
4924 Digital Cartridge Tape Drive ..... **\$2,990**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

Option A1 — Universal European Power (220V/16A) ..... NC  
Option A2 — UK (240V/13A) ..... NC  
Option A3 — Australian (240V/10A) ..... NC  
Option A4 — North American (240V/15A) ..... NC



**4952 Joystick**

**Proportional Cursor Speed Control**

The 4952 Joystick is available for Tektronix graphic systems users who need increased interactivity. Activated by the Pointer command, this sensitive fingertip cursor control allows quick, precise positioning of the cursor, making it easy to develop accurate graphics.

**The 4952 is Simplicity Itself**

Just move the center lever in the direction you want to move the cursor. Speed is controlled by the angle and distance of the lever from the center position. When you want to stop the cursor, simply release the lever to its neutral vertical position.

The 4952 is compatible with all of the Tektronix 4010 Family Terminals, 4081 Interactive Graphic Systems and 4050 Series Desktop Computers.

**CHARACTERISTICS**

- Control Actuation** — Spring return to center.
- Time Drift (Within 30-second Period)** — Adjustable to <1 part in 1024.
- Cursor Control Accuracy** — 0.1%.
- Resolution (X and Y)** — 1 part in 1024.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	mm	in	mm	in
Width	124	4.9		
Height	60	2.3		
Height w/lever	30	1.2		
Depth	173	6.8		
Weight	kg		lb	
	kg	lb	kg	lb
Net	0.9	2.0		

**ORDERING INFORMATION**

- 4952 Joystick (4014/4015)** ..... **\$625**
- Option 01** — Joystick (for 4010, 4012, and 4013) ..... **+\$75**
- Option 02** — Joystick (for 4050 Series) ..... **+\$100**

**4953/4954/4956 Graphic Tablets**

**Pen or Cursor Inputs**

**Worst Case Spec**

With the 4953/54/56 Graphic Tablets, you can choose one of two input device options: a pen for best convenience, or a push-button cursor where exacting accuracy is required. You can input points or vectors to digitize or display maps, graphic drawings, schematics and other designs.

From precision mapping to exacting parts outlines, Tektronix Graphic Tablets satisfy a wide range of user needs. You can select options from a written "menu" placed on a Graphic Tablet. You can store graphic input on peripheral disc or recorder devices, recall it later, and make quick, dry-process copies on a Tektronix hard copy unit.

Tektronix offers all of the peripheral equipment needed with your computer to configure a truly interactive graphics system. Take your pick of the 279 x 279 mm (11 x 11 in) 4953 model, the drawing board-sized 1016 x 762 mm (40 x 30 in) 4954 model, or the 4956 in two sizes; the standard 510 x 510 mm (20 x 20 in) or the Option 33 version, 910 x 1220 mm (36 x 48 in). The latter version is large enough to accommodate E-size engineering drawings. The 4956 is an IEEE Standard 488 device that connects to the 4050 Series Desktop Computers.

The 4954F32 Pedestal is a roll-around stand that allows the 4954 to be raised or lowered or tilted at any angle from vertical to horizontal.

**4953 CHARACTERISTICS**

- Size** — 279 x 279 mm (11 x 11 in).
- Active Writing Area** — 260 x 260 mm (10.24 x 10.24 in).
- Resolution** — 0.25 mm (0.01 in) minimum (10 bits).
- Accuracy** — ±0.975 mm (±0.030 in) over entire surface.
- Repeatability** — One point.
- Operating Modes** — Single or multiple point entry using either optical cursor or pen.

**AC POWER**

- Line Voltage** — 110 to 120 V ac.
- Line Frequency** — 60 Hz.
- Power** — 30 W maximum.

**INCLUDED ACCESSORIES**

Pen with inkless filler (119-0621-00); bias magnet, 11 x 11 in, 4953 only, (119-0686-00).

**4954 CHARACTERISTICS**

- Size** — 762 x 1016 mm (30 x 40 in).
- Active Writing Area** — 780 x 975 mm (30.7 x 38.4 in).
- Resolution** — 0.25 mm (0.01 in) minimum (12 bits).
- Accuracy** — ±2.5 mm (±0.10 in) over entire surface.
- Repeatability** — ±1 point.
- Operating Modes** — Single or multiple point entry using either optical cursor or pen.

**AC POWER**

- Line Voltage** — 110 to 120 V ac.
- Line Frequency** — 60 Hz.
- Power** — 30 W maximum.

**INCLUDED ACCESSORIES**

Pen with inkless filler (119-0621-00); bias magnet for 30 x 40 in (119-0687-00).

**4956 CHARACTERISTICS**

- Size** — 510 x 510 mm (20 x 20 in); Option 33, 910 x 1220 mm (36 x 48 in).
- Resolution** — 0.1 mm (0.004 in).
- Accuracy** — ±0.1 mm (0.004 in) ±1 LSB.
- Repeatability** — ±1/2 LSB.
- Repetition Rate** — Up to 30 CPS.
- Operating Modes** — Point, Stream, Switch Stream, Incremental.

**AC POWER**

- Line Voltage** — 115 V ac.
- Line Frequency** — 60 Hz.
- Power** — 60 W maximum.

**INCLUDED ACCESSORIES**

GPIB cable, 2 m, (012-0630-01); PLOT 50 graphics tablet supporting software tape (020-0223-00); bias magnet (119-0895-00), pen with inkless filler (119-0621-00).

**ORDERING INFORMATION**

- 4953 Graphic Tablet, 279 x 279 mm (11 x 11 in)** ..... **\$3,795**
- Option 48** — 220 V ac, 50 Hz power ..... **NC**
- 4954 Graphic Tablet, 762 x 1016 mm (30 x 40 in)** ..... **\$6,190**
- Option 48** — 220 V ac, 50 Hz power ..... **NC**
- 4954F32 Pedestal (for 4954 or 4956 Option 33)** ..... **\$1,325**
- 4956 Graphic Tablet, 510 x 510 mm (20 x 20 in)** ..... **\$5,670**
- Option 33** — Graphic Tablet, 910 x 1220 mm (36 x 48 in) for 4956 ..... **+\$2,600**
- Option 48** — 220 V ac, 50 Hz power ..... **NC**
- 4954F32 Pedestal (For 4954 or 4956 Option 33.)** ..... **\$1,325**

**PHYSICAL CHARACTERISTICS**

	Graphic Tablets						Controller					
	Dimensions			Weights			Dimensions			Weights		
	Width	Height	Depth	Net		Width	Height	Depth	Net			
4953	mm	390	31.7	390	kg	2.4	mm	213	95	282	kg	2.7
	in	15.4	1.2	15.4	lb	5.2	in	8.4	3.7	11.1	lb	6.0
4954	mm	1143	51	946	kg	23.4	mm	213	95	282	kg	2.7
	in	45	2.0	37.2	lb	52.0	in	8.4	3.7	11.1	lb	6.0
4954 Opt 33	mm	1416	50.8	1111	kg	32.4	mm	213	95	282	kg	2.7
	in	55.7	2.0	43.7	lb	72.0	in	8.4	3.7	11.1	lb	6.0
4956	mm	708	38	711	kg	10.1	mm	343	124	381	kg	6.2
	in	27.9	1.5	28.0	lb	22.5	in	13.5	4.9	15.0	lb	13.7

PERIPHERALS

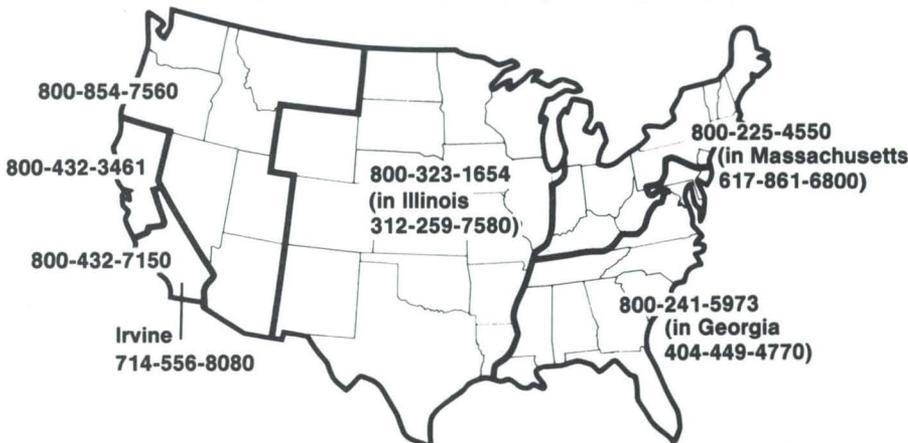
**Pens, papers, and accessories for your Tektronix Copiers, Plotters, Printers, and Graphic Display Devices.**



**It's easy to order Tektronix accessories and supplies.**

Just consult this listing for description, quantity, part number, and price. Then telephone your local Tektronix Sales Office or call the toll-free Direct Order Desk number for your area.

**Tektronix Direct Parts Order Desk Toll-Free Numbers**



*Note: All prices apply to the 48 contiguous United States only, and are subject to change without notice.*

**ORDERING INFORMATION**

**HARD COPY PAPERS**

- 4631, 4632 Hard Copy Units Tektronix Standard Dry Silver Paper (Type 7770), single roll.
- Order 006-1603-00 ..... \$80
- Carton of 4 rolls. Order 006-1603-01 ..... \$275
- 4633A Continuous Recorder, 4634 Imaging Hard Copy Units, Tektronix High Performance Dry Silver Paper (Type 7772), single roll. Order 006-2432-00 ..... \$185
- Carton of 4 rolls. Order 006-2432-01 ..... \$660

**QUANTITY DISCOUNTS FOR DRY SILVER PAPER**

Standard (Type 7770)	Discount	Price Per Roll	Price Per Carton
4-9 Cartons	5%	65.31	261.25
10-19 Cartons	10%	61.88	247.50
20+ Cartons	15%	58.44	233.75

High Performance (Type 7772)	Discount	Price Per Roll	Price Per Carton
4-9 Cartons	5%	156.75	627.00
10-19 Cartons	10%	148.50	594.00
20+ Cartons	15%	140.25	561.00

- 4611, 4612 Hard Copy Units, Tektronix Electrographic Hard Copy Paper, package of 2 rolls.
- Order 006-2838-00 ..... \$28

**DRY COPY TONER**

- 4611, 4612 Hard Copy Units, Dry Copy Toner, bottle 4.9 oz.
- Order 006-2990-00 ..... \$22

**PLOTTER PAPERS**

- 4662 Interactive Digital Plotter
- Paper, blank sheet, 11 X 16.5 in (100 ea).
- Order 006-2410-00 ..... \$10
- Printed Papers**
- Paper, Linear, 10 X 10 in grid; 11 X 16.5 in (100 ea).
- Order 006-1698-00 ..... \$12
- Paper, Linear, 10 X 10 cm grid; 11 X 16.5 in, (100 ea).
- Order 006-1699-00 ..... \$12
- Paper, Semi-log, 10 X 3 cycle, 11 X 16.5 in (100 ea).
- Order 006-1700-00 ..... \$12
- Paper, Semi-log, 10 X 2 cycle, 11 X 16.5 in (100 ea).
- Order 006-1701-00 ..... \$12
- Paper, Full-log, 2 X 3 cycle, 11 X 16.5 in, (100 ea).
- Order 006-1702-00 ..... \$12
- 4663 Interactive Digital Plotter
- Paper, blank sheet, 17 X 22 in, (100 ea).
- Order 006-3150-00 ..... \$15
- Vellum, 100% Rag content, blank sheet, 17 X 22 in, (100 ea).
- Order 006-2836-00 ..... \$35
- Paper, blank roll, 18 in X 200 ft, (C size after tear off) (2 ea).
- Order 006-2837-00 ..... \$40
- Paper, blank roll, 18 in X 200 ft, (Metric size A2 after tear off) (2 ea). Order 006-3473-00 ..... \$42

SUPPLIES

**Pens, papers, and accessories for your Tektronix Copiers, Plotters, Printers, and Graphic Display Devices.**

**PLOTTER FILMS**

**\*Quick-Dry Plotter Film**, (50 Sheets), 8 1/2 X 11 in.  
 Order 006-5939-00 ..... **\$28**  
 \*New

**Antistatic Polyester Film**, 17 X 22 in, 100 sheets.  
 Order 006-2835-00 ..... **\$120**

**PLOTTER PENS FOR 4662 INTERACTIVE DIGITAL PLOTTER, (STANDARD 1-PEN UNIT)**

**Fiber Tip Pens for Paper**, (3-pen packages)  
 Red, Order 016-0589-00 ..... **\$8.00**  
 Green, Order 016-0589-01 ..... **\$8.00**  
 Black, Order 016-0589-02 ..... **\$8.00**  
 Blue, Order 016-0589-03 ..... **\$8.00**

**Fiber Tip Pens for Film**, (3-pen packages)  
 Black, Order 016-0648-00 ..... **\$8.00**  
 Brown, Order 016-0648-01 ..... **\$8.00**  
 Red, Order 016-0648-02 ..... **\$8.00**  
 Orange, Order 016-0648-03 ..... **\$8.00**  
 Yellow, Order 016-0648-04 ..... **\$8.00**  
 Green, Order 016-0648-05 ..... **\$8.00**  
 Blue, Order 016-0648-06 ..... **\$8.00**  
 Purple, Order 016-0648-07 ..... **\$8.00**  
 Magenta, Order 016-0648-08 ..... **\$8.00**

**Wet Ink Pens**

7002 TB-0, 0.35 mm, (0.014 in). Order 016-0448-00 ..... **\$24**  
 7002 TB-1, 0.46 mm, (0.018 in). Order 016-0449-00 ..... **\$24**  
 7002 TB-2, 0.56 mm, (0.022 in). Order 016-0450-00 ..... **\$24**

**Replaceable Wet Ink Pen Tips**

63 TB-0, 0.35 mm, (0.014 in). Order 016-0445-00 ..... **\$16.25**  
 63 TB-1, 0.46 mm, (0.018 in). Order 016-0446-00 ..... **\$16.25**  
 63 TB-2, 0.56 mm, (0.022 in). Order 016-0447-00 ..... **\$16.25**

**PLOTTER PENS FOR 4662 OPTION 31 (8-PEN UNIT) AND 4663 INTERACTIVE DIGITAL PLOTTERS**

**Fiber Tip Pens for Paper** (3-pen packages)  
 Black, Order 016-0414-00 ..... **\$8.00**  
 Red, Order 016-0415-00 ..... **\$8.00**  
 Blue, Order 016-0416-00 ..... **\$8.00**  
 Green, Order 016-0417-00 ..... **\$8.00**  
 Brown, Order 016-0682-00 ..... **\$8.00**  
 Orange, Order 016-0683-00 ..... **\$8.00**  
 Yellow, Order 016-0684-00 ..... **\$8.00**  
 Purple, Order 016-0685-00 ..... **\$8.00**  
 Magenta, Order 016-0686-00 ..... **\$8.00**  
 Multi-color (9-pen Package).  
 Order 016-0687-00 ..... **\$24**

**Plastic Hard Tip Pens for Paper** (3-pen packages)

Black, Order 016-0668-00 ..... **\$12**  
 Red, Order 016-0668-01 ..... **\$12**  
 Green, Order 016-0668-02 ..... **\$12**  
 Blue, Order 016-0668-03 ..... **\$12**

**Fiber Tip Pens for Film.** New pens specially formulated for optimal results when used with "Quick-Dry" Plotter Film (006-5939-00).

(3-pen packages)  
 \*Black, Order 016-0469-00 ..... **\$10**  
 \*Brown, Order 016-0469-01 ..... **\$10**  
 \*Red, Order 016-0469-02 ..... **\$10**  
 \*Orange, Order 016-0469-03 ..... **\$10**  
 \*Yellow, Order 016-0469-04 ..... **\$10**  
 \*Green, Order 016-0469-05 ..... **\$10**  
 \*Blue, Order 016-0469-06 ..... **\$10**  
 \*Purple, Order 016-0469-07 ..... **\$10**  
 \*Magenta, Order 016-0469-08 ..... **\$10**  
 \*Multi-Color (9-pen Package).  
 Order 016-0470-00 ..... **\$25**  
 \*New

**PLOTTER PENS FOR 4662 OPTION 31 AND 4663 PLOTTERS ONLY**

**WET INK PENS AND THEIR ACCESSORIES**

**Wet Ink Pens**, Pen, PL3, 0.3 mm, (0.01 in) dia.  
 Order 016-0444-01 ..... **\$23**

Pen, PL5, 0.5 mm, (0.02 in) dia. Order 016-0442-01 ..... **\$23**  
 Pen, PL8, 0.8 mm, (0.03 in) dia. Order 016-0443-01 ..... **\$23**

**Replaceable Wet Ink Pen Tips**, PL3, 0.3 mm, (0.01 in) dia.  
 Order 214-2706-00 ..... **\$15**

PL5, 0.5 mm, (0.02 in) dia. Order 214-2706-01 ..... **\$15**  
 PL8, 0.8 mm, (0.03 in) dia. Order 214-2706-02 ..... **\$15**

**Replacement Wet Ink Pens Parts Kit**, Contents: 1 Cap, 1 Body Section, 2 Lock Nuts, 6 Ink Cartridges.  
 Order 006-2968-01 ..... **\$4.30**

**Extra Ink Cartridges**, (1 ea). Order 016-0649-00 ..... **\$2.00**

**Inks for Wet Ink Pens**, for Film (3/4 oz squeeze bottle)  
 Brown, Order 016-0423-00 ..... **\$3.00**  
 Green, Order 016-0424-00 ..... **\$3.00**  
 Blue, Order 016-0425-00 ..... **\$3.00**  
 Red, Order 016-0426-00 ..... **\$3.00**  
 Black, Order 016-0427-00 ..... **\$3.00**

For Paper (3/4 oz squeeze bottle), Black.  
 Order 016-0428-00 ..... **\$5.00**

**Cleaning and Maintenance Systems**, Cleaning Tank, Ultrasonic (1 ea). Order 002-1555-00 ..... **\$170**

Cleaning Fluid, 3069 Ultrasonic (8 oz).  
 Order 002-1556-00 ..... **\$3.05**

Cleaning Fluid, 3068, with strainer (5.2 oz).  
 Order 002-0920-01 ..... **\$3.20**

Pressure/Suction Cleaning Bulb. Order 002-1560-00 .. **\$10.25**

Magnifying Instrument, 3095 PMG. Order 002-1558-00 .. **\$80**

Humidifier, Pen Storage 746-700. Order 002-1559-00 .. **\$9.25**

**PRESENTATION PACK**

Contains supplies to make overhead transparency plots.  
**\*Presentation Pack**. Order 020-0888-00 ..... **\$60**

Pack includes:  
**Plotter Pens For Film** (9).  
 Order 016-0470-00 ..... **\$25**  
**Quick Dry Plotter Film** (50 sheets). Order 006-5939-00 .. **\$28**  
 Pack also includes frames, covered pen tray, and storage box not separately orderable.

**PRINTER PAPER AND RIBBONS**

**4641 Printer Ribbon** (box of 12). Order 119-0820-00 .... **\$180**

**4642 Printer**, Paper-Tab Stock, Fan Fold, 269.88 mm X 279.4 mm (10.625 in X 11 in) (2500 sheets per carton).  
 Order 002-0262-01 ..... **\$60**

Paper-Roll (box of 12). Order 002-1084-01 ..... **\$70**

Ribbons (package of 4). Order 002-1451-01 ..... **\$70**

**\*4643 Printer**, Ribbon Cassette.  
 Order 118-1314-00 ..... **\$13.50**

**DIGITAL TAPE CARTRIDGES**

**Digital Tape Cartridge**, 300 ft long, Magnetic (box of 5).  
 Order 119-0680-01 ..... **\$180**

**\*Extra Length Cartridge**, 450 ft long, (1 ea).  
 Order 119-1439-00 ..... **\$45**

**MAGNETIC DISKS**

**4100 Series**, 8-inch diskette, 1-sided double density, soft sector box of 10 each. Order 119-1376-01 ..... **\$115**

**4907 File Manager**, Flexible Magnetic Disk Cartridge (box of 10). Order 119-1011-01 ..... **\$150**

**\*4909 Multi-User File Management System**, Cartridge Disk (1 ea, 16 mB). Order 119-1462-00 ..... **\$275**

**INK JET CARTRIDGES**

\*Cyan, Order 016-0713-00  
 \*Black, Order 016-0714-00  
 \*Yellow, Order 016-0715-00  
 \*Magenta, Order 016-0716-00

**\*INK JET PAPER**

**\*Blank Paper**, (500 Sheets).  
 \*English Sizes: 216 mm X 279 mm "A" (8 1/2 in X 11 in) sheets.  
 Order 016-0712-00  
 \*279 mm X 432 mm "B" (11 in X 17 in) sheets.  
 Order 016-0711-00  
 \*Metric Sizes: "A4" 210 mm X 297 mm.  
 Order 016-0709-00  
 \*\*A3" 297 mm X 420 mm.  
 Order 016-0710-00  
 \*New  
 \*Contact your nearest Tektronix Sales Office for prices of items not listed.

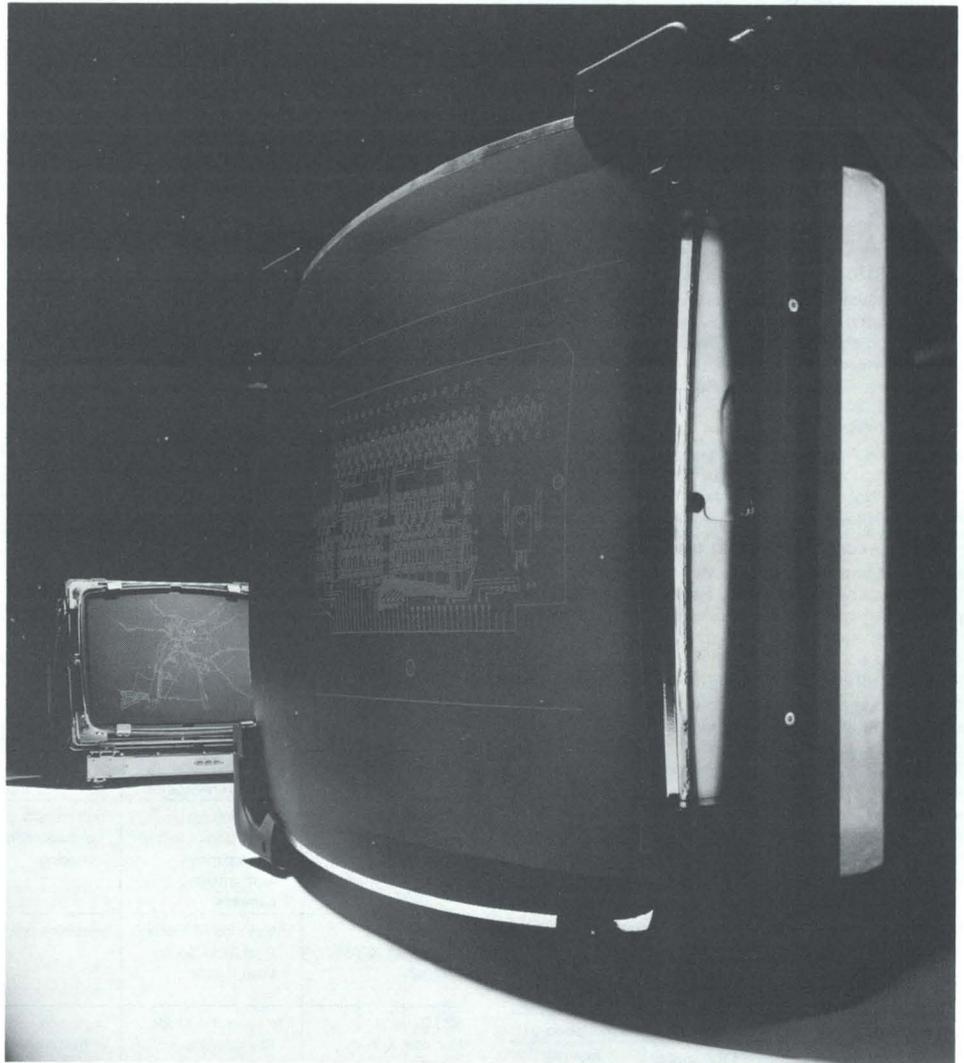
# OEM PRODUCTS

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OEM PRODUCTS

**The Tektronix OEM Commitment — Support, Reliability, Performance, Value**

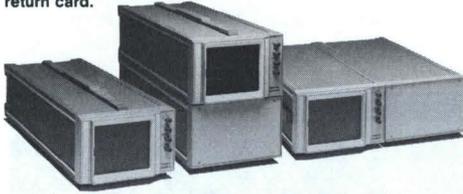
When you deal with Tektronix, you are dealing with a supplier who stands behind you every step of the way. As a world leader in display technology, we are committed to building lasting OEM relationships and supporting them with continuing new product developments.

Your Tektronix resource starts with a broad and comprehensive package of OEM support including: OEM service agreements and capabilities throughout the United States and in many countries; interface assistance and applications engineering, custom mods and documentation; and OEM pricing, terms, and conditions, to help make you competitive.

At Tektronix, our product reliability is your foundation. Your systems can only be as reliable as the components that go into them. Tektronix is committed to producing the most dependable products possible. You can be confident that the reliability we engineer into every product will help keep your customers satisfied and your service costs down.

Consider the advantages of working with us: product performance with built-in reliability and measureable value, in addition to extensive OEM service and support. Your local Tektronix OEM Representative will show you how you can profit from a partnership with Tektronix.

The standard displays come without a handle, feet or covers. See your local Tektronix Representative for complete specifications, options and ordering information, or use the return card.



**MODULAR PACKAGING AND RACK MOUNTING**  
PACKAGING FOR THE 620

- Vertical Package** — Includes handle, feet and covers.  
Order 016-0409-00 ..... **\$255**
- Horizontal Package** — Includes handle, feet and covers.  
Order 016-0410-00 ..... **\$255**
- Rackmount With Empty Compartment** — Slide-out 19 in rack assembly which rackmounts one 620 and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and combine it with the display. Includes frame, covers and rack slides. Not available with Options 06, 23, 28.  
Order 016-0404-00 ..... **\$295**
- Side-by-Side Rackmount** — Slide-out 19 in rack assembly which rackmounts two 620s side by side. Includes covers and rack slides. Not available with Options 06, 23, 28, 31.  
Order 016-0405-00 ..... **\$215**

**RACKMOUNTING FOR 606B, 608, 624**

- Rackmount and Empty Cabinet Kit** — Slide-out 19 in rack assembly which mounts a display monitor and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and connect it to the display, all in one enclosure.  
Order 040-0601-00 ..... **\$290**
- Display/Power Module Kit** — Allows rackmounting of 606B, 608, and 624 with TM 503 Power Module. Minimizes mechanical design time. Simply design your own electronics using TM 500 Custom Plug-in kits described on page 395. Then plug them in. Fits standard 19 in rack.  
Order 040-0624-01 ..... **\$120**
- Rackmounting Kit for 606B, 608, and 624** — Slide-out 19 in rack assembly which rackmounts any two of the above displays side by side. Includes covers and rack slides.  
Order 040-0600-00 ..... **\$180**
- Rackmount-to-Cabinet Conversion** — Required to convert a rackmount 606B, 608 or 624 to a cabinet style.  
Order 040-0602-00 ..... **\$160**

**KEY SPECIFICATIONS FOR 634 VIDEO DISPLAY**

Video Display		634	634 Option 01
Resolution *	Worst case	1100 line	650 line
	Nominal	1400 line	800 line
Display Size		9x12 cm (flat screen)	
Position Accuracy/ Non-Linearity		≤0.5% within 9 cm circle, ≤1% in corners. For Option 01: 1% within 9 cm circle, 2% at corners	
Brightness		515 cd/m <sup>2</sup> (150 fL) max	
Brightness Non-uniformity		< ± 10%	
Bandwidth		1 Hz - 10 MHz std. 20 MHz Video bandwidth available as Option 14.	

Note: Standard 634 accepts the line/field rate of 525/60 and 625/50.  
Discrete line rates of 675/60 through 1083/60 can be accommodated using Option 15.  
\*Merged raster lines.

**KEY SPECIFICATIONS FOR X-Y DISPLAYS**

See your local Tektronix representative for complete specifications, options and ordering information, or use the return card.

	608	620	624	606B
Spot Size*1	0.26 mm (10 mils)	<0.38 mm (15 mils)	0.30 mm (12 mils)	0.08 mm (3.1 mils)
Display Size	98 x 122 mm	100 x 120 mm	98 x 122 mm	80 x 100 mm
Acceleration Potential	22.5 kV	12 kV	≈18 kV	5.5 kV
Bandwidth, X-Y*2	≥5 MHz	≥2 MHz	≥3 MHz	>3 MHz
Bandwidth, Z*2	≥10 MHz	≥5 MHz	≥5 MHz	5 MHz
Risetime	≤35 ns		≤70 ns	≤116 ns
Input R and C, X-Y*3	1 MΩ    ≤60 pF	1 MΩ    47 pF	1 MΩ    <47 pF	1 MΩ ± 1% or 50 Ω    <47 pF
Input R and C, Z*3	1 MΩ    ≤60 pF	1 MΩ    <47 pF	1 MΩ    <47 pF	1 MΩ or 5 MΩ
X-Y Phase Difference	≤1° to 1.5 MHz	≤1° dc to 500 kHz	<1° to 1.0 MHz	1° to ≥500 kHz
Recommended Source Impedance, X-Y and Z	≤10 kΩ	≤10 kΩ	≤10 kΩ	50 Ω or ≤10 kΩ.
Temperature Range	0° to +50°C	0° to +55°C	0 to +50°C	0° to 50°C
Power Requirements*4	61 W	*5	61 W	75 W
Included Accessories	Lined external implosion shield (graticule) for adjustment purposes	Lined external implosion shield (graticule) for adjustment purposes		
Recommended Cameras*6	C-5C, C-59A, C-28	C-5C, C-5C Option 01 C-28	C-5C, C-28	C-28, C-30BP

\*1Measured at 0.5 μA.  
\*2Full spec would read: "dc to..." appropriate figure.  
\*3" || <" means "paralleled by less than".  
\*4Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V (± 10% on each range). 48 to 440 Hz. Number given shows W maximum at nominal line voltage.  
\*5The 620's power requirements are 90-132 and 180-250 V ac; 48-440 Hz line frequency, 22 W max. 0.2A at 120 V ac 60 Hz.  
\*6External 15 V dc 750 mA power supply required for C-28.

**APPLICATIONS FOR SELECTED OEM IMAGING PRODUCTS**

Recommended Display	Medical Instrumentation	Electronic Test Equipment	Defense Electronics	Analytical Instrumentation
634 Very High Resolution Video Display	Ultrasound raster scan Computerized tomography Multi-imaging cameras	High-density graphics, alphanumerics & imaging	Reconnaissance & surveillance Target acquisition FLIR LLLTV	Electron microscopy
608 High Brightness X-Y Display	Ultrasound M-Mode Real Time Sector scan B-scan	Spectrum analysis	Navigation & control Automated test systems Simulators IR imaging	Mass Spectrometry Nondestructive testing NMR FTIR
620 General Purpose X-Y Display	Ultrasound A-Mode Physiological measurements	Logic analyzers Automated test equipment Spectrum analysis RF-sweepers TV waveform monitor	Electronic counter-measures Radar-A scopes Sonar PPI	Nondestructive testing Multi-channel pulse height analyzers
606B Very High Resolution X-Y Display	Nuclear multi-imaging Gamma camera Ultrasound multi-imaging	High-density graphics alphanumerics & imaging	Imaging for scan conversion	Scanning electron microscopy Micro probe Radiation and thermal scanning



## 4041



The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

### Optimized for Interfacing Flexibility

### Modular Design – Rackmount or Portable

### Efficient, Easy to use BASIC Language with Extensions

### Expandable Memory Capability (To 160k Bytes) and Other Options

The 4041 Controller is a powerful, flexible, expandable IEEE Standard 488 systems controller designed to work with Tektronix and other vendor's IEEE Standard 488 instruments. While the basic unit is intended principally for *execute only* environments such as production line testing, a variety of options and peripherals will equip the 4041 for full interactive flexibility in research lab applications Tektronix full line of terminals (graphics or alphanumeric, storage or raster, and color) are compatible to create an optimum programmer interface in the more sophisticated areas. Software features similarly span the range from the occasional programmer to the sophisticated programming team tacking complex products. The basic 4041 compactness, permits configuration of very compact systems which can go into applications impractical for earlier generations of systems.

### 4041 Architecture

The 4041 controller contains three micro-processors. The CPU is the powerful 16-bit 68000. Standard memory is 32k bytes (approximately 19k user-available), with optional 32k increments to 160k maximum. A 20-character alphanumeric LED display, 20 character thermal printer, DC 100 cassette drive, 18 key system/function keypad, GPIB port, and a RS-232 port are standard. A realtime clock and calendar capability are standard on the 4041. Option 01 adds a second pair of ports (one GPIB and one RS-232). The Option 01 GPIB port has Direct Memory Access

capability. Other options include an 8-bit parallel TTL port. (Option 02) the program development ROMs and carrier (Option 30), and a program development/debug keyboard (Option 31). BASIC is an excellent language, and was chosen for the 4041. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for friendly, easy to use. To improve the self-documenting characteristics and thus reduce maintenance costs, 4041 BASIC is enhanced by several features. Variable names may be up to 8 characters, allowing the programmer to select meaningful names like RISETIME, VOLTAGE 1, or DELAY Subprograms and program lines may be named with examples such as SRQHNDL or CALCRMS.

4041 BASIC includes many enhancements such as FORTRAN-like subprograms. Variable passing from main to subprograms and the ability to declare any variables as local or global means that a team of programmers can work quite independently on a massive task, with the main program ultimately being not much more than a series of subprogram CALL statements. Other powerful features include optional data types (short and long floating point plus integer), a COMPRESS command to optimize memory use, a proceed mode which overlaps I/O and processing operations for maximum system speed, logical unit assignment capability, and up to 160k bytes of memory directly addressable without overlays or paging techniques.

### Test and Measurement Orientation

The 4041 controller was developed and optimized as an instrument controller. Many of the IEEE Standard 488 functions are simple high level commands in 4041 BASIC. Examples include ATN, GET, LLO, and several others. In its power-up default condition, the 4041 implements Tektronix *Standard Codes and Formats* and thus can communicate instantly with Tektronix IEEE Standard 488 instruments without any programmer attention to formats, syntax, delimiters, number format, etc. However, the 4041 also has virtually complete, programmable control over every IEEE Standard 488 line and condition. When this ability is combined with the 4041's Logical Unit assignment and stream specification ability, virtually any IEEE Standard 488 instrument or device can be easily handled. The stream specification ability means that a particular device's format, syntax, end-of-message character, and other idiosyncrasies can be described one time in a Logical Unit assignment statement. Thereafter, the programmer can control or obtain data from that instrument as easily as from an instrument which fully complies with Tektronix *Standard Codes and Formats*.

The error trapping and handling capabilities of the 4041 are a particular importance in test and measurement systems. Virtually any category of error — in instruments, peripherals, on the bus, or even within the 4041 — can be trapped and handled by user specified software drivers.

## CHARACTERISTICS

### ARCHITECTURE

**CPU** — 68000, 16-bit.

**Standard Memory** — 32k bytes expandable to 160k.

### DISPLAY

**Type** — LED.

**Segments** — 16.

**Characters** — 20 Alphanumeric.

### IEEE STANDARD 488 INTERFACE

#### Transfer Rates Normal Mode

Input: >5k bytes/s.

Output: >5k bytes/s.

#### Transfer Rate Fast Mode

Input: >16.5k bytes/s.

Output: >19.5k bytes/s.

### SERIAL INTERFACE

**Type** — Asynchronous RS-232.

**Full Duplex** — Full capability (half duplex not supported).

**Transmit/Receive** — Matched rate only.

**Bits Per Character** — 5,6,7, or 8 bits.

**Stop Bits** — One or two.

**Parity** — Even, Odd, High, Low, None.

**Baud Rate** — Selectable, any integer between 2 and 9600.

### MAGNETIC TAPE DRIVE

**File Structure** — 48 named files (maximum).

**Typical Capacity** — 650 records (600 minimum).

**Physical Record** — 256 bytes.

**Average Transfer Rate** — 10.24k bits/s.

**Tape Cartridge** — 100A Certified Data Cartridge from Tektronix.

### PRINTER

**Method** — Thermal, fixed head.

**Capacity (Per Fixed Line)** — 20 character Alphanumeric.

**Speed** — 2 ± 0.24 lines/s.

**Line Spacing** — 6 ± 1/2 lines/in.

**Character Set** — 128 total.

**Paper Size** — 60 mm x 25 m (2.36 in x 82 ft).

### ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature** — Without data cartridge or printer page: 0°C to +55°C. With data cartridge or printer page: 0°C to +45°C.

**Storage Temperature** — Without data cartridge or printer paper: -40°C to +75°C.

**Humidity** — Without data cartridge or printer paper: 95%. With data cartridge or printer paper: 85%. Nonoperating: 95%.

**Altitude** — Operating: Sea level to 4500 m (15,200 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

**EMI** — Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

### AC POWER

**Line Voltage** — 90 to 132 or 180 to 250 V ac ± 10%.

**Line Frequency** — 48 to 66 Hz.

**Power Consumption** — 120 W maximum.

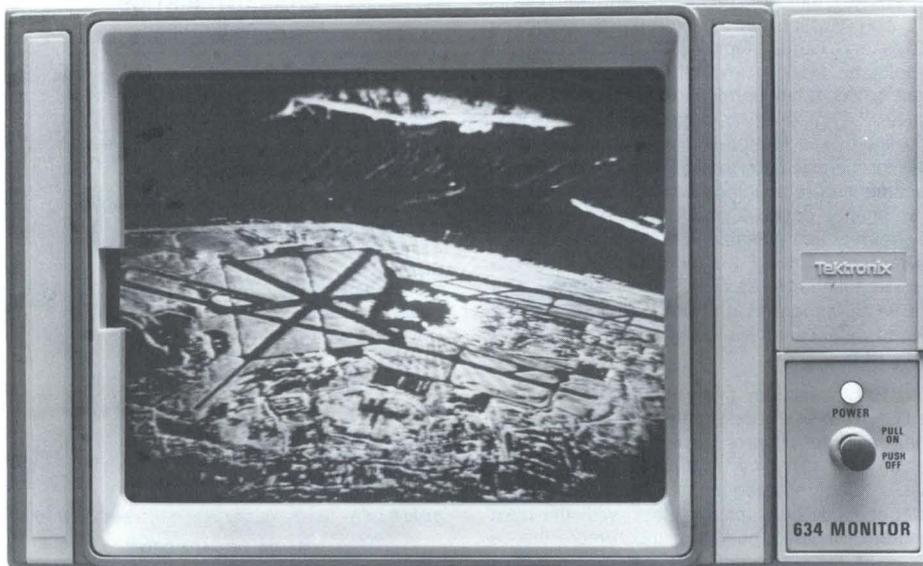
### INCLUDED ACCESSORIES

DC 100 Tape cartridge, blank (119-1350-00); system verification tape (062-5828-00); power cord (161-0066-00); roll of printer paper (006-3557-00); loop back connector, RS-232 male (013-0198-00); blank overlays for FP keyboard (334-4074-00).

### PHYSICAL CHARACTERISTICS

Dimensions	mm		in	
	mm	in	mm	in
Width	215.5	8.5	180	7.2
Height	180	7.2	527	20.8
Depth	527	20.8		
Weight	kg		lb	
Net	7.8	17.5		
Net, with Options	8.8	19.5		

For more complete description and Ordering Information refer to pages 391-393.



**634**

**High Resolution Low Distortion Display for Critical Applications (1400 lines, shrinking raster)**

**<1/2% Non-Linearity Inside the 9 cm Quality Area**

**Excellent Gray Scale and Brightness Uniformity**

The 634 Video Display monitor delivers extremely high quality video images for both viewing and photography. Applications include: medical diagnostic imaging, military infrared imaging, and automated test systems.

Tektronix' distortion requirements surpass normal standards. With the 634, you'll have less than 1/2 percent distortion inside a 90 mm circular area; less than one percent for the rest of the screen. The 634 has a flat faceplate that preserves geometric accuracy in viewing and photographic applications. Dynamic focusing assures crisp images, even in the corners.

Resolution on video displays can be separated into two categories: vertical and horizontal. Vertical resolution is limited by the video line rate used. At the RS-170 rate of 525/60, approximately 480 lines are visible. Option 15 extends the 634 line rate to 1083/60, and improves the vertical resolution. Determined by spot size and video bandwidth, horizontal resolution typically exceeds 1400 lines per screen height at center screen. Option 14 increases video bandwidth to 20 MHz.

**Excellent Gray Scale and Brightness Uniformity**

The 634's CRT is designed to faithfully display gray scale images. This CRT utilizes an advanced gun design for excellent brightness uniformity (variation is less than ±ten percent across the screen).

The 634 may be operated on either ac or dc power. Ac power is standard; Option 20 configures the unit for dc power.

**CHARACTERISTICS**  
**DISPLAY**

- CRT Type** — Raster scan, monochrome.
- Dimensions** — 90 mm x 120 mm (3.5 in x 4.7 in), 15 cm (5.9 in) diagonal.
- Aspect Ratio** — 4 x 3.
- Resolution** — Measured using the shrinking raster method (no interlace) center screen at 100 cd/m<sup>2</sup>, (30 fL): 1400 lines nominal (1100 lines worst case) or 800 lines nominal (650 lines worst case) with Option 01.
- Position Accuracy** — ≤0.5% within 90 mm circle (≤1% with Option 01); ≤1% outside 90 mm circle (≤2% with Option 01).

**LINE/FIELD RATE**

- Standard** — 525/60 and 625/50.
- Option 15** — 1083/60, adjustable down to 675/60.
- Brightness** — 515 cd/m<sup>2</sup> (150 fL) maximum.
- Brightness Uniformity (Using J16 Photometer)** — Better than ±10% over the scan area.
- Phosphor Type** — P45.

**VIDEO INPUT**

- Signal** — Composite video with negative sync; RS-170 compatible.
- Signal Level** — 0.35 V p-p to 2.0 V p-p.
- Maximum Safe Input** — 5.0 V p-p.
- Bandwidth** — 1 Hz to 10 MHz (20 MHz with Option 14).
- Impedance** — 75 Ω loop through; switchable 75 Ω termination.
- Return Loss** — 46 dB to 5 MHz with or without internal 75 Ω termination and power on.
- Dc Restoration** — Referenced to back porch or sync tip.

**SAFETY**

Department of D.H.H.S. (BRH Rule 1020 10 (C) (1) standard. UL 544 Listing (Option 06) and UL 544 Component Recognition (Option 09). C.S.A. certified.

**AC POWER**

- Voltage Ranges (±10%)** — 100, 110, 120, 200, 220, and 240 V ac.
- Line Frequency** — 48 to 440 Hz.
- Power** — 50 W at 120 V ac, 60 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	214	8.4
Height	133	5.2
Height (Option 06)	149	5.9
Depth	423	16.7
Depth (Option 20)	367	14.7
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	6.3	13.8
Net (Option 20)	4.6	10.1

**INCLUDED ACCESSORIES**

CRT graticule (337-2537-01); CRT filter (378-0133-00).

**ORDERING INFORMATION**

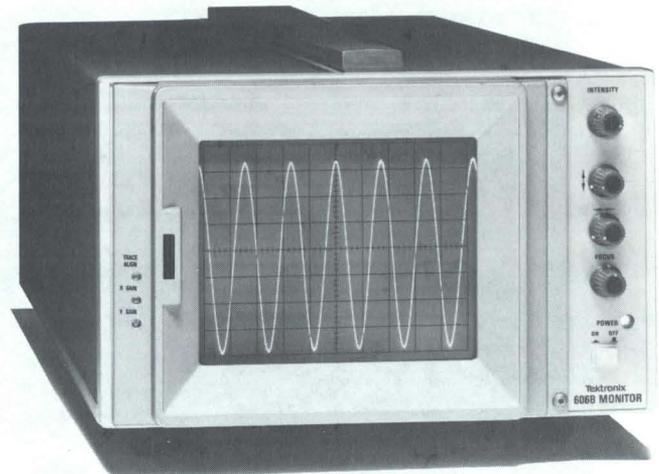
- 634 Video Display**  
(Without handle, feet and covers.) ..... **\$2,900**
- Option 01** — Resolution of 800 lines nom, 650 lines worst case ..... **-\$205**
  - Option 06** — UL 544 Listing. (Covers included; not available with Options 20.) ..... **+\$100**
  - Option 09** — UL 544 Component Recognition ..... **NC**
  - Option 11** — External Sync — switchable ..... **+\$40**
  - Option 13** — Video Reverse ..... **+\$85**
  - Option 14** — 20 MHz Video Amplifier ..... **+\$145**
  - Option 15** — High line rate. Factory calibrated at 1083/60. User changeable to rates between 675/60 and 1083/60 with supplied parts kit ..... **+\$280**
  - Option 16** — Remote Brightness, Contrast, Focus, Video Reverse, Blanking ..... **+\$15**
  - Option 20** — Dc Supply — +23 V, -22 V, +9 V (Unregulated) ..... **-\$235**

**MECHANICAL PACKAGE OPTIONS**

- Rackmount kit to mount two 634s side by side in 19 in rack. Not compatible with Option 20.**  
Order 016-0403-00\* ..... **\$250**
- Rackmount Kit to mount one 634 and one empty cabinet side by side. Not compatible with Option 20.** Order 016-0402-00\* ..... **\$345**

\*OEM pricing not available on rackmount kits. Quantity discount information is available on request.

**SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.**



620

General Purpose Economical, X-Y Waveform Display

Many Packaging Configurations (See page 118)

Exceptionally High Reliability

The 620 has Built-in Reliability

With fewer parts and lower power, display and system reliability are improved, and service costs are lower.

Package the 620 the Way You Want It

A wide variety of packaging configurations are available for easy integration into your system.

CHARACTERISTICS

DISPLAY

- CRT Type** — Flat-faced rectangular CRT.
- Dimensions** — 100 x 120 mm (3.9 x 4.7 in).
- Phosphor Type** — P31.
- Spot Size** — 0.38 mm (15 mils) at 0.5  $\mu$ A.
- Linearity** — The voltage required to produce a 25-mm deflection from any point on the CRT will not vary more than 5%.
- Usable Brightness** — Up to 100 cd/m<sup>2</sup> (30 fL).

VERTICAL AND HORIZONTAL AMPLIFIERS

- Bandwidth** — Dc to 2 MHz.
- Settling Time** — 1  $\mu$ s from any point on the CRT within 0.5 mm of final position.
- Deflection Factor** — Adjustable,  $\leq 0.9$  V to  $\geq 1.5$  V per 100 mm (vertical),  $\leq 0.8$  V to  $\geq 1.2$  V per 100 mm (horizontal).
- Input R and C** — 1 M $\Omega$  shunted by  $< 47$  pF.
- X-Y Phase Difference** — 1° maximum, dc to 500 Hz.
- Maximum Input Voltage** —  $\pm 25$  V (dc plus peak ac).
- Recommended Source Impedance** —  $\leq 10$  k $\Omega$ .

Z-AXIS AMPLIFIER

- Bandwidth** — Dc to  $\geq 5$  MHz.
- Input Sensitivity Range** — Not adjustable. 1.0 V will produce maximum brightness with Intensity Control set at mid-range.

AC POWER

- Voltage Ranges ( $\pm 10\%$ )** — 100, 110, 120, 200, 220 and 240 V ac.
- Line Frequency** — 48 to 440 Hz.
- Power** — 22 W at 120 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height (without feet)	133	5.2
Width	213	8.4
Depth	500	19.7
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net(without handle, feet, and covers)	5.3	11.7
Shipping	6.9	15.2

INCLUDED ACCESSORIES

CRT Graticule (337-2537-00).

ORDERING INFORMATION

- 620 Display (without handle, feet or covers)** ..... **\$1,400**
- Option 01** — Internal Graticule (8 x 10 div at 12.2 mm/div.) ..... **NC**
- Option 06** — UL 544 Listed. (Includes handle, feet, and covers.) ..... **+\$100**
- Option 09** — UL Component Recognition. (Not compatible with Option 06.) ..... **NC**
- Option 10** — Remote 25-pin Program Connector, X, Y, Z-axes. Single-ended inputs only. (Not available with Option 31.) ..... **+\$50**
- Option 20** — Delete ac power. External dc power required (17 to 26 V, at 0.9 A.) (Not available with Option 06 or 31.) ..... **-\$25**
- Option 23** — Handle, feet and covers. (Not available with Options 06, 28, or 31.) ..... **+\$80**
- Option 25** — TTL Blanking ..... **+\$50**
- Option 28** — With cover only — no trim strips, no feet. (Not available with Options 06, 23, or 31.) ..... **+\$70**
- Option 31** — Delete all rear panel BNCs, dc power connector and ac power supply and switch. Provision for external dc power (+17 V unregulated) is provided. (Not compatible with Options 06, 10, 20, 23 and 28.) Can be used with 016-0409-00 or 016-0410-00 packaging ..... **-\$25**

606B

Very High-Resolution X-Y Display for Applications Requiring the Most Critically Sharp Photographs and Displays

The 606B offers image stability, gray-scale performance, and uniform brightness, critical to the quality of measurement or the accuracy of a medical diagnosis.

Uniform resolution and variable spot size are also provided by the 606B. The 606B's metal bezel is a solid mount for heavy cameras and prevents light leaks or distortion.

CHARACTERISTICS

DISPLAY

- CRT Type** — Flat-faced rectangular CRT.
- Dimensions** — 80 x 100 mm (3.2 x 3.9 in).
- Display Linearity** — 1% of full scale along major axes.
- Spot Size** — 0.079 mm (3.1 mils) or less.
- Spot Growth** — Not  $> 20\%$  at constant intensity within the quality area (70 x 90 mm).
- Brightness Uniformity** —  $< 10\%$  variation within quality area (70 x 90 mm).
- Phosphor** — P31.

606B

VERTICAL AND HORIZONTAL AMPLIFIERS

- Risetime** — 116 ns or less.
- Settling Time** —  $< 500$  ns with deflection-input attenuation in 1X position.
- Bandwidth** — Dc to at least 3 MHz ( $-3$  dB).
- Input** — Differential; BNC connectors.
- Deflection Factor (Vertical and horizontal)** — Adjustable, 0.5 to 2.5 V for 80 mm deflection.
- Input Impedance** — 1 M $\Omega$  or 50  $\Omega$   $\pm 1\%$ , paralleled by  $< 47$  pF; internally selectable.
- X-Y Phase Difference** — Not more than 1° to at least 500 kHz.
- Maximum Input Voltage** — With 1 M $\Omega$  Z<sub>in</sub>,  $\pm 100$  V (dc peak ac); with 50  $\Omega$  Z<sub>in</sub>,  $\pm 5$  V (dc peak ac).

Z-AXIS AMPLIFIER

- Input** — Differential; BNC connectors.
- Bandwidth** — Dc to 5 MHz ( $-3$  dB).
- Risetime** —  $\leq 35$  ns.
- Sensitivity Range** — Adjustable from 0-1 V to 0-5 V for full intensity control.

AC POWER

- Voltage Ranges ( $\pm 10\%$ )** — 100, 110, 120, 200, 220, and 240 V ac.
- Line Frequency** — 48 to 440 Hz.
- Power** — 50 W nominal; 75 W maximum at 120 V ac.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	133	5.2
Width	213	8.4
Depth	519	20.4
<b>Weight <math>\approx</math></b>	<b>kg</b>	<b>lb</b>
Net	7.9	17.5
Shipping	10.3	22.7

INCLUDED ACCESSORIES

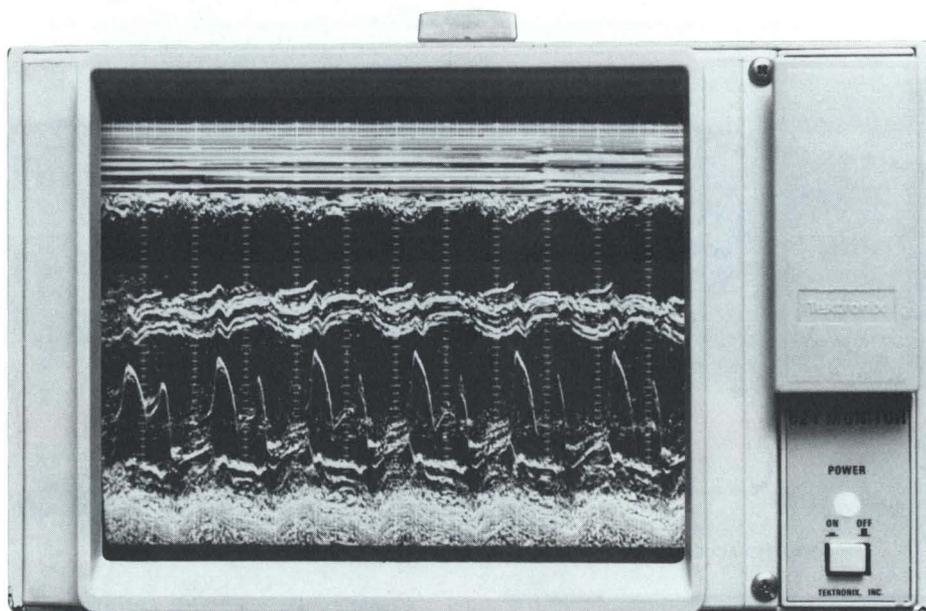
25-pin connector (131-0570-00); 25-pin connector housing (200-0821-00); power cord (161-0066-00); graticule (337-1674-00).

ORDERING INFORMATION

- 606B Display (no handle, feet or covers.)** ..... **\$4,450**
- Option 06** — UL 544 Listing. Includes handle, feet, and covers. .... **+\$100**
- Option 07** — Front-panel controls changed to screwdriver adjustments. .... **+\$30**
- Option 09** — UL 544 Component Recognized ..... **NC**
- Option 28** — With covers. (Not available with Option 06.) ..... **+\$70**

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

OEM PRODUCTS



## 608/624

High Resolution With Ambient Light Viewing

Expansion Mesh Halo Suppression

Excellent Gray Scale High Brightness Displays

Optional UL 544 Listing

The 608 is Tektronix' finest directed-beam viewing monitor. It is extremely well suited for high-performance display applications such as medical and military imaging and electronic instrumentation. The 608's high usable brightness, small spot size, and large screen give excellent direct-viewing capability. When such clarity or brightness is not required, the comparable 624 is recommended. Both the 608 and 624 produce detailed displays that are easy to read in high ambient light and allow quality photographs.

Special CRT design suppresses expansion-mesh halo, which ordinarily causes lower contrast and a "washed out" appearance that interferes with high-brightness gray-scale displays. Expansion-mesh-halo suppression results in a more readable display with subtle and accurate gray-scale images and detailed waveforms. In addition, imaging is critically sharp from corner to corner, particularly on the 608, which uses dynamic focusing.

The wide deflection factor facilitates integration with a broad range of designs. An optional metal bezel lets you use heavy cameras, including those with motorized roll-film backs, without causing distortion, defocus, or light leaks.

In addition, optional full-differential inputs help reject unwanted common-mode signals such as ground noise and power-supply hum. Plus, the 608 can be ordered with gamma-correction for photographic applications. This option produces linear light-output changes with a linear change of Z-axis input, typically within 20 percent.

### CHARACTERISTICS

#### DISPLAY

**CRT Type** — Flat-faced, electrostatic.

**Dimensions** — 98 x 122 mm (3.9 x 4.8 in).

**Phosphor Type** — P31 (standard).

#### Spot Size

608 — 0.25 mm (10 mils) at 170 cd/m<sup>2</sup> (50 fL); maximum brightness — 240 cd/m<sup>2</sup> (75 fL).

624 — 0.3 mm (12 mils) at 170 cd/m<sup>2</sup> (50 fL).

#### VERTICAL AND HORIZONTAL AMPLIFIERS

##### Bandwidth

608 — Dc to at least 5 MHz.

624 — Dc to at least 3 MHz.

**Deflection Factor** — Adjustable 50 mV/div to 0.25 V/div. Option 22 (5X attenuator) extends deflection factor to 1.25 V/div.

##### Input R and C

608 — 1 M $\Omega$  paralleled by <60 pF.

624 — 1 M $\Omega$  paralleled by <47 pF.

##### X-Y Phase Difference

608 — One degree maximum to at least 1.5 MHz.

624 — One degree maximum to at least 1.0 MHz.

**Maximum Input Voltage** —  $\pm 100$  V (dc plus peak ac).

**Linear Common-Mode Signal Range (with Option 21)** —  $\pm 3$  V. (Option 22 extends range to  $\pm 15$  V.)

**Recommended Source Impedance** —  $\leq 10$  k $\Omega$ .

#### Z-AXIS AMPLIFIER

Z-Axis amplifier permits intensity modulation of the writing beam.

##### Bandwidth

608 — Dc to 10 MHz over usable range.

624 — Dc to 5 MHz over usable range.

Sensitivity range is adjustable from 0 to +1 V to 0 to +5 V for full-intensity control.

##### Input R and C

608 — 1 M $\Omega$   $\pm 1\%$  and <60 pF.

624 — 1 M $\Omega$   $\pm 1\%$  and <47 pF.

**Linear Common-Mode Signal Range (with Option 21)** —  $\pm 5$  V.

#### AC POWER

**Voltage Ranges ( $\pm 10\%$ )** — 100, 110, 120, 200, 220, and 240 V ac.

**Line Frequency** — 48 to 440 Hz.

**Power** — 61 W maximum at nominal line voltage.

#### PHYSICAL CHARACTERISTICS

Dimensions	Option 23		Rackmount	
	mm	in	mm	in
Width	213	8.4	213	8.4
Height	169	6.6	133	5.2
Depth	518	2.4	483	19.0
<b>Weight <math>\approx</math></b>	<b>kg</b>	<b>lb</b>		
Net	8.0	17.6		
Shipping	10.4	23.0		

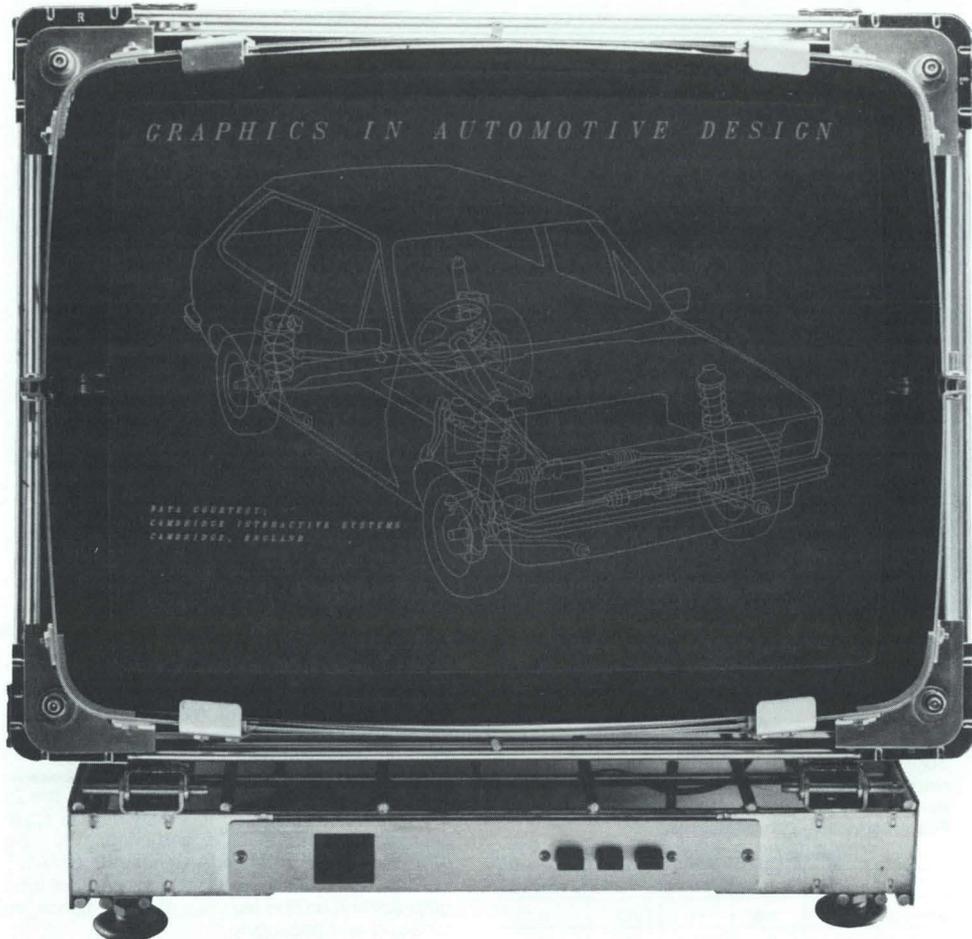
#### INCLUDED ACCESSORIES

CRT Graticule (337-2126-02).

#### ORDERING INFORMATION

<b>608 Display</b>	
(No handle, feet, or covers.) .....	<b>\$2,690</b>
<b>624 Display</b>	
(No handle, feet, or covers.) .....	<b>\$2,640</b>
<b>Option 01</b> — Internal Graticule .....	<b>NC</b>
<b>Option 09</b> — UL 544 Component Recognition .....	<b>NC</b>
<b>Option 10</b> — 25-pin Remote Program Connector X, Y, and Z, single-ended inputs .....	<b>+\$50</b>
<b>Option 20</b> — Without ac supply	
( $\pm 18$ V unregulated dc supply required.) (624 only.) ....	<b>-\$30</b>
<b>Option 21</b> — Full Differential Inputs (X,Y,Z) .....	<b>+\$50</b>
<b>Option 22</b> — Extended Gain Range 5X Attenuator .....	<b>+\$35</b>
<b>Option 23</b> — Handle, feet, and covers.	
(Not available with Option 28.) .....	<b>+\$80</b>
<b>Option 25</b> — TTL Blanking .....	<b>+\$75</b>
<b>Option 28</b> — Covers only	
(Not available with Option 23.) .....	<b>+\$70</b>
<b>Option 29</b> — Metal Bezel .....	<b>+\$70</b>

**SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.**



## GMA103

### Storage and Color Enhanced Refresh

### Graphic and Alphanumeric Display

### Modular Construction, 19-inch, High Performance Display

The GMA103 is a high performance member of the GMA display product family. Its storage mode provides high resolution, high density graphics at a low cost. Color and refresh add increased viewability, selective erase, interactivity, and dynamic motion with the same high resolution. GMA Family features include modular construction, a blending of storage and refresh technology, and interface/packaging options to configure a display for user applications.

Quick differentiation of working and stored information. By placing finalized data in store (green display) while retaining working data in refresh (yellow-orange display), you can achieve high density, graphics while using your computer to address other tasks.

### Modular Construction

The CRT, low voltage power supply and printed circuit board modules are arranged on a unique high-strength wireform chassis. This construction not only supports different performance, interface, and packaging options but permits easy removal of modules for field service.

### Operations

All display functions are completely programmable and designed to interface to TTL logic. The GMA103 is completely compatible with other members of the GMA family. If refresh is already being used in a GMA family display, no new signals are required to support color refresh.

A CRT anti-burn circuit is provided to protect against burning the CRT phosphor in the event that X and Y deflection is not commanded to move or is lost with the writing beam on. In addition, the screen is automatically erased after 30 minutes from the last Z-AXIS or G-BUSY pulse or VIEW initiate.

## CHARACTERISTICS

### DISPLAY

- CRT Type** — Directed beam, Direct View Storage.
- Dimensions** — 48 cm (19 in) diagonal.
- Addressable Area** — 267 x 356 mm (10.5 x 14 in).
- Stored Resolution** — 40 line pairs/in center screen; 35 line pairs/in at screen periphery.
- Stored Dot Writing Time** — 5  $\mu$ s or less.
- Stored Vector Writing Rate** — 150 m/s (5900 in/s).
- Refreshed Vector Writing Rate** — 1200 m/s, (47,240 in/s.)
- Viewing Time** — At least 15 minutes at specified resolution.
- Erase Time** — 1.5 s  $\pm$  20%.

### DEFLECTION AMPLIFIERS

- X-Y Input** — Differential analog.
- Origin (X = 0, Y = 0 Volts)** — Center screen.
- Input Sensitivity**
  - Long Axis — 10 V p-p full screen  $\pm$  2.5%.
  - Short Axis — 7.5 V p-p full screen  $\pm$  2.5% of long axis.
- Maximum Input Voltage** —  $\pm$  6.5 V (dc + peak ac).
- Input Impedance** — 10 k $\Omega$   $\pm$  10%. paralleled by <100 pF.
- Slew Rate (non-linear operation)** — 5000 m/s.
- Settling Time (non-linear operation)** — 1  $\mu$ s + 2  $\mu$ s/cm to within one spot diameter for vector lengths > 1 cm; 3  $\mu$ s to within one spot diameter for vector lengths of 1 cm or less.
- Positional Accuracy** — All points within the CRT addressable area are addressable with an accuracy of  $\pm$  1.25% of the long axis dimension.

### Z-AXIS

- Input Requirements** — TTL compatible. LO True. (Strap selectable to HI True).
- Risetime** — 70 ns, limited to 1 MHz continuous repetition rate.
- Input Impedance** — 50  $\Omega$  (Strap selectable to 75 or 93  $\Omega$ ).
- Status Signals** — D Busy, SLU (HCU available when an appropriate hard copy device is connected).

### AC POWER

- Voltage Range** — 90 to 110, 108 to 132, 198 to 242 or 216 to 264 V ac (jumper selectable).
- Line Frequency** — 48 to 66 Hz.
- Power** — 315 W maximum at 115 V ac.

### PHYSICAL CHARACTERISTICS

Dimensions Horiz Fmt (no tilt)	mm	
	mm	in
Width	487	19.2
Height	461	18.2
Depth	705	27.8
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	45.0	100
Shipping	56.7	125

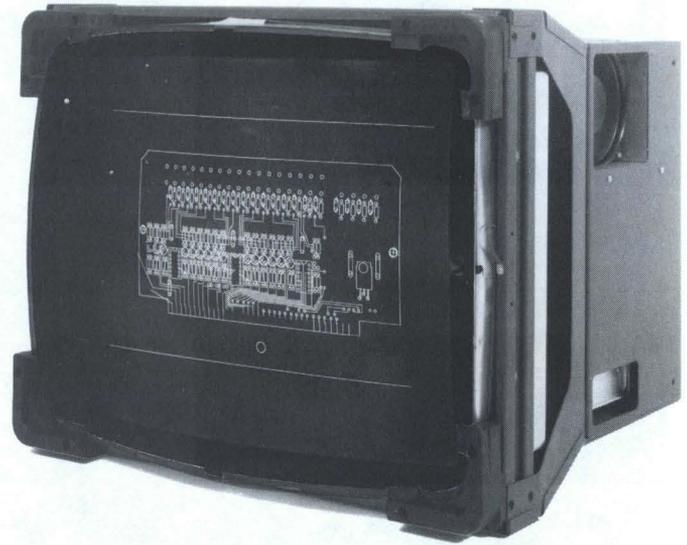
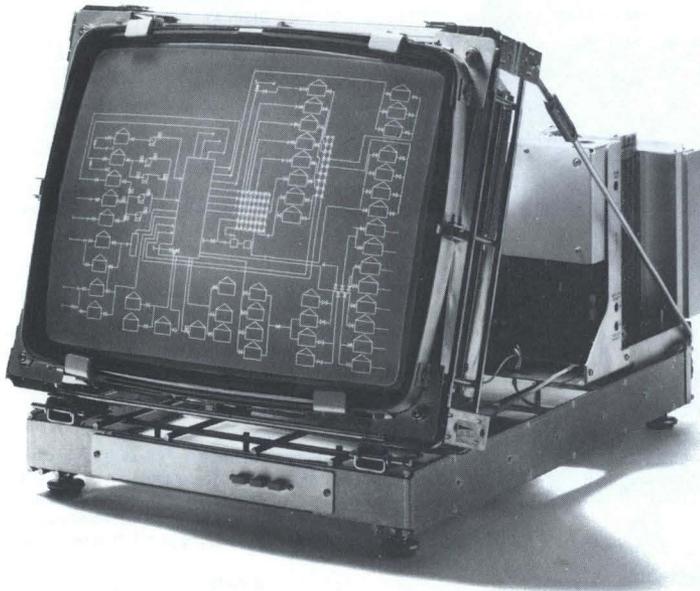
### ORDERING INFORMATION

#### GMA103 Computer Display Module

- Option 33** — Front Panel Pushbuttons
- Option 34** — Analog Rear Connector
- Option 35** — Digital Rear Connector
- Option 43** — High Speed Vector/Dot Character Generator

Prices available to qualified OEM users.

Tektronix offers service training classes on the GMA Computer Display Module Series. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



## GMA101A/GMA102A

### Modular Construction

### 19 inch Diagonal CRT

The GMA101A has been tailored for applications that emphasize storage graphics. This 19-inch storage-only unit makes the benefits of low cost, high resolution storage technology graphics available to the builders of OEM systems. High density interactive graphics are realized while your computer is available to address an application rather than drive the display.

The GMA102A storage mode provides high density graphics at low cost, while its refresh feature adds the benefits of selective erase, interactivity and dynamic motion with the same high resolution.

Both units are configured for optimum modularity, with printed circuit board modules arranged on a unique high-strength wireform chassis. This construction not only supports different performance, interface, and packaging options, but permits easy removal of modules for field service. Space is available for up to three additional circuit boards. The display on both units can be supplied with the CRT module tilted as far back as 15 degrees or oriented in either the horizontal or vertical (page) format.

### CHARACTERISTICS (Both Units) DISPLAY

- CRT Type** — Directed beam, Direct View Storage.
- Dimensions** — 48 cm (19 in) diagonal.
- Addressable Area** — 267 mm x 356 mm (10.5 in x 14 in).
- Stored Resolution** — 40 line pairs/in at screen center; 35 line pairs/in at screen periphery.
- Stored Dot Writing Time** — 5  $\mu$ s or less.
- Stored Vector Writing Rate** —  
GMA101A — 100 m/s (3937 in/s).  
GMA102A — 150 m/s (5900 in/s).
- Refreshed Vector Writing Rate** —  
GMA101A — 500 m/s (19,685 in/s) nonstore; 16.5 vector meters (650 vector in) maximum at 30 frames/s.  
GMA 102A — 1200 m/s (47,240 in/s) write-thru and nonstore; 40 vector meters (1575 vector in) maximum at 30 frames/s.

**Viewing Time (At Specified Resolution)** — At least 15 minutes.

**Erase Time** — 1.5 s  $\pm$  20%.

### AC POWER

**Voltage Ranges** — 90 to 110 V ac; 108 to 132 V ac; 198 to 242 V ac; 216 to 264 V ac (jumper selectable).

**Line Frequency** — 48 to 66 Hz.

**Power, GMA101A** — 220 W maximum.

**Power, GMA102A** — 314 W maximum.

### PHYSICAL CHARACTERISTICS

Dimensions	Horizontal Format		Vertical Format	
	mm	in	mm	in
Width	487	19.2	425	16.8
Height	461	18.2	563	22.2
Depth	705	27.8	705	27.8

Dimensions, Chassis	mm	in
Width	425	16.8
Depth	610	24.0
<b>Weight <math>\approx</math></b>	<b>kg</b>	<b>lb</b>
GMA101A	40.8	90.0
GMA102A	49.0	108.0

### ORDERING INFORMATION

#### GMA101A Computer Display

- Option 30** — Non-Hard Copy Compatible
- Option 31** — Vertical Format
- Option 33** — Front Panel Pushbuttons
- Option 34** — Analog Rear Panel Connector
- Option 36** — Excess Current +5 Volt Supply
- Option 37** — Green Glass CRT Filter
- Option 38** — Blue Glass CRT Filter

#### GMA102A Computer Display

- Option 30** — Non-Hard Copy Compatible
- Option 31** — Vertical Format
- Option 33** — Front Panel Pushbuttons
- Option 34** — Analog Rear Panel Connector
- Option 35** — Digital Rear Panel Connector
- Option 36** — Excess Current +5 Volt Supply
- Option 37** — Green Glass CRT Filter
- Option 38** — Blue Glass CRT Filter
- Option 42** — High Speed Vector Generator (Includes Option 36)
- Option 43** — High Speed Vector/Dot Character Generator (Includes Option 42)

Prices available to qualified OEM users.

## GMA125

### Combined Storage and Write Thru

### 25 inch Diagonal CRT

Designed exclusively for systems builders, the 25 inch GMA125 is intended to satisfy display applications of the greatest size and complexity. Like other members of the GMA Series, the GMA125 provides low cost, high resolution, storage tube graphics and unique flexibility of performance, interfacing and packaging.

### CHARACTERISTICS DISPLAY

**CRT Type** — Directed beam, Direct View Storage CRT.

**Dimensions** — 60 cm (24 in) diagonal.

**Quality Area** — 490 X 362 mm (19.3 X 14.25 in).

**Addressable Area** — 457 x 343 mm (18 x 13.5 in).

**Visual Resolution** — 40 line pairs/in, center screen; 35 line pairs/in, at screen periphery.

**Stored Dot Writing Time** — 2  $\mu$ s or less.

**Stored Vector Writing Rate** — 200 m/s (7800 in/s).

**Refresh Vector Writing Rate** — 1500 m/s (59055 in/s) write-thru and nonstore; 50 vector meters (1968 in) max at 30 frames/s.

**Viewing Time (At Specified Resolution)** — At least 15 min.

**Erase Time** — 1.0 s  $\pm$  12%.

### AC POWER

**Voltage Ranges** are 90 to 132 V ac and 180 to 250 V ac at 48 to 440 Hz. Power dissipation is 350 W maximum (420 W maximum for Opt 36).

### PHYSICAL CHARACTERISTICS

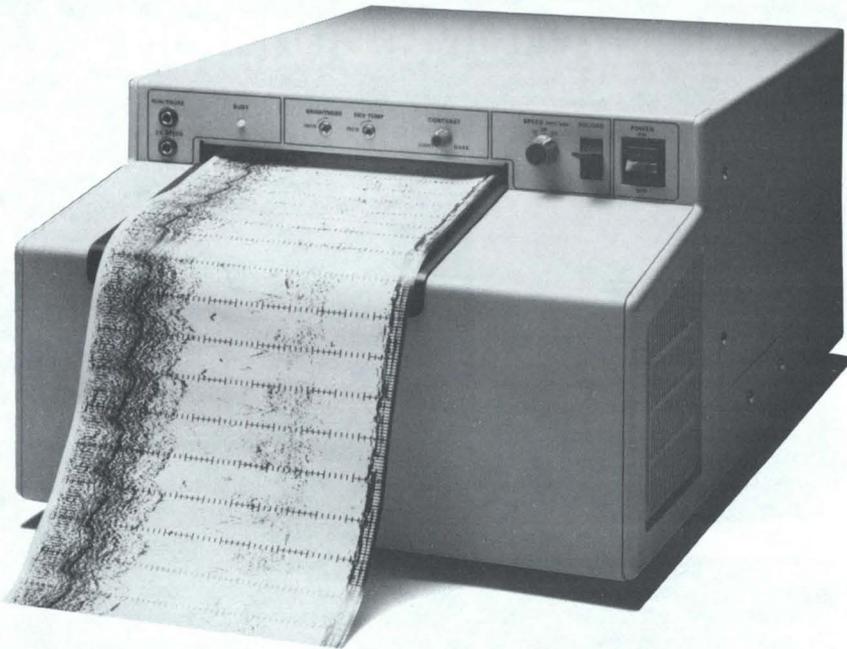
Dimensions	mm	in
Width	610	24.0
Height	478	18.8
Depth	531	20.9
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	47.9	105.6
Shipping	66.0	145.5

### ORDERING INFORMATION

#### GMA125 Display Module

- Option 30** — Non-Hard Copy Compatible
- Option 34** — Analog Rear Panel Connector
- Option 35** — Digital Rear Panel Connector
- Option 36** — Excess Current (+5 V Supply) and Fan
- Option 38** — Blue Glass CRT Filter
- Option 42** — High-Speed Vector Generator
- Option 43** — High-Speed Vector/Dot Generator

Prices available to qualified OEM users.



## 4633A

### Line Scan Recorder

### Black on White Recording

### Excellent Gray Scale

### 100 mm/s Paper Speed

The Tektronix 4633A Continuous Recorder provides hard copy output from devices that provide it with a Z-axis input signal concurrent with an X-axis (horizontal ramp) signal. This OEM product is designed for real time data recording and can be modified for specific applications such as diagnostic, ultrasound and oil well logging.

After the paper has been exposed by a fiber optic CRT, it passes through a processor where the latent image is thermally developed. The developed image is then transported through an opening in the front panel.

Unwanted interruptions will be minimal. Big 500-foot paper rolls mean few time-outs for reloading. The paper is a full 8 1/2 inches wide.

The 4633A's image quality, convenience and competitive pricing combine to make it a valuable component of an OEM system.

The 4633A is available as either a rackmount or benchtop model. The rackmount version fits into any standard 19 inch rack.

### CHARACTERISTICS

#### DISPLAY

- Spot Size — 0.15 mm maximum (at 10 V grid drive).
- Luminance Variation — 1.3 to 1 maximum.
- Optical Fiber Diameter — 10  $\mu$ m (4 X 10<sup>-5</sup> in).

#### RECORDING MEDIUM

- Dry Silver Paper — Tektronix High Performance Dry Silver Paper (Type 7772).
- Optical Density — 1.4 maximum; 0.2 minimum.
- Paper Packaging — Light-sealed cylindrical cassette.
- Paper Roll Length — 152 m (500 ft).

Paper Roll Width — 216 mm (8.5 in).

\*Shelf life is 12 month at 20° C w/50% relative humidity.

#### PERFORMANCE CHARACTERISTICS

- Recording Technique — Line-scan w/fiber optic CRT.
- Developing Technique — Internal thermal processor.
- Warmup Time — 20 minutes.
- Image Width — 142 mm (5.5 - 7.9 in).
- Image Format — Scan lines perpendicular to direction of exiting paper.
- Recording Speeds — 10, 25 and 50 mm/s or 20, 40 and 100 mm/s.
- Gray Shades — Five levels minimum.
- Resolution — 3.94 lines/mm (100 lines/in).

#### AC POWER

- Line Voltages — 100, 115, 120, 200, 220, 230, 240 V ac  $\pm$  10% (jumper selectable).
- Line Frequency — 48 to 62 Hz.
- Power — 360 W typical; 750 W maximum.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	266	10.5
Width	425	16.7
Depth	654	25.7
Weight	kg	lb
Net	30.5	67.0

Heat Dissipation — 955 BTU/hour average; 1910 BTU/hour maximum.

#### INCLUDED ACCESSORIES

High Performance Dry Silver Paper, (Type 7772), 500 ft roll, (006-2432-00).

### ORDERING INFORMATION

#### 4633A Continuous Recorder

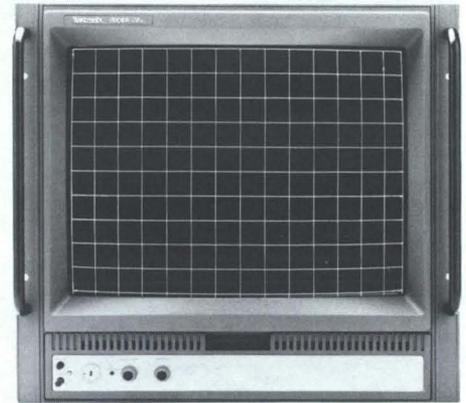
- Option 30 — Delete rackmount hardware
- Option 48 — 220 V/50 Hz Operation
- High Performance Paper (Type 7772) — One roll. Order 006-2432-00
- High Performance Paper (Type 7772) — Four rolls. Order 006-2432-01

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

- Option A1 — Universal Euro 220 V/16A, 50 Hz
- Option A2 — UK 240 V/13A, 50 Hz
- Option A3 — Australian 240 V/10A, 50 Hz
- Option A4 — North American 240 V/15A, 60 Hz

Prices available to qualified OEM users.

For ordering Hard Copy Paper see page 115.



## 690SR

### High-Resolution, 19 inch, RGB Color Display

### Delta Gun, Dot-Shadow Mask CRT

### Variable Scan Rates

### Adjustable Picture Size and Aspect Ratio

### Precise Color Convergence

### Plug-in Interface Modules

### Stabilized Color Balance

### Rugged Construction

### Recommended for Television Display or Computer Graphics

The 690SR family of high performance 19 inch color display monitors, is designed to meet state-of-the-art television display and computer graphics needs. Precise, versatile electronics combined with a high-resolution, delta gun, dot-shadowmask CRT makes this monitor an ideal choice for research and development and systems applications.

For OEM applications the 690SR Option 48 Mainframe with 69M41 RGB Interface Module provides an optimum configuration to display high quality images or graphics. Various CRT phosphors are available to satisfy special needs for colorimetry or for flicker reduction.

Flexible scan circuitry allows the 690SR Option 48 to be calibrated for any horizontal scan rate from 15 kHz to 37.5 kHz and be used with either interlaced or non-interlaced fields. (The standard display is factory-calibrated to operate at a 31.5 kHz horizontal rate.) With these scan rates, the monitor displays from 240 to 600 active lines, non-interlaced, at a 60 Hz frame rate; or from 480 to 1200 active lines, 2:1 interlaced at a 30 Hz frame rate.

Picture size can be adjusted from overscan to underscan without significant loss in convergence or linearity. This feature makes it possible to conduct experiments at various image sizes and aspect ratios or to set the monitor for different system characteristics by merely readjusting the size and position controls.

See page 157 for additional information.

## COMMUNICATIONS DIVISION



Providing quality instruments designed to test, measure and monitor television, RF, fiber optic, and data communications network signals is the responsibility of Tek's Communications Division. Tom Long, vice president and general manager, shown here with representative spectrum analyzer and data communication analyzer instruments, has intensified our continuing commitment to these products and the broadening markets we serve. Tom is also president of The Grass Valley Group, a Tektronix subsidiary.

Tek's new television production studio, shown below, is characteristic of today's in-house private television facilities which, together with the established broadcast industry, represent other market segments for the Communications Division. We have been fulfilling the needs of television broadcasters for over 30 years; and we will continue to do so. Through a cohesive network of domestic and international sales and service locations, each with personnel experienced and knowledgeable in the communications marketplace, we bring Tektronix performance and support to our Communications Division customers throughout the world.



# NETWORK COMMUNICATION ANALYZERS



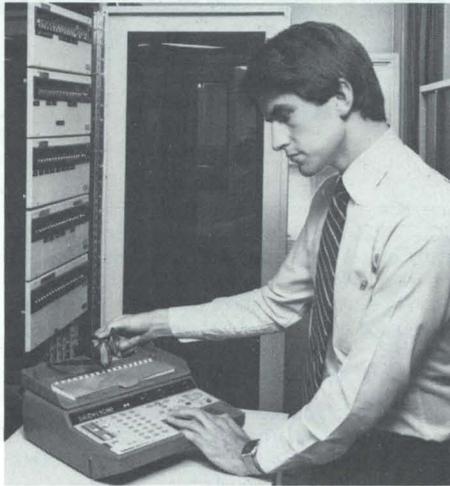
*Bisynchronous System Exercising*



*Communications System Monitoring*



*Communications Equipment Check-out*



*Data Link Testing*

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## 834

**Programmable**

**Allows Automation of Tests**

**Easy to Operate**

**Handles ASYNC/ASYNC BLOCK/BISYNC/  
HDLC/SDLC**

**Portable and Lightweight**

The Tektronix 834 Programmable Data Communications Tester is a powerful network troubleshooter designed to meet the demand for cost and time-effective first-line field service. The 834's portability (5.5 kg, 12 lb), ruggedness, and ease of use gives you a welcome independence from bulky, expensive equipment.

The 834 is compatible with EIA RS-232, and CCITT V.24 interfaces and can be expanded to many others with appropriate options. The 834 provides: system monitoring, DTE and DCE simulation to evaluate the entire network, bit error rate testing for analyzing phone lines and modems, the ability to calculate and confirm block check characters, and internal self-diagnostics.

The fast 19.2 kilobaud rate lets you test the most modern networks. The bright 16-character front panel display is fully decoded in ASCII, EBCDIC, HEX, your own, or optional character set.

We have programmed new features along with common test routines and setups into a series of application ROM packs that easily slip into the 834 and extend its testing capabilities in specific areas.

### MODES OF OPERATION

#### Monitor

The 834 monitors and records activity occurring on the interface without interfering with data transmission. The major control line status is recorded with each character. Trigger capability allows selective capture of data (refer to Triggering).

#### Modem (DCE) Simulation

In this mode, the 834 functions as Data Communications Equipment (DCE) or modem simulator for testing the Data Terminal Equipment (DTE). Messages can be sent to the unit under test (UUT), and messages received from the UUT can be examined and cause further action by the 834. The sequence of events is controlled by a stored program (in the 834) which can be manually entered or stored in a user defined ROM (refer to Programmability).

#### Terminal (DTE) Simulation

In this mode, the 834 performs as Data Terminal Equipment (DTE) or terminal simulator for testing the Data Communications Equipment (DCE) side of the interface. Otherwise, operation is similar to the modem (DCE) simulator mode described above.

#### Bert Mode

In this mode the 834 performs bit and block error rate testing using the 511-bit CCITT standard pseudo-random pattern. Additional patterns and testing capabilities are available with appropriate ROM pack.

#### Self Test Mode

In this mode, internal diagnostics and exercising routines can be called up by the operator to verify that the 834 is functioning properly.

**CHARACTERISTICS**

**INTERFACE COMPATIBILITY**

Compatible with EIA RS-232 and CC1TT V-24 interfaces. Optional interfaces also available.

**DATA TRANSFER**

**Data Transmission Timing** — Synchronous and asynchronous.

**Communications Mode** — Half or full-duplex.

**Bits Per Character** — 5, 6, 7, 8, 9; characters with five bits do not include parity; characters with nine bits are available in asynchronous mode with parity.

**Codes** — ASCII, EBCDIC, HEX standard (others available with application ROM packs).

**DATA TRANSFER RATES**

**Internal (Crystal Controlled)** — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, and 19,200 bits/s; (synchronous full-duplex up to <math>\leq 9600</math> bits/s).

**External** — Limited to maximum of 19,200 bits/s; (synchronous full-duplex up to <math>\leq 9600</math> bits/s).

**Parity** — None, odd, even, all mark, all space.

**RTS/CTS Delay (Half-Duplex Mode Only)** — Programmable from 0 to 9999 ms. (Defaults to 200 ms if not programmed.)

**Accuracy** — +5, -15 ms.

**Block Check Characters** — CRC-16, CRC-CCITT, LRC; (expanded with ROM packs).

**Bit Error Rate/Block Error Rate Tests** — The 834 uses the 511-bit CCITT standard pseudo-random pattern sent in blocks of 1000 bits. Errors are counted continuously or over a test length of  $10^5$  or  $10^6$  bits stored in error, blocks sent, blocks in error, and sync faults. See 834R03 Link Test ROM Pack for additional capabilities.

**SET-UPS**

**ASYNCHRONOUS OPERATION**

**Stop Bits** — Transmits 1, 1.5 or 2; responds to 1.

**End of Frame** — One programmable character in any bit combination; (defaults to 0A); (ASCII New line).

**Timing** — Normal or isochronous.

**SYNCHRONOUS OPERATION**

**Synchronizing Character** — Programmable to require any 1 or 2\* characters (defaults to 32 32).

**End of Frame** — Programmable to recognize any of a number of idle conditions (Mark, Space, Syn) and/or a single character (defaults to 37, EBCDIC EOT).

**Clock** — Normal, derived, DTE.

\*If 2, they may be different.

**HDLC OPERATION**

**NRZI** — On or off.

**Clock** — Normal, derived, DTE.

**TRIGGERING**

**Trigger Location in Buffer** — Start, center, end.

**Match (Source of Data Being Searched for Trigger Events)** — NONE, DTE, DCE.

**Trigger Sequence** — Programmable to require a sequence of 0-25 characters (0-5 if no mask programmed).

**Mask Sequence** — Programmable to mask a 0-25 character trigger sequence.

**Error Conditions**

In Async — Parity or frame error.

In Sync — Parity error.

In HDLC — CRC error, abort sequence or short frame (<math>< 32</math> bits).

**Marker** — Low-to-high or high-to-low transition of marker can be selected.

**Buffer Capacity** — 2699 character (expanded with some ROM packs).

**PROGRAMMABILITY**

**Program Steps** — 99 available.

**Message Lengths** — 50 totaling 3000 bytes.

**Data Captured** — Always the last 2699 character received before the program stops or before STOP is pressed; (number of characters expanded with some ROM packs).

**Basic Instruction Set (Additional Instructions Available in ROM Packs)**

**HALT:** mm

Stop and display message mm.

**SEND:** mm

Send contents of message buffer mm as a frame.

**RECEIVE**

Obtain next complete data frame for processing.

**COMPARE:** mm

Search frame for a match with message buffer mm.

**JUMP EQ:** ss

Jump to step ss if a match is found.

**JUMP NE:** ss

Jump to step ss if a match is not found.

**JUMP:** ss

Jump to step ss.

**IF TIME:** ss

Jump to step ss if the timer expires.

**TIME OUT #** pp

Start timer with value in parameter pp.

**MASK:** mm

Use message mm for mask during COMPARE operation.

**WAIT #** pp

Start time with value in parameter pp and do not proceed to following step until timer expires (10 to 9999 ms).

**INTERFACE ACCESS PANEL**

**All Pins (2 through 25)** — Accessible.

**Major Control Lines** — May be connected or disconnected from the 834 via rocker switches. These include: TXD, RXD, RTS, CTS, DSR, GND, CD, TX0 (DCE), RX0 (DCE), DTR, TX0 (DTE).

**Interface Configuration** — Can be modified using jumper straps and the +12 (space) and -12 (mark) V sources provided on panel. Control lines CD, RTS, CTS, DSR, and DTR are program controllable with most ROM packs.

**Probe** — Via a dual LED display, allows checking the current condition of any of the lines.

**Marker** — Allows the status of any interface line to be stored with each received character. This storage is in conjunction with the major control lines automatically recorded (CD, RTS, CTS). The marker, CD, RTS, CTS, DSR, and DTR can also be tested under program control with most ROM packs.

**DISPLAY**

**Alphanumeric Display** — 16 fluorescent digits. (Each digit is a 5 x 7 dot matrix 9 mm high.)

**Status Indicator for Control Lines** — LED.

**PHYSICAL CHARACTERISTICS**

Dimensions $\approx$	mm	in
Width	305	12.1
Height	102	4.0
Depth	306	12.4
Weight $\approx$	kg	lb
Net	5.5	12.0

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 90 to 132 V ac; 180 to 250 V ac; 115 V nom.

**Line Frequency Range** — 48 to 440 Hz.

**ENVIRONMENTAL CHARACTERISTICS**

**Operating Temperature Range** — 0 to 50°C (32 to 122°F).

**Storage Temperature Range** — -40 to 75°C (-40 to 167°F).

**Humidity** — 95% relative humidity, 30 to 60°C.

**Operating Altitude** — Sea level to 4500 m (15,000 ft).

**Nonoperating Altitude** — Sea level to 15 000 m (50,000 ft).

**Shock** — 50 gs, 1/2 sine. 11 ms duration in each major axis.

**OPTIONAL INTERFACES**

**Current Loop Interface (Option 02)** — Operates in both two-wire (simplex or half-duplex) and four-wire (full duplex) modes. The current source for each of the two loops is selectable; either externally or internally supplied. Internal current sources are 20 mA and 60 mA.

**RS-449 Interface (Option 03)** — Supports both differential (RS-422) and single-ended (RS-423) circuits. This interface permits the use of a 9-pin connector for secondary channels along with the main 37-pin connector.

**MIL-STD-188C Interface (Option 04)** — Conforms to the military communication system technical standard MIL-STD-188C. Menu selectable, inverted or normal data allows the 834 to easily switch to an RS-232 compatible mode.

The MIL-STD-188C interface is factory installed only. The current loop and RS-449 interfaces are external PODS which can also be purchased as optional accessories and added at any time. When a POD interface is not connected, the standard RS-232 interface is functional.

**INCLUDED ACCESSORIES**

RS-232 3 Connector Cable Assembly, front panel jumper set (198-4006-00); US 115 V power cord (161-0066-00).

**ORDERING INFORMATION**

- 834 Programmable Data Communications Tester** ..... **\$3,990**
- Option 02** — Current Loop Interface ..... **+\$325**
- Option 03** — RS-449 (RS-422/RS-423) Interface ..... **+\$750**
- Option 04** — MIL-STD-188C ..... **+\$350**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro 220 V/16 A ..... **NC**
- Option A2** — UK 240 V/13 A ..... **NC**
- Option A3** — Australian 240 V/10 A ..... **NC**
- Option A4** — North American 240 V/15 A ..... **NC**

**ROM PACKS**

- 834R01** — General Purpose ROM Pack ..... **\$280**
- 834R02A** — Bisynchronous ROM Pack (EBCDIC) ..... **\$350**
- 834R03A** — Link Test ROM Pack ..... **\$370**
- 834R04** — HDLC/X25 ROM Pack ..... **\$450**
- 834R05** — Extended Instruction Set ROM Pack ..... **\$240**
- 834R06** — Bisynchronous ROM Pack (ASCII) ..... **\$350**
- 834R07** — PARS/IPARS ROM Pack ..... **\$375**
- 834R10** — SDLC/SNA ROM Pack ..... **\$450**
- 834R11** — Extended Monitor ROM Pack ..... **\$425**
- 834RDA** — ROM Development Aid ROM Pack ..... **\$1,200**

**OPTIONAL ACCESSORIES**

- Current Loop Pod Accessory** Order 015-0361-00 ..... **\$350**
- RS-449 Interface Order** A6741 ..... **\$750**
- User ROM Pack (empty)** Order 020-0607-00 ..... **\$110**
- Diagnostic ROM Pack** 067-0986-00 ..... **\$480**
- Carrying Case** 016-0672-00 ..... **\$80**



A variety of training accessories are also available including workbooks, video tapes, etc.

Additional information available in the 834 Selection Guide (request number 35W4922). Request copies at your local sales office or via the return card in this catalog.



## 834RDA

### The System For Developing Customer User ROMs For 834 ROM Packs

The Tektronix 834RDA is the tool that gives users the ability to automate and extend the capabilities of the 834 Programmable Data Communications Tester by developing custom application ROMs for use with 834 application ROM packs.

The 834RDA supports the generation of user-defined programs, set-ups and messages. It also aids the user in extending the Baud, Code, Idle and transfer function directory menus by adding new menu entries.

PROMs are developed by building a ROM image in the 834 system. The ROM image is the entire contents of the ROM you are creating, including all the messages, programs, power-up set-ups and transfer functions that you develop. The 834RDA uses the RS-232 or an optional port on the 834 to interface to an external PROM programmer, a printer or terminal, or a unit under test. The 834RDA and 834 are used with an external PROM programmer to read and write PROMs. A terminal or printer used with the system produces formatted listings of the ROM image contents. With the 834 connected to the unit under test, the ROM image can be executed to verify operation and correctness.

The 834RDA also contains the Extended Instruction Set available in most 834 ROM packs.

#### FUNCTIONS OF THE ROM DEVELOPMENT AID

##### Save Program/Setup Function

The Save Program/Setup Function provides an easy method of saving individual instrument set-ups or simulation programs for storage in ROM. These set-ups and simulation programs will be callable by the user, or may be called up by preprogrammed test routines.

##### Record Mode

In Record Mode all keystrokes are recorded in the order that they are entered until the exist command is executed. Afterwards, the keystroke sequences may be edited. Record Mode is particularly useful for preprogramming 834 operations or test routines. It can also be used to create individual instrument set-ups or simulation programs for storage in ROM. The user can also easily set up automated test sequences in Record Mode by the call-up of previously programmed instrument set-ups and simulation programs.

##### Form Entry Functions

Several types of entries can be created using the Form Entry Functions. These include menu additions (baud rates, translation code tables, directory entries, and sync idle characters); keystroke sequences (power up and normal); character strings (for addition to message buffers). These functions can also be used to edit or modify existing programs or routines.

##### New Key Codes

The 834RDA includes two additional Code menu items. The KEYS translation code produces a one-character representation of each key and is used when editing key sequences. The DISPLAY translation code makes all 834 display characters available to the user for building new code translation tables.

##### Input-Output Functions

The 834RDA system can accept input from any PROM burner that supports the TEK HEX format and has an RS-232 interface. Error detection checks are made to assure correct image transfer from the PROM programmer to the 834. The ROM image contains all of the completed entries plus the appropriate "overhead" data such as header, trailer, byte counts and checksum information. Upon completion of new entries or changes to the ROM image contents, the 834RDA ROM Development Aid can send a completed ROM image back to the PROM burner.

A listing of the entire ROM image or of individual entries can be sent to a printer or terminal for documenting purposes.

##### 834RDA Menu

Level 1:

Copy Entry, Replace Entry, Delete Entry, Write 2K, Write 4K, Read ROM, Clear ROM, Print ROM.

Level 2:

HDR:, Size =, (list of additional entries as created).

Level 3:

Form Keys, Form Messages, Form Directory, Form Baud, Form Idle, Form Code, Form Pupkeys.

##### Program Edit Functions

The program edit functions enable users to insert and delete program steps. The resulting program is automatically renumbered to reflect the changes and all JUMP and CALL instructions will be adjusted accordingly.

##### Program Debut Functions

The program debug functions enable users to interrupt an executing 834 program, cause single-step program execution, set a breakpoint and display or change program steps, parameters, and messages.

##### ADDITIONAL INFORMATION

The 834RDA should be used with an 834 having level 04 or greater software. This can be verified by placing the 834 in self-test mode; scrolling down two levels to the LIST-DSROM display, then over one entry to LIST-CSROM0. Press the start key; the display will read "CSRM0;PN=0836-04" or similar. This is the part number of the ROM containing the pertinent 834 software, and the last two digits should be 04 or greater.

A level 04 or greater ROM is supplied with each RDA in case it is needed. If it is not, the ROM can be erased and used for recording your custom routines.

If additional information or updates are required, contact your local Tektronix Sales or Service Center.

The 834RDA system is compatible with several PROM burners. Tektronix application note 35AX-4780 is available with additional detail on PROM programmer compatibility, selection criteria and operation information.

**Order 834RDA ROM Pack Development Aid ..... \$1,200**

## 834 ROM Packs

834 ROM packs are firmware extensions of the 834 Programmable Data Communications Tester. These products all contain the extended instruction set as listed on this page. They (except the 834R01) also include program debug and edit functions plus the unique capabilities listed for each individual ROM Pack.

Additional information is available in the 834 Selection Guide (request number 35W4922). Request copies at your local sales office or via the return card in this catalog.

In each ROM Pack, at least one ROM space is reserved for customer use. Each ROM space can accommodate a 2k or 4k ROM or EPROM. The custom ROM area of the ROM Pack can be programmed using 2716, 2732, 2516 or 2532 single power supply EPROMs or combination of the above.

As new ROM Packs have been introduced and existing ROM Packs enhanced, the firmware in the 834 has been expanded. The description for each ROM Pack includes the 834 firmware revision level required to make available all the capabilities of the ROM Pack. New 834's are shipped with the latest firmware and will support all the 834 ROM Packs in this catalog.

The software level of older 834s can be easily verified as follows:

Place 834 in Self-Test mode.

Scroll down two levels (press ↓ key twice) to the LIST DSROM display.

Press the → key once to obtain the LIST CSROM display.

Press START key.

The display will read CSROM=PN=0836-XX.

The last two digits indicate the software level of the 834 Data Communications Tester.

Contact your local Tektronix Sales or Service Center if additional information or updates are required.

## EXTENDED INSTRUCTION SET

- 11 LOAD # pp**  
Load register with value in parameter PP
  - 12 STORE # pp**  
Store register value in parameter PP
  - 13 COMPARE # pp**  
Compare register value to value in parameter PP
  - 14 INCRMNT # pp**  
Increment value in parameter PP by one
  - 15 DECRMNT # pp**  
Decrement value in parameter PP by one
  - 16 DISPLAY # pp**  
Display value in parameter PP
  - 17 LOAD: mm**  
Load register with character from message MM
  - 18 STORE: mm**  
Store register value in message MM
  - 19 DISPLAY: mm**  
Display message MM
  - 20 CLEAR: mm**  
Clear message MM
  - 21 TRANSFR # pp**  
Invoke key sequence described by value in parameter PP
  - 22 SETEIA = nn**  
Set EIA RS-232 control line specified by value NN
  - 23 TESTEIA = nn**  
Test EIA RS-232 control line specified by value NN
  - 24 TESTFRM = nn**  
Test for type of frame indicated by value NN
  - 25 TESTKEY = nn**  
Test for keyboard input indicated by value NN
  - 26 BREAK # pp**  
Send BREAK for length of time specified in parameter PP
  - \*27 BCC: mm**  
Calculate and insert BCC for message MM
  - \*28 PROTOCOL**  
Enables customized BCC calculation for particular protocols and translation codes
  - \*29 BLOCK: mm**  
Compare frame to message buffer MM and count bit errors
  - \*30 CLEAR # pp**  
Set contents of parameter PP to zero
  - \*31 CALL→ss**  
Program execution continues at step SS after placing the number (SS+1) in the register.
  - \*32 RETURN # pp**  
Program execution continues at step number contained in parameter PP
  - \*33 OVERLAY # pp**  
Invoke transfer function xx, where xx is the contents of parameter PP
- In addition to the Extended Instruction Set, the following instructions are resident in selected ROM packs.**
- 34 PACKFRM : mm**  
Pack control field data into message mm, or, if mm = 0, unpack control field data from received HDLC/SDLC frame.
  - 35 HEXCONV : mm**  
Convert an item in the register to the hexadecimal value of the item; add the hexadecimal character string to message mm.
  - 36 AND # pp**  
AND the contents of the register with the value in parameter pp, then place the ANDed value in the register.
  - 37 OR # pp**  
OR the contents of the register with the value in parameter pp; then place the ORed value in the register.

\* Not in 834R01



## 834R01 General Purpose ROM Pack

The 834R01 ROM Pack\* simplifies and expands operation of the 834 Data Communications Tester for use with asynchronous systems.

The following capabilities are programmed into the 834R01 ROM Pack:

Sets up conditions for asynchronous operation upon instrument power up.

The addition of correspondence and baudot character decode tables.

Additional idle menu selections.

Split baud rate capability allows either the transmit or receive baud rate to be changed.

Basic printer tasks verify:

That characters are positioned and printed properly. Also evaluates DTR response and X-on, X-off feature.

Simulate and repeat modes (with and without trigger).

Correspondence code set-up (sets the 834 to the most common correspondence setup).

Baudot code set-up (sets up the 834 for the most common Baudot code set-up).

Block asynchronous setup (sets up the 834 to operate in the block-asynchronous mode).

Graphic test patterns for calibrating screen attributes in Tektronix 4010 Series terminals.

Extended instruction set through the BREAK instruction (#26).

\*Level 3 or higher 834 software required.



**NEW**  
**834R02A**  
Bisynchronous (EBCDIC) ROM Pack



**NEW**  
**834R06**  
Bisynchronous (ASCII) ROM Pack

The 834R02A and 834R06 ROM Packs\* extend and simplify the use of the 834 in exercising components of the IBM 3270 Information Display System family and compatible terminals manufactured by other companies.

The following capabilities are provided in an EBCDIC version in the 834R02A\* and ASCII in the 834R06:

Frame Summaries to provide frame level mnemonic summary on a frame-by-frame basis. (This enables the user to quickly and easily step through data a frame at a time while viewing straight forward descriptions rather than sorting through long streams of data.)

- Automated BCC checking and insertion
- Preprogrammed common bisync messages
- Terminal setup and status tests
- Attribute Exercise Pattern for testing screen attributes and orders of a video display terminal.
- Multiple alignment patterns for video displays
- New line/End-of-message patterns for testing printers
- Control Key Response test
- Various utility programs
- Extended instruction set, plus Hex conversion
- The AND instruction, and the OR instruction

\*Level 5 or higher 834 software required.



**NEW**  
**834R03A** Link Test ROM Pack

The 834R03A ROM Pack\* extends the Data Communications Link testing capability of the 834.

The following Bit Error Rate Test (BERT) patterns are provided in the 834R03A ROM Pack:

- User defined (may be 4 to 3000 bytes in length)
- 2047-bit pseudo-random pattern
- 63-bit pseudo-random pattern
- 511-bit pseudo-random (CCITT V.25) pattern sent in block sizes of 511 bits instead of 1000
- Continuous space
- Continuous mark
- Alternating spaces and marks
- 3 spaces alternating with 1 mark
- 1 space alternating with 3 marks
- 7 spaces alternating with 1 mark
- 1 space alternating with 7 marks

**Additional test lengths:**

- 10 kilobits
- 10 megabits
- Timed termination

- Independent transmit and receive baud rates
- Over and under baud rate deviation tests ( $\pm 1, 2.5\%$ )
- Turn around delay measurement
- Control line tests
- Full and Half duplex ping-pong tests
- Half duplex BERT
- Bias distortion test
- Gross start-stop distortion test
- Individual start-stop distortion test
- Isochronous distortion test
- Extended Instruction set

\*Level 4 or higher 834 software required.



**834R04** HDLC/X.25 ROM Pack

The 834R04 ROM Pack\* expands the operational scope of the 834 when monitoring and simulating HDLC and X.25 packet switching networks and their components.

The following capabilities are included in the 834R04 ROM Pack:

- Frame-by-frame analysis of data exchanges
- Packet-by-packet analysis of data exchanges
- Construction of HDLC-formatted frames under applications control
- LAP and LAPB setup-shutdown tests
- Extended instruction set
- Packfram instruction
- Option 01 (Factory installed only) makes the 834R04 compatible with HDLC networks using Bisync Framing.

\*Level 5 or higher 834 software required.



**834R05**  
Extended Instruction Set ROM Pack

The 834R05 ROM Pack\* is for users with unique application requirements that cannot be fulfilled by the standard application programming included in other ROM Packs. The 834R05 contains the extended instruction set and program debug and edit functions. The remainder of the ROM Pack is reserved for user application ROMs.

The 834R05 reserves room for three user ROMs.  
\*Level 4 or higher 834 software required.



## 834R07 PARS/IPARS ROM Pack

The 834R07 ROM Pack\* expands the operation of the 834 Data Communications Tester for testing Programmed Airline Reservation Systems.

The following capabilities are included in the ROM Pack:

- SABRE translation
- Reversed Hexidecimal translation
- Inverted data capabilities
- Direct Poll — continually sends a Go-Ahead message and looks for replies after each poll.
- 768 E-Pattern (64 X 12) for terminal alignment
- 960 E-Pattern (64 X 15) for terminal alignment
- 65 Character Print (64 X 12) "Stairstep" pattern
- Reset Terminal — sends terminal reset command (3E HEX) to interchange unit to effect erasure of all terminal screens.
- Terminal Echo — polls an interchange and when text message is received, echoes that message back to the originating terminal.
- Printer Test — tests new line function
- Terminal Simulation — responds to direct polls, write, erase/write commands, and unsolicited message commands.
- ASCU Set-ups — for communicating to Agent Set Control Unit Equipment
- Extended Instruction Set

\*Level 4 or higher 834 software required.



## NEW 834R10 SDLC/SNA ROM Pack

The 834R10 ROM Pack\* enhances the capabilities of the 834 when operating in an SDLC/SNA environment by providing easy to read SDLC frame and SNA command summaries. This allows quick and straightforward analysis of data transactions.

The following capabilities are included in the 834R10 ROM Pack:

- Attribute tests for 3274 and 3276 displays
- Display alignment pattern
- New-Line/End-of-Message pattern for testing printers attached to 3274s and 3276s.
- Control Key Response Test
- Extended Instruction Set, plus
- HEX conversion
- AND instruction
- OR instruction

\*Level 5 or higher 834 software required.



## NEW 834R11 Extended Monitor ROM Pack

The 834R11 ROM Pack\* implements more powerful monitoring functions. It allows the recognition of events to cause programmable actions rather than simply triggering the 834. Using event-action pairs provides the mechanism for manipulating counters and timers that facilitate statistical analysis of interactions or events within a network as well as complex triggering.

There are three event-action pairs available with this ROM Pack plus a timeout-action pair that activates when an event does not occur within a specified time.

The 834R11 does not require the extended instruction set.

834R11 ROM Pack event selections:

- DCE Messages with or without masking
- DTE Messages with or without masking
- Error
- Selected Control line change

834R11 ROM Pack action selections:

- Trigger the 834
- Decrement or increment specified counter
- Start interval timer
- Enable event-action pairs
- Disable all actions except Enable

\*Level 5 or higher 834 software required.

### ORDERING INFORMATION

<b>834R01</b> General Purpose ROM Pack ....	<b>\$280</b>
<b>834R02A</b> Bisynchronous ROM Pack (EBCDIC) .....	<b>\$350</b>
<b>834R03A</b> Link Test ROM Pack .....	<b>\$370</b>
<b>834R04</b> HDLC/X.25 ROM Pack .....	<b>\$450</b>
Option 01 — Bisynchronous Framing (834R04 only) .....	<b>+\$50</b>
<b>834R05</b> Extended Instruction Set ROM Pack .....	<b>\$240</b>
<b>834R06</b> Bisynchronous ROM Pack (ASCII) .....	<b>\$350</b>
<b>834R07</b> PARS/IPARS ROM Pack .....	<b>\$375</b>
<b>834R10</b> SDLC/SNA ROM Pack .....	<b>\$450</b>
<b>834R11</b> Extended Monitor ROM Pack ..	<b>\$425</b>

Additional information available in the 834 Selection Guide (request number 35W4922). Request copies at your local sales office or via the return card in this catalog.

ROM PACKS



**833**

**Bit Error Rate Testing**

**CRC Character Calculation**

**String Search**

**Easy to Operate**

**Portable and Lightweight**

The Tektronix 833 Data Communications Tester is a high-performance, first-line service tool that provides the service technician with the means to locate problems in a data communications network. The 833 is lightweight (under 5.5 kg/12 pounds), compact, and portable. Keypad entry and an easy-to-understand front panel simplify learning to use the 833. A string search function permits automatic examination of stored data.

The 833 Data Communications Tester operates on RS-232, CCITT V.24, or current loop (option) interfaces. The 833 can MONITOR the DCE and DTE in synchronous, asynchronous, and HDLC modes. HDLC data streams can be either standard or NRZI-encoded. The 833 can SIMULATE the DCE in synchronous and asynchronous modes and can also calculate and verify CRC-16, CCITT-CRC and LRC-8 block check characters.

The 833 features bit error rate testing capabilities to check modems and phone lines.

Echo and Repeat modes are also part of the 833's capabilities.

Built in, self diagnostic routines can assure you at any time that the 833, like the 834 and 832, is operating properly.

**833/832 PROM OPTIONS**

The 833/832 user PROM feature gives the first line service force a pre-programmed series of tests. This PROM is user-defined for specific applications so the 833/832 can be customized to fit particular service needs. Use this PROM to perform frequently used standard test sequences, and then, if necessary, create test sequences directly in the 833/832 to make more specific tests and further isolate faults.

Support materials (manuals, user's guides) and video tape training aids are available for all Data Communications Testers.

For more information about how Data Communications Testers can help you identify problems in data communications systems, contact your Tektronix Sales Engineer.

In the U.S., write Tektronix, Inc., U.S. Marketing, P.O. Box 1700, Beaverton, OR 97075. In Africa, Europe, Middle East, write Tektronix Europe B.V. European Headquarters, Postbox 827, 1180 AV Amstelveen, The Netherlands. In Asia, Australia, Japan, Central and South America write Tektronix, Inc., Export Marketing, P.O. Box 500, Beaverton, OR 97077. (For a complete listing including telex numbers, see pages 10 through 12.)

**832**

**Low Cost**

**Easy to Operate Keypad**

**Portable and Lightweight**

The Tektronix 832 Data Communications Tester is a portable digital service instrument that can be used to direct the user to possible problems in data communications systems. It can monitor, analyze, test and trouble-shoot data communications interfaces that conform to EIA standard RS-232C, CCITT V.24 or current loop (option). The 832 operates as a serial-data-transmission monitor or as a modem simulator for off-line testing of data terminal equipment (DTE).

In Monitor mode the 832 reads and selectively records DTE data and Data Communications Equipment (DCE) data, as well as recording the status of key interface lines.

In Simulate mode the 832 simulates the operation of a modem. The 832 can send a message to the DTE and record its response. This data can be sent directly from the 832 or can be transmitted upon receipt of an expected trigger from the DTE.

Echo mode is the same as Simulate, except the 832 sends back to the DTE (echoes) any character sent by the DTE.

In Repeat mode the 832 can send data repeatedly to the DTE, or the 832 can be programmed to repeat the transmission only upon receipt of an expected trigger from the DTE.

**833/832 CHARACTERISTICS**

**ELECTRICAL**

**Data Transmission Timing** — Synchronous and asynchronous.

**Communications Mode** — Half- or full-duplex.

**Bits Per Character** — 5, 6, 7, 8, 9. 5 bits/character cannot be selected with parity; 9 bit/character, cannot be selected without parity and is available with 833 only.

**Data Transfer Rates** — Internal (crystal controlled) — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, and 4800 bits/second. 9600 bits/second at 8 bits/character, half duplex only. Accuracy: within 0.5%. External: Determined by the DCE or DTE clock.

**Parity** — Odd, even, or none.

**RTS/CTS Delay, (half-duplex mode only)** — Programmable from 0 to 255 ms. If not programmed, defaults to 200 ms. Accuracy: Within 1% ± 1 ms.

**Trigger** — Programmable to require a sequence of 1, 2, or 3 characters.

**Trigger Position** (Location of last trigger character in receive buffer) — Posttrigger: 000; Center: 127; Pretrigger: 255.

**833 ONLY**

**Block Check Characters** — CRC-16, CRC-CCITT, LRC.

**Synchronizing Character (SYN), (synchronous mode only)** Programmable to require one or two characters. If not programmed, defaults to ASCII SYN character.

**Stop Bits (asynchronous mode only)** — Programmable to 1, 1½, 2.

**Bit Error Rate/Block Error Rate Tests** — Standard 511-bit pattern stream for 1000-bit blocks; continuous, 10<sup>5</sup> or 10<sup>6</sup>-bit block test; stores bits in error, blocks sent, blocks in error, and sync faults.

**String Search** — Programmable to search for one sequence of 1, 2, or 3 characters.

**Full duplex DTE simulation.**

**832 ONLY**

**Synchronizing Character (SYN), (synchronous mode only)** Programmable to require one character, or two equal characters. If not programmed, defaults to ASCII SYN character.

**Stop Bits (asynchronous mode only)** — Responds to one or more. Transmits two.

**RS-232 DCE CONNECTOR (J1405)**

**INPUTS**

**Pin 3 Received Data, Pin 5 Clear to Send, Pin 6 Data Set Ready, Pin 8 Carrier Detect, Pin 15 Transmission Signal Element Timing (DCE source), Pin 17 Receiver Element Timing (DCE source) —**

MARK or OFF: -25 V ≤ V in ≤ +0.75 V.  
SPACE or ON: +1.5 V ≤ V in ≤ +25 V.  
Input Impedance: 3 kΩ ≤ Z in ≤ 7 kΩ.

**Pin 20 Data Terminal Ready, Pin 24 Transmit Signal Element Timing (DTE source) —** MARK or OFF: -25 V ≤ V in ≤ -3 V. SPACE or ON: +3 V ≤ V in ≤ +25 V. Input Impedance with corresponding pin in DTE connector disconnected: Pin 20 Z in ≥ 40 kΩ. Pin 24 Z in ≥ 100 kΩ.

**OUTPUTS**

**Pin 2 Transmitted Data, Pin 4 Request to Send —**

MARK or OFF: V out ≤ -7.5 V.  
SPACE or ON: V out ≥ +7.5 V.  
With Load Impedance: R<sub>L</sub> ≥ 3 kΩ.

**OTHER**

**Pin 1 Ground** — Connected to pin 1 of DTE connector.

**Pin 7 Signal Ground** — Connected to instrument ground.

**Pins 9 thru 14, 16, 18, 19, 21 thru 23, and 25** — Connected through switches (Breakout Panel DIP switches) to their corresponding pins in the DTE connector.

**RS-232 DTE CONNECTOR (J2205)**

**INPUTS**

**Pin 2 Transmitted Data, Pin 4 Request to Send —**

MARK or OFF: -25 V ≤ V in ≤ +0.75 V.  
SPACE or ON: +1.5 V ≤ V in ≤ +25 V.  
Input Impedance: 3 kΩ ≤ Z in ≤ 7 kΩ.

**Pin 20 Data Terminal Ready, Pin 24 Transmit Signal Element Timing (DTE source) —** MARK or OFF: -25 V ≤ V in ≤ -3 V. SPACE or ON: +3 V ≤ V in ≤ +25 V. Input Impedance with Corresponding Pin in DCE Connector Disconnected: Z in ≥ 100 kΩ.

**OUTPUTS**

**Pin 3 Received Data, Pin 5 Clear to Send, Pin 6 Data Set Ready, Pin 8 Carrier Detect, Pin 15 Transmission Signal Element Timing (DCE source), Pin 17 Receiver Signal Element Timing (DCE source) —**

MARK or OFF: V out ≤ -7.5 V.  
SPACE or ON: V out ≥ +7.5 V.  
With Load Impedance: R<sub>L</sub> ≥ 3 kΩ.

**OTHER**

**Pin 1 Ground** — Connected to pin 1 of DCE connector.

**Pin 7 Signal Ground** — Connected through a switch (Breakout Panel DIP switch) to instrument ground.

**Pin 9 thru 14, 16, 18, 19, 21 thru 23, and 25** — Connected through switches (Breakout Panel DIP switches) to their corresponding pins in the DCE connector.

**BREAKOUT PANEL**

**Probe —**

Space: +3 V ≤ V in ≤ +25 V.  
Mark: -25 V ≤ V in ≤ -3 V.  
Input Impedance: ≥ 50 kΩ.

**Marker —** MARK or OFF: -25 V ≤ V in ≤ -3 V.  
SPACE or ON: +3 V ≤ V in ≤ +25 V (Schmitt input).

**+12 Volt Source —** +12 V ± 1 V (no load). Output Impedance ≈ 3 kΩ (each pin).

**DISPLAY**

**Buffer Content** — 2 hexadecimal digits: 7-segment, LED displays.

**Buffer Location** — 3 decimal digits: 7-segment, LED displays.

**Data Source** — DCE, DTE: 2 LED indicators.

**Error** — Parity, Frame: 2 LED indicators.

**No Trigger, No Syn** — 2 LED indicators.

**RS-232 Control Lines** — DSR, CD, CTS, RTS, DTR, and MARKER: 6 LED indicators.

**Probe** — Mark, Space: 2 LED indicators.

**MEMORY**

Receive buffer is 256 characters and send buffer is 255 characters. Basic instrument contains in memory a group of 7 separate standard test messages such as "THE QUICK BROWN FOX" — and the full ACII Alphanumeric set.

There is provision in the 833/832 for installation of user defined programmed EPROM containing messages specific to particular tests. A total memory space of 2048 characters is available for user specification.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 115 V — 90 to 132 V, 230 V — 180 to 250 V.

**Line Frequency Range** — 48 to 440 Hz.

**Power Consumption** — ≈ 15 watts.

**ENVIRONMENTAL**

**Temperature** — Operating: +0° to +50°C (+32° to +122°F). Nonoperating: -55° to +75°C (-67° to +167°F).

**Humidity** — 5 cycles (120 hours), +30° to +60°C, 95% relative humidity.

**Altitude** — Operating: To 4500 m (15,000 ft). Nonoperating: To 15 000 m (50,000 ft).

**Vibration** — Cycle the vibration frequency from 10 to 55 to 10 Hz (linear or logarithmic sweep) for a duration of 15 minutes in each major axis at a displacement of 0.64 mm (0.025 in) p-p. Dwell for 10 minutes in each major axis at any resonant frequency.

**Shock** — 50 g's, ½ sine, 11 ms duration, three shocks in each major axis for a total of 18 shocks.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	330	13.0
Height	102	4.0
Depth	305	12.0
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net	5.0	11.0

**INCLUDED ACCESSORIES**

**Both 833/832**

RS-232 Cable Assembly (012-0815-00), jumper set (198-4006-00), power cord (161-0066-00), Y-Connector (012-0893-00) 833 only.

**ORDERING INFORMATION**

**833 Data Communications Tester ..... \$2,750**  
 Option 0A — DATASPEED 40 ROM ..... +\$210  
 Option 0B — IBM 3270 Exercizer ROM ..... +\$210  
 Option 02 — Current Loop Interface ..... +\$300

**832 Data Communications Tester ..... \$1,995**  
 Option 0A — DATASPEED 40 ROM ..... +\$210  
 Option 0B — IBM 3270 Exercizer ROM ..... +\$210

**OPTIONAL ACCESSORIES**

**Current Loop Pod Accessory**  
 Order 015-0361-00 (833 only) ..... \$350  
**Carrying Case** Order 016-0672-00 ..... \$80



DATA COMMUNICATIONS ANALYZERS

**830 SERIES PRODUCT LINE COMPARISON**

	<b>832</b>	<b>833</b>	<b>834</b>
<b>Operation Modes</b> Monitor DCE Simulate DTE Simulate Bit Error Rate Testing Bias Distortion Test Inverted Data Capabilities Self Test	Yes Yes No No No No Functional	Yes Yes Yes (FDX only) 511 Pattern No No Functional	Yes Yes Yes Multiple Patterns* Yes* Yes* Functional & Diagnostic
<b>Maximum Data Transfer Rate</b> <b>Separate Transmit/Receive Rates</b>	9.6k baud No	9.6k baud No	19.2k baud Yes*
<b>Memory</b> Receive buffer (characters) Send buffer (characters) User PROM (characters) Receive buffer search	256 255 2048 (data only) No	256 255 2048 (data only) Yes	2699* 3000 Up to 16k (data or program sequence) Yes
<b>Display</b> Number of characters & type	3 address + 2 data 7 segment LED	3 address + 2 data 7 segment LED	12 data & 4 scratch pad 5x7 matrix flourescent
<b>Operating Controls</b> Operator menu Programmed sequences Initialization  Programmable timeout	No No Fixed default or manual No	No No Fixed default or manual No	Yes Yes (manual or from ROM pack) Fixed default, program initialization, manual Yes
<b>Triggering/Trapping</b> Strings  Errors Events	3 characters  No No	3 characters  No No	1-5 characters (nonmasked) 1-25 characters (masked) Yes Yes
<b>Error Check</b> Parity check Frame check Block check function Generate Check Type  Auto CRC Insertions	Yes Yes  No No None  No	Yes Yes  Yes Yes LRC, CRC, CRC 16, CRC-CCITT No	Yes Yes  Yes Yes LRC, CRC-16, CRC-CCITT,CCC-6* Yes*
<b>Programmable:</b> Stored programs Stored messages Recallable keystroke sequences Counters	No No 255 characters No No	No No 255 characters No No	Yes 99 steps(extendable through overlays*) 3000 characters Yes Yes*
<b>Optional Interfaces</b> Current Loop RS-449 (RS-422, RS-423) MIL STD 188C	Yes No No	Yes No No	Yes Yes Yes
<b>Codes</b> Standard Optional*	Hex None	Hex None	EBCDIC, ASCII, HEX Correspondence, Baudot, Sabre, Reverse Hex, User Defined
<b>Data Communications Environments</b> Asynchronous Bisynchronous  HDLC/SDLC X.25/SNA PARS/IPARS	Monitor/Simulate Monitor/ Limited Simulate Monitor No No	Monitor/Simulate Monitor/ Limited Simulate Monitor No No	Monitor/Simulate Monitor/Simulate  Monitor/Simulate* Monitor/Siimulate* Monitor/Simulate*
<b>Net Weight</b>	11 lb 5.0 kg	11.5 lb 5.2 kg	12 lb 5.5 kg

\*Provided or enhanced with appropriate ROM pack.

851

Designed for Digital Field Service Applications

Small and Lightweight

The 851 Digital Tester is an easy-to-operate first-line service tool used to troubleshoot and maintain a wide range of digital equipment.

With this portable digital tester (only, 6 kg, 13 lb), a first-line service engineer can make many of the same measurements that now require an oscilloscope, DMM, counter, timer, logic probe, thermometer and special purpose test equipment.

One knob lets you dial 22 functions to perform a wide variety of tests and measurements. Eleven functions measure timing, two register plus and minus peak voltages, three carry out DMM measurements through separate leads and one reads line voltage at the outlet. Another function allows you to take temperature readings with an optional temperature probe. The 851 also measures its four input thresholds to adjust to the logic levels of the equipment being serviced.

All functions are completely autoranging and the indicator lights tell you exactly what range is being used.

CHARACTERISTICS

INPUTS

- (ACV, DCV, Ω)
- Resistance and Capacitance** — 10 MΩ ± 1% and ≈ 100 pF. Red to black terminal. (Volts only.)
- Maximum Safe Input Voltage** — ± 500 V (peak) ACV/DCV (≤ 1 kHz)
- Resistance Ranges** — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ, and 50 MΩ.

AC VOLTS

- (Average responding RMS calibrated for sinewave.)
- Ranges** — 2 V, 20 V, 200 V, and 350 V.
- Accuracy** — 2 V and 20 V: ± 0.5% or reading ± 4 counts, 40 Hz to 1 kHz. ± 2% of reading ± 4 counts, 1 kHz to 25 kHz. > 9% full scale. 200 V and 350 V: ± 0.5% of reading ± 4 counts, 40 Hz to 1 kHz. Extended temperature range: add ± 0.2%.

DC VOLTS

- Ranges** — 2 V, 20 V, 200 V, and 500 V.
- Accuracy** — 2 V, 20 V and 200 V: ± 0.1% of reading ± 3 counts. 500 V: ± 0.15% of reading ± 3 counts. Extended temperature range: add ± 0.05%.

LINE VOLTAGE

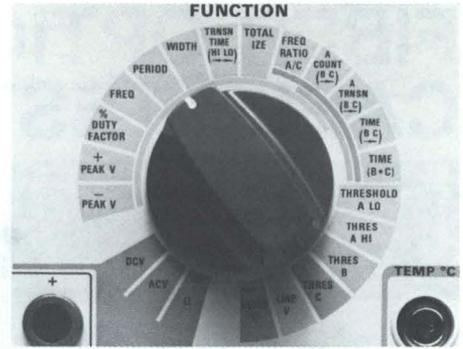
- Range** — 90 to 132 V and 180 to 250 V.
- Accuracy** — ± 3% of reading.

TEMPERATURE

- Range** — -55° to +150°C.
- Accuracy** — ± 2°C (0.01° resolution). Extended temperature range: add ± 1°C.

INPUTS

- 3 probes; one for each channel A, B, C.)
- Resistance and Capacitance** — 10 MΩ and ≈ 12 pF.
- Maximum Safe Input Voltage** — ± 500 V at probe tip (≤ 50 kHz).



**Threshold Levels** — Variable (4 controls) range: ± 30 V; setability ± 10 mV.

**TTL (nominal, in detent position)** — Input A LO + 0.7 V; HI + 2.1 V; Input B and C + 1.4 V.

**Input Filter (Narrow pulse rejection)** — Maximum input rep rate for pulse rejection = 20 MHz.

**Range** — Off and 50 ns ± 20% to > 300 ns. Channel to channel delay mismatch: < 100% of setting.

POSITIVE AND NEGATIVE PEAK VOLTS

- Range** — ± 30 V.
- Accuracy** — ± 2% of reading ± 3% of p-p signal ± 90 mV. Maximum time between recurrent peaks, 25 ms. Peak amplitude must be maintained for at least 25 ns. Extended temperature range: add ± 1% of reading ± 1% of p-p signal ± 10 mV.

FREQUENCY

- Ranges** — 100 kHz (1 Hz resolution), 1 MHz, 10 MHz, and 35 MHz.
- Accuracy** — ± 0.005% of reading ± 1 count.

TIME MEASUREMENTS

- (Period, pulse width, transition time, time interval, and coincidence time.)
- Ranges** — 1 ms (10 ns resolution), 10 ms, 100 ms, 1 s, and 10 s.
- Minimum Time Interval** — 20 ns.
- Accuracy** — ± 0.005% of reading ± 1 count ± Trigger Error.

COUNTING

- (Totalize, frequency ratio, events count, and transitions count.)
- Range** — 0 to 99,999.
- Maximum Input Frequency** — 35 MHz (except 17.5 MHz for transition counting).
- Accuracy** — ± 1 count, ± A Input event or transition frequency multiplied by the Time Interval Trigger Error.

DUTY FACTOR

- Range** — 0 to 100%.
- Input Frequency Range** — 40 Hz to 10 MHz.
- Minimum Pulse Width** (HI and LO portions) — 50 ns.

READOUT

- Type** — Five digits, fully buffered seven segment, 0.5 in LEDs.
- Polarity Indication** — + for positive readings, - for negative readings.
- Overrange Indication** — Display flashes.

**Range Indicators** — LEDs show function ranges in Ω, kΩ, MΩ, MHz, kHz, ms, μs and V.

**Logic State Indicators** — Red, yellow, and green LEDs show valid and invalid logic state inputs for CH A. Red and green LEDs show logic states above or below the threshold set for CH B and C. Any state change indication is sustained long enough to be visible.

**Threshold Lock Indicator (LO > HI)** — Red LED indicates when CH A LO and HI thresholds are locked together (LO threshold setting is higher than the HI setting).

POWER REQUIREMENTS

- Line Voltage Range** — 90 to 132 V or 180 to 250 V.
- Frequency** — 48 Hz to 440 Hz.
- Power Consumption** — 57 w maximum.

ENVIRONMENTAL CHARACTERISTICS

- Ambient Temperature** — Operating: +15°C to +40°C. Non-operating: -40°C to +75°C. Extended operating range: +5°C to +50°C.
- Altitude** — Operating: to 3048 m (10,000 ft). Nonoperating: to 10 665 m (35,000 ft).
- Vibration** — Operating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. After cycle vibration in each axis, hold frequency steady at 55 Hz for 10 minutes. All major resonances must be above 55 Hz.
- Humidity** — To 90% at 30°C Tektronix Test Method #1 90% relative humidity at 30°C for 4 hours.
- Shock** — Two shocks at 30 g's, 1/2 sine, 11 ms duration, each direction along each major axis. Total of 12 shocks.
- EMC** — Reference Mil Standard 461A-462 susceptibility as specified. Conducted emission, relax 10 dB. Radiated emission, relax 15 < 100 MHz and relax 25 dB ≥ 100 MHz.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	330	13.0
Height	310	13.0
Depth	180	7.0
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net	6.0	13.0

INCLUDED ACCESSORIES

Three signal probes (010-0280-00), two DMM probes (012-0732-00).

ORDERING INFORMATION

- 851 Digital Tester** ..... \$3,220
- Option 01** — (with temperature probe) ..... +\$160

OPTIONAL ACCESSORIES

- Temperature Probe** Order 010-6430-00 ..... \$201
- Rain Jacket** Order 016-0639-00 ..... \$15

DIGITAL TESTER

# FIBER OPTIC TDR CABLE TESTER



## OF150 Fiber Optic TDR

LCD Readout Resolution to 0.1 dB/1.0 Meter

Accurate, Repeatable Measurements

Built-in Chart Recorder

Digital Storage Provides Easy to View Waveform and Noise Reduction

Two Selectable Pulse Widths

Portable - Operates from 12 Volt Vehicle System or Battery Pack

FIBER OPTIC TESTER/TDR

### Unmatched Range

The OF150 is a high performance, easy to use, portable instrument that can perform repeatable, accurate distance and loss measurements on multi-mode optical fibers.

Typical applications include: splice measurement through a one-way cable loss of up to 21.5 dB to within  $\pm 0.1$  dB; detection of fiber ends, (four percent Fresnel reflection) through a one-way cable loss of up to 42.5 dB; and measuring distance to discontinuities (such as splices, Fiber faults and ends) to 19.9 km, with one meter resolution.

### Direct Readout Saves Time and Errors

The OF150 gives you direct LCD readout of results, eliminating voltage-to-power and time-to-distance computations and risk of operator errors. Direct readout assures accurate, repeatable measurements every time. A built-in chart recorder provides a permanent record of the waveform for reference and comparison.

### Get an Accurate Picture of Splice Loss

Digital storage produces a consistently sharp, easy-to-view trace. Signal averaging and selectable filters help maintain waveform resolution, so that measurements are made as accurately at long distances as closer in.

Two filters provide signal averaging and incremental decreases in the RMS noise floor. Compared to Fast filter operation (fast sweep), the Medium filter (medium sweep) provides a 7.5 dB reduction and the Slow filter (slow sweep) a 15 dB reduction. By using the Fast-Medium-Slow selection, you can pick the optimum signal acquisition speed/noise reduction combination.

The OF150 also offers two selectable pulse widths. The short pulse increases resolution for close-in measurements, while the long pulse extends distance/loss measurement range.

### Easy to Use

The OF150 combines high performance with ease of use. With Tektronix supplied manuals, craftspeople or technicians can learn to use this instrument in two hours or less.

### Portability and Convenience

Its compact size, light weight and rugged design, plus the ability to operate easily from a 12 volt vehicle system or external battery pack, enables the OF150 to offer exceptional portability in a high performance instrument.

## OF150 CHARACTERISTICS

### OPTICAL TEST SIGNAL

**Wavelength** — 820 nm (nominal).

**Displayed Pulse Width** — Long Pulse: 5.5 m,  $\pm 1$  m. Short Pulse: 1.5 m,  $\pm 0.3$  m.

**Displayed Noise on the Incident Pulse** —  $< \pm 1.0$  dB peak (FAST filter).

**System Pulse Rate** — 4.762 kHz,  $\pm 5$  Hz.

**Optical Output Amplitude** —  $\geq 25$   $\mu$ W Time-average power coupled into test fiber (50  $\mu$ m core, 0.20 NA) (Long Pulse mode).

**Optical Pulse Amplitude Stability** —  $< 0.4$  dB drift over the duration of a SLOW sweep.

**Absolute Maximum Optical Output Amplitude** — 200  $\mu$ W time averaged power.

**Displayed Pulse Risettime** —  $< 0.7$  m from  $-20$  dB point to  $-6$  dB point.

**Displayed Pulse Falltime** —  $\leq 5$  m from trailing pulse corner to the  $+60$  dB point relative to bottom of display range.

$\leq 500$  m from trailing pulse corner to the  $+30$  dB point relative to bottom of display range.

$\leq 2$  km from trailing pulse corner to the  $+15$  dB point relative to bottom of display range.

### MEASUREMENT RANGE

**Displayed RMS Noise Floor** —  $+1.8$  div,  $\pm 0.4$  div from bottom of display range with Fast filter and 10 dB/div scale.

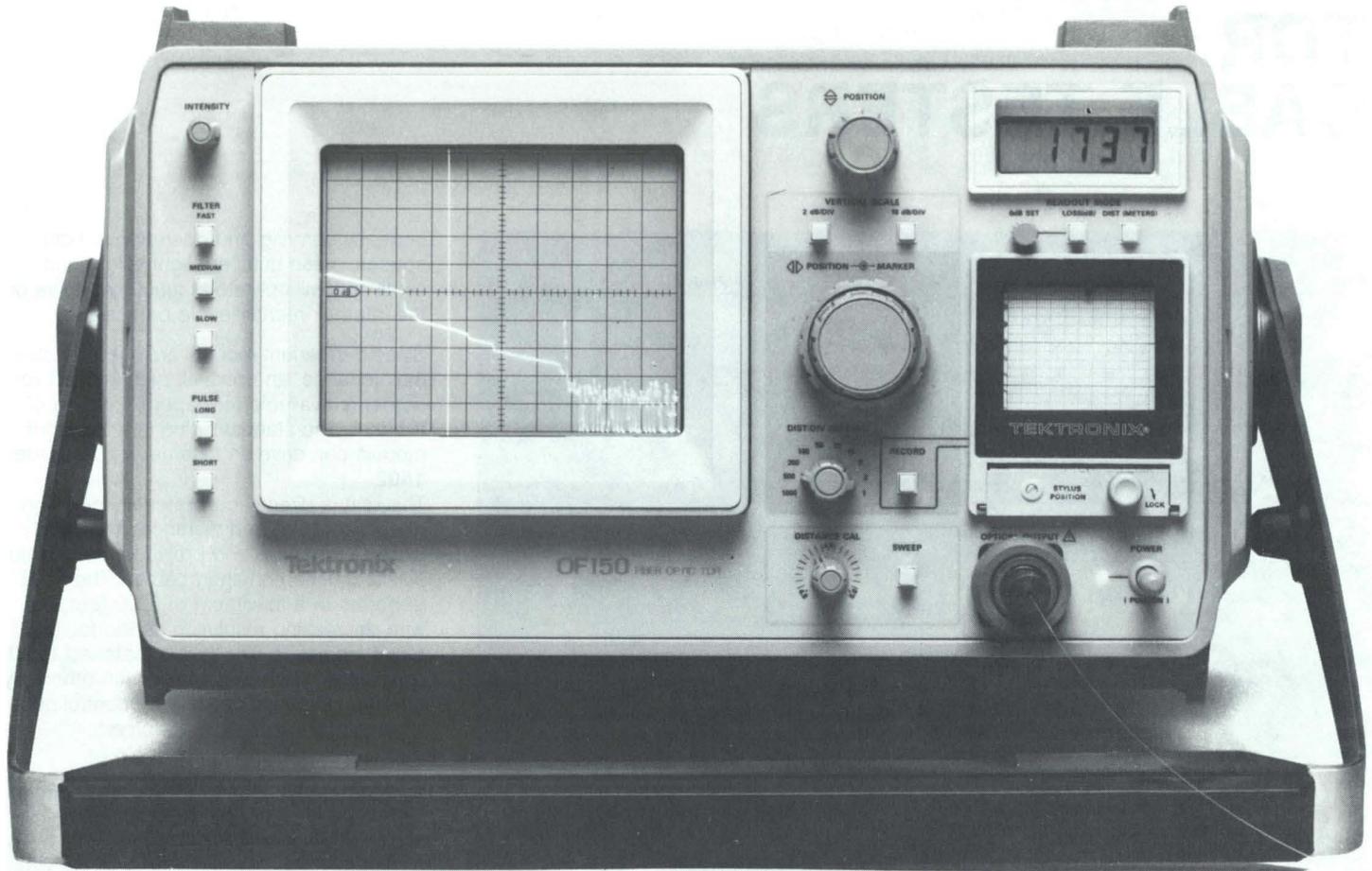
**Decrease in RMS Noise Floor through Filtering** — With medium filter: 0.75 div (7.5 dB). With slow filter: 1.5 div (15.0 dB).

**Optical Input Sensitivity** —  $\leq 0.40$   $\mu$ W input for 30 dB above displayed RMS noise floor.

**Dynamic Range** — 105 dB (typical) between peak optical output pulse and RMS noise floor (Slow filter).

**Maximum Round Trip Fiber Loss for Fiber End Detection** — 85 dB typical (assuming 4% Fresnel reflection).

**Maximum Round Trip Fiber Loss for  $\pm 0.1$  dB Scattering Signal Measurements** — 43 dB typical (dependent on fiber characteristics).



**CRT VERTICAL DISPLAY**

**Vertical Scales** — 10 dB/div and 2 dB/div (10 div).  
**dB Scale Accuracy** — ±0.5 dB over any 10 dB increment from +20 dB to +70 dB, relative to bottom of display range.  
**Incremental dB Scale Accuracy** — ±0.05 dB (typical) over any 1 dB, increment from +10 dB, to +70 dB relative to bottom of display range.

**CRT HORIZONTAL DISPLAY**

**Distance Scales** — 1 m/div to 1000 m/div.  
**Display Limits** — -5 m to 19.9 km from front-panel connector.  
**Sweep Time** — 0.15 s (FAST); 3.15 s (MED); 55 s (SLOW).  
**On-screen Distance Calibration** — 4.88 ns/m.  
**"Zero" Distance Reference Accuracy** — ±0.5 m on screen.

**LCD NUMERIC READOUT**

**Distance Readout Range** — 0 to 19.9 km.  
**Distance Readout Resolution** — 1 m.  
**Distance Cal Factor Range** — 4.8 to 5.0 ns/m.  
**Distance Cal Factor Accuracy** — Within 0.01 ns/m of panel indication at center of scale (4.900); within 0.02 ns/m of panel indication at scale end points.

**Loss Measurements**

**Readout Range:** -25 dB to +25 dB (one way fiber loss) from center reference point.  
**Readout Resolution:** 2 dB/div scale: 0.1 dB; 10 dB/div scale: 0.5 dB.  
**Distance Measurement Accuracy** — ±0.3%\* ± uncertainty in Fiber Cal Factor.

**CHART RECORDER**

**Chart Dimensions** — 40 mm x 125 mm (corresponding to the full CRT graticule area).  
**Chart Distance Scale Linearity** — ±0.2 major division match at any point.  
**Chart Vertical Scale Linearity** — ±5% of deflection from center, ±0.3 major division.  
**Chart Running Time** — 16 s.

**SAFETY**

Meets Class I Laser product safety classification under Radiation Control for Health and Safety Act of 1968. Optical output connector interlock prevents optical output when interlock is open.

**ENVIRONMENTAL CHARACTERISTICS**

The OF150 meets the specifications of MIL-T-28800B, Type III, Class 3, Style C except for Radiated Emission specification RE-01.  
**Altitude** — Operating: 4600 m (15,500 ft). Nonoperating: 12 000 m (40,000 ft).  
**Temperature** — Operating: -15°C to +55°C. Nonoperating: -62°C to +85°C.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
(Without front cover, handle or feet)		
Width	327	13.1
Height	175	7.0
Depth	499	20.0
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net (Includes accessories except manual)	16.6	37.0

**POWER REQUIREMENTS**

**Ac Operation** — 90 to 132 V ac, 45-440 Hz 180 to 250 V ac, 45-440 Hz 24 W nominal (55 W maximum).  
**Dc Operation** — 10 to 16 V dc 20 W nominal (33 W maximum).

**INCLUDED ACCESSORIES**

Optical fiber interface cable, 1 meter long, Deutsch Connector on one end, protective cover on the other end (175-4572-00); roll of chart recorder paper (006-3618-00); battery power cord (161-0149-00); ac power cord (161-0118-00); interlock contact ring (352-0654-01); replacement lens assembly (131-2741-02); protective cover for fiber optic interface cable (200-2736-00); cable retainer (343-0170-00); ac power cord (161-0149-00).

**ORDERING INFORMATION**

**OF150 Fiber Optic Time Domain Reflectometer** ..... **\$17,500**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland 220 V/10A, 50 Hz ..... **NC**

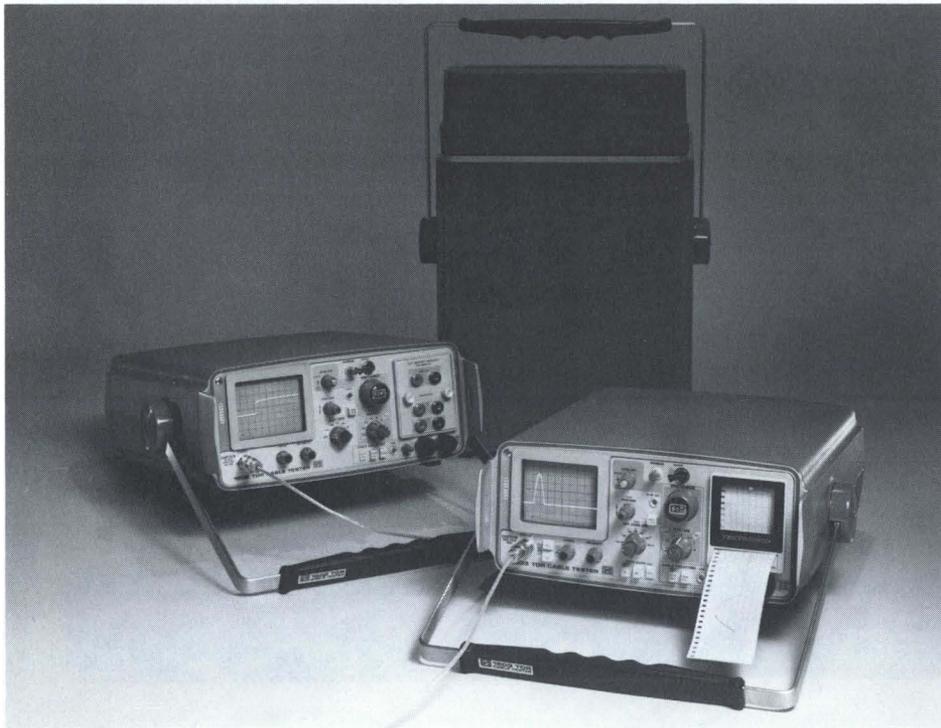
**OPTIONAL ACCESSORIES**

**C-5C Camera** ..... **\$525**  
**Hard Case (transit) Order 016-0658-00** ..... **\$625**  
**Soft Case Order 016-0659-00** ..... **\$125**  
**Chart Paper (roll) Order 006-3618-00** ..... **\$9.25**  
**Connector, Receptacle, Optical (1 each) Order 131-2741-02** ..... **\$60**  
**Connector, Receptacle, Optical (10 each) Order 013-0207-02** ..... **\$375**

FIBER OPTIC TESTER/TDR

\* Instrument timing in accuracy plus distance cal factor indication error.

# TDR CABLE TESTERS



**Portable —**  
Battery Powered, Self-  
Contained, Lightweight

**Rugged —**  
Meets MIL-T-28800, Type III,  
Class 3, Style A

**Versatile —**  
Test Any Type Paired  
Conductor and Coax Cable

**Easy to Use —**  
Produces Results with  
Minimal Operator Training

## Time Domain Reflectometry TDR\*

The portable, rugged 1502 and 1503 TDR Cable Testers are field maintenance tools that are simple to operate and will test any transmission cable under virtually any conditions. The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications.

These units use a technique called Time Domain Reflectometry (TDR) to identify and locate cable faults. When connected to a line in the cable, the unit sends out an electrical pulse that is reflected back to the unit by a fault in the cable. Fault type is identified by the shape of the display, and fault distance is determined by the displayed interval from the test pulse to the fault pulse.

*\*Also known as cable radar.*

For easy carrying and operating in tight spaces, these units are lightweight and small and will operate at least five hours on the internal, rechargeable batteries.

Since permanent records are useful in cable maintenance, an optional, plug-in chart recorder is available for paper recording of the test. The standard plug-in X-Y output module can drive an external X-Y Recorder.

### 1502

This unit is directly calibrated in reflection coefficient ( $\rho$ ) and distance. The 1502 uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet, but with decreasing resolution as the fault distance increases. The unit is matched to 50-ohm cables, but may be used on others by adjusting the front panel GAIN control or using optional impedance adaptors.

### 1503

For long cables, the 1503 provides high-energy,  $1/2$ -sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet. Resolution capability provides for resolving faults as close together as three feet on short cables. Impedance levels of 50, 75, 93 and 125 ohms are selectable.

### 1503 Option 01

1503 Option 01 has Distance Cal switches that make it more convenient for fault location in a variety of cables including coax. When the 1503 Option 01 has been calibrated for each cable before trouble occurs, and the records are kept, the Distance Cal switches can be set exactly and damage location can begin immediately.

### Metric Instruments (1502, 1503)

For distance measurements in meters, instead of feet, there is Option 05 of both the 1502 and 1503. These instruments are fully metric versions of the 1502 and 1503 with no conversion from feet to meters involved.

The 1502 Option 05 has a distance resolution of 15 mm and measures 500 meters.

The 1503 Option 05 has a resolution of 0.9 meter and measures 10 000 meters.

1502

CHARACTERISTICS

TEST SIGNAL

**Shape** — Step rise. 

**Amplitude** — 225 mV nominal (into 50 Ω load), dc coupled.

**Aberrations** — Within ±5% during 1st 10 ft after rise. Within ±0.5% peak beyond 10 ft NOISE FILTER "out."

**System Reflected Rise** — ≤0.07 ft (≤140 ps).

**Jitter** — ≤0.02 ft (≤40 ps) for X.1. ≤0.1 ft (≤200 ps) for X1.

**Test Connector** — BNC.

**Termination** — 50 Ω, within ±2%.

**Maximum Input** — DO NOT APPLY EXTERNAL VOLTAGE.

VERTICAL SYSTEM

**Display Range** — ±4 divisions.

**Accuracy** — Within ±3%.

**Calibration Point** — 2 divisions = 1 μ.

**Deflection Factor** — 5 mp/division to 500 mp/division, 7 steps, 1-2-5 sequence.

**Variable** — ≥3.5:1 from calibration point.

**Displayed Noise**  
NOISE FILTER switch "out" — ±5 mp or less.  
NOISE FILTER switch "in" — ±2 mp or less.

HORIZONTAL SYSTEM

**Distance Controls**  
**Distance Dial**  
Range — 0 to 100 ft for X.1. 0 to 1000 ft for X1.  
Accuracy — Within ±2% of reading ±0.05 ft for X.1. Within ±2% of reading ±0.5 ft for X1.

**FEET/DIV Control**  
Range — 0.1 to 20 ft/division for X.1. 1 to 200 ft/division for X1.

Accuracy — Within 2% of full CRT screen.

**CABLE DIELECTRIC Scales (Vp/Vair)** — SOLID POLY, 0.66; SOLID PTFE, 0.70; Other VAR, 0.55 to 1.0. VAR is calibrated for air when turned fully cw.

**Sweep Repetition** — 40 Hz within +0 Hz, -10 Hz with NOISE FILTER switch "out." 4 Hz within ±20% with NOISE FILTER switch "in." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder).

UNIQUE 1502 OPTION 05 CHARACTERISTICS

TEST SIGNAL

**Aberrations** — Within ±5% during 1st 300 cm after rise. Within ±0.5% peak beyond 300 cm NOISE FILTER "out."

**System Reflected Rise** — ≤2.1 cm (≤140 ps).

**Jitter** — ≤0.6 cm (≤40 ps) for X.1. ≤3 cm (≤200 ps) for X1.

HORIZONTAL SYSTEM

**Distance Controls**  
**Distance Dial**  
Range — 0 to 25 m for X.1. 0 to 250 m for X1.  
Accuracy — Within ±2% of reading ±0.02 m for X.1. Within ±2% of reading ±0.2 m for X1.

**METERS/DIV Control**  
Range — 0.025 to 5 m/division for X.1. 0.25 to 50 m/division for X1.

INCLUDED ACCESSORIES

Watertight front cover, TDR slide rule (003-0700-00); 50 Ω BNC terminator (011-0123-00); precision 50 Ω cable (012-0482-00); viewing hood (016-0297-00); X-Y output module (016-0606-00); replacement fuses (for front panel) 110 V ac (159-0032-00) or 220 V ac (159-0029-01); power cord (161-0066-00); mesh filter (CRT) (378-0055-00); BNC female-to-female adaptor (103-0028-00).

ORDERING INFORMATION

**1502 TDR Cable Tester** ..... \$5,650

**Option 04** — (with recorder) ..... \$1,050

**Option 05** — (metric version) ..... NC

**Option 76** — (P7 Phosphor) ..... +\$35

INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC

**Option A2** — UK 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A4** — North American 240 V/15A, 60 Hz ..... NC

1502 OPTIONAL ACCESSORIES

**Chart Recorder** Order 016-0506-04 ..... \$1,100

**Chart Paper (roll)** Order 006-1658-01 ..... \$7.50

**Chart Paper (100 roll case)** Order 006-1658-02 ..... \$550

**Accessory Pouch** Order 016-0351-00 ..... \$25

**Static Suppressor** (helps protect front end from damage). Order 011-0132-00 ..... \$45

**Impedance Adaptor**  
50/75 Ω. Order 017-0091-00\* ..... \$115  
50/93 Ω. Order 017-0092-00\* ..... \$115  
50/125 Ω. Order 017-0090-00\* ..... \$115

\*Should be purchased with following two parts:  
**Connector, BNC Female-to-GR**  
Order 017-0063-00 ..... \$43  
**Connector, BNC Male-to-GR**  
Order 017-0064-00 ..... \$75

1503

CHARACTERISTICS

TEST SIGNAL

**Shape** — 1/2 sine within ±20% 

**Amplitude** — 10 V ±20% unterminated. 5 V ±20%, terminated, ac coupled.

**Aberrations** — —30 dB p-p. (Equivalent to ±1.6%).

**Duration** — ≤10 ft (10 ns),\* ≤100 ft (100 ns),\* ≤1000 ft (1000 ns).\*

**Jitter** — ≤1 ft for X10 (≤2 ns). ≤10 ft for X100 (≤20 ns).

**Test Connector** — BNC.

**Termination** — 50 Ω, 75 Ω, and 93 Ω, within 1%; 125 Ω within 3%.

**Maximum Input** — ±400 V (dc + peak ac at maximum frequency of 440 Hz).

VERTICAL SYSTEM

**Display Range** — ±4 division.

**Accuracy** — Within ±0.25 dB (within ±3%).

**Calibration Point** — 2 division = 0 dB.

**Deflection Factor** — 0 to 60 dB, 7 steps, 10 dB per step.

**Variable** — 0 to 18 dB additive to steps.

**Displayed Noise**  
NOISE FILTER switch "out" — —80 dB RMS, random.  
NOISE FILTER switch "in" — —86 dB RMS, random.

HORIZONTAL SYSTEM

**Distance Controls**  
**Distance Dial** — Range: 0 to 2,500 ft at X10. 0 to 25,000 ft at X100. Accuracy: Within 2% of reading ±2 ft for X10. Within 2% of reading ±20 ft for X100.

**FEET/DIV Control** — Range: 5 to 500 ft/division at X10. 50 to 5000 ft/division at X100. Accuracy: Within 2% of full CRT screen.

**CABLE DIELECTRIC Scales (Vp/Vair)** — SOLID POLY, 0.66; FOAM POLY, 0.81; VAR, 0.31-1.0. VAR is calibrated for air when turned fully cw.

**Distance Cal Scales, Option 01 only (Vp/Vair)** — Selectable from 0.2 to 1.0 in 0.01 increments.

**Sweep Repetition** — 40 Hz within +0 Hz, -10 Hz with NOISE FILTER switch "out." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder). 4 Hz within ±20% with NOISE FILTER switch "in."

UNIQUE 1503 OPTION 05 CHARACTERISTICS

TEST SIGNAL

**Duration** — ≤3 m (10 ns),\* ≤30 m (100 ns),\* ≤300 m (1000 ns).\*

**Jitter** — ≤0.2 m for X1 (≤2 ns). ≤2 m for X10 (≤20 ns).

HORIZONTAL SYSTEM

**Distance Controls**  
**Distance Dial**  
Range — 0 to 500 m at X1. 0 to 5,000 m at X10.  
Accuracy — Within 2% of reading ±0.2 m for X1. Within 2% of reading ±2 m for X10.

**METERS/DIV Control**  
Range — 1 to 100 m/division at X1. 10 to 1000 m/division at X10.

INCLUDED ACCESSORIES

Watertight front cover, replacement fuses (for front panel) 110 V ac (159-0032-00) or 220 V ac (159-0029-01); power cord (161-0066-00); viewing hood (016-0297-00); 50 Ω BNC terminator (011-0123-00); X-Y output module (016-0606-00); mesh filter CRT (378-0055-00); 9 ft BNC-to-clip-lead cable (012-0671-02).

ORDERING INFORMATION

**1503 TDR Cable Tester** ..... \$4,750

**Option 01** — (Distance Cal) ..... +\$375

**Option 04** — (with recorder) ..... +\$1,050

**Option 05** — (metric version) ..... NC

**Option 76** — (P7 Phosphor) ..... +\$35

INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC

**Option A2** — UK 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A4** — North American 240 V/15A, 60 Hz ..... NC

1503 OPTIONAL ACCESSORIES

**Chart Recorder** Order 016-0506-03

**Chart Paper (roll)** Order 006-1658-01 ..... \$7.50

**Chart Paper (100 roll case)** Order 006-1658-02 ..... \$550

**Isolation Network** (for balanced lines). Order 013-0169-00 ..... \$155

**Adaptor Cables (BNC-to-Clips)**  
9 foot. Order 012-0671-02 ..... \$60  
30 foot. Order 012-0671-03 ..... \$70

**Accessory Pouch** Order 016-0351-00 ..... \$25

**Direct Current Adaptor with Filter** (for use with standard 12 V automobile lighter plug with negative ground).  
**25 Foot Cord** Order 015-0327-00 ..... \$160

1502 & 1503 COMMON CHARACTERISTICS

POWER REQUIREMENTS

**Ac Power**  
Line Voltage — 117 V ac ±20% and 234 V ac ±20%.  
Line Frequency — 48 to 410 Hz.

**Dc Power**  
**Battery Pack Operation** — At least 5 hours (+20°C to +25°C charge and discharge temperature) including 20 chart recordings.  
**Full Charge Time** — 16 hours.  
**Typical Charge Capacity**

Charge Temperature	Discharge Temperature		
	-15°C	+20°C to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

EXTERNAL RECORDER INTERFACE

(STANDARD X-Y MODULE)

**Horizontal** — 0.1 V/division, source impedance is 10 kΩ.  
**Vertical** — 0.09 to 0.13 V/division (adjustable), source impedance is 10 kΩ.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
	Width (with handle)	315
Width (without handle)	300	11.8
Height	127	5.0
Depth (handle extended)	475	18.7
Depth (handle not extended)	419	16.5
Weights	kg	lb
	Net (with front cover and accessories)	8.2
Net (without front cover or accessories)	7.3	16.0
Domestic Shipping (complete) ≈	11.1	24.4
Export Shipping (complete) ≈	16.3	36.0

LOGISTICS INFORMATION

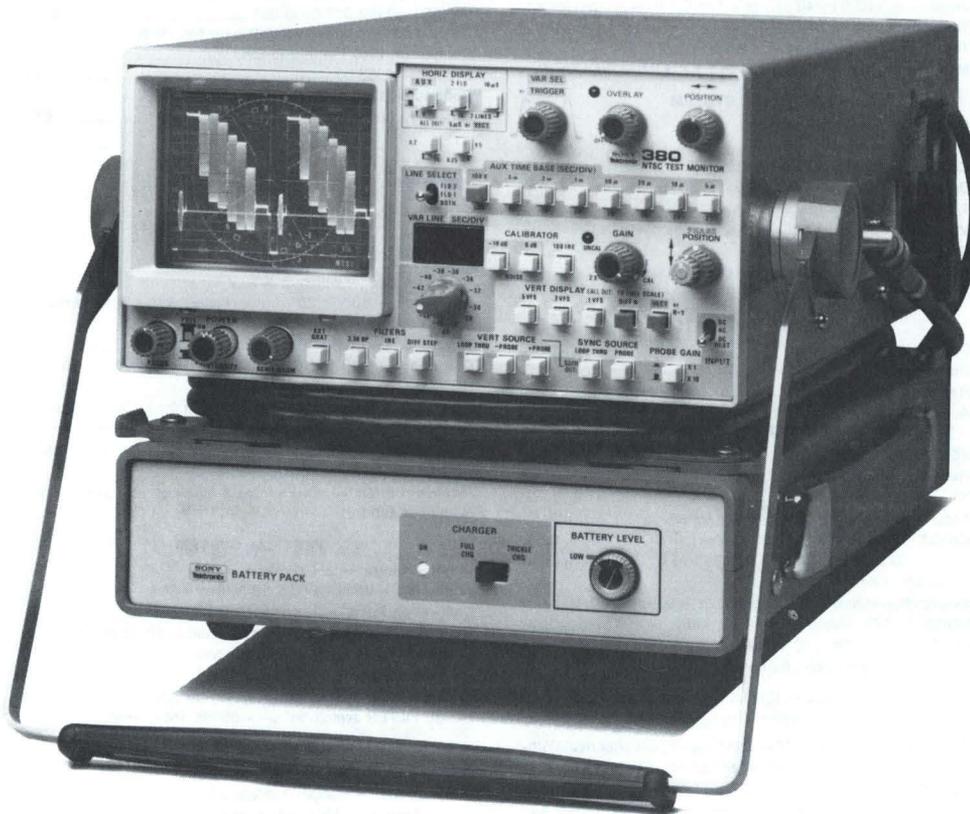
For logistics data, see Tektronix Logistics Data Book.

\*Duration times are within ±20% at half amplitude.

# TELEVISION PRODUCTS

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**NEW**

380 Test Monitor with optional Battery Pack

TELEVISION PRODUCTS

### High Performance Spectrum Analyzers for Your RF Measurements

See pages 198 through 214 for details on Tektronix lab grade performance spectrum analyzers: rugged 490 Series portables for measurements at the transmitter site and the field; 7000 Series analyzers for plug-in versatility and economy in high performance measurements; the 1405 Television Sideband Adaptor (for 7000 Series and 490 Series spectrum analyzers) to analyze the sideband response of a television transmitter.

## 380/381

### Ac or Dc Operation

### NTSC or PAL Versions

### Bright CRT

### Precise Frequency Response

### Noise Measurement

### Probe Input

### Line Selection

The 380 and 381 Test Monitors are compact, lightweight instruments optimized for portability in many television environments, including maintenance, engineering and EFP. The 380 is used in NTSC systems, the 381 in PAL systems. Both units have the combined capabilities of a precision waveform monitor, vectorscope, and general purpose oscilloscope.

The flexibility of the 380 and 381 makes them an ideal choice for a variety of applications. Video technicians, for example, find them invaluable when maintaining such video equipment as VTRs, cameras, and transmitters, particularly in remote locations. With an auxiliary oscilloscope trigger, sweep, and display, the 380 and 381 are also well-suited for maintaining other equipment, such as audio systems, servos, and control and switching systems.

Video engineers make good use of their extensive measurement capabilities, which include differential phase and gain, tangential noise, vertical interval line selection, short-time distortion, trace overlay, and a 0.5% calibrated amplitude comparator, to name only a few. The operator can choose to make video measurements from a 75-ohm or probe input.

Production personnel take advantage of the monitor's bright display and portability during remote productions, on EFP carts, in production vans, and in other remote applications. Pushbutton controls bring up standard horizontal (line) and vertical (field) waveform displays. A vectorscope display provides easy monitoring of color bars and chroma.

### Waveform Monitor

In the waveform monitor mode, the 380 and 381 have the flat frequency response ( $\pm 2\%$  to 5 MHz) required for measuring or monitoring a video signal. The monitors provide a full set of input filters, including chroma band pass, IRE or low pass, and differential step. The input signal

can be ac or dc coupled, or dc restored, and switched between a loop-thru and probe input, with independent sync source selection. Calibrated vertical displays at 0.1, 0.2, 0.5 and 1.0 volts full scale, along with a variable gain control, provide a full range of amplitude control.

Discrete, and variable vertical interval, line selection allows any individual line in any frame to be displayed and identified by line and field number. All displays can be expanded horizontally 2, 5 or 25 times for increased clarity of fast signal components.

### Vectorscope

In the vectorscope mode, the vector display of either a full field or vertical interval signal can be selected. The display can be referenced to either the displayed signal or an external composite color video signal.

A decoded R-Y (or V) line sweep display is available, and the 381 is switchable between a PAL or NTSC type vector display.

### Oscilloscope

In the oscilloscope mode, a selectable time base from 50 milliseconds per division to 0.2 microseconds per division, along with negative or positive slope trigger for nonvideo signal observation are provided.

### Battery Pack

An optional battery pack attaches to the bottom of the 380/381 for complete portability, providing more than two hours of continuous operation. A convenient recharger is built into the pack. The battery pack is quickly replaceable for long term remote operation.

## CHARACTERISTICS

### Deflection Factor

	Loop Thru Probe X10	Probe X1
1 V	$\leq 1\%$	$\leq 2\%$
0.5 V	$\leq 3\%$	$\leq 4\%$
0.2 V	$\leq 3\%$	$\leq 4\%$
0.1 V	$\leq 3\%$	$\leq 4\%$

**Variable Volts Full Scale Range** —  $X0.2 (\pm 4\%)$  to  $\approx 1.4$ .

### Maximum Input Signal

Loop Thru:  $\pm 1.5$  V dc + peak V ac, (dc coupled).  
 $\pm 2.0$  V p-p at any APL (ac coupled).

Probe X1:  $\pm 5$  V dc + peak V ac,  $< 1$  kHz (Signal Out not terminated).

Probe X10:  $\pm 0.5$  V dc + peak V ac,  $< 1$  kHz (Signal Out not terminated).

**Maximum dc Output into 75  $\Omega$  (Signal Out)** —  $\pm 0.5$  V dc.

**Frequency Response** — Flat (from 50 kHz reference).

Loop Thru (including Signal Out):  $+10^\circ\text{C}$  to  $+30^\circ\text{C}$ : 50 kHz to 5 MHz  $\pm 2\%$ ; 5 MHz to 10 MHz  $+2\%$ ,  $-5\%$ .

Loop Thru (including Signal Out):  $+0^\circ\text{C}$  to  $+50^\circ\text{C}$ : 50 kHz to 5 MHz  $\pm 3\%$ ; 5 MHz to 10 MHz  $+3\%$ ,  $-5\%$ .

Probe: Typically  $< 1$  dB down to 15 MHz;  $< 2$  dB down to 18 MHz;  $< 3$  dB down to 20 MHz.

IRE (380): Conforms to IEEE Standard 205, 1972.

LUM (381):  $< 3$  dB down at 1 MHz; at least 40 dB down at 4.43 MHz.

3.58 MHz (380):  $\pm 1\%$  of Flat at 3.58 MHz, bandpass  $\approx 600$  kHz.

4.43 MHz (381):  $\pm 1\%$  of Flat at 4.43 MHz, bandpass  $\approx 800$  kHz.

Diff Step: Attenuation  $\leq 2$  dB from 0.4 to 0.5 MHz;  $\geq 20$  dB at 14 kHz and 2 MHz;  $\geq 40$  dB at 3.58 MHz and 4.43 MHz.

### Linear Waveform Distortion (2T)

Pulse Preshoot:  $\leq 0.5\%$  of applied pulse amplitude.

Pulse Overshoot:  $\leq 1.0\%$  of applied pulse amplitude.

Pulse Ringing:  $\leq 0.5\%$  of applied pulse amplitude.

25  $\mu\text{S}$  Bar Tilt:  $\leq 1\%$ .

Field Square Wave Tilt:  $\leq 1\%$ .

Pulse to Bar Ratio: 0.99 to 1.01:1 (at 1.0, 0.5 or 0.2 V full scale). 0.98 to 1.02:1 (at 0.1 V full scale).

### Non-Linear Waveform Distortion

Differential Gain Displayed:  $\leq 0.5\%$  at any APL.

Signal Out:  $\leq 1.0\%$  of any APL.

Differential Phase Displayed:  $\leq 0.25^\circ$  at any APL.

Signal Out:  $\leq 0.5^\circ$  at any APL.

**Return Loss** — Loop Thru Input:  $\geq 40$  dB, dc to 5 MHz.

**Calibrator Accuracy**

100 IRE:  $\leq 0.5\%$ .

Noise: 0 dB = 700 mV  $\pm 5\%$ . Step Accuracy:  $\leq 1$  dB. Instru-  
ment S/N:  $\leq -60$  dB.

**Probe**

Input Resistance: 1 M $\Omega$ ,  $\pm 2\%$ .

Input Capacitance:  $\approx 24$  pF.

Maximum Safe Input Volt: 250 V dc + Peak V ac 1 kHz or less.

**1 V Cal Out**

Output Voltage: 1.000 V  $\pm 0.005$  V.

Waveform: Squarewave.

Frequency:  $\approx 1$  kHz.

Output Impedance:  $< 1 \Omega$ .

**Vertical Geometry** —  $\leq 0.15$  div error.

**Horizontal Geometry** —  $\leq 0.15$  div error.

**Sweep Timing Accuracy and Linearity (over center 10 div)**

TV Time Base — At 5  $\mu$ s timing 1%, linearity 2%; at 10  $\mu$ s timing 2%, linearity 3%.

Auxiliary Time Base — Timing 4%, linearity 5%.

**Magnified Timing and Linearity** — X2, X5 & X25: Add 1%, error for center ten divisions of unmagnified sweep.

**Two Field Sweep Length** — 12.7 div;  $\pm 0.5$  div.

**Field Selector** — Positive selection of Odd (2 and 4), Even (1 and 3).

**Line Selector**

Variable Range — From  $\approx$  line 17 of the selected field to 25% into adjacent field; lines intensified by the strobe in two Field display.

Discrete (380) — Selects line 15 to line 21.

Discrete (381) — Selects line 16 to line 22 and line 329 to line 335.

**Sync Input Requirements**

TV Sync: 200 mV p-p to 2 V composite video.

Auxiliary Sync:  $\leq 20$  mV at 50 Hz;  $\leq 10$  mV at 50 kHz  $\leq 50$  mV at 5 MHz.

**Chrominance Bandwidth**

Upper -3 dB Point — Fsc +500 kHz  $\pm 100$  kHz.

Lower -3 dB Point — Fsc -500 kHz  $\pm 100$  kHz.

**Vector Phase Accuracy** —  $\leq 2^\circ$

**Subcarrier Regenerator**

Pull-in Range: Within 50 Hz of Fsc.

Pull-In Time:  $\leq 1$ s.

Phase Shift with Subcarrier Frequency Change:  $< 1^\circ$  typically from fsc to fsc +10 Hz, or from fsc to fsc -10 Hz;  $< 2^\circ$  typically from fsc to fsc +20 Hz, or from fsc to fsc -20 Hz.

Phase Shift with Burst Amplitude Change:  $\leq 2^\circ$  from nominal burst amplitude to  $\pm 6$  dB.

Phase Control Overall Range:  $\pm 30^\circ$  (380), at least  $80^\circ$  (381).

Vector Gain Accuracy:  $\leq 2$  IRE.

Differential Phase Accuracy:  $\leq 10\%$  of measurement  $\pm 0.3^\circ$ .

**Optional Battery Pack**

Power Output: 11 to 12 V dc; 6 Amp hours (0°C to +40°C); 3 Amp maximum.

Operating Time:  $> 2$  hours.

Charge Time: 14 to 16 hours (0°C to +40°C).

Storage Temperature: (-40°C to +60°C).

Power Consumption: 30 W maximum.

**Mains Voltage Range**

115 V ac: 90 V ac to 132 V ac.

230 V ac: 180 V ac to 250 V ac.

Power Consumption — 35 W.

Mains Frequency: 48 Hz to 440 Hz.

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature**

Nonoperating: -25°C to +75°C.

Operating: 0°C to +50°C.

**Altitude**

Nonoperating: To 15 200 m (50,000 ft).

Operating: To 4500 m (15,000 ft).

**PHYSICAL CHARACTERISTICS**

**380/381**

Dimensions	mm	in
Width, w/handle	237	9.5
Height	112	4.5
Depth, handle not extended	372	14.9
Depth, handle extended	482	19.3
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	5.5	12.1

**BATTERY PACK**

Dimensions	mm	in
Width	209	8.4
Height	68	2.7
Depth	353	14.1
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	4.0	8.8

**INCLUDED ACCESSORIES**

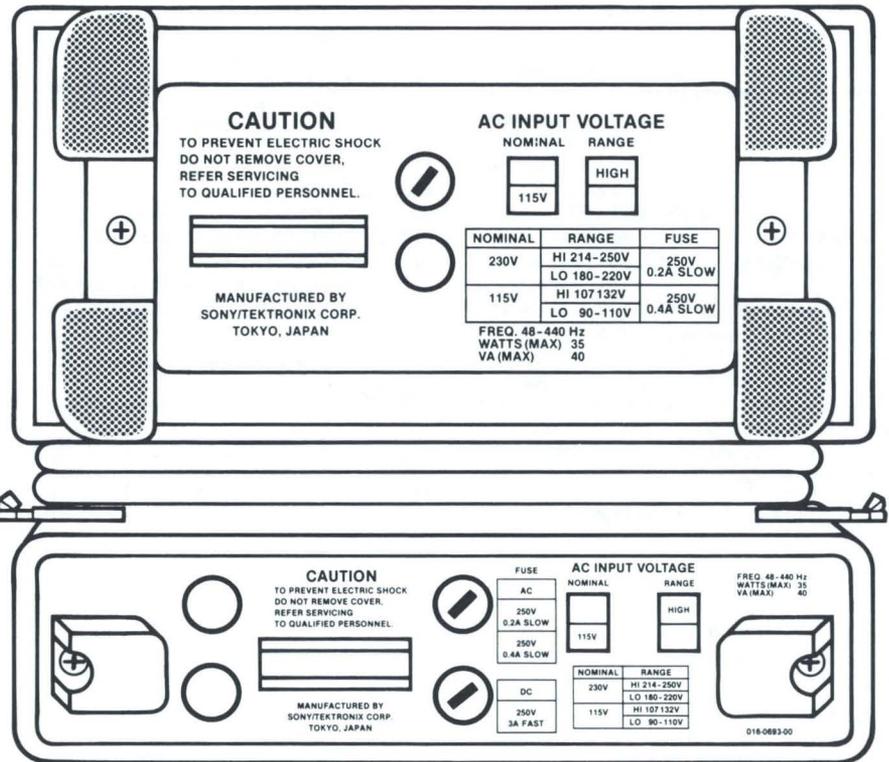
Probe package (010-6149-03); cable assembly, external dc (012-0406-00); carrying case (016-0663-02); 3A fast fuse 250 V (159-0015-02); 1.5A fast fuse 250 V (159-0156-00); 0.2A slow fuse 250 V (159-0180-00); 0.4A slow fuse 250 V (159-0179-00); cover carrying case (200-2260-00); strap assembly carrying (346-0131-00); viewing hood (016-0297-00).

**ORDERING INFORMATION**

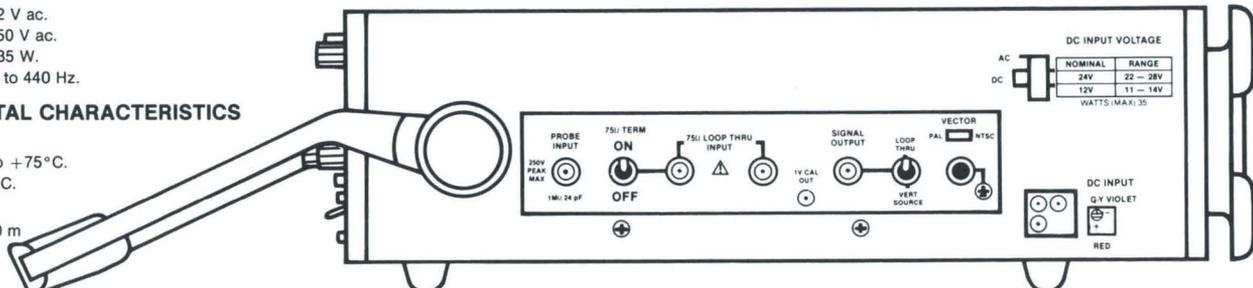
**380 Test Monitor**  
(For NTSC Systems) ..... **\$5,495**  
**381 Test Monitor** (For PAL Systems) . **\$5,495**  
Option 11 — With Battery Pack included ..... +\$845  
Option 89 — Required for export orders ..... NC

**OPTIONAL ACCESSORIES**

Battery Pack Order 016-0693-00 (for 380) ..... **\$875**  
Order 016-0693-04 (for 381) ..... **\$875**  
Camera Adaptor (mounts the C-30B camera)  
Order 016-0327-01 ..... **\$169**

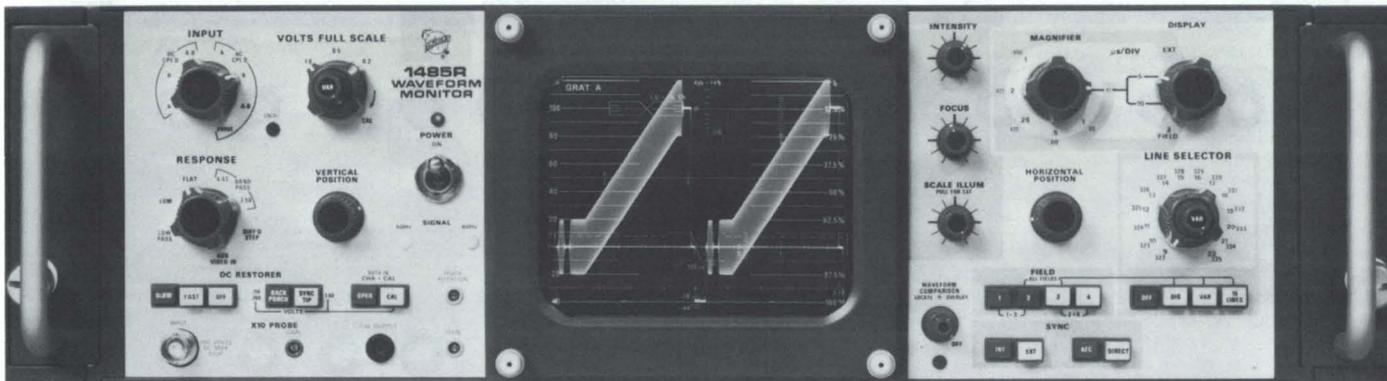


380/381 and Optional Battery Pack Back Panels



Side panel of the 380/381 (vector switch on 381 only)

The SONY®/TEKTRONIX® 380/381 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 380/381 is available from Tektronix, Inc. its marketing subsidiaries and distributors.



1485R Option 01 PAL/NTSC Dual Standard Waveform Monitor (Rackmount)

## 1480

Bright CRT Especially Suitable for Vertical Interval Testing

Advanced Measurement Modes

Amplitude Measurement Accuracy Approaching 0.2%

Digital Selection of Line and Field

Probe Input Option

15-Line Display for VTR Applications

The 1480 Series Waveform Monitors have excellent amplitude measuring accuracy and many unique operating modes that enable you to work more precisely and accurately. The monitoring needs of CCU, VTR, control room, transmission facilities, transmitter, and special systems have been researched thoroughly in order to assure that the 1480's will fit your expressed needs. We believe that the 1480's have anticipated your needs for years to come. We will describe here the things that 1480's can do, but there is nothing like seeing one to really communicate the impressive performance of these monitors.

The 1485C and 1485R PAL/NTSC, Dual Standard Monitors (see photos) represent the essentials of all eight monitors in the 1480 Series. The differences between the monitors in the series are essentially confined to what lines in the vertical interval are selectable, what filters are selectable in the response mode, and in the field selection modes. Dual-Standard Monitors recognize the signal standard in use automatically and indicate that standard with front panel indicators.

### Vertical Interval Testing

Have you ever had to turn the lights down or shade a CRT with your hand to see a particular Vertical Interval Test Signal? That is not necessary with the 1480 Series because the CRT is bright. So bright that one Vertical Interval Test Signal selected out of four fields, can be seen with ease even in a well-lighted area. This solution to VITS display problems required the design of a very high light-output, cathode-ray tube. But the bright CRT is just one of the unique features of the 1480 Series.

### More Accuracy, Greater Resolution

In recognition of the need for more accuracy the 1480's provide several advanced measurement modes. In these modes the 1480's give you the capacity to make amplitude measurements with accuracy approaching 0.2%. In one mode a precision display offset is used. A proven video measurement technique, offsetting displays with an amplitude standard is an easy-to-use method that achieves accuracy by eliminating parallax and transfer errors. Transfer errors are eliminated because you compare your signal to a precise one volt standard rather than to graticule calibration. Measurements made with comparison techniques also have a high order of consistency and repeatability. When your signal precisely matches the standard your signal amplitude will be determined to the value and accuracy of the offset. The tolerance of the internal calibration signal used as the standard is 0.2%.

Resolving power is an important factor in achieving very accurate amplitude measurements. The 1480's provide great resolving power through calibrated five-times expansion of the vertical display. Expansion not only means that signal and standard comparison is more precise, it means that the differences (errors) between signal and standard are easier to see and to measure.

Greater resolution of the five times expansion is facilitated by a vernier position control. With this control any portion of a standard amplitude signal can be positioned on screen and then examined in detail. A 0.2% amplitude standard, 5X expansion, offset comparison, fine CRT spot size, these are some but not all of the factors that make the 1480's very accurate video monitoring instruments.

### Fast Time Base with an AFC Mode

The fastest sweep of the 1480's is 0.1 microseconds per division. Fast enough and bright enough to examine T pulses even in the vertical interval.

The 1480's are calibrated in microseconds with a basic 2% time base accuracy. Less than  $\pm 3\%$  when using the multiplier. 50X is the greatest range of magnification with steps of 10, 5, 2, and 1; calibration is in time and magnification value. The sync recognizer has a new automatic frequency control mode for the display of sync jitter.

### Dc Restoration and Dc Coupling

Other improvements provided by the 1480's include slow dc restoration which will display any hum present, or a new mode (fast) to filter out hum so that measurements can be made more accurately. Also selectable are backporch or sync tip dc restoration. A dc coupled input mode is provided for measuring diode demodulator output and other applications.

### Side-By-Side Comparison Mode

We call this mode overlay or sweep foldback. The 1480's can actually overlay a later segment of a display on the earlier segment. Superimposing waveforms over other waveforms allows exact comparison of levels. With overlay you can exactly compare the elements of complex vertical interval test signals. Add the extra resolving power of five times vertical expansion with precision offset and the overlay mode reaches its full potential.

### Sure Line Selection and Positive Field Identification

Digital selection of field and line assures positive identification of displayed information. For example when you select line 18 of field 2 it is certain that what you will see is line 18, field 2. Digital techniques will not allow an incorrect selection.

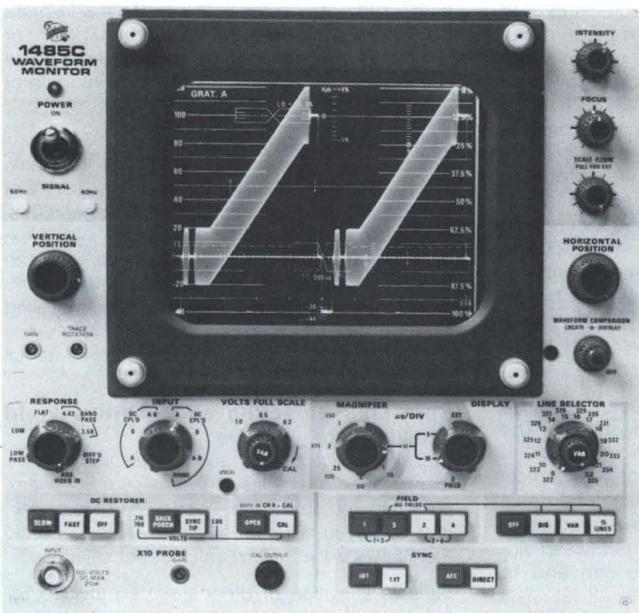
Variable selection of other lines is provided for full field signal analysis. In all line selection modes a line intensifying strobe is provided with video for picture monitor displays. A second line strobe output is provided to strobe 520A Series Vectorscopes, etc. Intensified two-field displays on the 1480 help you locate the line or lines selected.

### Response Selection and A Unique Auxiliary Mode

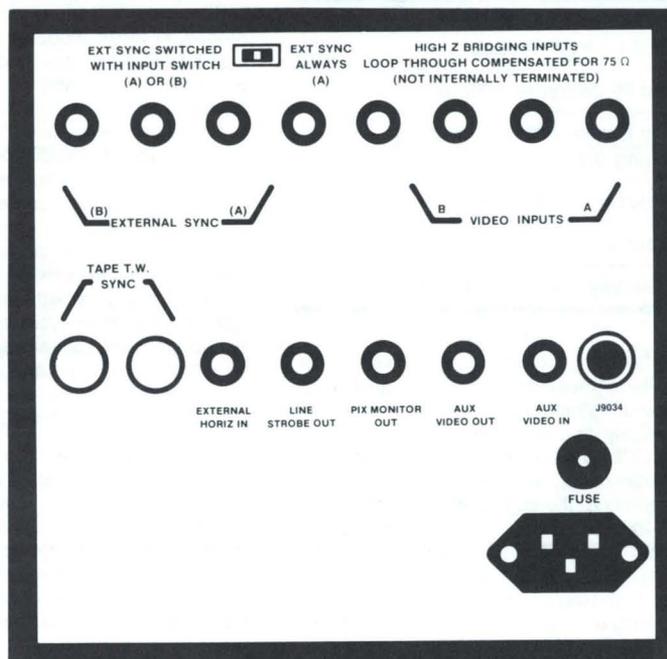
Many television measurements require the filtering of some components from the composite signal. For example, luminance signal rejection by 3.58 MHz or 4.43 MHz subcarrier filters for differential gain measurements. A selection of appropriate filters is provided in the 1480's; including low pass, IRE, subcarrier and one for staircase linearity measurements call "differentiated staircase". When your specialized or unique measurements require a special filter, insert that filter between the auxiliary video output and auxiliary input without breaking into the program line. The auxiliary video input and output are buffered by amplifiers to provide a precise 75-ohm source and load.



1485R Rear Panel



1480 NTSC Waveform Monitor (Cabinet)



1485C Rear Panel

WAVEFORM MONITORS

**Factors That Affect Displays, Graticules, Focus and Brightness**

Two graticules are provided. One, internal and illuminated, is used for most of your applications. An internal graticule has no parallax. The other graticule is external and can be easily changed, a feature useful for special applications. The external graticule is illuminated by a separate system with a control that turns the internal one off—getting it out of sight so you can see only the external one.

In the 1480 Series monitor, focus and brightness controls compensate for changes when switching from two field to a faster time base and can easily be set to an optimum level.

**PROBE OPTION**

The 1480's make convenient high impedance probing available with a probe option. This option provides an input that accepts most Tektronix probes. As a part of this option a probe compensation waveform test point is pro-

vided (A ten-times amplifier keeps full screen sensitivities while using X10 attenuator probes.)

**Balanced Operation for 124 Ohm (Option 06)**

The 1480R Option 06 is a high-performance television waveform monitor designed for use in your television operating center or by your field service force. It is designed for measurements in long-distance, video transmission systems using 124-ohm balanced lines. WECCO-style input jacks allow this instrument to operate in a 75 ohm system. With these features the 1480R Option 06 has been designed to operate in either a 124 ohm balanced or 75 ohm unbalanced system.

Vertical sensitivity, with automatic bandpass limiting, has been increased to 0.05 volts full scale for making differential phase and gain measurements with Bell Kelley or Teletest Test Sets. A 5 to 12 second, variable sweep has been added to measure low frequency distortions and system bounce caused by large APL changes in the video signal.

Each 1480R Option 06 is supplied with hardware for both rackmounting and portable configurations.

**Slow Sweep (Option 07)**

A random sampling technique is employed by 1480-Series Option 07 monitor to display long-time distortions. Sampling maintains display intensity at a level suitable for viewing and photography.

A 1480-Series Option 07 monitor in the slow sweep mode is triggered from APL change or by a 50-60 Hz squarewave that has no field sync and filtered line sync thru a loop-thru rear panel input. Either + polarity, starting the slow sweep on the transition from, at, or near black level to peak or near peak white, or - polarity, white to black, may be selected. In addition, a choice of trigger source, either internal, stripped from incoming video, or external, through the External Sync Inputs, is available. If insufficient or no trigger is present, the slow sweep will operate in a

free-run mode. This free-running mode has a noticeably reduced repetition rate; however, sweep duration and linearity are unchanged.

The sweep duration is controlled by a variable front panel control, located on the display switch. Range of control over the duration of the sweep is approximately 4 to 15 seconds.

**CHARACTERISTICS**  
**VERTICAL DEFLECTION**

**Inputs** — Input A and B are 75 Ω high impedance loop-through. Return loss is ≥40 dB from dc to 5 MHz in a 75 Ω system. Aux Video Input is internally terminated in 75 Ω. Return loss is ≥34 dB from dc to 5 MHz.

**Scale Factor** — A and B input calibrated 1.0 V ± 7 mV, 0.5 V ± 15 mV, 0.2 V ± 7 mV, (0.05 V ± 2.5 mV Option 06) volts full scale. Variable — Range for each scale factor at least +40% to -50%. Aux Video Input 1.5 dB gain.

**Maximum Input Voltage** — 2 V p-p (ac coupled), ± 1.5 V dc + peak ac (dc coupled).

**Frequency Response** — Flat — Flat to 5 MHz ±2%; 5 MHz to 10 MHz +2%, -5%. Low Pass — Attenuation ≥14 dB, 500 kHz and above. 3.58 MHz Band Pass — Amplitude within ±1% of amplitude in Flat response position. Bandpass ≈ 600 kHz. 4.43 MHz Band Pass — Amplitude within ±1% of amplitude in Flat response position. Bandpass ≈ 800 kHz. IRE — Conforms to IRE Standard 23S-1 1958 amended.

**Dc Restorer** — Keyed type, may be turned off. Clamping point: BACK PORCH/SYNC TIP. TIME CONSTANT: FAST reduces mains hum ≥26 dB, SLOW reduces mains hum <0.9 dB.

**Calibrator** — Amplitude selected by dc Restorer switch. Sync Tip: 1 V ± 0.2%. Back Porch: 714 mV or 700 mV ± 0.5%.

**Linear Waveform Distortion** — Pulse/bar Ratio: ±1%. SHORT TIME: preshoot, overshoot, ringing ≤0.5% on 100 ns sin<sup>2</sup> pulse. LINE TIME: TILT or rounding ≤1.0%. FIELD TIME: (Ac coupled) ≤1%.

**Non-Linear Distortion** — Differential Gain: ≤0.5%.

**HORIZONTAL DEFLECTION**

**Time-Base** — 5 μs and 10 μs timing accuracy ±2% (center 10 divisions); 5 μs and 10 μs linearity ±1% (center 10 division).

**External Sync Input** — Two loop-through high impedance, with ≥46 dB return loss in a 75 Ω system. Inputs are slaved to A and B input or to A external sync input only.

**External Sync Input Requirements** — 400 mV to 2 V composite video or 200 mV to 8 V composite sync.

**Field Selector** — Positive selection of Field 1 or 2 in the NTSC system. Positive selection of 1, 2, 3, 4, or 1 & 3, 2 & 4 in the PAL systems.

**Line Selector** — DIG—Selects lines 9 to 22 NTSC, line 9/322 to line 22/335 PAL, line 9/272 to line 22/285 PAL-M. VAR—Approx line 20 of the selected field to line 4 of the next related field. 15 lines — Identical to VAR, except 15 successive lines are displayed.

**Sync** — AFC Horizontal frequency range is 15.75 kHz ± 200 Hz. Maximum Jitter with Respect to Input Sync: 10 ns with 4 V RMS hum (30 ns with the addition of -36 dB white noise). Direct Horizontal frequency up to ≤20 kHz. Maximum Jitter with Respect to Input Sync: 12 ns with 4 V RMS hum (90 ns with the addition of -36 dB white noise).

**OUTPUTS**

**Line Strobe** — TTL amplitude pulse. Pulse coincident with line or lines selected by VAR, 15 LINE or DIG modes of DISPLAY switch.

**Picture Monitor** — Output of incoming video with LINE STROBE added. Output impedance is 75 Ω. Output gain adjusted to unity with respect to A and B video input.

**Aux Video** — Output of incoming video. 75 Ω output impedance. Gain adjustable to unity with respect to A and B video input.

**OTHER CHARACTERISTICS**

**RGB/YRGB Staircase Input** — ≈12 V for 12.7 divisions deflection. RGB sweep length internally selected for 1/3 normal sweep. YRGB sweep length internally selected for 1/4 normal sweep length.

**Mains Voltage** — Ranges 100, 110, 120, 200, 220, 240 V ac ±10%. Frequency 48 Hz to 62 Hz, maximum power consumption 75 W. At factory, 1480, 1482 preset for 110 V ac. 1481, 1485 preset for 220 V ac.

**CHARACTERISTICS, OPTION 01**

**10X Probe Channel** — Scale Factor 1 V, 0.5 V, 0.2 V full screen with 10X attenuator probe. GAIN range ±10%. Tilt ≤5% on 50 Hz squarewave, high frequency response ±3%, 25 Hz to 5 MHz. Referenced to 50 kHz. Input resistance 1 MΩ, ±2%, not including probe. Input RC Product 20 μs, ±1%, not including probe. BNC connector accepts most Tektronix probes.

**10X Probe Calibrator** — Output voltage 1,000 V ± 0.005 V or 0.995 to 1.005 V.

**CHARACTERISTICS, OPTION 06 & 07**

**Duration** — 4 to 12 s, variable with front panel control.

**Linearity** — ±5% of full-screen over the length of the sweep.

**Indicator** — Front panel indicator on when slow sweep is operating but sweep is not running.

**Triggering Signal** — APL change ≤10% to 90% (Bump or Bounce), front panel selectable for either + or - level change.

**Sensitivity** — 400 mV to 2 V p-p composite video with APL change.

**Rate** — ≥0.2 Hz, free-runs at rates <0.2 Hz or with no triggering signal.

**Input** — Internal or External.

**50/60 Hz Squarewave Triggering** — Sensitivity 400 mV p-p minimum to 3 V p-p maximum. Input Impedance ≈ 10 kΩ ac coupled (Rear Panel loop-through connectors not return loss compensated.)

**PHYSICAL CHARACTERISTICS**

Dimensions	1480		R1480	
	mm	in	mm	in
Width	216	8.5	482	19.0
Height	210	8.25	133	5.25
Depth	430	16.9	457	18.0
Weights ≈				
Net	9.8	21.5	11.2	24.6
Shipping	24.1	53.1	24.1	53.1

**INCLUDED ACCESSORIES**

Two BNC right angle Adaptors (103-0031-00); SWR Slide, ext slide pair, (351-0195-01); various external graticules (see matrix below).

External Graticules w/Tek P/N	1480 R/C			
	1480 R/C	1481 R/C	1482 R/C	1485 R/C
Blank				
331-0393-00	x	x	x	x
NTSC Composite				
331-0393-01				x
CCIR				
331-0393-02				
CCIR K Visual				
331-0393-05		x		x
CCIR K Photo				
331-0393-07		x		x
GRAT A Visual				
331-0393-08				x
GRAT B Visual				
331-0393-18	x			x
GRAT A Photo				
331-0393-10				x
GRAT B Photo				
331-0393-17	x			x

**ORDERING INFORMATION**

- 1480C NTSC Waveform Monitor ..... \$5,495
- 1480R NTSC Waveform Monitor ..... \$5,495
- 1481C PAL Waveform Monitor\*1 ..... \$5,595
- 1481R PAL Waveform Monitor\*1 ..... \$5,595
- 1482C PAL-M Waveform Monitor ..... \$5,895
- 1482R PAL-M Waveform Monitor ..... \$5,895
- 1485C PAL/NTSC Dual Standard Waveform Monitor\*1 ..... \$5,795
- 1485R PAL/NTSC Dual Standard Waveform Monitor\*1 ..... \$5,795

**Option 01** — 1 MΩ, 20 pF Probe Input (not available with Option 06, probe not included) ..... +\$275  
Suggested Probe: P6108 10X Probe 2 m (010-6108-03); 3 m (010-6108-05) ..... \$101

**Option 02** — Carrying Case (cabinet version only) .... +\$140

**Option 04** — Tone Wheel Sync (1480C, and 1485C only. Replaces 529 or T04 in some RCA VTRs—Check with RCA for retrofit compatibility) ..... +\$795

**Option 06** — 124 Ω WECO Style Inputs (1480R only) +\$1,885

**Option 07** — Slow Sweep\*2 (Option 07 performance included with Option 06. Do not order with Option 06) . +\$465

**Option 08** — SECAM Field Identification (1481C, 1481R, 1485C and 1485R only) ..... +\$315

\*1 1481C/R, 1485C/R meets European Broadcast Union Tech. 3221-E, Guiding Principles for design of Television Waveform Monitors.

\*2 Option 07 satisfies EBA Tech 3321-E § 3.2.2.

**OPTIONAL ACCESSORIES**

**Mounting Cradles** — A cradle assembly, with associated bezel, allows the 1480C Waveform Monitor to be mounted alongside a 9 in Conrac Picture Monitor in a standard 19 in rack. A cradle and bezel are also available for mounting two 1480C's side-by-side.

**Cradle Assembly** — Requires 8 3/4 inch rack space.  
Order 014-0020-00 ..... \$225

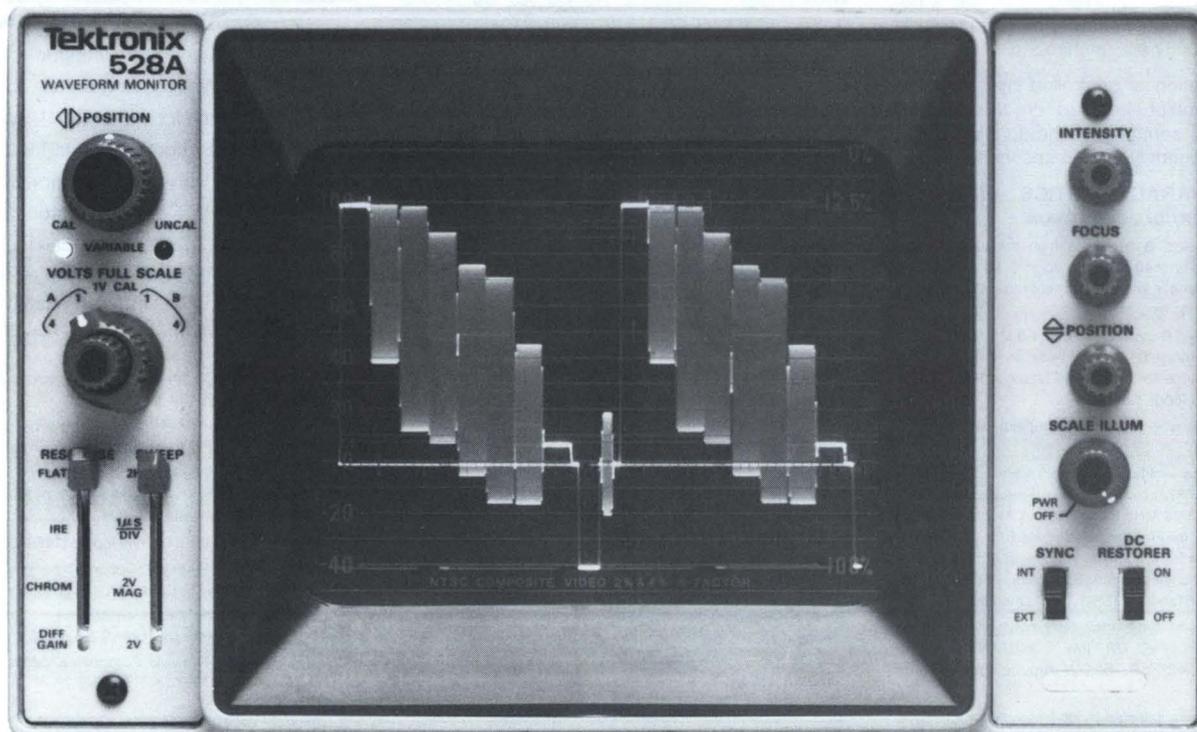
**Bezel** — For mounting 1480C on operator's left and SNA-9 picture monitor on right.  
Order 014-0023-00 ..... \$300

**Bezel** — For mounting 1480C on operator's right and SNA-9 picture monitor on left.  
Order 014-0024-00 ..... \$225

**Bezel** — For two 1480C's side-by-side.  
Order 014-0022-00 ..... \$200

**1480R Cradle Assembly** — For mounting the 1480R in a WECO backless rack.  
Order 426-0309-00 ..... \$40

**Trace Recording Cameras** — Both the Tektronix C-53P and the C-59AP can be used. The C-53P gives the largest image possible on Polaroid pack film. The C-53P requires a battery pack (016-0270-02) and camera adaptor (016-0342-00). The C-59AP is less expensive but produces a smaller image on the film. The C-59AP requires a camera adaptor (016-0224-01). See camera section of this catalog.



## 528A

**Internal Graticule CRT Ac or Dc Input Coupling**

**Video Output of Displayed Signal**

**Precise Frequency Response**

**Line Tilt and Pulse Response (K Factor) Measurements**

**Different Versions for 525 or 625 Line Systems**

**UL 1244 Listed and Certified to CSA 556B**

The Tektronix 528A Waveform Monitor is intended for television measurement and monitoring applications.

The 528A provides bright, easy-to-read waveform displays on a 5-inch (125 mm) CRT with illuminated internal graticule for parallax-free waveform monitoring and measurement while only requiring 5¼ inches of vertical height and ½ rack width mounting space. This permits mounting the 528A side-by-side with another 528A or other monitors, such as the Tektronix 1420 Vectorscope. A version of the 528A in a carrying case is also available.

Selectable from the front panel, either of two 75-ohm video inputs may be displayed and the selected input is available on the rear panel VIDEO OUT connector for routing to a picture monitor or other device. These inputs are normally ac coupled, but are easily set for dc coupling.

Calibrated 1 volt and 4 volt full scale sensitivities are provided for displaying video and sync levels and a Variable Volts Full Scale control permits uncalibrated displays from 0.25 volts to 4.0 volts full scale. A built-in 1 volt calibration signal may be switched on to confirm the vertical calibration.

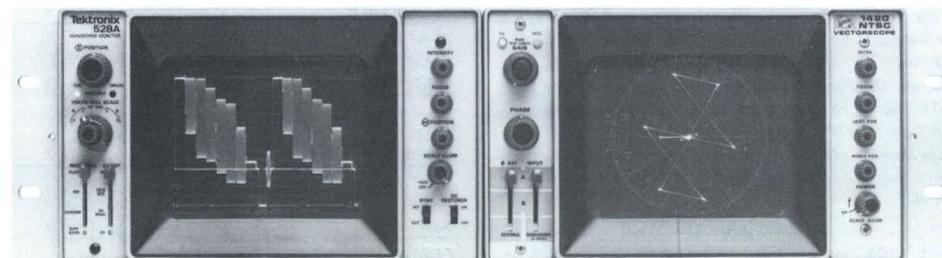
Input signal characteristics can be evaluated by using the Response switch in the Flat position for full bandwidth display, IRE position for IEEE Standard 205 roll off display, Chroma position for a display without luminance components, or Diff Gain position for displaying the differential gain error of the input signal. A dc restorer, that may be turned off when not required, maintains the back porch at an essentially constant level regardless of changes in signal amplitude, average picture level, and color burst. Selectable external sync capability is also provided.

Horizontal sweep selection includes: 2H (two line), 1 μS (expanded two line), 2V (two fields) and 2V Mag (expanded two-field). Displays of

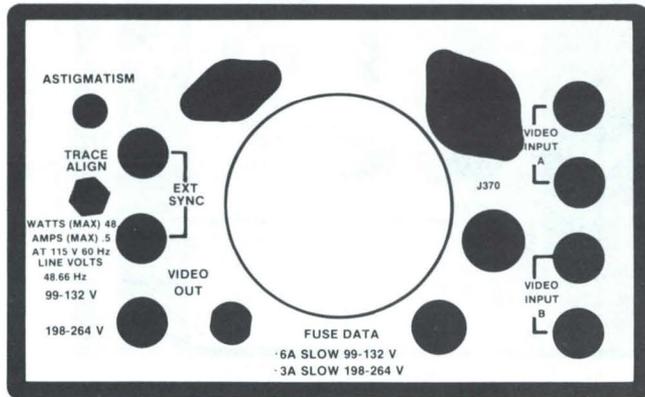
RGB and YRGB waveforms from a color camera are provided for by using a rear panel 9-pin interface.

This compact instrument is especially suited for monitoring signals from studio camera outputs, video system inputs and outputs, production switchers, and editing consoles. The 528A allows the operator to adjust and monitor video and sync levels, check and adjust system timing, ensure continuity of the signal and perform camera alignment procedures. The 528A also meets many of the requirements of video tape recorder monitoring bridges for VTR alignment and set-up, differential gain measurements, line time tilt measurements, and pulse response (K Factor) measurements. In general, the 528A is well-suited for all television applications where consistent video quality monitoring is requirement.

WAVEFORM MONITORS



528A Waveform Monitor mounted side-by-side with a 1420 Vectorscope in optional rack adaptor.



528A Back Panel

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Inputs** — Two rear panel BNC connectors: (A and B) provide two 75 Ω loop through connections (normally ac coupled but may be easily modified for dc coupling); return loss for both inputs (when terminated in 75 Ω, operating or nonoperating): At least 46 dB to 5 MHz.

#### Deflection Factor

1 V Full Scale: 140 IRE units ±1% with 1 V input.  
4 V Full Scale: 140 IRE units ±3% with a 4 V input.

**Variable** — Uncalibrated displays from 0.25 V to 4.0 V full scale.

#### Frequency Response Positions

Flat: 25 Hz to 3.6 MHz, ±1% of response at 50 kHz; 3.6 MHz to 5 MHz, +1%, -3% of response at 50 kHz.

IRE: Conforms to IEEE Standard 205 (Option 03, 625 line: attenuation at 4.43 MHz is >22 dB).

**Chroma** — Response at 3.58 MHz does not vary between FLAT and Chroma by more than 1%, bandpass ≈ 600 kHz.

(Option 03, 625 line: Response at 4.43 MHz does not vary between FLAT and Chroma by more than 1%, bandpass ≈ 800 kHz).

**Diff Gain** — Same as Chroma except that gain is increased by a factor of 3 to 5.5.

**Displayed Differential Gain** — 1% or less with 20 to 90% APL (when baseline is at 50 IRE and signal amplitude is adjusted to 100 IRE units).

**Transient Response** — 1 V Full Scale FLAT Response Position using 125 ns HAD sin<sup>2</sup> pulse and bar:

Preshoot: 1 IRE unit or less.

Pulse-To-Bar Ratio: 0.99:1 to 1:01:1.

Overshoot: 1 IRE units or less.

Ringing: 1 IRE units or less.

#### Low Frequency Tilt (dc restorer off)

Field Rate Squarewave: 1% or less.

Vertical Window: 1% or less.

25 μs Pulse: 1% or less.

**Maximum Input Levels** — ±5 V, ac coupled\*. ±1.1 V, dc coupled (±4.4 V in 4 V full scale position). Input signal amplitude should be limited to produce displays not exceeding 200 IRE units. (Flat and IRE positions).

\*Exceeds CCIR recommendation 567, Para D.2.3.

### OUTPUT

**Video Output** — The displayed signal is provided at the Video Out rear panel connector.

**Frequency Response** — 25 Hz to 5 MHz within 3%.

**Output Signal Amplitude** — 1 V within 15% for 140 IRE unit display.

**Dc Level on Output** — 2 V or less into 75 Ω load.

**Output Impedance** — 75 Ω nominal.

**Dc Restoration** — Slow acting back porch dc restoration. Blanking level shift caused by introduction of color burst is 1 IRE unit or less. APL changes from 50% to 10% or 90% will cause a blanking level shift of 1 IRE unit or less. (May be disabled).

**Calibrator** — An internal calibration signal provides a convenient reference to verify the deflection factor. Calibrator amplitude is 1.0 V p-p ± 1%.

### TIME BASE

Provides four time base operating modes; baseline visible in each mode with no external video or sync inputs.

**2 V Sweep Mode** — Repetition Rate: Equal to 1/2 field rate of applied video or external sync.

**2 V Mag Sweep Mode** — Magnification: ≈X20 (expands vertical blanking interval).

**2 H Sweep Mode** — Repetition Rate: Equal to 1/2 line rate of applied video or external sync.

**1 μs/Div Sweep Mode** — Accuracy — 1 μs/div ±3% within center 10 major divisions.

**Linearity** — 3% maximum non-linearity throughout horizontal position range within center 10 major divisions.

### EXTERNAL SYNC

**Input** — BNC, 75 Ω loop-through connection.

**Input Impedance** — ≈15 kΩ in parallel with ≈5 pF\*.

**Input Signal Levels** — 1.5 to 4.5 V p-p (composite sync will synchronize sweeps).

**Return Loss** — 46 dB minimum to 5 MHz (when terminated in 75 Ω loop through connection).

**Input Voltage Levels** — ±20 V maximum.

\*Exceeds CCIR recommendation 567, Para D.2.3.

### YRGB AND RGB

The 528A can be used with color camera processing amplifiers that provide the necessary signal switching and staircase signals. A 9-pin receptacle on the monitor's rear panel factory wired for RGB (3 step) input provides the interfacing connection.

**Staircase Amplitude** — A 10 V p-p signal will produce a horizontal display of 9 divisions ±15%.

**Maximum Staircase Input Level** — ±12 V dc (plus peak ac); maximum ac is 12 V p-p.

**Control Signals** — The RGB and YRGB modes may be initiated by the application of external voltages (12 to 15 V dc) to

selected pins on the rear panel 9-pin receptacle. (A 9-pin mating plug is supplied as a standard accessory.)

### AC POWER

**Line Voltage Ranges** — 99 to 132 V ac and 198 to 250 V ac, 48 to 66 Hz line frequency.

**Line Frequency Range** — 48 to 440 Hz.

**Power Consumption** — ≈48 W at 115 V ac, 60 Hz (528A is factory set to 115 V ac; Option 03, set to 230 V ac).

### SAFETY

All 528A Waveform Monitors shipped with case installed are UL 1244 listed and CSA 556B certified. 528A's shipped without a case are UL recognized components.

### ENVIRONMENTAL CHARACTERISTICS

**Operating Temperature Range** — 0°C to +50°C.

**Nonoperating Temperature Range** — -40°C to +65°C.

**Operating Altitude Range** — Sea level to 4500 m (15,000 ft).

**Nonoperating Altitude Range** — Sea level to 15 000 m (50,000 ft).

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	216	8.5
Height	133	5.25
Depth	470	18.5
Weight	kg	lb
Net with accessories	6.8	15.0
Shipping	10.4	23.0

### INCLUDED ACCESSORIES

Power cord; 9-pin, plug connector (136-0099-01).

### ORDERING INFORMATION

**528A Waveform Monitor (for 525 line) \$2,285**

**Option 01** — Without cover ..... - \$30

**Option 02** — With blue protective carrying cabinet ..... + \$65

**Option 03** — Modified for use with 625 line (CCIR) television systems and wired for use with 230 V ac 50 Hz power sources (unless otherwise specified) ..... NC

### OPTIONAL ACCESSORIES

**Side-by-Side Rack Adaptor**  
Order 016-0115-02 ..... \$180

**Blank Half-Rack Width Panel Assembly**  
Order 016-0116-00 ..... \$42

**Mounting Cradle** A cradle assembly with associated bezel and mounting brackets allows the 528A Waveform Monitor to be mounted alongside a 9-in Conrac Picture Monitor in a standard 19-in rack.  
Order 014-0020-00 ..... \$225

**Bezel and Brackets (left side mounting of 528A).**  
Order 014-0038-00 ..... \$315

**Bezel and Brackets (right side mounting of 528A).**  
Order 014-0037-00 ..... \$315

**Camera, Trace Recording** Tektronix C-5C Option 01 recommended for display photos. See camera section of this catalog.



R520A NTSC Vectorscope

## 520A/521A/522A

### Luminance Amplitude

### Chrominance Amplitude and Phase

### Differential Phase

### Differential Gain

The Tektronix 520A Series vectorscopes include three basic instruments available in both cabinet and rackmount configurations. These are the 520A/R520A for NTSC, the 521A/R521A for PAL, and the 522A/R522A for PAL-M.

#### DISPLAYS

The vector display shows the relative phase and amplitude of the chrominance signal on polar coordinates. To help identify these coordinates, the graticule has points corresponding to the proper phase and amplitude of the primary and complementary colors: R (Red), B (Blue), G (Green), C<sub>Y</sub> (Cyan), Y<sub>L</sub> (Yellow), and M<sub>G</sub> (Magenta).

Any errors in the color encoding, video-tape recording, or transmission processes that change these phase and/or amplitude relationships cause color errors in the television picture. Polar coordinate displays, such as those obtained on the 520A, 521A, and 522A CRT, have proven to be the best method for displaying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Amplitude is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) amplitude of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits ( $\pm 10^\circ$ ,  $\pm 20\%$ ). For the 520A (NTSC) the inner boxes indicate  $\pm 2.5^\circ$  and 2.5 IRE units, and correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup. For the 521A (PAL) and 522A (PAL-M), the inner boxes indicate  $\pm 3^\circ$  phase angle and  $\pm 5\%$  amplitude.

An internally generated test circle, used with the vector graticule, verifies quadrature accuracy, horizontal to vertical gain balance, and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase shifts are provided. You can accurately read large phase shifts from the parallax-free vector graticule. A precision calibrated phase shifter with a range of  $30^\circ$ , spread over 30 inches of dial length, is provided for measuring small phase shifts.

#### Dual Vector Display

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync, and switching transients are blanked. You can conveniently compare input/output signals from video equipment on Channel A or B for phase and/or amplitude distortion.

The subcarrier processing channel contains two uncalibrated 0 to  $360^\circ$  phase-shifters and one  $30^\circ$  Calibrated Phase shifter. While viewing Channel A or B, you can switch either of the uncalibrated phase-shifters, A $\phi$  or B $\phi$  into the subcarrier processing channel. Each phase shifter locks to its respective channel when A and B channels are time-shared, permitting independent phase control of the Channel A and B displays. Unequal signal paths causing phase shifts are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies.

Video cable lengths may be accurately matched for time delay at color subcarrier frequency to less than  $0.5^\circ$  phase difference.

You can make accurate amplitude measurements of chrominance and luminance from the CRT display. Use the internal 1 volt luminance amplitude calibration test signal to check the gain accuracy of Channel A and B amplifiers and the luminance channel.

#### Time Base Displays

The linear time base operates at the line rate. Color signals may be demodulated along any desired axis, I, Q, and R-Y (for NTSC), and U, and V (for PAL and PAL-M), and displayed at the line rate on a linear time base.

#### Luminance-Color Separation

A luminance channel permits the separation and display of the luminance (Y) component from the composite color signal. You can also combine the Y component with the output of the chrominance demodulators for R, G, and B displays at a line rate. Amplitude measurements of color signal components can be made with an accuracy of 3%.

#### Vertical Interval Test Signal Observation

You can display vertical Interval Test Signals from front-panel selected lines of either field 1 or 2 on the 520A Vectorscope. For the 521A (PAL) and the 522A (PAL-M), you can display ITS from either fields 1 and 3 or fields 2 and 4.

#### Differential Gain and Differential Phase Measurements

The two main chrominance signal distortions — differential gain and differential phase — can be measured on the 520A (NTSC), 521A (PAL), and 522A (PAL-M) Vectorscopes. Differential gain (Figure 1) is a change in color subcarrier amplitude as a function of luminance level. In the reproduced color picture, saturation will be distorted in the areas between the light and dark portions of the scene. The 520A, 521A, and 522A permit differential gain measurements with accuracy to better than 1%.

Differential phase (Figure 2) is a phase modulation of the chrominance signal caused by changes in the luminance signal level. The hue will vary with scene brightness in the reproduced color picture. Differential gain and differential phase occur separately or together. You can read differential phase errors from the precision calibrated phase shift control or directly from the differential phase markings on the graticule.

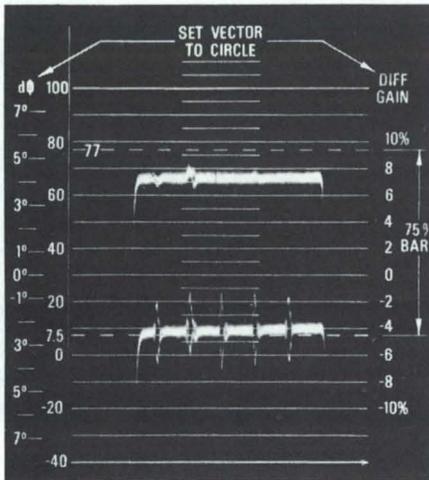


Figure 1. Differential Gain display from the 520A. Luminance is on in lower trace. On upper trace, luminance is off. Minor divisions of graticule indicate 1% differential gain. Double exposure.

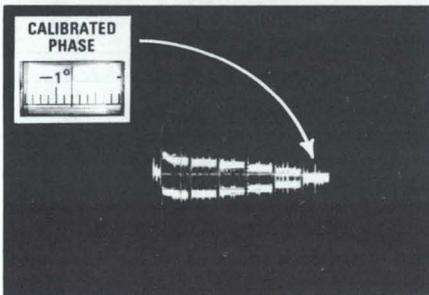
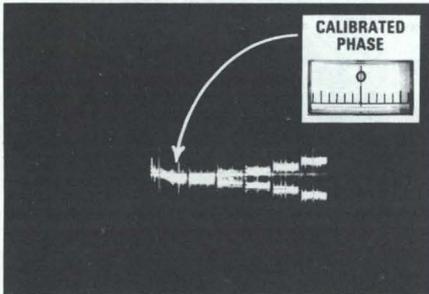


Figure 2. Differential Phase presentation from the 520A using a modulated staircase signal. Trace overlay technique provides excellent resolution for measuring small phase changes. The differential phase error from the reference point in top photo (first step of staircase signal overlaid) to point of measure in bottom photo (sixth step overlaid) is 1.2°.

**CHARACTERISTICS**

**Graticule** — Two separate graticules provide reference for vector and line sweep displays. The parallax-free vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

**Z-Axis Input** — The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest.

**Video Inputs** — Dual BNC input connectors for each channel permit 75 Ω loop-through operation with a return loss >46 dB to 5 MHz (exceeds CCIR recommendation 567, Part D and D.2). Amplitude range is 0.7 V to 1.4 V Video (sync tip to peak white).

**AC POWER**

**Mains Voltage Range** — 90 to 136 V ac or 180 to 272 V ac.  
**Mains Frequency** — 47 to 63 Hz.

As displayed on 520A

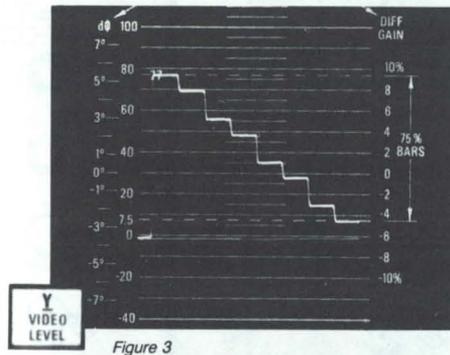


Figure 3

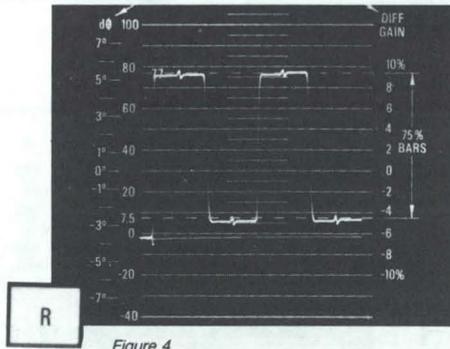


Figure 4

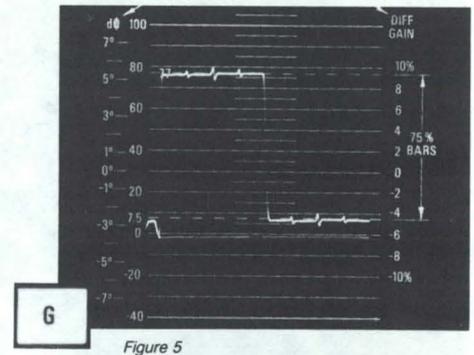


Figure 5

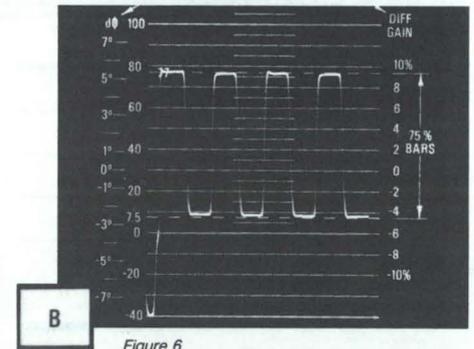


Figure 6

75% amplitude Color Bar Signal displayed on the line sweep graticule. Pushbuttons select line-sweep displays of luminance (Figure 3), decoded Red (Figure 4), decoded Green (Figure 5), and decoded Blue (Figure 6).

**Power Consumption** — 95 W maximum at 115 V ac/60 Hz. (Rear panel selector provides rapid accommodation to six line-voltage ranges. Factory set at 115 V ac for the 520A and 522A and 230 V ac for the 521A.)

**ENVIRONMENTAL CHARACTERISTICS**

**Operating Temperature Range** — 0°C to +50°C ambient.

**MECHANICAL CHARACTERISTICS**

The vectorscopes are available in two mechanical configurations, a cabinet model and a rackmount model. These versions are electrically identical. The rackmount models fit in a 19 in rack and are provided with slide-out assemblies for convenient access to internal components.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	429	16.9	483	19.0
Height	178	7.0	178	7.0
Depth	487	19.2	483	19.8
<b>Weights</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net	15.0	33.0	15.0	33.0
Shipping ≈	27.7	61.0	27.7	61.0

**INCLUDED ACCESSORIES**

Smoke-gray filter, installed (378-0581-00); power cord; Rackmount: same as cabinet but includes rackmounting hardware, and slide-out assembly (351-0195-01).

**ORDERING INFORMATION**

<b>520A NTSC Vectorscope (Cabinet) ....</b>	<b>\$7,425</b>
<b>R520A NTSC Vectorscope (Rackmount) .....</b>	<b>\$7,425</b>
<b>521A PAL Vectorscope (Cabinet) .....</b>	<b>\$7,725</b>
<b>R521A PAL Vectorscope (Rackmount) .</b>	<b>\$7,725</b>
<b>522A PAL-M Vectorscope (Cabinet) ...</b>	<b>\$8,295</b>
<b>R522A PAL-M Vectorscope (Rackmount) .....</b>	<b>\$8,295</b>

**OPTIONAL ACCESSORIES**

**75 Ω Voltage Step-Up Termination** when used with a Tektronix Vectorscope, the 75 Ω Voltage Step-up Termination provides an X5 increase in chrominance amplitude and lets you make more accurate Differential Gain and Differential Phase measurements. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the vectorscope.

**Voltage Step-up Termination** for use with 520A (NTSC), 522A (PAL-M) Vectorscopes.

Order 011-0100-01 ..... **\$70**

**Voltage Step-up Termination** for use with the 521A Vectorscope.

Order 011-0109-00 ..... **\$85**

**Single Sideband Chroma Amplitude Corrector** designed for use with a Tektronix Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides an X2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 7 Ω.

**Chroma Amplitude Corrector** for use with 520A (NTSC), 522A (PAL-M) Vectorscopes.

Order 011-0107-01 ..... **\$70**

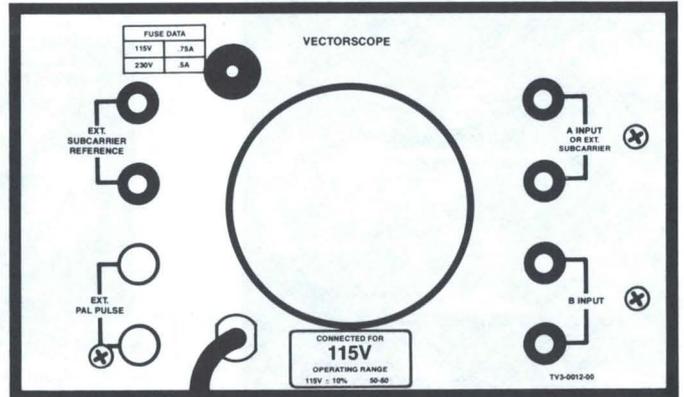
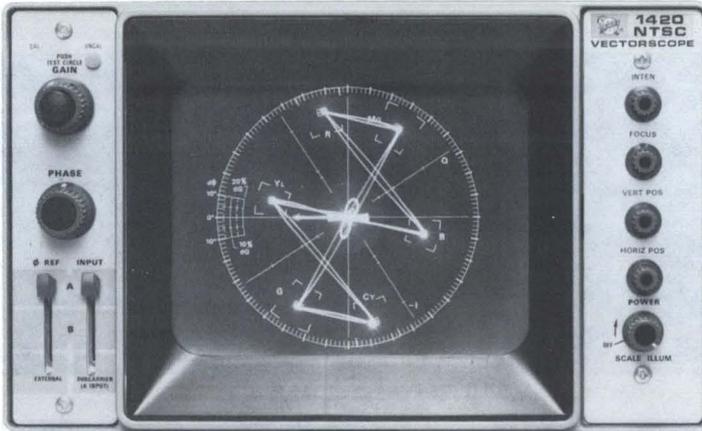
**Chroma Amplitude Corrector** for use with 521A Vectorscope.

Order 011-0108-01 ..... **\$105**

**Recommended Camera** for display photographs: C-59AP with adaptor 016-0295-01. See camera section of this catalog for information.

**R520A Cradle Assembly** — For mounting the 520A in a WECO backless rack.

Order 426-0667-00 ..... **\$40**



**1420 Series**

**Precise Vector Phase Accuracy**

**Parallax-free Internal Graticule**

**Half Rack Width**

**Proven Performance**

**Available in NTSC, PAL, PAL-M Models**

**Continuous 360° Phase Control**

1420 Series Vectorscope rear panel



1420 NTSC Vectorscope shown side-by-side with a 528A Waveform Monitor

**CHARACTERISTICS**

**Chrominance Bandwidth** — Upper -3 dB Point: Fsc +550 kHz ±100 kHz; Lower -3 dB Point: Fsc -550 kHz ±100 kHz.

**Vector Phase Accuracy** — Within 1°.

**Pull-In Range** — Within 50 Hz of subcarrier frequency.

**Phase Control Range** — 360° continuous rotation with goniometer.

**Input Amplitude Range** — 1 V ±6 dB.

**Input Dc Voltage (Maximum)** — +20, -20 V.

**Front Panel Gain Control Range** — Unity to +15.12 dB; Unity to -6 dB.

**Input Return Loss** — At least 46 dB to 5 MHz.

**Input Amplitude Range External Subcarrier** — 1 to 4 V p-p.

**Phase Shift with Burst Amplitude Change** — Within 2° from nominal burst amplitude to ±6 dB.

**Phase Shift with Subcarrier Source Change** — Within 0.5°.

**Phase Shift with Input Channel Change** — Within 0.5°.

**Phase Shift with Front Panel Gain Change** — Within 1°.

**Burst Jitter** — 0.5° or less.

**Differential Phase** — 1° or less.

**Differential Gain** — 1% or less.

**Graticule** — Internal, non-parallax, illuminated.

**AC POWER**

**Mains Voltage Ranges** — 90 to 132 V ac, and 180 to 250 V ac. Selectable by internal plug-jumpers.

**Typical Power Consumption** — 45 W.

**Maximum Amps at 115 V ac, 60 Hz** — 0.5 A.

**Mains Frequency** — 48 Hz to 66 Hz.

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature Range**

Nonoperating: +40°C to +65°C.

Operating: +0°C to +50°C.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	mm	in	mm	in
Width	216	8.5		
Height	133	5.3		
Depth	470	18.5		
Weight ≈	kg		lb	
	kg	lb	kg	lb
Net (with Option 02)	6.8	15.0		
Shipping	9.1	20.0		

**INCLUDED ACCESSORIES**

75 Ω termination (011-0102-00).

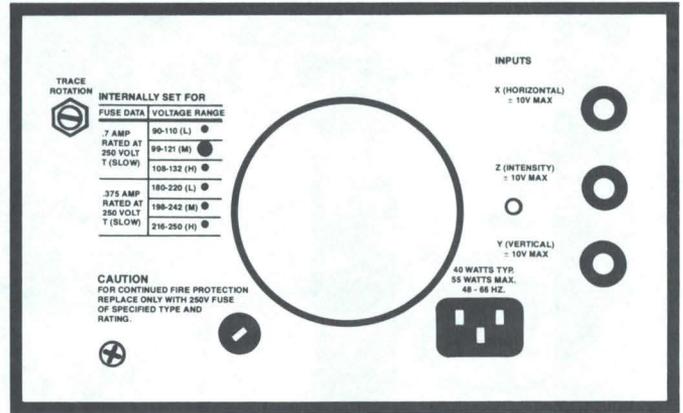
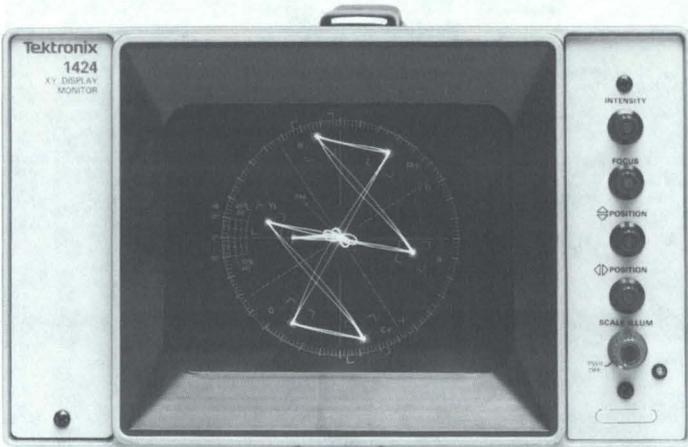
**ORDERING INFORMATION**

<b>1420</b> Vectorscope for NTSC, (factory wired for 115 V) .....	<b>\$2,795</b>
<b>1421</b> Vectorscope for PAL, (factory wired for 230 V) .....	<b>\$2,895</b>
<b>1422</b> Vectorscope for PAL-M, (factory wired for 115 V) .....	<b>\$3,150</b>
<b>Option 01</b> — Vectorscope without cabinet .....	<b>-\$30</b>
<b>Option 02</b> — Vectorscope with protective carrying cabinet .....	<b>+\$65</b>

**OPTIONAL ACCESSORIES**

<b>Side-by-Side Rack Adaptor</b> Order 016-0115-02 .....	<b>\$180</b>
<b>Blank Half Rack Width Panel Assembly</b> Order 016-0116-00 .....	<b>\$42</b>
<b>Graticule External</b> , Scaled in 8 x 10 div. Order 331-0406-01 .....	<b>\$4.65</b>
<b>Camera, Trace Recording</b> Tektronix C-5C Option 01 recommended for display photos. See camera section of this catalog.	

VECTORSCOPIES



1424 Display Monitor rear panel

**1424 XY Display Monitor**

Available in NTSC and PAL Models

Half-Rack Width

Proven Performance

The 1424 XY Display Monitor provides a vector display of the chroma portion of the television signal by utilizing the decoder in a Tektronix 650HR Picture Monitor or other suitable monitor. By interfacing the 1424 with the proper picture monitor, vector displays for NTSC, PAL and SECAM color television systems can be obtained. Dual standard displays can be obtained by interfacing the 1424 with a Tektronix 655HR (NTSC & PAL) Picture Monitor or a 656HR (SECAM & PAL) Picture Monitor.

The Z axis input allows the writing beam to be modulated for special applications.

**CHARACTERISTICS**

**VERTICAL AND HORIZONTAL DEFLECTION SYSTEMS**

**Deflection Factor**

Vertical (Y): 0.100 V/cm  $\pm$  2%.  
Horizontal (X): 0.100 V/cm  $\pm$  2%.

**Display Linearity**

Vertical Axis:  $\leq$  2% (center 6 divs).  
Horizontal Axis:  $\leq$  6% (center 8 divs).

**Input R and C** — 100 k $\Omega$ , within 10%, paralleled by  $\leq$  30 pF.

**Bandwidth (X and Y) Amplifiers** —  $\geq$  500 kHz.

**Signal Source Impedance Level** —  $\leq$  1 k $\Omega$ , recommended.



1424 XY Display Monitor shown side-by-side with a 528A Waveform Monitor

**Z AMPLIFIER**

**Input Requirements** — Input Signal: Analog input, dc to 500 kHz over a 0.0 V to +1 V range. (Linear amplifier modulates writing beam.)

**Input R and C** — 100 k $\Omega$ , within 10%, paralleled by  $\leq$  70 pF.

**Signal Source Impedance Level** —  $\leq$  1 k $\Omega$ , recommended.

**Circuit Response**

Risetime: 150 ns or less.

Falltime: 300 ns or less.

**Bandwidth** — Dc to 500 kHz.

**AC POWER**

**Mains Voltage Range** — 90 to 132 V ac and 180 to 250 V ac.

**Typical Power Consumption** — 40 W.

**Maximum Amps at 115 V ac, 60 Hz** — 0.52 A.

**Mains Frequency** — 48 Hz to 66 Hz.

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature**

Nonoperating:  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

Operating:  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ .

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	216	8.5
Height	133	5.3
Depth	470	18.5
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net with cabinet	7.0	15.5
Net without cabinet	5.9	13.0
Shipping $\approx$	9.1	20.0

**ORDERING INFORMATION**

**1424 XY Display Monitor for**

NTSC/PAL ..... **\$2,450**

**Option 01** — XY Display Monitor without cabinet ..... **-\$30**

**Option 04** — External SECAM/PAL Graticule, Blank CRT ..... **+\$100**

**Option 05\*** — Combination NTSC/PAL Internal Graticule CRT ..... **+\$100**

\* For Ampex VTRs — check with Ampex for compatibility.

**OPTIONAL ACCESSORIES**

**Side-by-Side Rack Adaptor**

Order 016-0115-02 ..... **\$180**

**Blank Half-rack Width Panel Assembly**

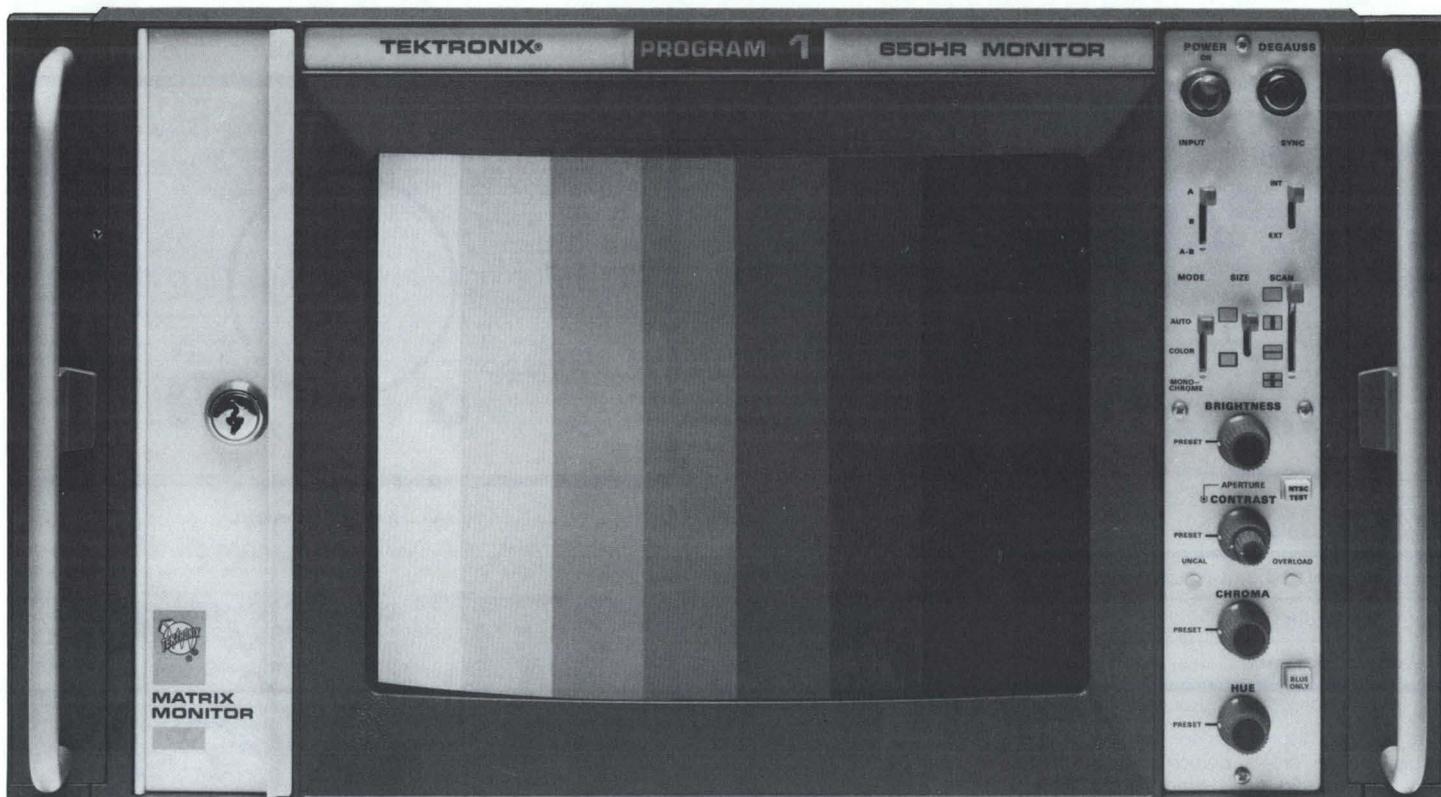
Order 016-0116-00 ..... **\$42**

**Graticule External**, scaled in 8 x 10 divs.

Order 331-0406-01 ..... **\$4.65**

**Camera, Trace Recording** Tektronix C-5C camera recommended for display photos. See camera section of this catalog.

DISPLAY MONITORS



650HR High Resolution Color Monitor

## 650HR

High Resolution Trinitron CRT

Variable Aperture Correction

Precise Color Tracking Over Full Signal Range

Two Switchable Inputs Isolated From Ground for Hum Rejection

External Sync Switching Capability

Differential (A-B) Inputs for Sync Timing and Burst Phasing Adjustments

NTSC, PAL, and Dual Standard Versions — RGB Inputs Optional

Rapid Retrace — Entire active Picture Area Can Be Displayed in Underscan

Precision Decoding — Outputs Can be Used to Present Vector Displays on X-Y Oscilloscopes

Unique "Blue Only" Capability for Optimizing VTR Settings

The Tektronix 650HR Series Color Picture Monitors are designed for exacting applications where picture quality is particularly important. The 650HR offers the features and capabilities of earlier Tektronix 650 Series Color Monitors and adds a high resolution Trinitron CRT and improved decoder. The improved CRT features more phos-

phor stripes than before, and the decoder gives wider (1.3 MHz) bandwidths for even greater detail.

The unique Blue Only mode ties the blue drive signal to the red, green, and blue channels simultaneously. This provides a monochrome display with a high sensitivity to VTR noise and banding problems.

Circuits in the Tektronix 650HR Series are designed for color stability and consistency. Outputs are provided from the precision decoders and may be used to drive an X-Y monitor for a vector display. The regulated EHT supply is not affected by extreme changes in APL even when calibrated brightness, at peak white, is set at 30 fL. Raster size is held within 1%, while excellent clamping maintains a stable black level with a 0% to 100% range of APL.

The Mode switch controls the chrominance channel activation. In the Auto mode, the chrominance channel is activated by the presence of burst. In the Color mode, the chrominance channel is activated whether burst is present or not. In the Monochrome mode, the chrominance channel is deactivated at all times.

In all Tektronix Color Monitors, you can shift the picture either horizontally or vertically, or both (pulse cross). This lets you monitor sync, burst, blanking, vertical interval test and reference signals. When the monitor is operating in any of these display modes, brightness is automatically advanced to permit observation of the sync pulses and burst. Expansion of the vertical scan is provided in the pulse cross and vertical delay modes, so you can view individual lines in the vertical blanking interval.

The 650HR Series Monitors can be used in rack installations or separately in their own cabinets. They are compact, requiring only 276 mm (10.5 in) vertically. Versions are available for NTSC and PAL systems. Dual standard and RGB input versions are also available.

### CHARACTERISTICS

**Input Signal Level** — 0.5 V p-p minimum composite video 2 V p-p maximum. (Exceeds CCIR recommendations 567, Part D and D.2.)

**Impedance** — Unterminated: High Z bridging inputs loop-through compensated for 75  $\Omega$  (not internally terminated). Return Loss:  $\geq 46$  dB to 5 MHz, power on or off, input in use or not.

**Maximum Safe Input** — Exceeds CCIR Recommendation 451-2 ( $\pm 5$  V peak).

**Hum Rejection** — Hum is  $\geq 50$  dB down when 4 V maximum RMS common mode mains hum signal is applied to the monitor in floating ground mode.

**NTSC Luminance Channel** — Bandwidth (notch filter removed)  $\approx 6$  MHz. Subcarrier notch filter automatically removed when burst is not present and MODE switch is in AUTO position. Subcarrier notch filter removed when MODE switch is in Monochrome position. Dc Restoration back porch type; not affected by burst. Mains hum reduction due to dc restorer is  $< 6$  dB. Amplitude Linearity: within 2%.

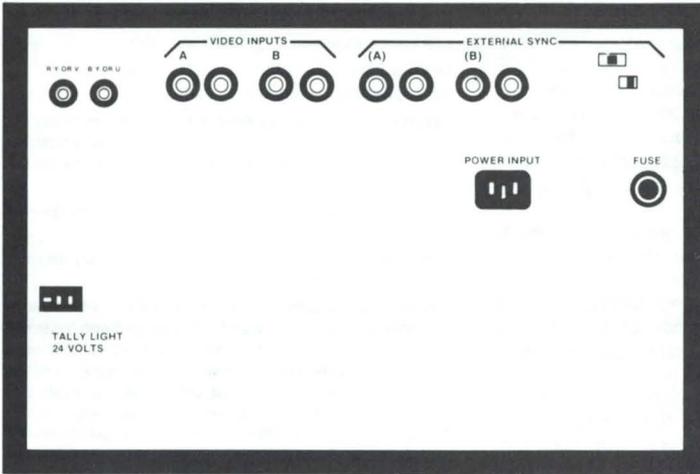
**NTSC Chrominance Channel** — Demodulation Axis: R-Y, B-Y. Bandpass: 1.3 MHz equiband. Gain Range: preset at 0 dB; adjustable from  $-6$  dB to  $+10$  dB.

**PAL Luminance Channel** — Bandwidth (notch filter removed)  $\approx 6$  MHz. Subcarrier notch filter can be removed by changing internal jumper. Subcarrier notch filter normally left in circuit.

**PAL Chrominance Channel** — Demodulation Axis: U, V. Bandpass:  $\approx 1.2$  MHz. Gain Range: Preset at 0 dB; adjustable from  $-6$  dB to  $+10$  dB.

**Residual Subcarrier Detection (on applied signal)** — Color of displayed picture will shift due to any residual subcarrier. This feature can be inhibited by a jumper on the decoder board.

**Chrominance/Luminance** — Time Error:  $< 30$  ns. Gain Error:  $< 3\%$ .



Rear Panel

**Delay** — Red to green to blue <50 ns.

**Subcarrier Regeneration** — Phase Error: within 1° with input burst variation of ±10 Hz from subcarrier nominal burst frequency. With Temperature Variation: within 5° with ambient temperature variation from 0°C to +50°C; with 1°, for any +10°C increment within the range 0°C to +50°C. With Input Signal Variation: within 1° with input signal variations of ±3 dB from 1.0 V, within 3° with variation of burst/sync ratio of -6 dB to +10 dB. Breezeway Stability: ≤0.2° for burst timing errors including burst width variance (8 to 11 cycles), and breezeway variance ±0.28 μs. Phase Error Due to Noise: within 1° with RMS white noise at -24 dB (0 dB = 700 mV RMS).

**PICTURE**

**Height** — 184 mm (7.2 in).

**Width** — 244 mm (9.6 in).

**Underscan** — ≈20% reduction in both height and width.

**Aspect Ratio** — 4:3.

**Deflection Linearity** — Vertical and Horizontal: 1% of picture height within a central area bounded by a circle whose diameter equals picture height, ±2% of picture height outside of central area.

**Convergence Error** — <1 mm within the central area. Outside of the central area, color separation (misconvergence) is <2 mm.

**Unblanking** — All active picture elements are displayed. (Horizontal retrace is accomplished within 10 μs.)

**Color Temperature** — 6500°K. Easily adjustable to other standards.

**Calibrated Contrast** — 30 fL at peak white of standard 1 V signal.

**Calibrated Brightness** — Displayed black may be preset to a level appropriate for ambient conditions.

**EHT (Extremely High Tension)** — 19 kV nominal, regulated. Load variations cause <1% picture size variation. Monitor complies, as of date of manufacture, with applicable DHHS standards under Radiation Control for Health and Safety Act of 1968.

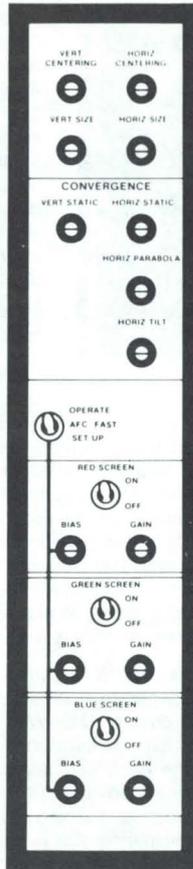
**Kinescope Protection** — Failure of horizontal or vertical scanning shuts off the EHT. Failure of HV Regulator circuit does not cause EHT to soar excessively. EHT supply is current limited.

**Heater Voltage** — Regulated dc.

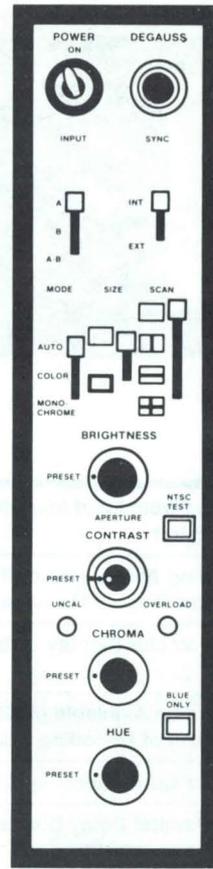
**SYNC and TIMING**

**Signal Range** — Composite sync 0.5 V p-p to 8 V p-p or composite video 0.5 V p-p to 2 V p-p.

**Impedance** — Unterminated: High Z bridging inputs loop-through compensated for 75 Ω (not internally terminated). Terminated: 75 Ω. Return Loss: ≥46 dB to 5 MHz with respect to 75 Ω.



Left Panel — Convergence is simple in the 650HR Series. Adjustments are located behind a locked panel door.



Right Panel Operational Controls — The variable aperture control is concentric with the contrast control.

**Synchronization** — Stable subcarrier regeneration, limited by line sync performance. Line sync white noise immunity is 20 dB. Field sync white noise immunity is 20 dB. Field sync stable with tilt equal to 100% of sync amplitude in vertical blanking. Stable with 20 IRE mains hum.

**AFC (Two Loop AFC Type)** — Phase Corrector: Corrects for phase errors due to side pincushion correction and other effects within the monitor. Slow AFC: Displays timing errors of incoming sync, particularly, 60 Hz or 240 Hz timing errors. Bandwidth is ≈25 Hz. Fast AFC: Largely corrects for incoming sync errors, ≈2 kHz bandwidth.

**Scan Delay** — Horizontal Delay: ≈1/4 line; displays burst. Vertical Delay: Displays the vertical blanking interval of the input signal expanded ≈2.5 times unless underscan is activated. If the underscan button is depressed, vertical expand is inhibited.

**AC POWER**

**Mains Voltage Range** — 115 V: within 10% (104 V ac to 126 V ac). 230 V: within 10% (207 V ac to 250 V ac maximum). 650HR, 650HR-1 are factory set for 115 V. 651HR, 651HR-1, 655HR, 652HR and 652HR-1 are factory set for 230 V.

**Crest Factor** — ≥1.3.

**Mains Current** — 1.5 A RMS maximum at 115 V, 60 Hz. 0.75 A maximum at 230 V, 50 Hz. Current is substantially higher during degaussing.

**Degaussing Surge Current** — 5 A RMS.

**Power Consumption** — 150 W maximum, 110 W typical.

**Mains Frequency** — 48 Hz to 66 Hz.

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature Range** — Nonoperating: -40°C to +65°C. Operating: 0°C to +50°C.

**Altitude Range** — Nonoperating: to 15 km (50,000 ft). Operating: to 4.5 km (15,000 ft).

**Shock** — To 30 g's, 1/2 sine, 11 ms duration.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	426	16.8	483	19.0
Height	279	11.0	266	10.5
Depth	419	16.5	464*	18.3*
Weights	kg	lb	kg	lb
Net	22.7	50.0	23.5	52.0
Domestic Shipping	28.5	65.0	30.4	67.0
Export Shipping	36.3	80.0	37.2	82.0

\*With handles

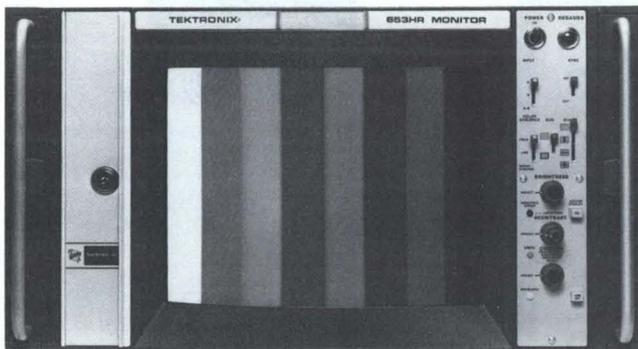
**650HR ORDERING INFORMATION**

All 650HR Monitors are shipped with rackmounting hardware. Cabinet version hardware is also included.

<b>650HR NTSC</b> .....	<b>\$5,650</b>
<b>650HR-1 NTSC + RGB</b> .....	<b>\$5,850</b>
<b>651HR PAL</b> .....	<b>\$5,890</b>
<b>651HR-1 PAL + RGB</b> .....	<b>\$6,130</b>
<b>652HR PAL-M</b> .....	<b>\$6,300</b>
<b>652HR-1 PAL-M + RGB</b> .....	<b>\$6,530</b>
<b>655HR NTSC + PAL</b> .....	<b>\$6,530</b>
<b>655HR-1 NTSC + PAL + RGB</b> .....	<b>\$6,790</b>

For Vector Display with NTSC, PAL or NTSC + PAL Monitors Order Type 1424 Display Unit ..... **\$2,450**

PICTURE MONITORS



653HR Color Picture Monitor

## 653HR

**Color Sequencing from Field Identification Signals or Line Burst**

**Precision Decoding Allows Use of R-Y, B-Y Outputs for Vector Display Measurements**

**RGB Inputs with Vector Display Outputs (Optional)**

**PAL/SECAM Version Available (656HR) with Front Panel Control of Decoding Standard**

**Variable Aperture Correction**

**Vertical and Horizontal Delay Display Modes**

**Reduced Chrominance Line Crawl**

**Indicates Color Sequence Error**

**Rapid Retrace — Entire Picture Area is Displayed in Reduced Scan**

**Two Switchable Inputs Isolated From Ground for Hum Rejection**

Tektronix SECAM Color Picture Monitors are identical to the 650HR Series except they are specially designed for use on SECAM systems. They are available in versions for SECAM (653HR), SECAM + RGM (653HR-1), SECAM/PAL (656HR) and SECAM/PAL + RGB (656HR-1).

All monitors provide unique measurement possibilities and are designed for exacting applications. For example, with an auxiliary vector display, encoding tolerances (including white reference quality) are displayed for both 75% and 25% amplitude color bars. You can observe encoder-limiting action on field identification signals and encoder transient behavior.

Color sequencing is front panel controlled by a three position mode switch. In the Field mode, field identification signals are used for color sequencing and a color display is enabled by the presence of detectable field identification signals. In the Line mode, line burst determines color sequence, and a color display is enabled whenever detectable SECAM subcarrier is present. Use of the Monochrome mode blanks the chrominance channel.

In the internally selectable Forced-Color mode, the very high limiting ratio of the chrominance channel lets you use the Tektronix 653HR Series monitors to search for very small amounts of crosstalk or other unwanted signals. By displaying the chrominance portion of such signals on a brightened display, you can easily identify the source. Two PROMs (Programmable Read Only Memories) are used in the Tektronix 653HR Series Monitors for generating accurate timing signals. Their use eliminates the need for many

internal adjustments and possible drift related to the timing of internal signals. One of these PROMs is programmed with information corresponding to the lines containing subcarrier (including field identification lines) in 625/50 SECAM systems. The monitor then serves as a check on improper additions or deletions of lines that might possibly occur in improperly adjusted VTRs, processing amplifiers, and switchers.

Chrominance line crawl is greatly reduced by using separate acoustical delay lines; one for D'R and one for D'B. With front panel controls, you can turn off luminance or chrominance, and examine each one separately. Brightness is automatically advanced for easier viewing when luminance is turned off for examination of chrominance. For purity checks, you can set up the equivalent of a flat field display by switching luminance off in a monochrome mode (chrominance off).

The monitor's chroma control has two operating modes. When the control is in, the chrominance is independent of subcarrier amplitude. When the control is out, the chrominance is proportional to subcarrier amplitude. In the first mode, the saturation will vary with incoming video level. In the latter mode, correct saturation will be maintained for varying signal levels. In either mode, both a preset (detent) position and a variable range are available. Switching between the two modes in the preset position provides an indication of abnormal chrominance or luminance amplitude.

### CHARACTERISTICS

#### SECAM PERFORMANCE-LUMINANCE CHANNEL

**Bandpass without Chrominance Trap** — Aperture Corrector set for 0 dB. Amplitude:  $\pm 0.5$  dB to 5 MHz. Aperture Corrector Maximum Range: 8 dB; doubled peaked at 2.5 MHz and 7 MHz;  $\leq 3$  dB between 4.0 MHz and 5 MHz.

**Chrominance Filter** — Subcarrier Rejection:  $>25$  dB at 4.250 and 4.406 MHz,  $<-1$  dB at 5.5 MHz. NOTE: The chrominance filter is removed from the luminance channel whenever the display is monochrome.

**Pulse Distortion** —  $<1\%$  tilt on 50 Hz squarewave.  $<0.5\%$  tilt on 15 kHz squarewave.

**DC Restoration** — Back porch type, not affected by burst. Mains hum reduction due to dc restorer is  $<6$  dB.

**Amplitude Linearity** — Within 2%.

**Luminance Off Faculty** — Displays chrominance only and automatically advances brightness.

#### SECAM PERFORMANCE-CHROMINANCE CHANNEL

**High Frequency De-emphasis** — Matching to encoder high frequency pre-emphasis: Error  $\leq 0.5$  dB over the range 3.9 MHz to 4.75 MHz;  $<3$  dB at 2.85.

**Drift (CENTER FREQUENCY)** — Within  $\pm 20$  kHz.

**Luminance Rejection** —  $>46$  dB at 15 kHz.

**Limiting Ratio** —  $>60$  dB.

**Ultrasonic Delay Line Error** —  $<30$  ns.

**Crosstalk at Input to Discriminators** — Between Direct and Delayed Chrominance Signals: Alternate line crawl on display is minimized through the use of separate delay lines for the D'R and D'B chrominance signals.

**Discriminator Linearity** — Overall within  $\pm 1\%$ . Incremental within 1%.

**Demodulator Center Frequency** — Clamped to crystal reference stabilized within  $\pm 0.250$  kHz.

**Chrominance Sequence and Color Enable** — Chrominance sequence and enable are statistically averaged with hysteresis for best performance under poor signal-to-noise conditions. Field Mode: Based upon field identification signals. Chrominance Amplitude: Disable when chrominance is more than 12 dB low, may be internally selected. Line Mode: normally based upon line burst with no chrominance amplitude disable. An internal jumper provides chrominance amplitude disable if required.

**Chrominance Unblanking** — Programmed internally according to 625 line 50 Hz SECAM standards. Field identification signals are displayed in vertical scan delay modes.

**Saturation** — Selectable to treat subcarrier as FM signal or to vary the saturation with incoming chrominance level. Independent of Subcarrier Amplitude: Gain Error  $<3\%$ . Dependent on Subcarrier Amplitude: Tracking error  $<5\%$  for signals within  $\pm 3$  dB to  $-6$  dB of normal amplitude. Chroma Control Separately Adjustable:  $\pm 6$  dB.

**Cross Talk** — Between R-Y and B-Y  $>40$  dB attenuation.

**Chrominance/Luminance Time Error** —  $<60$  ns with properly adjusted bell filter and low frequency de-emphasis.

**Sequence Error Indicator** — When the front panel red light indicates that the incoming SECAM signal has a chrominance sequence opposite to that indicated by an externally applied 7.8 kHz signal. Also when the monitor is used in the Line mode the light will indicate when the field identification signals are reversed with respect to the Chrominance Sequence present during the active picture.

#### VECTORSCOPE OUTPUTS

**Calibrated Modes (dots in boxes)** — Selected by front-panel control for either 75% color bars or 25% color bars (SECAM and RGB only). Vector locations are within  $\pm 2\%$  of vector magnitude.

**Vectorscope Drive Capability** — Suitable to drive 10 ft of 75  $\Omega$  coaxial cable (unterminated) to X-Y display.

**Required X-Y Display Deflection Sensitivity** — 0.05 V/cm on both X and Y axis.

**Required X-Y Display Input Resistance** —  $\geq 100$  K  $\Omega$ .

**RGB Vector Display** — R, G, and B input signals are matrixed to form R-Y and B-Y signals which are switched to the rear-panel vector output connectors when the RGB inputs are selected.

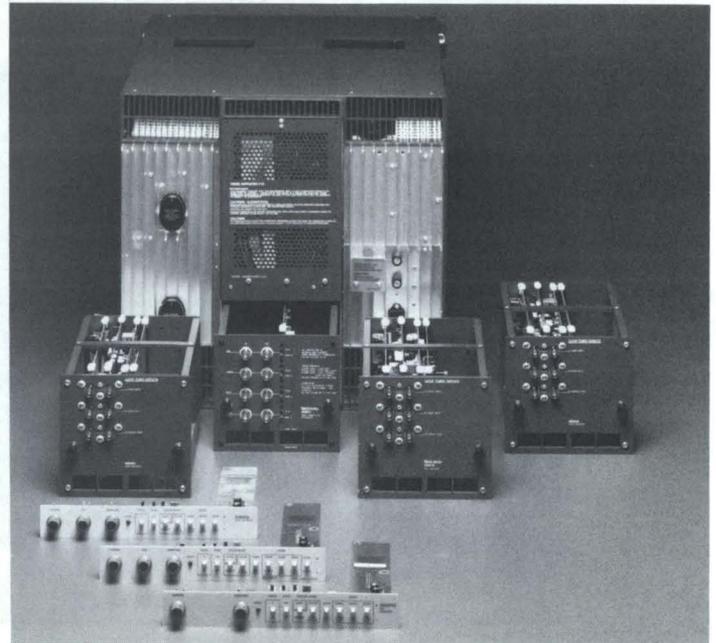
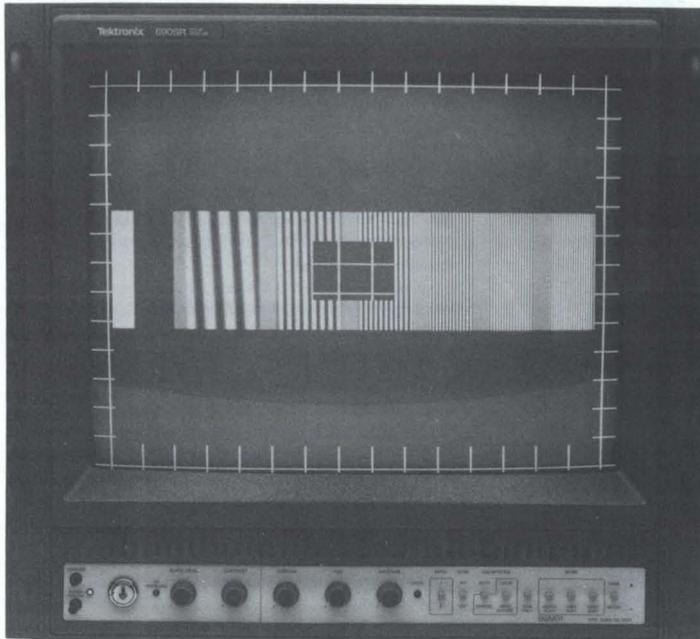
**RGB Matrix Error** — R-Y and B-Y relative output signal amplitudes are within  $\pm 2\%$  of desired values when equal R, G, and B signals are supplied.

**RGB Centering** — Black level is clamped to within  $\pm 9$  mV which corresponds to  $\pm 1$  mm in the 75% vector display.

**Other Inputs and Outputs** — 7.8 kHz input, 7.8 kHz output, and field 1 pulse output.

#### ORDERING INFORMATION

653HR SECAM Monitor .....	\$6,900
653HR-1 SECAM + RGB .....	\$7,140
656HR SECAM + PAL .....	\$7,370
656HR-1 SECAM + PAL + RGB .....	\$7,590
Option 01 — MiniQuick Connectors .....	+\$200



## 690SR Color Monitor

### High-Resolution 19-in Dot-Shadowmask CRT

### Precise Color Convergence

### Stablized Color Balance

### Rugged Modular Construction

### Plug-in Interface Modules

### Adjustable Picture Size and Aspect Ratio

### Recommended for Critical Picture Evaluation

The 690SR is designed to meet critical needs for picture evaluation and quality control. With a high-resolution delta gun, dot-shadowmask picture tube, and precise stable decoding circuitry, the 690SR provides faithful rendition of picture details and ease of closeup viewing. An optional medium resolution CRT provides tightly controlled phosphor chromaticity, uniform screen appearance, and excellent resolution at normal viewing distances.

With both picture tubes, Tektronix' unique color convergence system provides accurate color registration over the entire screen (less than 0.5 mm maximum error, equivalent to less than 0.18% of picture height) so that fine details can be observed anywhere in the picture. Stabilized circuitry compensates for picture tube aging and maintains accurate color balance.

A logical and non-interactive set of convergence controls makes reconvergence a quick and straight forward task. All controls are identified by color-coded patterns and produce a comfortable up-down or right-left motion on the screen with negligible interaction. Several function switches are also located within the front drawer in the television models (Options 01, 02, and 11). In

general, these switches permit the 690SR to be used either as an accurate picture/signal monitor to display faults if they are present, or as a high quality picture display monitor that provides a clean picture even in the presence of signal defects.

Front panel controls have detent positions so that the monitor may be returned to its preset condition quickly and accurately. Adjustments for the preset positions of front panel controls are located within the lockable front drawer together with virtually all other adjustments needed for routine servicing.

Picture size can be adjusted from overscan to underscan without significant loss in convergence or linearity. This feature makes it possible to conduct experiments at various image sizes and aspect ratios or to set the monitor for different system characteristics by readjusting the size and position controls.

White balance is adjustable to standard D6500 or to other desired standards using controls located in the front drawer. A Setup switch allows the raster height to be reduced to facilitate low-level-light adjustments. CRT beam currents are regulated to a preset level to minimize effects of CRT aging, helping to maintain accurate colorimetry without frequent maintenance. Additional features in the television models include horizontal and vertical scan delays, and pulse cross. The CRT is automatically brightened in these modes to facilitate evaluation of blanking interval detail.

A modular plug-in design permits the 690SR to accommodate changes in standards, and additional plug-in modules will become available to satisfy future needs.

All 690SR color monitors are fully enclosed and may be mounted in a standard relay rack. The 690SR complies with UL478 and UL1244, CSA Bulletin 556B, IEC348, and IEC435. The 690SR also complies, as of date of manufacture, with applicable DHHS standards under Radiation Control for Health and Safety Act of 1968 and with FCC/CBEMA standards for electromagnetic-interference control.

#### 690SR OPTION 01

The 690SR Option 01 is a NTSC color monitor system that consists of a notch filter/decoder module (69M00 NTSC Decoder) installed in a 690SR mainframe.

#### 690SR OPTION 02

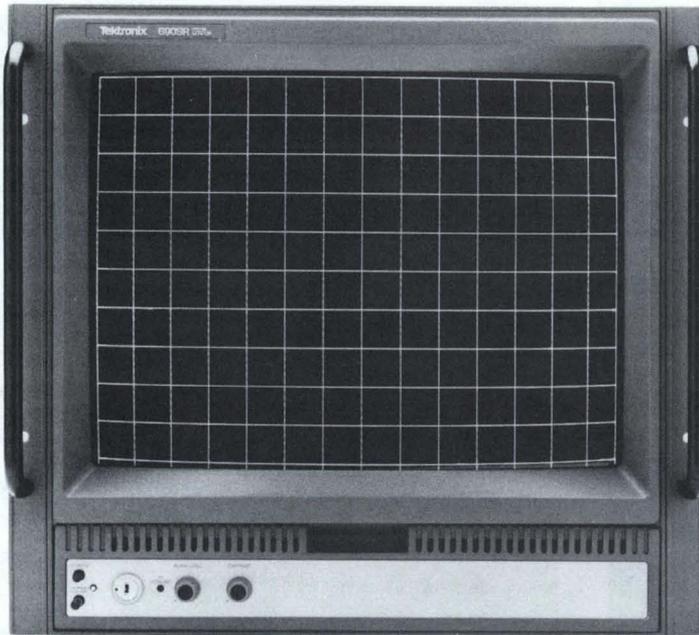
The 690SR Option 02 is a NTSC color monitor system that consists of a comb/notch filter/decoder module (69M01 Comb Decoder) installed in a 690SR Mainframe.

#### 690SR OPTION 11

The 690SR Option 11 is a PAL color monitor system that consists of a notch filter/decoder module (69M10 PAL Decoder) installed in a 690SR Mainframe. The picture tube has controlled phosphor chromaticity values in accordance with EBU recommendations.

#### 690SR OPTION 42

The 690SR Option 42 is a RGB color monitor system which is suitable for television and non-television color graphics or imaging applications. This system consists of a RGB module (69M41 RGB/Comp Sync Interface) installed in a 690SR mainframe. Flexible scan rate circuitry allows the system to be calibrated for a horizontal scan rate from 15 kHz to 37.5 kHz and be used with either interlaced or non-interlaced fields. (The standard display is factory-calibrated to operate at a horizontal scan rate of 31.5 kHz.) With these scan rates, the monitor displays from 240 to 600+ active lines, non-interlaced at a 60 Hz frame rate; or from 480 to 1200+ active lines, 2:1 interlaced at a 30 Hz frame rate.



**TV INTERFACE CHARACTERISTICS**

(690SR Options 01, 69M00; Option 02, 69M01; Option 11, 69M10 as noted.)

**VIDEO INPUT**

**Amplitude** — 0.5 V to 2.0 V p-p composite video.

**Connector Type** — BNC.

**Return Loss** — 46 dB minimum to 5 MHz loop-through compensated for 75 Ω (not internally terminated).

**Common-Mode Hum Rejection** — 50 dB minimum (with 4 V RMS mains hum applied to the shield and center conductor).

**LUMINANCE CHANNEL**

**Amplitude Linearity** — Within 2%.

**Bandwidth** — (Measured with aperture corrector off).

**Option 01** — 15 kHz to 8 MHz (with chrominance filter removed).

**Option 02** — 15 kHz to 10 MHz (with the chrominance filter removed).

**Option 11** — Flat within ±1 dB from 15 kHz to 8 MHz and ±1.5 dB from 8 MHz to 12 MHz with the response at 15 kHz as the reference.

*Note: The chrominance filter is automatically removed when Mode switch is in Auto position and burst is not present or when Mode switch is in Manual and Color Monochrome switch is in Monochrome.*

**Aperture Corrector Range** — ≈6 dB boost available at 3.5 MHz or 7 MHz depending upon an internal jumper position.

**Chrominance Rejection** — ≥20 dB at fsc.

**Dc Restoration** — Back porch negligibly affected by normal burst amplitudes.

**CHROMINANCE CHANNEL**

**Demodulation Axis**

**Option 01 and 02 (NTSC)** — R-Y, B-Y.

**Option 11 (PAL)** — V and U.

**Bandwidth**

**Option 01 (NTSC)** — 1.3 MHz.

**Option 02 (NTSC Comb)** — 3 dB down at 0.6 MHz and 10 dB down at 1.0 MHz.

**Option 11 (PAL)** — Simple Decoding = ±1.3 MHz from fsc to -3 dB response; Deluxe Decoding ±0.8 MHz from fsc to -3 dB response.

**Gain Range** — -6 dB to +10 dB (preset at 0 dB).

**Chrominance/Luminance Timing Error** — 50 ns maximum.

**Residual Subcarrier Detection** — 3-position switch selects to display or not display color shift due to residual subcarrier; the third switch position causes color to shift at a 2 Hz rate for enhanced visibility when residual subcarrier is present.

**Blue Only** — Selectable from the front panel. (When activated, all three output amplifiers are driven with the blue signal resulting in a monochrome display. This enhances noise visibility and is useful for checking and adjusting chroma and hue controls using SMPTE Bar test signals. Not available in the Option 01 system).

**Color Bar Decoding Error** — ±3%.

**Display Modes**

**Options 01 and 02 (NTSC)** — Auto, color, and monochrome.

**Option 11 (PAL)** — Auto, color (PAL Deluxe and PAL simple), and Monochrome.

**SYNC AND TIMING**

Stable subcarrier regeneration limited by line-sync performance; field sync stable with tilt = to 100% of sync amplitude in vertical blanking; field stable with 20 IRE mains hum for Option 02, and 143 mV of mains hum for Option 11.

**Modes** — Internal or external sync, selectable from the front panel.

**Input** — 0.5 V to 2 V p-p composite video or 0.2 V to 8 V p-p composite sync.

**Return Loss** — 46 dB minimum to 5 MHz; Loop-through compensated for 75 Ω (not internally terminated).

**Line Sync White Noise Immunity** — 26 dB.

**Field Sync White Noise Immunity** — 26 dB.

**Horizontal Jitter** — Typically 50 ns or less (Slow AFC Mode) with 1 RMS V of voltage mains hum, variable APL 10% to 90%, and -26 dB white noise.

**Vertical Jitter** — 1 μs p-p maximum; typically ≤100 ns.

**AFC** — Switchable Slow/Fast; Slow AFC displays errors of incoming sync; Fast AFC largely corrects for incoming sync timing errors.

**Scan Delay** — Horizontal Delay: ≈one-third line time. Vertical Delay: ≈one-half field time. Display is intensified in delayed scan modes to enhance blanking and sync details.

**Underscan** — Switchable; factory-set to reduce size by 10%; adjustable range ≈1% to 15%.

**RGB INTERFACE CHARACTERISTICS**

(690SR Option 42, 69M41)

**RGB VIDEO INPUTS**

**Nominal Non-Composite Signal (external sync required)** — 0 V low light (black); 0.7 V high light for each RGB channel.

**Nominal Composite Signal (internal sync)** — 0 V low light (black); 0.7 V high light; -0.3 V sync. Sync may be present on each RGB channel, but internal sync is taken only from green channel.

**Maximum Allowable Signal Range** — Equivalent to the nominal levels ±6 dB (0.5 to 2X nominal p-p signal levels).

**Connector Type (BNC)**

Input Impedance: 75 Ω ±1% loop through or switch selectable internal termination; >15 kΩ unterminated.

**Return Loss** — 30 dB from 50 kHz to 25 MHz; 27 dB from 25 MHz to 50 MHz.

**Ac Coupled** — <1% line-time tilt for a 64 μs line.

**Back Porch Clamp Timing** — Clamp is active from a minimum of 0.54 μs to a maximum of 1.44 μs after the trailing edge of sync; vertical serrations must be at least 1.44 μs wide, if used.

**Pulse Response** — (10% to 90%) ≤5.5 ns risetime or falltime.

**SYNC AND TIMING**

**Input** — Internal and external sync; jumper selectable.

**External Sync Operating Input Range** — 100 mV to 8 V p-p adjustment range with composite sync applied to Comp Sync input connector.

400 mV to 8 V p-p adjustment range with composite video applied to Comp Sync input connector.

**Internal Sync Operating Input Range** — 400 mV to 2 V p-p adjustment range with composite video applied to Green input connector.

**Connector Type (BNC)**

Input Impedance: 75 Ω ±1% terminated loop through or switch selectable internal termination; >15 Ω unterminated.

**Return Loss** — 30 dB from 50 kHz to 10 MHz.

**Coupling** — Ac coupled and dc restored at sync tip.

**Sync Polarity** — Jumper selectable.

**Horizontal Timing** — RS-170, RS-330 or RS-343A sync; vertical serrated pulses and/or equalizers may be omitted; front porch not required (Block Sync).

**Horizontal Rates (AFC)** — 15 kHz to 38 kHz.

**Random Sync Jitter (p-p)** — <0.2% of horizontal period.

**Lock-in Range** — ±500 Hz without adjustment.

**Horizontal Position Adjustment Range** — >±12% of horizontal period.

**Vertical Rates** — 43 Hz to 90 Hz.

**Vertical Sync Pulse Required** — >60 μs; <240 μs.

**Vertical Sync Random Jitter** — 0.2 μs p-p.

## 690 COLOR CRT SCREEN CHARACTERISTICS AND OPTIONS AVAILABLE

	Dot Pitch	Phosphor Screen	Application Information					
			Red		Green		Blue	
			X	Y	X	Y	X	Y
Standard Product	0.31 mm	Nominal	0.610	0.340	0.280	0.590	0.152	0.063
		Tolerance	±0.02		±0.02		±0.02	
		Persistence	Medium Persistence					
Option 25 Television Display (U.S.)	0.43 mm	Nominal	0.630	0.340	0.310	0.595	0.155	0.070
		Tolerance	±0.005		±0.005		±0.005	
		Persistence	Medium Persistence					
Option 26 Computer Display (Interlaced)	0.31 mm	Nominal	0.620	0.330	0.210	0.675	0.150	0.060
		Tolerance	±0.02		±0.02		±0.02	
		Persistence	0.6 ms (to 10%)	16 ms		0.02 ms		
Option 27 Television Display (EBU)	0.43 mm	Nominal	0.640	0.330	0.290	0.600	0.150	0.060
		Tolerance	±0.005		±0.005		±0.005	
		Persistence	Medium Persistence					

Note: X, Y values are based upon 1931 CIE system

### MAINFRAME CHARACTERISTICS

#### PICTURE

**CRT Size** — 19 in diagonal (Nominal).  
**Height** — 279 mm (11 in).  
**Width** — 373 mm (14.7 in).  
**Aspect Ratio** — 4:3.  
**Phosphor Dot Triad Spacing** — 0.31 mm (standard); (see CRT options for other triad spacing).  
**Convergence Error** — Maximum misconvergence 0.5 mm anywhere on the screen.  
**Geometric Distortion** — ±1% within a circle bounded by screen height; ±1.5% anywhere else.  
**Incremental Linearity Error** — ±1.8 mm (±0.07 in) over a nominal 25.4 mm (1 in) distance anywhere on the screen.  
**White Colorimetry** — Factory-adjusted to Standard D6500; may be adjusted to other standards.

#### Contrast (light output)

Standard or Option 25 CRT: highlight preset range 10 to 50 fL, maximum control range 6 to 62 fL.  
 Option 11 or Option 27 CRT (EBU): highlight preset range 9 to 45 fL, maximum control range 5 to 55 fL.  
 Option 26 CRT (long persistence): highlight preset range 9 to 23 fL, maximum control range 5 to 23 fL.

**Gamma** — Determined by CRT (≈2.3).

**CRT Protect** — Failure of horizontal or vertical scan will turn off CRT high voltage supply.

**Blanking** — Vertical: <600 μs. Horizontal: <6.75 μs.

#### POWER REQUIREMENTS

**Input Voltage Ranges** — 103 V ac to 127 V ac or 207 V ac to 250 V ac.

**Frequency Range** — 48 Hz to 66 Hz.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	444	17.5
Depth	579	22.8
Weights ≈	kg	lb
Net	49.9	110
Domestic Shipping	72.6	160

**Rackmounting Information** — Rear surface of monitor 559 mm (22 in) behind rackmounting surface, 690SR with interface module installed.

### ENVIRONMENTAL

**Operating Temperature** — 0°C to +50°C.  
**Nonoperating Temperature** — -55°C to +75°C.  
**Relative Humidity** — Operating: To 90% at +30°C (derated by 0.75% for each degree above +30°C). Nonoperating: to 90% at +60°C.  
**Altitude** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 000 m (50,000 ft).

#### INCLUDED ACCESSORIES

Power cord, 8 ft (161-0104-00); Slide-out tracks (1 pair) w/mounting hardware (351-0395-00); Front drawer keys (2) (214-3292-00).

### ORDERING INFORMATION

**690SR Television Color Monitor**  
**Mainframe** ..... **\$7,450**  
**Option 01** — 69M00 NTSC Decoder Installed ..... **+\$700**  
**Option 02** — 69M01 NTSC Comb Decoder Installed . **+\$900**  
**Option 11** — 69M10 PAL Decoder and EBU Phosphor, Medium-Resolution (0.43 mm triad pitch) CRT Installed ..... **\$1,000**  
**Option 20** — Delete rack slides and front handles ..... **-\$150**  
**Option 25** — Controlled Phosphor, Colorimetry, Medium Resolution (0.43 mm triad pitch) CRT ..... **-\$250**  
**Option 26** — Long Persistence Phosphors CRT ..... **+\$150**  
**Option 27** — EBU Phosphors, Colorimetry, Medium Resolution (0.43 mm triad pitch) CRT Installed ..... **+\$150**  
**Option 40\*** — Mainframe Only, Multirate Calibration Capability ..... **+\$1,000**  
**Option 42\*** — 69M41 RGB Interface Installed, Multirate Calibration Capability ..... **+\$1,750**  
**Option 48\*** — Mainframe Only, Single Rate Calibration Capability ..... **NC**  
*\* 690SR Options 40, 42 and 48 are factory calibrated to operate at 31.5 kHz horizontal scan rate unless otherwise specified on the order and will operate at any vertical scan rate within the specified range without special adjustment.*  
**69M00** NTSC Decoder ..... **\$800**  
**69M01** NTSC Comb Decoder ..... **\$1,000**  
**69M10** PAL Decoder ..... **\$1,000**  
**69M41** RGB Interface ..... **\$750**

### INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal European 220 V/16 A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/15A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10 A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15 A, 60 Hz ..... **NC**  
**Option A5** — Swiss 250 V./10 A, 50 Hz ..... **NC**

#### OPTIONAL ACCESSORIES

**Rigid Module Extender** for circuit modules.  
 Order 067-0999-00 ..... **\$50**  
**Minimum Load Unit** for power supply.  
 Order 067-0998-00 ..... **\$175**  
**Flexible Extender** for interface modules/decoders.  
 Order 067-1000-00 ..... **\$125**  
**Linearity Graticule** 11 x 15 ines.  
 Order 067-1034-00 ..... **\$150**  
**Linearity Graticule (NTSC)** 14 x 17 lines.  
 Order 067-1054-00 ..... **\$150**  
**Linearity Graticule (PAL)** 15 x 20 lines.  
 Order 067-1055-00 ..... **\$150**

**NTSC SIGNAL GENERATOR SELECTION CHART**

The following chart will help you select the proper NTSC generator to meet your needs. We recommend that you contact your nearest Tek sales engineer for further assistance.

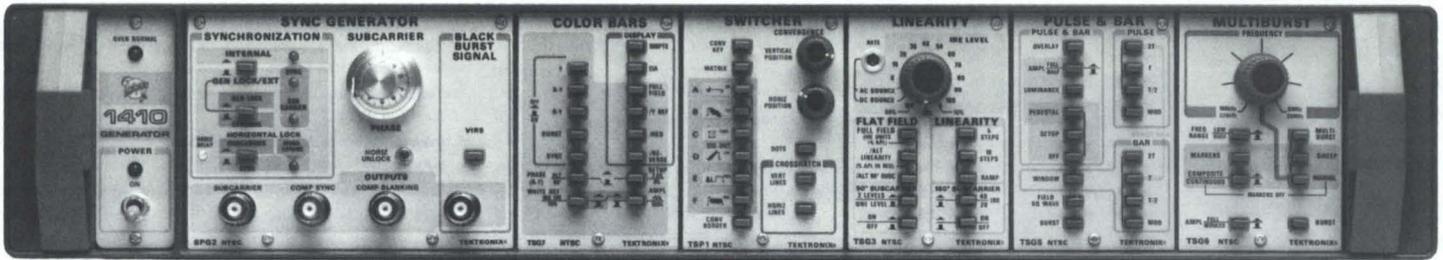
	1410 SERIES MAINFRAME						1470	147A	149A	1900	1900 OPT 01	1900 OPT 02
	TSG7	TSP1 TSG2	TSG3	TSG5	TSG6	SPG1 SPG2						
VIRS						★		VITS ONLY	VITS ONLY	••	••	••
Full Field Color Bars	•						•		••	••	••	
EIA Color Bars	•										•	•
SMPTE Color Bars	•										•	•
Color Bars/Y Reference	•								•	•	•	
Color Bars/Red Reference	•											
Color Bars/Reverse	•											
Red Field							•					
Blue Field							•					
Green Field							•					
Modulated 5-Step Staircase			•				•	••	••	••*2		
Modulated 10-Step Staircase			•					••	••			
Modulated Ramp			•					••	••	••	••	••
Modulated Pedestal			•						••	••		
Composite Test Signal								••	••	••	••	••*4
Convergence Signal		•					•			•	•	
Black Burst						•	•					
Full/Reduced Amplitude Multiburst					•		•	••	••	••*3	••*3	
Frequency Sweep					•							
Sin <sup>2</sup> Pulse and Bar				•				••	••			
Sin <sup>2</sup> Pulse and Window				•			*1	•	•	*1	*1	*1
Modulated Pulse and Modulated Bar				•								
Field Square Wave				•				•	•	•	•	•
Noise Measuring Capability								••				
Flat Field/Variable Level			•					•	•			
APL Bounce (AC)			•					•	•	•	•	•
APL Bounce (DC)			•									
Test Signal/Variable APL			•					•	•	*5	*5	*5
Multipulse										••		••
Sin X/X										••		••
MATRIX											•	•
NTC7 Combination									••*6			••
Digital Signal Generation										YES	YES	Yes
Ext VIT Input								YES	YES	YES	YES	YES
Digital Input/Output										YES	YES	YES
RS232 Programmability										YES	YES	YES
RS170A Standard Output	•	•	•	•	•	•				•	•	•

A few signals may require reprogramming and some signals may not be available simultaneously.

**Test Signals:**

- \*1 Window only.
- \*2 Unmodulated.
- \*3 Reduced only.
- \*4 NTC7 Composite Test Signal.
- \*5 10,50,90 only.
- \*6 Specify 149A Opt 01.
- Full-Field Signal.
- Full-Field Signal, also available as VITS.
- ★ As a line 19 signal on the Black Burst output.

TELEVISION SIGNAL GENERATORS



Test Signal Generators

## 1410 NTSC/1411 PAL/1412 PAL-M

### Two Sync Generators

### Six Test Signal Generators and One Switcher

The 1410 NTSC, 1411 PAL, and 1412 PAL-M Series Sync Pulse and Test Signal Generators are functionally identical within the specifications of each television system.

Each series provides a wide selection of sync pulse and test signal generators that can be combined with the mainframe in the color standard of your choice.

The mainframe unit for each generator series includes the power supply, an extender board, an interface board, and color-standard circuitry. Two color-standard circuits are available for the 1410. The standard 1410 Mainframe generates chrominance subcarrier at 3.579545 MHz  $\pm$  10 Hz. An Option 01 Mainframe generates chrominance subcarrier at 3.579545 MHz  $\pm$  1 Hz. The color standard circuitry for the PAL 1411 Mainframe has a chrominance subcarrier frequency of 4.43361875 MHz  $\pm$  1 Hz. The color standard for the PAL-M 1412 Mainframe has a chrominance subcarrier frequency of 3.57561149 MHz  $\pm$  1 Hz.

*Unless otherwise indicated by a statement enclosed by parentheses ( ), all information characteristics and descriptions of the 1410 NTSC Series and its generators applies equally to equivalent mainframes or generators for the 1411 PAL and 1412 PAL-M Series. Information in parentheses applies only to the specified series.*

### CHARACTERISTICS (1410 MAINFRAME)

- Subcarrier Frequency** — 3.579545 MHz  $\pm$  10 Hz. Option 01: 3.579545 MHz  $\pm$  1 Hz.
- Pull-in Range** — Fsc  $\pm$  50 Hz. Option 01 fsc  $\pm$  20 Hz.
- Subcarrier Input Requirements** — Amplitude: 1.0 V to 4.0 V p-p. Frequency: 3.579545 MHz  $\pm$  10 Hz.
- Subcarrier Input Return Loss** —  $\geq$  -46 dB to 3.579545 MHz.
- Mains Voltage Ranges** — 90-112 V ac. 106-132 V ac, 180-224 V ac and 212-250 V ac. Factory set at 106-132 V ac.
- Power Consumption** — 130 W maximum.
- Mains Frequency** — 50-60 Hz.

### (1411, 1412 MAINFRAMES)

- 1411 Subcarrier** — Frequency (fsc): 4.43361875 MHz  $\pm$  1 Hz. Drift  $\leq$  1 part in 10<sup>7</sup> per week. Pull-In Range: fsc  $\pm$  20 Hz.
- 1412 Subcarrier** — Frequency (fsc): 3.57561149 MHz  $\pm$  1 Hz. Drift:  $\leq$  1 part in 10<sup>7</sup> per week. Pull-In Range: — fsc  $\pm$  20 Hz.

**Subcarrier Input** — Amplitude: 1.0 V to 4.0 V p-p. Frequency: 4.43361875 MHz  $\pm$  10 Hz. Return Loss:  $\geq$  46 dB to 4.43361875 MHz.

### AC POWER (1411, 1412)

- Mains Voltage Range** — 100 V ac: 90 to 112 V ac. 120 V ac: 106 to 132 V ac. 180 to 224 V ac. 240 V ac: 212 to 250 V ac.
- Maximum Power Consumption** — 130 W.
- Mains Frequency** — 47 to 63 Hz.

### ENVIRONMENTAL CHARACTERISTICS (all 1410 Series)

- Temperature Range**  
Operating: 0°C to 50°C.  
Storage: 40°C to +65°C.
- Amplitude Range**  
Operating: Sea level to 4500 m (15,000 ft).  
Storage: Sea level to 15 200 m (50,000 ft).

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	482.6	19.0
Height	88	3.5
Depth	487.7	19.2
<b>Weight (w/Plug-ins)</b>	<b>kg</b>	<b>lb</b>
Net $\approx$	9.7	21.2
Rackmount	13.8	30.0

### SAFETY CERTIFICATIONS (all 1410 and 1411 Series)

Underwriters Laboratories, Inc.: Listed, 242T; Canadian Standards Association: Certified, LR37158; International Electrotechnical Commission (IEC 348): Certified by Tektronix, Inc.

## SPG1, SPG11, SPG12 and SPG2

### Sync Pulse Generators

### Sync to Subcarrier Phasing Maintained or Corrected

### Color Frame Reference Output

### Genlock to Composite Video (SPG2, SPG12)

### Lock to External References

### Adjustable Blanking Widths

### Broadcast Quality

The SPG1 (SPG11) and SPG2 (SPG12) are high quality sync generators designed for use in systems where accuracy, stability sync to subcarrier (SCH) phasing capability, and lockup mode versatility are of prime importance.

Two external synchronization modes, external reference or genlock, are available. In the genlock mode (SPG2, 12 only), line, field, subcarrier, and PAL pulse (SPG12 only) timing are derived from the incoming composite video signal.

In the external reference mode, line, field, subcarrier, and PAL pulse timing is derived from individual reference signals applied to the generator.

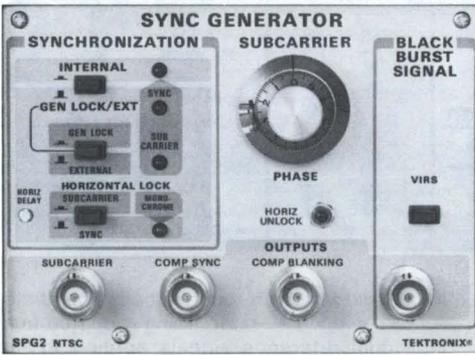
The sync-to-subcarrier (SCH) phasing can be set or maintained at any offset. This is made possible by locking the generator color subcarrier to the reference color subcarrier and referencing generator-line and field-sync-signal timing to subcarrier rather than line and field sync on the incoming reference signals. This feature is of value in editing and program assembly applications. A color frame identification pulse output identifies field 1 of the color field sequence. Should the user desire, the SCH phasing feature of the Sync Pulse Generator can be disabled with a front panel control. In this mode of operation the SCH phasing of the incoming signal is maintained by locking subcarrier to incoming burst or subcarrier, sync to incoming sync.

A slow gen-lock mode is provided for those applications where fast-lock may upset the system. The slow-lock selector is located on the generator card sets.

Genlock or external reference lock mode selection may be remotely controlled. Remote manual phasing of the SPG11 or SPG12 signal to an external source is possible in the internal mode. Vertical and/or horizontal timing are altered as in slow lock operation. Front panel LED's are used to indicate generator lock status.

Internal adjustments permit some variation of burst and blanking widths on the burst flag, comp blanking, and black burst outputs. These adjustments are preset to conform to recognized standards. You can reduce widths initially to allow for the widening that sometimes occurs when the video signal is processed.

The SPG1, SPG11, SPG2, SPG12 provide a black burst output independent of all other outputs. For NTSC systems, the Vertical Interval Reference Signal (VIRS) is factory programmed on line 19, field 1 and 2 of the black burst when selected by a front panel switch on the SPG1 and SPG2. VIRS can be selected on line 18 if desired.



The SPG2 and SPG12 Sync Generators have gen-lock capability. The almost identical SPG1 and SPG11 do not.

**CHARACTERISTICS**  
**SYNC GENERATOR OUTPUTS**

**Output Level (into 75 Ω)** — 1 V, 2 V, or 4 V (selectable) ± 0.2 V.

**Return Loss** — ≥ 30 dB to 5 MHz.

**Risetime and Falltime SPG11/SPG12** — 10% to 90%. (Linear Ramp) Normally set to 2 V, 250 ns. Other values internally selectable.

**GEN-LOCK (SPG2 ONLY)**

**Input Configuration** — 75 Ω loop-through with return loss ≥ -46 dB to 5 MHz.

**Input Requirements** — 1 V nominal composite video or black burst, sync negative. Sync Amplitude: 286 mV ± 6 dB. Burst Amplitude: 286 mV ± 12 dB. Burst Sync Ratio: within 6 dB.

**Subcarrier Phase Range** — 360° via front-panel goniometer.

**Line Sync Delay Range** — Adjustable to advance output sync ≥ 10 μs or delay ≥ 4 μs (internal adjustment). A front panel screwdriver adjustment provides a delay/advance range of ± 0.5 μs.

**Stability (over ambient temperature range 0°C to 50°C)** — Line Lock: Within 70 ns. Subcarrier Lock: Within 35 ns.

**Field/frame Sync** — Fast Lock: Direct-acting in one field. Slow Lock: One line/field slow.

**EXTERNAL REFERENCE (SPG1/SPG2)**

**Input Configuration** — 75 Ω loop-through with return loss ≥ -46 dB to 5 MHz.

**Subcarrier Input Requirements** — Amplitude: 1.0 V to 4.0 V p-p. Frequency: 3.579545 MHz ± 10 Hz. Return Loss: ≥ 46 dB to 3.579545 MHz.

**Comp Sync Input Requirements** — Amplitude: 2.0 V to 8.0 V p-p. Polarity: negative.

**Loss of Lock** — Indicated by front-panel LED indicators. Automatic switching to partial or full internal reference.

**Subcarrier Stability** — Output follows input.

**Line Sync Delay Range** — Adjustable to advance output sync ≥ 10 μs or delay ≥ 4 μs (internal adjustment). A front panel screwdriver adjustment provides a delay/advance range of ± 0.5 μs.

**Subcarrier Phase Range** — 360° via front-panel goniometer.

**OUTPUTS (SPG1/SPG2)**

**Subcarrier** — Amplitude: 2 V p-p into 75 Ω. Return Loss: ≥ 30 dB to 5 MHz.

**Composite Sync** — Equalizing Pulse Duration: 2.3 μs ± 100 ns. Field Sync Duration: 27.0 μs ± 200 ns. Interval Between Field Sync Pulses: 4.7 μs ± 100 ns. Line Sync Duration: 4.7 μs ± 100 ns. Return Loss: ≥ -30 dB to 5 MHz. Isolation: ≥ -30 dB. Output Level into 75 Ω: 4 V ± 5%. Risetime and Falltime: linear ramp, 10% to 90% time 140 ns ± 20 ns.

**Jitter** — Linelock: ≤ 10 ns. Subcarrier Lock: ≤ 4 ns.

**Comp Blanking** — Line Blanking Duration: 10.7 μs nominal, adjustable 9 to 12 μs. Field Blanking Duration: 20 lines nominal, adjustable 16 to 21 lines. Output Level into 75 Ω: 4 V ± 5%.

**Burst Flag** — Delay From Line Sync: adjustable. Duration: 2.51 μs ± 50 ns (9 cycles of subcarrier, adjustable).

**Horizontal Line Drive** — Duration: start of line blanking to end of line sync ± 100 ns. Output Level into 75 Ω: 4 V ± 5%.

**Vertical Drive** — Duration: 9 lines. Output Level into 75 Ω: 4 V ± 5%.

**Field REF** — Position: field one, line 11 or field three, line ten. (internally selectable).

**VIR Signal** — Chrominance: amplitude 286 mV ± 2.85 mV (40 IRE); phase within 0.5° of burst; envelope risetime Sin<sup>2</sup> shaped, 1 μs ± 150 ns. Luminance: setup level 53.57 mV ± 3.57 mV (7.5 IRE ± 0.5 IRE); gray level 357 mV (50 IRE ± 0.5 IRE); chroma pedestal 500 mV ± 5 mV (70 IRE ± 0.7 IRE); risetime and falltime Sin<sup>2</sup> shaped, 250 ns ± 39 ns.

**Black Burst** — Setup 53.57 mV ± 3.57 mV (7.5 IRE ± 0.5 IRE).

**COMPOSITE VIDEO OUTPUT (SPG1, SPG2)**

**Total Amplitude** — 1 V into 75 Ω.

**Sync Amplitude** — -285 mV. ± 2.86 mV.

**Peak Level Amplitude** — 714.3 mV ± 7.14 mV.

**Blanking Dc Level** — 0 V ± 50 mV.

**Return Loss** — ≥ -30 dB.

**Isolation** — -40 dB.

**Field Period** — 16.68 ms.

**Line Period** — 63.56 μs.

**Risetime and Falltime** — 130 ns, +20, -10 ns.

**Front Porch Duration** — Adjustable, 1.6 μs ± 100 ns, factory set.

**Line Blanking Interval** — Adjustable 10.7 μs, factory set.

**Breezeway** — 800 ns-3135 ns.

**Burst** — Risetime and Falltime: 400 ns ± 60 ns. Delay From Line Sync: 5.309 μs (19 cycles of subcarrier) ± 35 ns.

**HAD of Envelope** — 2.51 μs (9 cycles of subcarrier) ± 70 ns.

**Amplitude** — 285.7 mV ± 8.75 mV. Phase 180°.

**GEN LOCKS (SPG2 ONLY)**

**Input Configuration** — 75 Ω loop-through.

**Input Requirements** — Sync Source: 1 V nominal composite video or black burst, sync negative. Sync Amplitude: 300 mV ± 6 dB. Burst Amplitude: 300 mV ± 12 dB. Burst/Sync Ratio: within 6 dB. Return Loss: ≥ 40 dB to 7 MHz.

**Loss of Lock** — Indicated by front-panel LED's (automatic switching to full or partial internal).

**Chroma Phase Range** — 360° via front-panel goniometer.

**Line Sync Delay Range** — Internal switch sets delay range to +10 μs, -4 μs. Front panel range ± 1/2 μs.

**Subcarrier Stability (over ambient temperature range 0 to 50°C)** — Line Lock: Within 70 ns. Subcarrier Lock: within 35 ns.

**Horizontal Jitter** — Line Lock: ≤ 10 ns. Subcarrier Lock: ≤ 4 ns.

**Field/Frame Sync** — Fast Lock: direct acting in 1 field ± 1 line time off-set provided. Slow Lock: 1 line/field slow.

**EXTERNAL REFERENCE INPUTS SPG11, SPG12**

**Input Configuration** — 75 Ω loop-through.

**Subcarrier Input Requirements** — Amplitude: 1.0 V to 4.0 V p-p. Frequency: 4.43361875 MHz (3.57561149). Return Loss: ≥ 46 dB to 4.43361875 MHz (3.57561149 MHz).

**Comp Sync Input** — Amplitude: 1.0 V to 8.0 V p-p. Polarity: negative-going. Return Loss: ≥ 40 dB to 7 MHz (46 dB to 5 MHz).

**Loss of Lock** — Indicated by front-panel LED indicators. Automatic switching to partial or full internal reference.

**Subcarrier Stability** — Output follows input.

**Line Sync Delay Range** — Internal switch sets delay range to +10 μs, -4 μs. Front Panel Range to ± 1/2 μs.

**Chroma Phase Range** — 360° via front-panel goniometer.

**PAL Pulse Input** — Amplitude: 1.0 to 8.0 V p-p, negative going. Waveshape: pulse or squarewave. Timing: pulse duration ≥ 4 μs. Squarewave Rate: H/2. Phasing: pulse-negative going transitions coincident with start of line sync on either a + V or - V line. Return Loss: ≥ 40 dB to 7 MHz (46 dB to 5 MHz).

**COMP SYNC SPG11, SPG12**

**Equalizing Pulse Duration** — 2.30 μs (2.38 μs) ± 100 ns. Measured at 50% points.

**Field Sync Pulse Duration** — 27.2 μs (27.0 μs) ± 100 ns. Measured at 50% points.

**Interval Between Field Sync Pulses** — 4.8 μs ± 100 ns. Measured at 50% points.

**Field Period** — 20 ms (16.68 ms).

**Line Period** — 64 μs (63.56 μs).

**Line Sync Duration** — 4.7 μs ± 100 ns.

**Jitter** — ≤ 4 ns.

**Comp Blanking** — Line Blanking Duration: 12.0 μs (11.1 μs) nominal, adjustable 9 to 12 μs. Measured at 50% points. Field Blanking Durations: 25 (21 lines nominal, adjustable 16 to 25 (21) lines).

**Burst Flag** — Delay from Line Sync: Adjustable. Duration: 3.6 μs (2.51 μs) ± 100 ns (adjustable).

**Horizontal Drive** — Duration: Start of line blanking to end of line sync ± 100 ns, or line sync time.

**Vertical Drive** — Duration: Starts at Vertical blanking: 7 1/2 (9) lines. Starts at Vertical Sync: 5 lines.

**Field Reference** — Position Field 1. Line 7 (8).

**PAL Pulse, Phasing** — Negative transition coincident with leading edge of line sync on either + V or - V lines. Factory set to + V. Duration: 4.7 μs, within 0.2 μs. Level: 2 V 75 Ω at H/2 Rate.

**PAL Pulse Squarewave** — (May be internally selected in place of pulse.) — Level: 1 V, 75 Ω, H/2 rate. Phasing Transition is coincident with leading edge of line sync. Polarity may be high or low during -135° burst lines.

**V/2** — Level: 1 V, 75 Ω. Rate: 25 (30) Hz squarewave. Phasing: positive during fields 2 and 4 (1 and 3). V/4 Level: 1 V, 75 Ω. Rate: 12.5 Hz (15 Hz) squarewave. Phasing: positive during fields 1 and 4 (1 and 2). 64H Level: 1 V, 75 Ω. Frequency: 1 MHz (1.006993 MHz).

**Subcarrier** — Amplitude: 2 V p-p ± 10% 75 Ω. Return Loss: ≥ 30 dB to 5 MHz. Isolation: ≥ 40 dB.

**Black Burst Amplitudes** — Sync: -300 mV ± 3 mV from blanking. Burst: Absolute 300 mV ± 9 mV. Relative: alternate burst amplitudes equal within 1%. Blanking Level: 0 V + 50 mV. Setup Level: 0% setup (50 mV ± 2.5 mV).

**COMPOSITE VIDEO SPG11, SPG12**

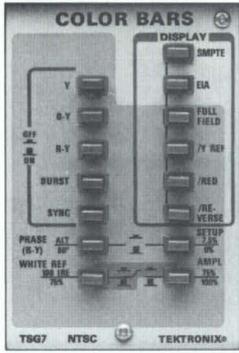
**Amplitude** — Sync: -300 mV ± 3 mV from blanking. Setup Level: 0% setup (50 mV ± 2.5 mV). Pedestal: 175 mV ± 5 mV. Burst: absolute, 300 mV ± 9 mV. Relative: alternate bursts are equal within 2%. U and V Components: equal within 1%. Blanking level 0 V ± 50 mV.

**Timing** — Line Blanking Interval: 12.05 μs ± 250 ns. Front Porch: ≥ 1.40 μs. Sync Risetime: 250 ns ± 50 ns. Sync HAD: 4.7 μs ± 100 ns. Breezeway: 800 ns typical. Burst Delay: 5.6 μs ± 100 ns or 25 cycles of subcarrier. Burst Risetime: 350 ns ± 50 ns. Burst Envelope HAD: 2.25 μs ± 230 ns. Line Period: 64 μs. Field Period: 20 ms.

**Burst Phase** — +135° and -135° on successive lines. Angle Between Bursts: 90° ± 1°.

**Return Loss** — ≥ 30 dB, f < 5 MHz.

**Isolation** — ≥ 40 dB.



TSG7 Color Bars Generator

## TSG7 (TSG11) Color Bars Generator

### Color Bars Signals

#### EIA (TSG7 only)

#### Fixed Full Field (TSG11 only)

#### Full Field with Switchable Components

#### 75% or 100% Amplitude

#### Split Field/Y Reference

#### Split Field/Red

#### Split Field Bars/Bars Reversed

The TSG7 and TSG11 provide high-quality full field and split field color bars for the 1410 NTSC and 1411 PAL Series. The TSG7 (TSG11) operates independently from any other test signal installed in the mainframe with generator card sets. Its output is available simultaneously with all other test signal outputs. One of the sync pulse generators must be installed in the mainframe to drive the TSG7 (TSG11).

The composition of the TSG7 can be altered by switching off Y, B-Y, R-Y, Burst, and Sync. For the TSG11, this same change is made by switching off the Y, U, V, U & V, components of Burst and Sync. You may also select fixed or alternating R-Y (V) subcarrier phase, bar amplitude, white reference, and setup level (or pedestal).

The /Y REF switch selects a split field display of color bars in the same sequence as full field, followed by the luminance portion of the color bars for the remainder of the field. The split can be 1/2 or 3/4 field as selected by internal programming in the sync pulse generator. With this signal, you can check chrominance to luminance delay and picture monitor gray scale tracking while simultaneously evaluating color performance.

The /RED switch selects a split-field display of color bars, as in /Y REF, followed by red chrominance. (Same phase and amplitude, and at the same luminance level as the red bar.) Use this signal for adjusting VTR playback controls. Head equalization errors and noise are easily spotted on a red field. Other bar colors can be chosen by internal programming. The signal is also remotely switchable to color bars/white.

The/REVERSE switch selects a split field display of color bars as in /Y REF, followed by color bars in a reverse sequence. That is black, blue, red, magenta, green, cyan, yellow, white. This signal helps detect chrominance to luminance delay while viewing the kinescope of a color monitor/receiver. Reverse bars are also useful in detecting VTR velocity errors.

The TSG7 (TSG11) will produce color bars VIT on any VIT line desired. (VIT signals cannot be inserted on the program line. Use a 147A, 149A or 1900 for insertion of VITS on a program line.)

### CHARACTERISTICS (TSG7)

**Luminance Signal Accuracy** — Within 1% or 1.5 mV, whichever is greater.

**Chrominance Accuracy** — Absolute Amplitudes: within 3% (all subcarrier components). Relative Amplitudes: within 1% of the red chrominance bars or 1 mV plus p-p residual subcarrier amplitude, whichever is greater.

**Full Field Displays** — Bar Width: 6.45  $\mu$ s. White Bar Risetim: 130 ns, +20, -10 ns. Time Difference Between Chroma and Lum Channels:  $\leq$ 20 ns.

### TSG11

**Luminance Component Accuracy** — Within 1.5 mV, or 1% of level, which is greater.

**Chrominance Component Accuracy** — Absolute Amplitudes:  $\pm$ 3%. Relative Amplitudes: Within 1% of red bar, or 1 mV plus p-p residual subcarrier, whichever is greater.

**Bar Width** — 6.5  $\mu$ s  $\pm$ 325 ns.

**Luminance Risetim** — 115 ns  $\pm$ 15 ns. C/L DELAY —  $\leq$ 20 ns.

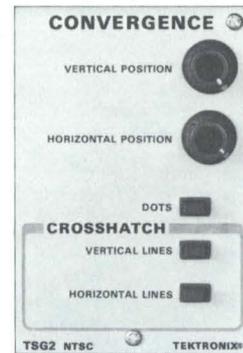
**Chrominance Risetim** — 350 ns  $\pm$ 50 ns.

**U, V Quadrature Error** —  $\leq$ 0.5°.

**V Axis Phase Switch Error** —  $\leq$ 0.5°.

**Split Field Displays** — Split is 1/2 — 1/2 or 3/4 — 1/4 internally selectable in SPG.

**Fixed Full Field Display** — Amplitude: 75%. Pedestal: 0% (Setup 5%). White Reference: 100%.



TSG2 Convergence Generator

## TSG2 and TSG12 Convergence Test Signal Generators

### Dots and Crosshatch

#### Dots Only

#### Vertical Lines Only

#### Horizontal Lines Only

#### Vertical and Horizontal Lines

#### Position Controls

The TSG2 and TSG12 provide high-quality convergence test signals for the 1410 NTSC and 1411 PAL Series respectively. You can use them to determine picture monitor or camera scanning linearity, aspect ratio, and geometric distortion. Signals for the TSG2 conform to IEEE Standard 202.

Provision is made in the TSG2 and TSG12 for on/off switching of the dots, vertical lines, and/or horizontal lines and for positioning vertical and horizontal lines. The signal output is located on the rear panel of the mainframe in which the test signal generator is installed. The convergence signal output is available simultaneously with all other test signal generator outputs.

A sync pulse generator must be installed in the mainframe for TSG2 and TSG12 operation.

### CHARACTERISTICS (TSG2, TSG12)

**Displays Available** — Crosshatch, vertical lines only, horizontal lines only, dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern). Horizontal and vertical positioning.

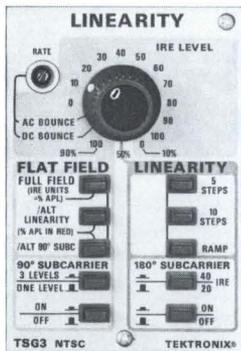
**Convergence Pattern** — Setup: 7.5 IRE  $\pm$ 1. Sync Amplitude: 40 IRE  $\pm$ 2. Peak Level: 77 IRE  $\pm$ 3. Risetim and Falltime: 135 ns  $\pm$ 15.

### COMPOSITE VIDEO (TSG12)

**Displays Available** — Vertical lines, horizontal lines, dots or any combination of these (dots appear centered in the rectangles formed by the crosshatch pattern).

**Risetim and Falltime** — Pulses and setup 115 ns  $\pm$  ns (125 ns  $\pm$  20 ns).

**Composite Video Amplitude** — Sync: -300 mV  $\pm$ 3 mV from blanking. Blanking Level: 0 V  $\pm$ 50 mV. Setup Level: 0% setup (50 mV  $\pm$ 2.5 mV). Pulse Amplitude: 525 mV (537.5)  $\pm$ 25 mV.



## TSG3, TSG13, and TSG23 Linearity and Modulated Pedestal Test Generators

5 and 10 Step Staircase Signal  
Ramp Signal  
2 Modulation Amplitudes

One-or-Three Level Modulated Pedestal

Flat Field with 11 Fixed Levels

Ac and Dc Bounce

The TSG3 (TSG13, 23) provide high-quality linearity and modulated pedestal test signals for the 1410 NTSC, 1411 PAL, and 1412 PAL-M, respectively. Combine variable APL with either of these signals to measure nonlinear distortions. The TSG3, TSG13 and TSG23 generators operate independently of all other test signal generators installed in the mainframe, while its rear panel output is available simultaneously with all other test signal generators' outputs. One of the sync (pulse) generators must be installed in the mainframe to drive the TSG3, TSG13, or TSG23.

You can select the 5 step and 10 step staircase signals and the ramp signal with or without 180° subcarrier modulation for NTSC, or U subcarrier modulation for PAL and PAL-M. The subcarrier amplitude is front panel selectable at 20 IRE or 40 IRE on the TSG3, or at 140 mV and 280 mV on the TSG13 and TSG23. Applications include measuring differential phase and gain, dynamic gain, luminance linearity, and burst phase errors.

With the TSG3, the flat field signal can be used on all active picture lines with levels set by the IRE Level control, or flat field on four lines can be alternated with one line of linearity or modulated pedestal (90° subcarrier). When using the alternate mode APL is controlled by the IRE level control.

The ac Bounce position of the IRE level switch (TSG3) or the peak white switch (TSG13, 23) percentage provides a signal in which the active portion of each line (excluding sync) changes APL levels at a rate determined by the rate control (1 to 30 second intervals).

For the TSG, amplitude of the bounce excursions is fixed at 0 to 100 IRE in flat field mode and 10% to 90% APL in alternate modes. Blanking level remains fixed at 0 V. To check ac coupled circuitry use ac bounce.

With the switch set to dc bounce, ac bounce occurs as described above. In addition, the entire signal changes dc level in the opposite direction at the same rate resulting in no change in average dc level. Clamp circuits may be checked using dc bounce.

The modulated pedestal, a unique, Tektronix-developed chroma-step signal, facilitates measurement of luminance signal distortion caused by the subcarrier signal (chrominance-luminance inter-modulation), and chrominance nonlinear gain and phase distortions.

### CHARACTERISTICS (TSG3, TSG13)

**Luminance Component** — Peak Amplitude: 714 mV  $\pm$  7.14 mV. 5 Step Amplitude: 143 mV. 10 Step Amplitude: 71.5 mV. Aberrations: within 2% of step amplitude. Step Rise-time: 250 ns  $\pm$  39 ns between steps within 1%.

**180° Subcarrier Component** — Absolute Amplitudes:  $\pm$  3%. Relative Amplitudes:  $\pm$  1%. 20 IRE: 143 mV  $\pm$  3%. 40 IRE: 285.7 mV  $\pm$  3%.

**Subcarrier Envelope** — Rise-time: 400 ns  $\pm$  60 ns. Duration: 47.7  $\mu$ s. Delay from Line Sync: 9.93  $\mu$ s.

**Differential Phase** — 0.1° or loss at 10%, 50%, and 90% APL.

**Differential Gain** — 0.5% or less at 10%, 50% and 90% APL.

**Modulated Pedestal** — 90° Subcarrier. Amplitude.

1 Level — 5 to 20 IRE (internally adjustable).

3 Levels — 20, 40, and 80 IRE.

### COMPOSITE VIDEO (TSG13, TSG23)

**Luminance Rise-time** — 250 ns  $\pm$  50 ns.

**Five-step Signal** — Step Amplitudes Nominal: 140 mV. Relative: largest within 1% of smallest.

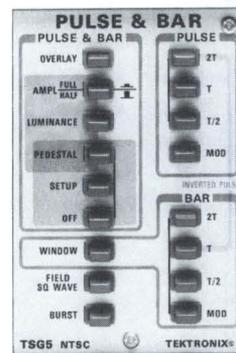
**Ten-step Signal** — Step Amplitudes Nominal: 70 mV. Relative: largest within 1% of smallest.

**Ramp Signal** — Linearity:  $\pm$  1%.

**Linearity Subcarrier** — Amplitudes: 140 mV  $\pm$  3%. 280 mV  $\pm$  3%. Differential Gain:  $\leq$  0.5%. Phase: 180°  $\pm$  1°. Differential Phase: 0.1° Start: 6t after To. Stop: 29t after To. Rise-time: 350 ns  $\pm$  50 ns (400 ns  $\pm$  60 ns).  $t = 2 \mu$ s.

**Flat-field Signals** — Pedestal Start: 5t after To. Stop: 31t after To. Flat Field Subcarrier: One level. Start: 6t after To. Stop: 29t after To. Three-level: Amplitudes absolute 140 mV  $\pm$  3%; 420 mV  $\pm$  3%; 700 mV  $\pm$  3%. Relative Percentage: within 1% of the largest chrominance amplitude, or 1.5 mV plus residual subcarrier amplitude, whichever is greater. Rise-time: 350 ns  $\pm$  50 ns (400 ns  $\pm$  60 ns). Phase 90°  $\pm$  2°, internally adjustable to 60°  $\pm$  3°. Phase Error: Largest amplitude to smallest  $\leq$  0.5°.

**Bounce Modes** — Ac: rate, 1/60 to 1/2 Hz. Dc: rate, slow 1/60 to 1/2 Hz. Dc Rate, Fast Selectable: line rate, field rate, or frame rate. Offset: 418.6 mV for 10% to 90% APL bounce.



## TSG5 and TSG15 Pulse and Bar Generators

Pulse and Bar Overlay

Full and Half Amplitude Pulse and Bar

Field Squarewave and Window

Modulated Pulse and Modulated Bar

Front Panel Selection of 2T, T, and T/2 Pulse  
Width and Bar Rise-time

The TSG5 and TSG15 are sin<sup>2</sup> pulse and bar television test signal generators designed for use with the 1410 NTSC and 1411 PAL mainframes, respectively. They're well suited for testing on equipment manufacturers' production lines and for testing of television transmitters, common carrier microwave and wire lines, and studio distribution systems. Front panel controls provide most test signal options, while internally selectable options provide additional versatility.

The pulse and bar test signal consists of a sin<sup>2</sup> modulated pulse, a sin<sup>2</sup> pulse, and luminance bar. The pulse and bar overlay mode lets you conveniently compare pulse to bar ratio without manipulating waveform monitor controls.

The inverted and non-inverted 2T pulses may be overlaid to compare shape and half amplitude duration (HAD). This capability is particularly useful in detecting quadrature distortion which results from envelope detection of the RF modulated video signal. The pulse and bar test signal is also useful in measuring line time and short time distortions.

For sin<sup>2</sup> pulse signals, three self-cancelling switches permit independent selection of pulse half amplitude duration (2T, T, T/2) independent of bar rise-time. In the bar mode, four self-cancelling switches permit selection of luminance bar rise-time (2T, T, T/2) or modulated bar.

Full or half amplitude pulse and bar test signals can be provided with or without pedestal or setup (the TSG15 does not offer setup capability). For the TSG5, full amplitude is 100 IRE units with no setup. Half amplitude is 50 IRE with no setup. For the TSG15, full amplitude is 100% (700 mV) with no setup. Half amplitude is 50% (350 mV) with no setup.

The luminance pulse, luminance bar, and luminance components of the modulated pulse and modulated bar may be switched off to provide chrominance pulse and chrominance bar. The chrominance pulse and bar may be placed on a pedestal (50 IRE for the TSG5, 50% for the TSG15) to prevent chrominance from extending below blanking level.

Use the standard field squarewave (with full amplitude and no setup) to measure field time distortion, and the window signal to measure line time distortion and picture monitor smearing. You can switch the color burst off without affecting the chrominance components of the test signals.

Use the TSG5 (and TSG15) for measuring overall gain, transient response, line and field time tilt, and chrominance to luminance delay and gain.

**CHARACTERISTICS  
(TSG5)**

	Full Amplitude	Half Amplitude
<b>Luminance Bar Amplitude</b> Setup Off	714.3 mV ±7.1 mV	357.1 mV ±3.6 mV
<b>Modulated Bar Amplitude</b> Setup Off		
Luminance	357.1 mV ±3.6 mV	178.6 mV ±1.8 mV
P-P Chrominance	714.3 mV ±14.3 mV	357.1 mV ±7.1 mV
<b>Pulse Amplitude</b> Setup Off		
2T	714.3 mV ±7.1 mV	357.1 mV ±5.4 mV
-2T	714.3 mV ±10.7 mV	357.1 mV ±7.1 mV
T	714.3 mV ±10.7 mV	357.1 mV ±7.1 mV
T/2	714.3 mV ±14.3 mV	347.1 mV ±14.3 mV
Modulated	714.3 mV ±7.1 mV	357.1 mV ±5.4 mV
<b>Pulse to Bar Ratio</b>		
2T	1:1 ±0.005	1:1 ±0.01
-2T	1:1 ±0.01	1:1 ±0.02
T	1:1 ±0.01	1:1 ±0.02
T/2	1:1 ±0.02	1:1 ±0.04
<b>Modulated Pulse to Modulated Bar</b>	1:1 ±0.01	1:1 ±0.02

**Modulated Pulse and Bar**  
Chrominance-Luminance Gain: 3.6 mV maximum amplitude difference of peak chrominance and peak luminance.  
Delay Residual: 5 ns maximum.

**Subcarrier Phase Factory Set** — Phase Modulated 360° at field rate.

Optional Subcarrier Harmonics: Fixed phase. At least 40 dB down.

	Half Amplitude Duration (HAD)	Overshoot
<b>Luminance Pulse</b>		
2T	250 ns ±5%	0.5%
T	125 ns ±5%	1.0%
T/2	62.5 ns ±10%	2.0%
<b>Modulated Pulse</b>		
12.5T	1562.5 ns ±5%	1.0%
20T	2500 ns ±5%	1.0%
<b>Bar</b>	<b>Risetime</b>	<b>Overshoot</b>
Detail		
2T	241.1 ns ±10%	0.5%
T	120.5 ns ±10%	1.0%
T/2	60.3 ns ±15%	2.0%
12.5T Modulated	1506.8 ns ±10%	1.0%
20T Modulated	2410.9 ns ±10%	1.0%
Line Tilt	0.5% maximum	

**Window**

Line Timing: Bar Timing.

Field Timing: White lines from line 67 to line 218 each field.

Field Tilt: 0.5% maximum.

**Field Squarewave**

Amplitude: 714.3 mV ±14.3 mV.

Field Timing: White lines 75 to 206 each field.

Field Tilt: 0.5% maximum.

**Setup**

Amplitude: 53.6 mV ±1.6 mV (7.5% or 7.5 IRE).

Risetime Timing: 130 ns +20 ns -10 ns. From 1410 main-frame Horizontal and Vertical Blanking.

**Pedestal**

Amplitude Luminance Off or Half Amplitude: 357.1 mV ±7.1 mV (50 IRE).

**TSG15 CHARACTERISTICS**

	Full Amplitude	Half Amplitude
<b>Luminance Bar Amplitude</b>	700.0 mV ±7.0 mV	350.0 mV ±5.3 mV
<b>Modulated Bar Amplitude</b>		
Luminance	350.0 mV ±3.5 mV	175.0 mV ±1.8 mV
P-P Chrominance	700.0 mV ±14.0 mV	350.0 mV ±7.0 mV
<b>Pulse Amplitude</b>		
2T	700.0 mV ±7.0 mV	350.0 mV ±5.3 mV
-2T	700.0 mV ±10.5 mV	350.0 mV ±7.0 mV
T	700.0 mV ±10.5 mV	350.0 mV ±7.0 mV
T/2	700.0 mV ±14.0 mV	340.0 mV ±14.0 mV
Modulated	700.0 mV ±7.0 mV	350.0 mV ±5.3 mV
<b>Pulse to Bar Ratio</b>		
2T	1:1 ±0.005	1:1 ±0.01
-2T	1:1 ±0.01	1:1 ±0.02
T	1:1 ±0.01	1:1 ±0.02
T/2	1:1 ±0.02	1:1 ±0.04
Modulated Pulse to Modulated Bar	1:1 ±0.01	1:1 ±0.02

**Modulated Pulse and Bar**

Chrominance-Luminance Gain: 3.5 mV maximum amplitude difference of peak chrominance and peak luminance.

Delay: 5.0 ns maximum.

	Half Amplitude Duration (HAD)	Overshoot
<b>Luminance Pulse</b>		
2T	200 ns ±5%	0.5%
T	100 ns ±5%	1.0%
T/2	50 ns ±10%	2.0%
<b>Modulated Pulse</b>		
10T (12.5T)	1000 ns ±5%	1.0%
20T	2000 ns ±5%	1.0%
<b>Bar</b>	<b>Risetime</b>	<b>Overshoot</b>
2T	192.9 ns ±10%	0.5%
T	94.9 ns ±10%	0.5%
T/2	48.2 ns ±15%	2.0%
10T Modulated	964 ns ±10%	1.0%
20T Modulated	1929 ns ±10%	1.0%
Line Tilt	0.5% maximum	

**Window**

Line Timing: Bar Timing

Field Timing: White lines 65 to 270 each field

Field Tilt: 0.5% maximum.

**Field Squarewave**

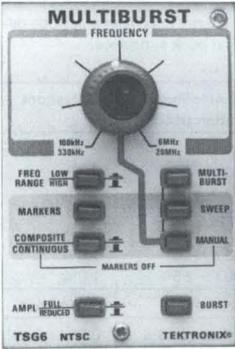
Amplitude: 700.0 mV ±14.0 mV.

Field Timing: White lines 65 to 220 each field.

Field Tilt: 0.5% maximum.

**Pedestal**

Amplitude Luminance Off or Half Amplitude: 350.00 mV ±7.0 mV (50%).



**TSG6 and TSG16  
Multiburst Signal Generators**

**Multiburst Signal**

**Controlled Risetime Burst Packets**

**Last Burst Frequency Variable**

**Manual and Field Swept Frequency Signals to 20 MHz**

**Markers for Both Frequency and Amplitude Reference**

**Full and Reduced Amplitude on all Signals**

The TSG6 and TSG16 are television multiburst and video sweep test signal generators designed for the 1410 NTSC and 1411 PAL mainframes, respectively. They feature front-panel controls for most test signal options, plus special Remote functions for additional versatility. The TSG6 and TSG16 can be used in many testing applications, including equipment manufacture and microwave or long-line transmission systems.

Performance advances include reduction in harmonic content of sinewave signals and skirt energy associated with gating burst packets. Phase modulation of the burst packets aids ease of measurement by filling in shape of packets. Two ranges of multiburst frequencies are available: the 500 kHz to 4.1 MHz (TSG6) range aids in testing television transmitters and common carrier links, while the 1.25 MHz to 12 MHz range is used in testing television studio equipment and cabling.

Use these new generators where nonlinearities make reduced amplitude test signals desirable. The reduced amplitude multiburst signal allows accurate testing of video tape record/playback systems, since it is not subject to the false distortion of the full amplitude multiburst that often occurs in such applications.

Using the front panel controls, you can select a high- or low-frequency band for each operating mode: Sweep, Manual, or Multiburst. Sweep allows selection of field sweep signal with or without markers. Markers inserts amplitude/frequency markers in Sweep, and amplitude markers in Composite/Manual. Burst allows insertion/deletion of color burst on composite video for use with systems that operate differently when burst is present. Composite/Continuous determines where sync, blanking, and a pedestal will be added to the sweep and manual signals.

Manual selects a fixed-frequency sinewave with frequency determined by the Frequency control and Frequency Range switch. Amplitude allows selection of either full or reduced amplitude in all operating modes, Multiburst selects line-rate discrete-frequency packets with reference insertion levels.

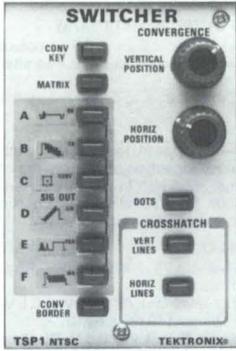
**CHARACTERISTICS**

	TSG6		TSG16	
	Low Range	High Range	Low Range	High Range
<b>Multiburst</b>				
Frequencies	500 kHz ± 3% 1.25 MHz ± 3% 2.00 MHz ± 3% 3.00 MHz ± 3% 3.58 MHz ± 3% 4.10 MHz ± 3%	1.25 MHz ± 3% 3.50 MHz ± 3% 5.50 MHz ± 3% 8.00 MHz ± 3% 10.0 MHz ± 3% 12.0 MHz ± 3%	500 kHz ± 3% 1.00 MHz ± 3% 2.00 MHz ± 3% 4.00 MHz ± 3% 4.80 MHz ± 3% 5.80 MHz ± 3%	1.00 MHz ± 3% 3.00 MHz ± 3% 5.00 MHz ± 3% 8.00 MHz ± 3% 10.0 MHz ± 3% 12.0 MHz ± 3%
Amplitude (First Multiburst Packet)				
Full	643 mV (90 IRE) ± 20 mV	643 mV ± 25 mV	700 mV ± 21 mV	700 mV ± 28 mV
Reduced	428 mV (60 IRE) ± 12 mV	428 mV ± 16 mV	420 mV (60 IRE)	420 mV ± 16 mV
Flatness, Reduced and Full	10 mV or less	16 mV or less	10 mV or less	17.5 mV or less
Packet Envelope Risetime	400 ns ± 60 ns	400 ns ± 60 ns	400 ns ± 60 ns	400 ns ± 60 ns
Burst Phasing	Phase shifted at field rate to provide filled-in burst packets.			
<b>Sweep/Manual</b>				
Sinewave				
Frequencies				
Start	100 kHz minimum	330 kHz minimum	100 kHz minimum	330 kHz minimum
Stop	6 MHz ± 10%	20 MHz ± 10%	6 MHz ± 10%	20 MHz ± 10%
Amplitude at First marker	643 mV ± 20 mV	643 mV ± 25 mV	700 mV ± 21 mV	700 mV ± 28 mV
Full Reduced	428 mV ± 12 mV	428 mV ± 16 mV	420 mV ± 12 mV	420 mV ± 16 mV
Flatness <sup>3</sup>				
Full and Reduced	10 mV	15 mV to 12 MHz 20 mV to 20 MHz	10 mV	17.5 mV to 12 MHz 21.0 mV to 20 MHz
<b>Markers</b>				
Frequencies	500 kHz ± 3%*1 1.0 MHz ± 3%*1 2.0 MHz ± 3%*1 3.0 MHz ± 3%*1 4.0 MHz ± 3%*1 5.0 MHz ± 3%*1	1.0 MHz ± 3%*1 2.0 MHz ± 3%*1 4.0 MHz ± 3%*1 6.0 MHz ± 3%*1 8.0 MHz ± 3%*1 10.0 MHz ± 4%*1 12.0 MHz ± 4%*2 14.0 MHz ± 6%*2 16.0 MHz ± 7%*2 18.0 MHz ± 7%*2 20.0 MHz ± 7%*2	500 kHz ± 3%*1 1.0 MHz ± 3%*1 2.0 MHz ± 3%*1 3.0 MHz ± 3%*1 4.0 MHz ± 3%*1 5.0 MHz ± 3%*1	1.0 MHz ± 3%*1 2.0 MHz ± 3%*1 4.0 MHz ± 3%*1 6.0 MHz ± 3%*1 8.0 MHz ± 3%*1 10.0 MHz ± 4%*1 12.0 MHz ± 4%*2 14.0 MHz ± 6%*2 16.0 MHz ± 7%*2 18.0 MHz ± 7%*2 20.0 MHz ± 7%*2
<b>Multiburst/Manual (Last Burst Variable Mode)</b>				
Frequency Range				
Start	<3.8 MHz	<14 MHz	<5.0 MHz	<14 MHz
Stop	>4.5 MHz	20 MHz ± 10%	>6.0 MHz ± 10%	20 MHz ± 10%
Accuracy	± 0.2% short term	± 1% short term	± 0.2% short term	± 1% short term
<b>Amplitude (Markers &amp; Pedestal all Modes)</b>				
Markers Relative to Pedestal Level				
Full	± 321 mV ± 1%	± 321 mV ± 1%	± 350 mV ± 1%	± 350 mV ± 1%
Reduced	± 214 mV ± 1%	± 214 mV ± 1%	± 210 mV ± 1%	± 210 mV ± 1%
Pedestal Level				
Full	393 mV ± 1%	393 mV ± 1%	350 mV ± 1%	350 mV ± 1%
Reduced	286 mV ± 1%	286 mV ± 1%	350 mV ± 1%	350 mV ± 1%
Risetime	250 ns ± 50 ns	250 ns ± 50 ns	250 ns ± 50 ns	250 ns ± 50 ns
<b>Harmonic Distortion (Single Frequency Relative to Fundamental)</b>	-44 dB, 0.3 to 4.2 MHz -40 dB, 0.1 to 0.3 MHz -40 dB, 4.2 to 6.0 MHz	-38 dB, 0.33 to 6.0 MHz -36 dB, >6 to 20 MHz	43 dB, 300 kHz 5.0 MHz -40 dB, 100 kHz to 300 kHz -40 dB, 5.0 MHz to 6.0 MHz	-30 dB, 330 kHz 56.0 MHz -36 dB, 6 MHz to 20 MHz

\*1 Within one television line either side of the marker.

\*2 Above 10 MHz, difference frequency between markers is 2 MHz ± 400 kHz.

\*3 Maximum-minimum diode detected peak-to-peak voltages.



**TSP1, TSP11 and TSP21 Switchers and Convergence Generators**

**Single Switchable Output for Two to Six Generated Signals**

**Blanking, Sync and Burst Insertion for External Signal**

**Matrixing — Eight Programmed Display Formats to up to Six Sequential Signals**

**Convergence Border**

**Convergence Key**

**Crosshatch or Dots**

**Combined Crosshatch and Dots**

The TSP1, TSP11, and TSP21 combine the capabilities of a test signal switcher and convergence signal generator in a single unit. They simplify and expand the uses of the 1410 NTSC, 1411 PAL and 1412 PAL-M Series Generators, respectively.

From a single, electronically switched output, you have access to all the test signals (from two to six) generated by the card sets in the mainframe. Meanwhile, you may continue to use the individual generator card sets' parallel outputs, so no restrictions are imposed on an established system. As an added feature, one of the input signals can be external (composite or noncomposite). All of the switcher inputs are provided with clamp circuitry.

Eight different matrixes are stored in the PROM. This signal matrixing capability, combined with the full-field mode of the TSP1 (TSP11, TSP21) presents several combinations of signals sharing the full field display.

Most of TSP1 (TSP11, TSP21) switching functions can be remotely controlled through the 1410, 1411, and 1412 mainframe's Remote connector J41.

**CHARACTERISTICS TSP11 SWITCHER**

**Input Signal**  
 Amplified Limits: 1.4 V p-p.  
 Input Return Loss:  $\geq 30$  dB, to 5 MHz.  
 Input Isolation:  $\geq 50$  dB, internal inputs.  
 Input Impedance: 75  $\Omega$ .

Convergence Pattern	Large squares	Small Squares
<b>Vertical Lines</b>		
Line to Line Duration	6.36 $\mu$ s	3.18 $\mu$ s
Position Range	$\geq 6.4 \mu$ s	$\geq 3.2 \mu$ s
Number per Field	8.9	16-17
Pulse Duration	225 $\pm$ 40 ns	225 $\pm$ 40 ns
<b>Horizontal Lines</b>		
Line-to-Line Duration	35 lines	17 lines
Position Ranges	$> 35$ lines	$> 16$ lines
Number per Field	6.7	13-14
Height	2 lines/frame	2 lines/frame
<b>Dots</b>		
Width (HAD)	225 ns $\pm$ 40 ns	350 ns $\pm$ 50 ns
Height	2 lines/frame	3 lines/frame

**Switcher Output Signal**  
 Timing: Same as inputs, delayed by 10 ns (10-20° of subcarrier).  
 Amplitudes: Within 2% of inputs.  
 Blanking dc Level: 0 V  $\pm$  100 mV.  
 Relative Blanking Level: Within 15 mV, between signals.  
**Added Distortion**  
 Noise:  $< 60$  dB, to 5 MHz.  
 Residual Subcarrier:  $< 1$  mV.  
 Differential Gain:  $< 0.5\%$ .  
 Differential Phase:  $< 0.3\%$ .  
 Luminance Linearity: 1%.  
 Pulse to Bar Ratio: 2T: 1:1  $\pm 0.5\%$ .  
 Tilt:  $< 1\%$ , line or field.  
 Flatness: 1% to 5 MHz, 2% to 10 MHz, 4% to 20 MHz.  
**Clamping**  
 Aberrations:  $< 10$  mV, at burst gate time.  
 Output Return Loss:  $\geq 30$  dB to 5 MHz.

**CONVERGENCE — (TSP11, TSP21)**

**Convergence Signal Line and Dot Pulses**  
 Amplitude: 525 mV  $\pm 25$  mV (537.5 mV  $\pm 25$  mV). Horizontal Line Bar Amplitude: within 1%.  
 Risetime and Faltime: 115 ns  $\pm 15$  ns (125 ns  $\pm 20$  ns).  
**Setup**  
 Amplitude: 0% (Selectable 50 mV  $\pm 5$  mV).

**ORDERING INFORMATION**

The 1410 NTSC and 1411 PAL Sync Pulse and Test Signal Generator Series card set construction allows you to order just the capabilities you need while leaving room for future expansion. For easy ordering of a 1410 or 1411 Generator, follow the steps listed here.

1. Select the functions you need. Choose from two mainframes for the 1410 (NTSC) and for the 1411 (PAL), two sync pulse generators, five test signal generators and one switcher. Put together any combination you desire. See typical packages information where X indicates installed and tested together.
2. If your order does not consist of Options 02, 03, or 04 for the mainframe selected, you can still order a test signal generator that has been tested and calibrated as a package. It is only necessary to add the words "Option 88" following each alternate plug-in designation on the purchase order to ensure shipment as a single-unit package.
3. If you already own a 1410 or 1411 Mainframe and are adding functions, you need order only the generator required.  
 Do not order Option 88 when adding to a mainframe package you already own.
4. If you are ordering more than one 1410 or 1411 Generator package on the same purchase order, be sure to indicate the appropriate options and/or functions to be included in each package.
5. For information on the 1412 Option 04 PAL M generator please contact your Tektronix representative.
6. Add the suffix letters C or R for cabinet or rackmount configurations as: 1410C or 1411R, etc.

**1410C NTSC Mainframe (Cabinet Version) ..... \$1,830**

**1410R NTSC Mainframe (Rackmount Version) ..... \$1,830**

**Option 01 —  $\pm 1$  Hz Color Subcarrier Frequency Accuracy ..... +\$405**

**Option 02 — NTSC Package Installed and Tested Together ..... +\$2,750**

**Option 03 — NTSC Package Installed and Tested Together ..... +\$5,880**

**Option 04 — NTSC Package Installed and Tested Together ..... +\$10,310**

**1410C/1410R NTSC PACKAGES**

**TYPICAL SYNC & TEST SIGNAL GENERATOR PACKAGES**

	Option 02	Option 03	Option 04
SPG2 (Sync Generator)	x	x	x
TSG2 (Convergence)		x	
TSG3 (Linearity)		x	x
TSG5 (Pulse and Bar)			x
TSG6 (Multiburst)			x
TSG7 (Color Bars)		x	x
TSP1 (Switcher)			x

**ALTERNATIVE SYNC GENERATOR PACKAGES**

Master sync generator without gen-lock. Color standard  $\pm 10$  Hz:  
**Order 1410C or 1410R Generator Option 88 and SPG1 Sync Generator Option 88 ..... \$4,450**  
 Master sync generator without gen-lock, Color standard  $\pm 1$  Hz:  
**Order 1410C or 1410R Generator Option 01 + Option 88 and SPG1 Sync Generator Option 88 ..... \$4,855**

**ALTERNATIVE SYNC AND TEST SIGNAL GENERATOR PACKAGES**

Master sync generator with gen-lock. Color standard  $\pm 10$  Hz. Select from test signal generators and switcher as required and:  
**Order 1410C or 1410R Generator Option 88 and SPG2 Gen-Lock Sync Generator Option 88 ..... \$4,940**  
 Select from:  
**TSG3 Linearity Generator Option 88 ..... \$1,220**  
**TSG5 Pulse and Bar Generator Option 88 ..... \$1,610**  
**TSG6 Multiburst Generator Option 88 ..... \$2,230**  
**TSG7 Color Bars Generator Option 88 ..... \$1,750**  
**TSP1 Switcher Option 88 ..... \$1,540**

**1411C PAL Mainframe (Cabinet Version) ..... \$2,245**

**1411R PAL Mainframe (Rackmount Version) ..... \$2,245**

**Option 02 — PAL Package Installed and Tested Together ..... +\$2,680**

**Option 03 — PAL Package Installed and Tested Together ..... +\$5,750**

**Option 04 — PAL Package Installed and Tested Together ..... +\$9,945**

**1411C/1411R PAL PACKAGES**

**TYPICAL SYNC & TEST SIGNAL GENERATOR PACKAGES**

	Option 02	Option 03	Option 04
SPG12 (Sync Generator)	x	x	x
TSG11 (Color Bars)		x	x
TSG12 (Convergence)		x	
TSG13 (Linearity)		x	x
TSG15 (Pulse and Bars)			x
TSG16 (Multiburst)			x
TSP11 (Switcher)			x

**ALTERNATIVE SYNC GENERATOR PACKAGE**

Master sync generator without gen-lock:  
**Order 1411C or 1411R Generator Option 88 and SPG11 Sync Generator Option 88 ..... \$4,865**

**ALTERNATIVE SYNC & TEST SIGNAL GENERATOR PACKAGES**

Master sync generator with gen-lock. Select from test signal generators and switcher as required and:  
**Order 1411C or 1411R Generator Option 88 and SPG12 Gen-Lock Sync Generator Option 88 ..... \$5,360**  
 Select from:  
**TSG11 Color Bars Generator Option 88 ..... \$1,505**  
**TSG13 Linearity Generator Option 88 ..... \$1,230**  
**TSG15 Pulse and Bar Generator Option 88 ..... \$1,605**  
**TSG16 Multiburst Generator Option 88 ..... \$2,230**  
**TSP11 Switcher Option 88 ..... \$1,545**

There are many other 1410 and 1411 Test Signal Generator packages available. Choose the combination that best suits your needs. A Tektronix Television Sales Engineer will gladly assist you in selection of test signal generator packages.

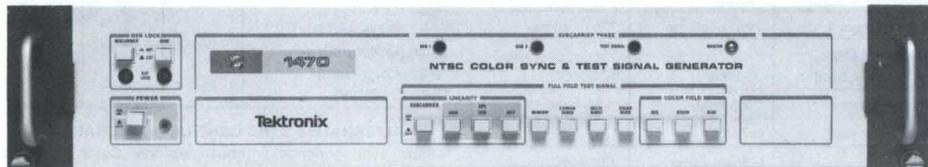
**OPTIONAL ITEMS (FOR ALL CONFIGURATIONS)**

**One Wide Blank Panel Order 333-2171-00 ..... \$1.35**

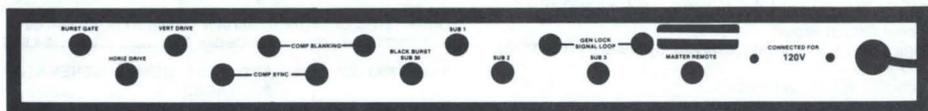
**Conversion kit for SMPTE Bars for TSG1 Module Order 040-1010-00 ..... \$375**



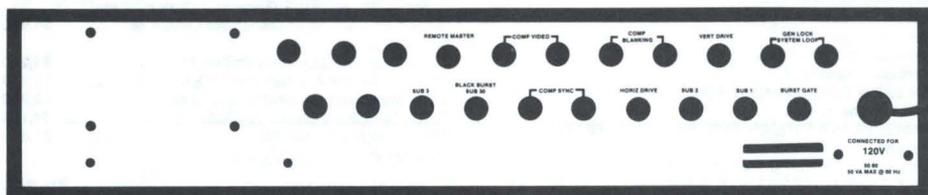
1474 NTSC Color Sync Generator



1470 NTSC Color Sync and Test Signal Generator



1474 Rear Panel



1470 Rear Panel

## 1470/1474

Full Color Sync Generator with Gen-Lock

Locks to Most Helical Scan VTRs

Simple to Operate

Compact and Economical

Full Selection of Sync and Timing Signals

Simplified Timing Via Multiple Subcarrier Phasing Controls

TELEVISION SIGNAL GENERATORS

The 1470 Sync and Test Signal Generator is a compact, full color, gen-lock sync generator providing a full selection of high quality test signals.

The 1474 is identical in performance to the 1470 with the exception of test signals which, in the interest of economy, are not included. Both products have color gen-lock compatible with composite video from all normal sources including most helical scan video tape recorders.

The 1470 and 1474 can operate as master-sync generators or as units fully or partially timed from external sources. Color gen-lock capable of locking to most helical scan VTRs is a standard feature.

Front-panel pushbutton selection of external synchronization is provided. In external mode, the 1470 and 1474 automatically lock on composite video (1 V), composite sync (-4 V), or reference subcarrier (2 V). Two front-panel lights show subcarrier and/or sync external lock. Lights out indicate a switch to internal standard.

### 1470 Test Signal Functions

To simplify your test signal selection and speed testing operations, the 1470 has push button selection of test signals. All test signal push buttons, except the color field selectors, are self-cancelling. Each test signal provides aberration-free transitions and accurate flat levels.

#### Color Bars

The 1470 provides full-field color bars signals useful for color monitor adjustments, VTR tape lead in, and system checks.

#### Color Fields

Red, green, and blue color-field signals are provided for checking purity on color monitors/receivers that do not have individual gen on/off controls. These signals may also be used to provide a color background source. The red, green, and blue selectors may be used simultaneously to provide yellow, cyan, magenta, and white full field signals.

#### Linearity (Staircase)

Staircase signal with selection of high, medium, or low APL. Staircase subcarrier may be switched on or off from the front panel.

#### Test Signals

Test Signals available include: Window, Convergence Multiburst.

Window signals are suitable for measuring both line time and field time distortion. Convergence test signals are used to check color monitor convergence and linearity, and camera scanning linearity. Multiburst signals are used to check system frequency response.

Both the 1470 and 1474 are configured for rackmounting and are shipped ready to install in a 19 in rack.

The GV3257A Changeover Unit is compatible with the 1470 and 1474.

## CHARACTERISTICS

### SYNC GENERATORS OUTPUTS (1470/1474)

**Horizontal Blanking** — Leading Edge: 2.2  $\mu$ s to 0.6  $\mu$ s before the leading edge of sync. Trailing Edge: 9.1  $\mu$ s to 10.7  $\mu$ s after the leading edge of sync.

**Horizontal Drive** — Leading Edge: 2.2  $\mu$ s to 0.6  $\mu$ s before the leading edge of sync.

**Vertical Blanking** — 20 or 21 lines.

**Subcarrier Phase Controls** — Composite Test Signals: Subcarrier 1 and 2. Blackburst: Independent adjustment range of  $\approx 120^\circ$ , and jumpers allow a full  $360^\circ$  shift in  $90^\circ$  steps. Gen-Lock Master: Independent  $360^\circ$  front panel adjustment and  $100^\circ$  remote control, via a rear-panel BNC connector.

### GEN-LOCK

**Composite Sync** — Output level into 75  $\Omega$ : 4 V  $\pm 0.5$  V. Rise-time and Falltime: 140 ns nominal.

**Composite Blanking** — Output level into 75  $\Omega$ : 4 V  $\pm 0.5$  V. Field Blanking Rise-time and Falltime: 140 ns nominal.

**Vertical Drive** — Output level into 75  $\Omega$ : 4 V  $\pm 0.5$  V. Rise-time and Falltime: 140 ns nominal. Duration: 9 lines.

**Horizontal Drive** — Output level into 75  $\Omega$ : 4 V  $\pm 0.5$  V. Rise-time and Falltime: 140 ns nominal. Duration: 6.35  $\mu$ s.

**Burst Gate** — Output level into 75  $\Omega$ : 4 V  $\pm 0.5$  V. Delay from line sync: 5.1  $\mu$ s  $\pm 0.1$   $\mu$ s. Rise-time and Falltime: 140 ns nominal. Duration: 2.5  $\mu$ s  $\pm 100$  ns.

**Subcarrier** — Output level into 75  $\Omega$ : 2 V. Frequency: 3.579545 MHz  $\pm 10$  Hz.

**Black Burst** — Sync amplitude into 75  $\Omega$ : 40 IRE. Burst Amplitude: 40 IRE (286 mV peak-to-peak). Burst Frequency: 3.579545 MHz  $\pm 10$  Hz.

**Gen-Lock Signal Loop Input** — Composite Video Input Range: 0.5 V to 1 V when loop-through connectors are externally terminated into 75  $\Omega$ . Comp sync 1 to 4 V, ref subcarrier 1.5 to 2 V p-p.

### TEST SIGNAL OUTPUTS (1470)

**Test Signal Generator Outputs Composite Video** — Return Loss:  $\geq 30$  dB to 5 MHz. Output Level into 75  $\Omega$ : 1 V. Sync: 40 IRE,  $\pm 1$  IRE (286 mV nominal amplitude). Peak Video Level:  $\pm 100$  IRE,  $\pm 2$  IRE (714 mV nominal amplitude). Blanking dc Level: 0 V,  $\pm 50$  mV.

**NTSC Color Bars** — Full Field: 75% amplitude, 100 IRE white reference, 7.5% setup. Luminance Signal Accuracy: Within 2%. Chrominance Signal Absolute Amplitudes: Within 3% (all subcarrier frequency components).

**Window Amplitude** — 100 IRE,  $\pm 2$  IRE. Duration: 25.8  $\mu$ s,  $\pm 3\%$ . Starts at line 66 in each field and ends at 218 in each field. Rise-time: 150 ns nominal.

**Crosshatch Pattern or Dots** — Setup: 7.5 IRE  $\pm 1$  IRE. Peak Level: 77 IRE  $\pm 2$  IRE. Rise-time and Falltime: 150 ns nominal.

**Multiburst** — White Reference Amplitude: 100 IRE  $\pm 2\%$  IRE. Multiburst Amplitude: 50 IRE  $\pm 2\%$  IRE. Average Level: 55 IRE  $\pm 1$  IRE. Multiburst Frequencies: 0.5 MHz, 1.5 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz, 4.2 MHz.

**Staircase Luminance Component** — Five Step Amplitude (each step): 20 IRE  $\pm 1$  IRE (143 mV). Staircase Amplitude: 100 IRE  $\pm 2$  IRE (714 mV). Aberrations: Within 2% of step amplitude. Step Rise-time: 150 ns nominal.

**Staircase Subcarrier Chrominance Component** — Amplitude: 40 IRE  $\pm 1$  IRE (286 mV p-p). Phase:  $180^\circ$ . Differential Phase:  $\leq 0.3^\circ$ . Differential Gain:  $\leq 0.5\%$ . Subcarrier Envelope Rise-time: 400 ns nominal.

### OTHER CHARACTERISTICS

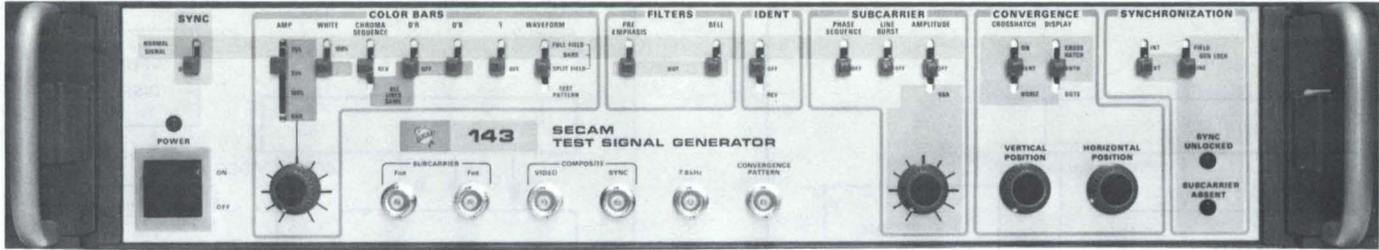
**1470 Power Requirements** — 115 V or 240 V line voltage, high-low ranges. Selection switches for line voltages and ranges are accessible internally. Factory set to 120 V. 120 V Range — High, 108 V to 132 V; Low, 95 V to 110 V. 240 V Range — High, 216 V to 250 V; Low, 198 V to 242 V. Line Frequency: 50 to 60 Hz. Power maximum: 50 W. 1474 Power Requirements — 115 V: 90 to 130 V. 240 V: 198 V to 250 V. Power: Maximum 40 W.

### PHYSICAL CHARACTERISTICS

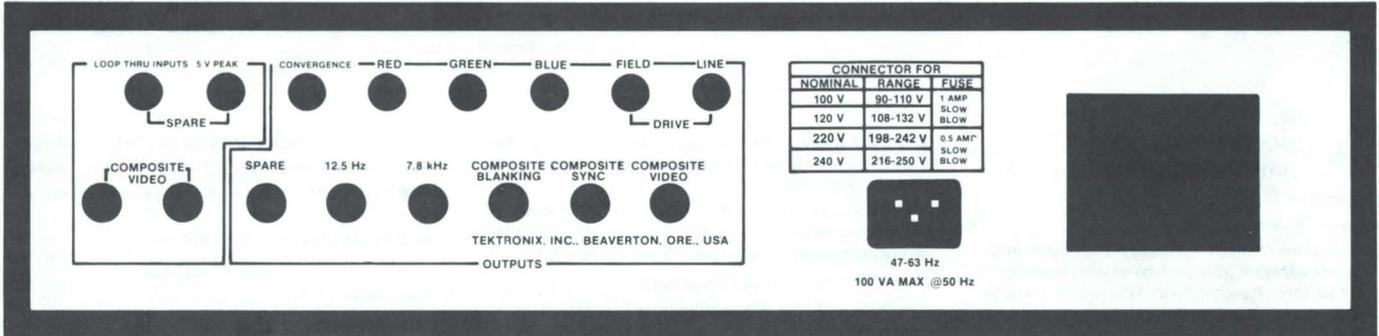
Dimensions	1470		1474	
	mm	in	mm	in
Width	483	19.0	483	19.0
Height	89	3.5	44	1.7
Depth	483	19.0	483	19.0
Weights	kg	lb	kg	lb
Net	4.9	10.8	4.2	9.2
Shipping	7.8	17.2	8.1	17.9

### ORDERING INFORMATION

**1470 Color Sync and Test Signal Generator (Rackmount)** ..... **\$3,760**  
**Option 01** — Sync Generator Without Gen-Lock ..... —\$245  
**1474 Color Sync Generator (Rackmount)** ..... **\$1,965**  
**Option 01** — Sync Generator Without Gen-Lock ..... —\$245  
**GV3257A Automatic Change Over Unit** **\$1,600**



143 SECAM Test Signal Generator rackmount version.



Rear Panel. BNC connectors are standard, miniQUICK connectors are available (Option 01).

## 143

### Broadcast-Quality Gen-Lock Sync and Test Signal Generator

### Composite color Bars, Convergence Patterns, and RGB Color Bar Signals

### Provisions to Modify Test Signal Components

The Tektronix 143 SECAM Test Signal Generator provides all the test, sync, and drive signals required to align and maintain SECAM television equipment. You can easily control all test signal components and synchronization modes from the front panel. Easy-to-change internal programming provides additional test signal capability to satisfy your unique testing requirements.

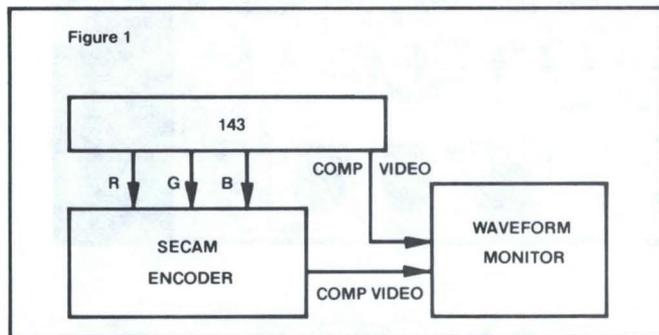
Test signals provided by the 143 are fully-encoded color bars, convergence pattern, and RGB color bar signals. You can select color bars in either a full-field or split-field configuration. Amplitude, white level, and chroma sequence can be changed from the front panel. You can also switch off the D'R, D'B and Y signal components individually using front panel controls.

The convergence pattern consists of movable vertical and horizontal lines plus dots. All three signals are available in any combination. A 7 x 9 or 14 x 17 crosshatch pattern may be internally selected.

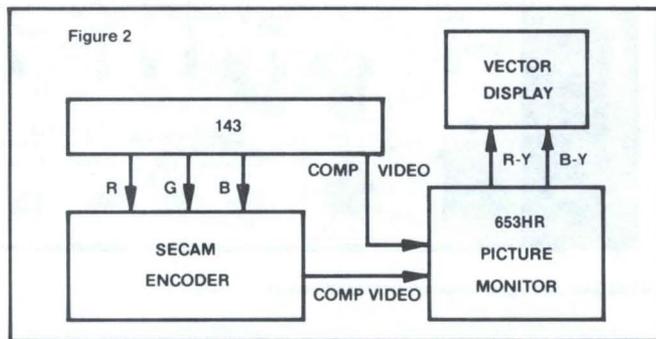
RGB color bars signals are available from three separate rear-panel outputs at all times and are independent of the position of the front panel controls.

The 143 may be operated from its own internal standards or gen-locked to a SECAM composite video signal. Color lock may be referenced to either the vertical identification signals or the line burst. Front panel LEDs indicate the gen-lock status.

Additional outputs provide useful auxiliary signals including line and field drive, line and field blanking, composite sync, and two specialized output signals. These two signals are a 12.5 Hz squarewave (for identification of the SECAM four field sequence), and a 7.8 kHz squarewave (for synchronizing a waveform monitor to view either D'B or D'R lines only, while the 143 is generating a complete test signal). As a special convenience, the two unmodulated carrier (rest) frequencies are brought out to the front panel. It's easy to verify 143 calibration whenever routine maintenance or recalibration is performed.



Encoder luminance level and encoder subcarrier setup test configurations



Encoder modulation linearity test configuration using the new Tektronix SECAM color picture monitor as a decoder.

## CHARACTERISTICS SYNC AND BLANKING

**Line Frequency** — 15.625 Hz  $\pm$  0.0001%.

**Line Period** — 64  $\mu$ s  $\pm$  0.0001%.

**Line Sync** — Pulse Duration: 4.7  $\mu$ s  $\pm$  0.2  $\mu$ s. Pulse Amplitude: -300 mV within 1% from blanking dc level. Front Porch: 1.5  $\mu$ s  $\pm$  0.3  $\mu$ s. Pulse Risetime (10 to 90%): 0.2  $\mu$ s  $\pm$  0.02  $\mu$ s. Interval (sync leading edge to end of subcarrier blanking): 5.6  $\mu$ s  $\pm$  0.2  $\mu$ s.

**Line Blanking** — Duration: 12  $\mu$ s  $\pm$  0.3  $\mu$ s. Dc Level: 0 mV within 100 mV.

**Field Frequency** — 50 Hz.

**Field Period** — 20 ms.

**Equalizing Pulse Duration** — 2.35  $\mu$ s  $\pm$  0.1  $\mu$ s.

**Equalizing Sequence Duration** — 2.5 lines.

**Field Synchronizing Pulse Duration** — 27.3  $\mu$ s  $\pm$  0.2  $\mu$ s.

**Field Synchronizing Sequence Duration** — 2.5 lines.

**Field Synchronizing Risetime** — (10 to 90%) -0.2  $\mu$ s  $\pm$  0.02  $\mu$ s.

**Field Blanking** — Duration: 1.6 ms + (12  $\mu$ s  $\pm$  0.3  $\mu$ s). Dc Level: 0 mV within 100 mV.

## GEN-LOCK

**Sync Source** — Nominal 1 V composite video. Input configuration 75  $\Omega$  loop-through. Return Loss:  $\geq$  46 dB to 5 MHz.

**Sync Amplitude** — 300 mV, within 10 dB.

**Sync Acquisition Time** —  $<$  0.6 s.

**D'R'D'B Lock-Up Level** — Subcarrier amplitudes from +6 dB to -18 dB of nominal.

**D'R'D'B Drop-Out Level** — Subcarrier amplitudes  $<$  -18 dB of nominal.

**D'R'D'B Acquisition Time** — Line:  $<$  100 lines (referenced to line burst). Field:  $<$  300 ms (referenced to field identification signals).

**Line Sync Delay** — Range: Adjustable to advance or delay 143 sync  $\geq$  500 ns. Stability: Within 70 ns over operating temperature range. Jitter:  $\leq$  5 ns.

**Lock-Up Range** — Gen-Lock 15.625 kHz  $\pm$  0.0005% (subcarrier is asynchronous with respect to line for line rates above and below tolerance). Sync-Lock: 15.625 kHz to  $\pm$  0.1%.

## PULSE OUTPUTS

**Amplitude** — 1, 2 or 4 V negative going from ground.

**Composite Sync** — Identical to sync to contained in the Composite Video, except risetime.

**Composite Blanking** — Identical to blanking for the Composite Video.

**Line Blanking Duration** — 12  $\mu$ s  $\pm$  0.3  $\mu$ s.

**Field Blanking Duration** — 1.6 ms + (12  $\mu$ s  $\pm$  0.3  $\mu$ s).

**Line Drive Duration** — 4.7  $\mu$ s  $\pm$  0.2  $\mu$ s.

**Field Drive Duration** — 5 lines.

**12.5 Hz Squarewave** — Rep Rate: 1 cycle/4 fields (12.5 Hz). Levels: Ground for fields 1 and 2, negative for fields 3 and 4.

**7.8 kHz** — Rep Rate: 1 cycle/2 lines (transition at leading edge of line drive). Levels: Ground for D'R, negative for D'B.

**Output** — Risetime (10 to 90%): 0.25  $\mu$ s  $\pm$  0.05  $\mu$ s (all pulse outputs listed). Return Loss:  $\geq$  30 dB to 4 MHz (all pulse outputs listed).

**Subcarrier Output** — D'R'D'B Subcarrier:  $\approx$  1 V into 50  $\Omega$  (for frequency counter).

## COMPOSITE VIDEO

**Outputs** — Full-field or split-field color bars or test pattern.

**Return Loss** —  $\geq$  36 dB to 7 MHz.

**Isolation Between Outputs** —  $\geq$  40 dB.

**Suppression of Subcarrier at Blanking** —  $\geq$  46 dB (referenced to nominal subcarrier amplitude).

**Risetime of Subcarrier Envelope at Blanking** — 400 ns  $\pm$  100 ns.

**Bell Filter** — Center Frequency: 4.286 MHz  $\pm$  20 kHz. Response:  $\pm$  0.5 dB of theoretical (subcarrier  $\geq$  -20 dB referenced to nominal amplitude). Off: Response flat  $\pm$  0.5 dB 3.9 to 4.75 MHz.

**Chrominance/Luminance Timing** — Within  $\pm$  50 ns (based on red-blue transition of the D'R line).

**Luminance Risetime** — 100 ns  $\pm$  10 ns.

**Color Bar Signal Subcarrier Tolerance** — Frequency:  $\pm$  (1.3% of deviation + 1 kHz). Amplitude: D'B line burst 166.7 mV  $\pm$  10% (subcarrier amplitude at other frequencies, relative to D'B line burst, determined by Bell filter tolerance). Variable:  $\approx$  6 dB to -54 dB relative to nominal amplitude.

**Color Bar Signal Luminance Tolerance** — Amplitude:  $\pm$  1% or 1.5 mV, whichever is greater.

## NON-ENCODED OUTPUT

**RGB Amplitude** — 525 mV  $\pm$  1% (except white, 700 mV).

**RGB Sync** — 300 mV  $\pm$  2% green only (delete by moving internal jumper).

**RGB Return Loss** —  $\geq$  36 dB to 6 MHz.

## CONVERGENCE

**Pedestal** — 0 V.

**Sync Amplitudes** — 300 mV  $\pm$  5%.

**Peak Luminance Level** — 525 mV  $\pm$  5%.

**Isolation** —  $\geq$  40 dB.

**Return Loss** —  $\geq$  35 dB to 5 MHz.

**Displays** — Vertical lines. Horizontal lines. Dots or any combination of the above.

## AC POWER

**Mains Voltage Range** — 100 V: 90 to 110 V ac. 120 V: 108 to 132 V ac. 220 V: 198 to 242 V ac. 240 V: 216 to 250 V ac.

**Maximum Power Consumption** — 100 W.

**Mains Frequency Range** — 48-62 Hz.

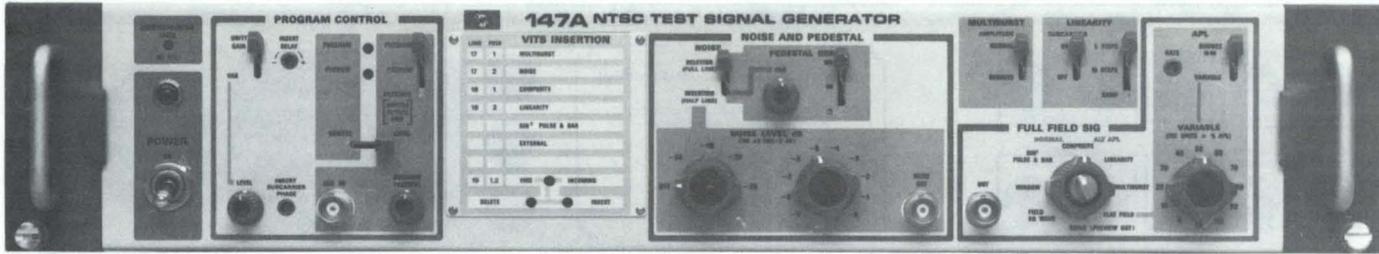
**Crest Factor** —  $\geq$  1.35.

## PHYSICAL CHARACTERISTICS

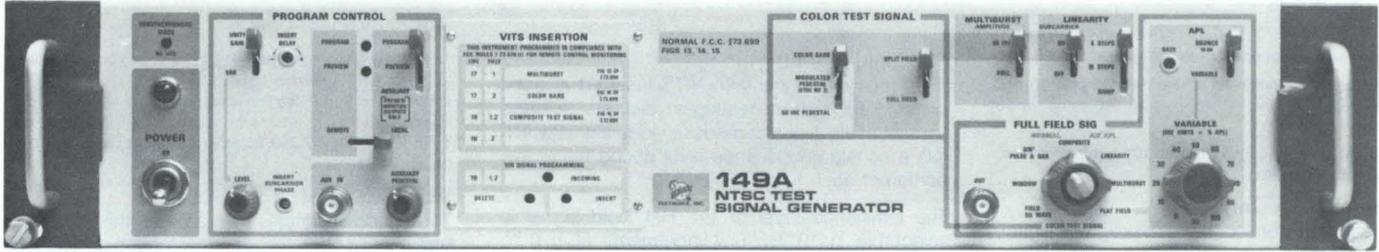
Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	420	16.8	483	19.0
Height	89	3.5	89	3.5
Depth	471	18.5	471	18.5
<b>Weights</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net	9.1	20.0	9.3	20.5

## ORDERING INFORMATION

<b>143 SECAM Test Signal Generator</b>	
(Cabinet) .....	<b>\$10,420</b>
<b>R143 SECAM Test Signal Generator</b>	
(Rackmount) .....	<b>\$10,420</b>
<b>Option 01 — MiniQUICK Connectors</b> .....	<b>+\$270</b>



R147A NTSC Test Signal Generator



R149A NTSC Test Signal Generator

## 147A/149A

### VITS Generation, Insertion, and Deletion

### Sync and Burst Regeneration

### Program Signal Protected

### Full Field Test Signals Independently Selectable from VITS Program

### Reprogrammable for New Signals

### Vertical Interval Reference Signal

### Noise Test Signal and Measurements (147A only)

### One Unit Source of Signals for Remote Transmitter Operation (149A only)

### Color Bars when Gen-Locked to a Program Signal (149A only)

The 147A and 149A NTSC Television Signal Generators are similar units that supply all the test signals commonly used for test and measurement of video transmission systems. The signals generated are available as full-field composite video test signals and Vertical Interval Test Signals (VITS) that may be inserted on an incoming composite video signal.

#### VERTICAL INTERVAL INSERTION/ DELETION AND PROGRAM CONTROL

The 147A and 149A will insert VITS only when gen-locked to an incoming composite video signal. A VITS deleter/inserter involves active circuit elements in the program line within the generator. Fail-safe provisions are provided in the event of a malfunction within the instrument, including loss of sync or power. Local and remote-control manual override capability is also provided.

Black-burst synchronization may be selected by a remotely controlled relay. In this mode, the 147A and 149A automatically go to the program line bypass operation. This bypassing operation can be defeated through the remote.

When incoming program is lost, the 147A and 149A will go to one of two operating modes selectable by internal reprogramming jumpers. They are: program line bypass, or full-field test signal, or flat-field signal. In the event the program signal is lost, the transmitter will continue on the air.

A preview function lets you observe deletions and inserted signals/levels before anything is actually done to the program signal. The preview/program function can be locally or remotely controlled.

A front panel address plate provides a means for identifying the actual VITS inserted and their line and field location. Externally generated VITS may be added to the program line if desired.

#### PROGRAM CONTROL FEATURES Processing Amplifier

In addition to performing deletion and insertion functions, the 147A and 149A generators are designed to function as a sync and burst regeneration amplifier.

The 147A sync and burst regeneration operating modes may be jumper selected as follows: (a) off, (b) monochrome signal — sync and burst regeneration inhibited, (c) monochrome signal — sync regeneration only. When in the regeneration mode, the 147A and 149A will not delete incoming VITS except when the 147A and 149A VITS programming takes priority.

#### Nonsynchronous Operation

A front panel warning light indicates absence of incoming synchronizing information without which VITS deletion or insertion is automatically discontinued.

#### Program Level

A front panel switch allows selection of either a preset gain, normally adjusted for unit gain between program input and program output, or front panel level adjustment to normalize the incoming program signal to provide 1 volt at the program output.

#### Local/Remote Control of Program or Preview

Switching of program or preview modes from the front panel (local) to a remote position is controlled by connecting a remote switching circuit to a rear-panel connector. When operating under local or remote control, a light indicates preview or program status, since the front panel switch position may not indicate the actual operating mode.

#### TEST SIGNALS

##### Vertical Interval Reference Signal

The VIR signal is generated and inserted by the generator on line 19 of both fields. The generator is programmable for many possible operating modes depending upon the presence or absence of a VIR signal on the incoming program line.

##### Field Squarewave Signal

The Field Squarewave signal provides a sensitive means for measuring field time distortions. In this mode, the 147A and 149A provide a composite video signal with 170 active lines at 100 IRE, which approximates a 60 Hz squarewave. This composite video signal reveals low-frequency phase and gain distortions as a simple 60 Hz squarewave will do, but unlike the latter, it can pass through clamper amplifiers.

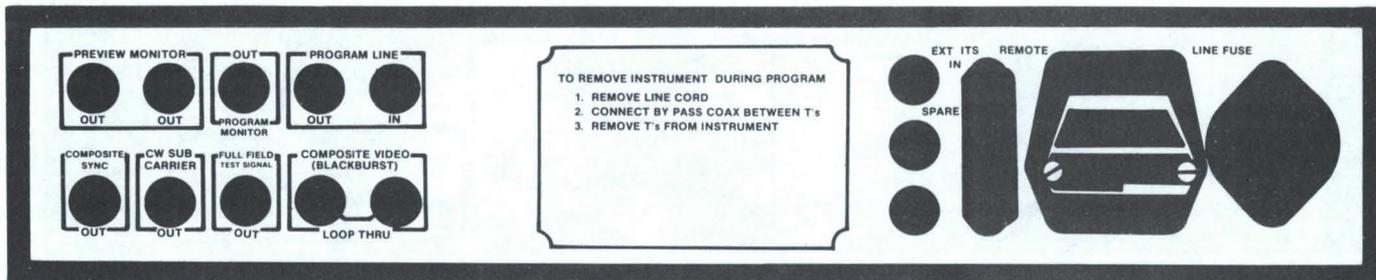
**Amplitude** — Within  $\pm 1$  IRE of white reference.

**Number of White Lines** — 57 through 227 on each field. All remaining active lines are black.

**Risetime** — Shaped by  $\sin^2$  filter with first zero in frequency domain at 4 MHz.

##### Multiburst Signal

The Multiburst Signal is generated by a function generator controlled by the digital programmer. This approach eliminates the need for individual start/stop oscillators for each burst, and for individual amplitude and ac axis adjustments for each burst. Each burst start time is completely stable, and each burst consists of an exact integer number of cycles, regardless of the frequency. They start at  $0^\circ$  of the first cycle and end at  $360^\circ$  of the last cycle. Location of the white flag may be programmed with relation to the bursts and used for source identification.



147A and 149A Rear Panel

**White Reference Amplitude** — 100 IRE  $\pm$  1 IRE.

**Burst Amplitude** — Normal Amplitude: 90 IRE plus 10 IRE setup. Reduced Amplitude: 60 IRE plus 10 IRE setup, or 50 IRE with no setup.

**Average Burst Level** — 55  $\pm$  1 IRE with 10% setup. Reduced: 40  $\pm$  1 IRE with 10% setup.

**Color Bars (149A Only)**

The 149A, when gen-locked to a program signal, provides either full-field or split-field color bar signals selectable by a front panel switch. This split-field signal is used to show gray scale tracking and consists of the luminance component of color bars on all active lines. The chrominance component is added to lines 66 through 218.

**Linearity Signal**

Three linearity test signals are selectable with front-panel controls: 5 step, 10 step, and ramp; either modulated or unmodulated. The luminance component is selectable at either 10 equal 10-IRE step, 5 equal 16-IRE step, or a 100-IRE ramp. Each of these is internally adjustable from 80 to 100 IRE peak amplitude. The subcarrier component is phase-locked to color burst. You can use these signals for measurement of differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal nonlinearity, and burst phase errors.

Measurements of differential gain and phase can be made more easily with 40 IRE subcarrier to override noise than with 20 IRE subcarrier. The subcarrier amplitude can be varied from 20 to 40 IRE by internal selection. Since the 40 IRE level of subcarrier should not be used together with full amplitude staircase or ramp where the test signal may be radiated, luminance amplitude of modulated linearity signals can be reduced to 80 IRE by internal adjustment.

**Luminance Component** — Peak Amplitude: 100 IRE within 1%. Each step is 20 IRE, within 1%, in 5 step and 10 IRE in 10 step. Step Risettime: 230 ns. Aberrations: within 2%. Step durations: 6  $\mu$ s for 5 steps, 3  $\mu$ s for 10 steps.

**Chrominance Component** — Amplitude: 286 mV p-p (40 IRE) within 5% and in phase with burst. (Can be 143 mV 20 IRE with internal jumper change.)

**Differential Phase** —  $\leq$  0.2°.

**Differential Gain** —  $\leq$  0.5%.

**Subcarrier Envelope** — Risettime: 375 ns.

**Ramp Luminance Amplitude** — 714 mV, 100 IRE  $\pm$  1%.

**Ramp Linearity** — Within 1%.

**Ramp Duration** — 40  $\mu$ s.

**Flat Field Signal**

The Flat Field signal with VITS inserted is used primarily for system testing at discrete average picture levels. It is a composite video signal which has a constant luminance level during the active portion of each field.

The luminance level of the Flat Field signal is selectable in 10 IRE unit increments from 0 to 100 IRE. An alternate selection provides a bounce between 10 and 90 IRE at 0.1 to 1.0 Hz rate.

An added feature combines flat field and one other selectable test signal, i.e., color bar (149A only), multiburst, pulse and bar, linearity, and composite. This mixed test signal provides a brighter waveform monitor display (than VITS and flat field) by alternating four lines of the variable flat field pedestal with one line of the selected other test signal during each active field.

**Luminance Level** — Within 2% of the indicated level except the 100 IRE level which is within 1%.

**Risettime** — Shaped by sin<sup>2</sup> filter with first zero in the frequency domain at 4 MHz.

**Pulse and Bar Signal**

Two nine-pole Kastelein filters generate highly precise 2T and T pulses. The digital programmer provides the high timing accuracy required in these pulses to eliminate jitter and long term drift. The programmer also determines exact signal element-to-element spacing and bar duration. It may be readily reprogrammed, in 2  $\mu$ s increments, to produce different spacings or bar widths.

The sin<sup>2</sup> pulse may be either 2T (0.25  $\mu$ s HAD) or T (0.125  $\mu$ s HAD). The transitions of the bar are also controlled by either of the two Kastelein filters so that frequency spectrum is limited to 4 MHz or 8 MHz. Shape of these transitions is integrated sin<sup>2</sup>.

The modulated sin<sup>2</sup> pulse (12.5T) is used in measuring relative gain and delay errors between chrominance and luminance signals. It is extremely sensitive to delay distortion and easily used, as delay distortion equal 10 d, where d equals baseline sinusoidal ripple in percent. The 20T pulse is also available

**2T Pulse Amplitude** — Within 1% IRE of T Bar.

**2T HAD** — 250 ns within 7.5 ns.

**2T Ringing** — Amplitude  $<$  0.5 IRE; duration  $<$  4 cycles.

**Time Location** — Internally programmable in 2  $\mu$ s increments.

**T Bar Amplitude** — 714 mV (100 IRE)  $\pm$  1%.

**T Bar Risettime** — 115 ns  $\pm$  15%.

**T Bar Time Location** — Start and stop internally programmable in 2  $\mu$ s increments.

**12.5T Modulated Pulse Peak Chrominance to Peak Luminance Amplitude Difference** —  $<$  0.5 IRE.

**12.5T Modulated Pulse Had** — 1.57  $\mu$ s or can be internally set to 2.5  $\mu$ s 20T, if desired.

**T Modulated Sin<sup>2</sup> Pulse Residual Subcarrier** —  $<$  0.5 IRE on insertion line.

**T Modulated Sin<sup>2</sup> Pulse Relative Chroma-Luminance Time Delay** —  $<$  10 ns.

**Window Signal**

The Window signal is the same as the Pulse and Bar except that the Window occupies lines 66 through 218 only. It is sensitive to both line time and field time distortions and is especially useful in evaluating picture monitors. Where field rate distortion is present, the Window signal will be more affected than the Pulse and Bar.

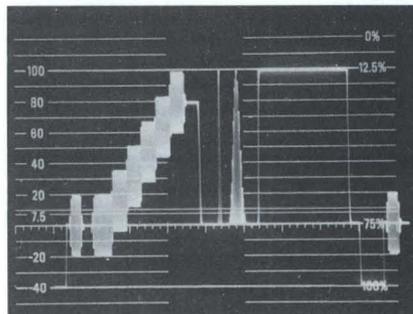
**Amplitude** — 100 IRE within 1 IRE.

**Risettime** — Internally Programmable: either 2T pulse and T Bar, or T pulse and 2T bar.

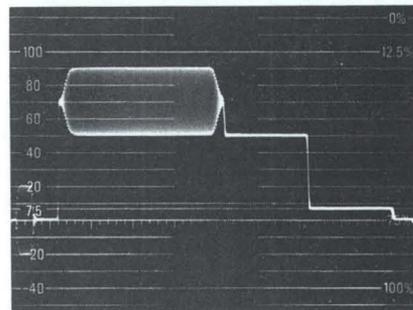
**Window Duration** — Lines 66 through 218.

**Composite Test Signal**

The Composite Test signal is a multiple function signal suitable for use as a VITS or as a full field signal. The multiple elements of this signal, available in both NTC7 and FCC formats, meet a wide variety of testing needs. Phase of the subcarrier of the modulated 20T pulse may be used to identify the VITS insertion point.



Composite Test Signal per FCC §73.699



Vertical interval reference signal (VIRS) per FCC 73.699

TELEVISION SIGNAL GENERATORS

## NOISE TEST SIGNAL (147A Only)

The 147A offers a signal-to-noise measuring technique for in-service testing during the vertical interval. The noise present in the middle portion of a line is deleted while the noise generated in a calibrated source is inserted for measurements by comparison. You then adjust the calibrated attenuator until inserted and incoming noise appear the same on a waveform monitor. The measured noise values are independent of operator interpretation errors to within 2 IRE.

External filters are required within the 147A when making noise measurements.

**Noise Pedestal Amplitude** — Selectable 10, 50, or 100 IRE within 0.2 IRE.

**Variable Pedestal** — Provided.

**Noise Levels** — -20 dB to -59 dB in 1 dB steps (0 dB = 700 mV RMS).

**Flat Noise Spectrum** — Energy Until Bandwidth: 15 kHz to 5 MHz  $\pm 6$  dB. (Spectrum extends well beyond 5 MHz.)

**Output Impedance** — 75  $\Omega$ .

**Return Loss** —  $\geq -30$  dB to 5 MHz.

**Important** — External filters are required for low pass filtered and weighted noise measurements.

## CHARACTERISTICS

### PROGRAM CONTROL SYSTEM

**Input Level** — Adjusted to Unity Gain.

**Variable Input level** —  $\pm 30\%$ .

**Input Return Loss** —  $< 46$  dB to 5 MHz. Power on, 40 dB to 5 MHz in bypass.

**Output Dc Level** —  $< 50$  mV (no signal).

**Isolation Between Program and Program Monitor Outputs** —  $> 34$  dB.

**Inserted Signal Level** — 714 mV (100 IRE)  $\pm 1\%$ .

**Frequency Response, Program, and Preview Channel** —  $\pm 1\%$ , 50 kHz to 5 MHz;  $+1\%$ ,  $-5\%$ , 5 MHz to 8 MHz.

**2T Pulse to Bar Ratio** — 100%  $\pm 0.5\%$ , 100%  $\pm 0.25\%$  for the 149A.

**Field Time Tilt** —  $< 0.5\%$ .

**Line Time Tilt** —  $< 0.5\%$ .

**Differential Phase at any APL, Standard Input** — Program Output:  $< 0.15\%$ . Preview Output:  $< 0.3\%$ .

**Differential Gain at any APL, Standard Input** — Program Output:  $< 0.2\%$ . Preview Output:  $< 0.4\%$ .

**Line Time Amplitude Nonlinearity** —  $< 0.5\%$ .

**Random Noise Output Program Channel** —  $< -75$  dB RMS.

**Residual Subcarrier on Noninserted Line** —  $< -60$  dB p-p.

**Hum, Transients on Noninserted Lines** —  $< -60$  dB.

**Spurious Signals During Blanking Time** —  $< -40$  dB.

**Signal Attenuation in Delete Mode** — 2T pulse  $> -70$  dB; subcarrier (color bars)  $\geq -60$  dB.

**Crosstalk into Program Channel from Internal Signals** — 2T pulse  $< -70$  dB, subcarrier (color bars)  $< -60$  dB.

**Line Timing Adjustment Range with External Sync** —  $\pm 0.5$  s.

**Jitter** —  $< 5$  ns.

### OTHER CHARACTERISTICS

**Power Requirements** — 90 to 136 V ac or 180 to 272 V ac, 48 Hz to 66 Hz, 40 W maximum at 115 V ac and 60 Hz. Rear panel selector provides rapid accommodation for 6 line-voltage ranges. (Shipped set at 115 V ac.)

**Inputs** — External VITS Inputs, Program Input, Auxiliary Input, Composite Sync, and Subcarrier.

**Output** — Program Monitor, Preview Monitor (two each), and Full Field.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

## PHYSICAL CHARACTERISTICS

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	455	17.9	483	19.0
Height	99	3.9	89	3.5
Depth	436	17.9	436	17.9
Weights	kg	lb	kg	lb
Net	89.0	19.0	91.0	20.0
Domestic Shipping	159.0	35.0	163.0	36.0
Export Shipping	250.0	55.0	254.0	56.0

## Generation, Insertion and Deletion of Signals Required for Remote Operation of Transmitters

### 149A Option 01

The 149A is an excellent one-unit source of the signals required for transmitter remote operation. The 149A recognizes monochrome transmissions (no burst) and includes facilities which may be used to inhibit the chrominance components of the color bar signal as required. The 149A has all the features of the 147A except Noise Test Signal.

### 147A Option 01

The 147A Option 01 is an alternate source of the signals required for transmitter remote control, but Color Bars must be provided from an alternate source such as the Tektronix earlier models 140, 144, 146, or the current model 1410, SPG2, TSG7.

## INCLUDED ACCESSORIES

75  $\Omega$ , BNC termination (011-0103-02); 2 each BNC-T adaptors (103-0030-00); 7 1/2 ft power cable, three-wire (161-0036-00); VIT program clear plastic cover plate (200-1474-00); front panel protective cover (200-1328-00); R147A and R149A include rackmounting hardware.

## ORDERING INFORMATION

**147A NTSC Signal Generator** ..... **\$9,555**

Option 01 — NTSC Signal Generator ..... **NC**

**R147A NTSC Signal Generator (Rackmount)** ..... **\$9,555**

Option 01 — NTSC Signal Generator (Rackmount) ..... **NC**

**149A NTSC Signal Generator** ..... **\$9,555**

Option 01 — NTSC Signal Generator ..... **NC**

**R149A NTSC Signal Generator (Rackmount)** ..... **\$9,555**

R149A Option 01 — NTSC Signal Generator (Rackmount) ..... **NC**

## OPTIONAL ACCESSORIES

### Noise Measurement Filters

External filters are required with the 147A Generator when making noise measurements. For systems using 525/60 standards

#### Low Pass Filter

Order 015-0212-00 ..... **\$125**

#### Noise Weighting Filter

Order 015-0214-00 ..... **\$90**

#### Low Pass 4.2 MHz 525/60

Order 015-0212-00 ..... **\$125**

#### Noise Weighting 4.2 MHz 525/60

Order 015-0214-00 ..... **\$90**

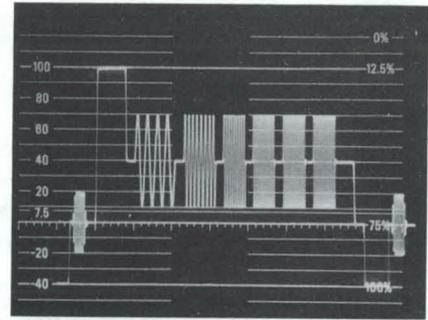
CCIR recommendation 568 provides for measuring signal-to-weighted random noise on all international transmissions (both 525/60 and 625/50) with a 5.0 MHz low pass filter and a unified noise weighting filter.

#### Low Pass 5 MHz

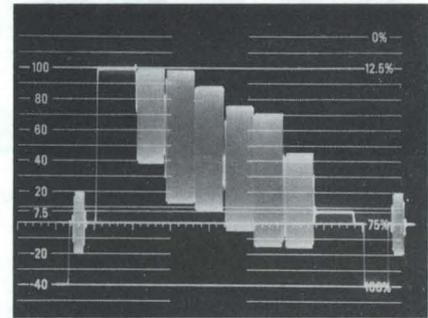
Order 015-0213-00 ..... **\$125**

#### Unified Noise Weighting

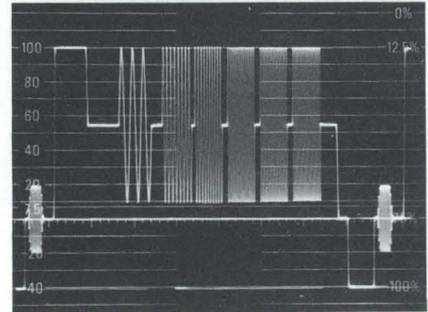
Order 015-0283-00 ..... **\$65**



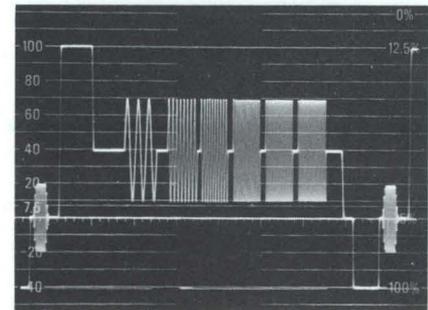
Multiburst per FCC \$76.699



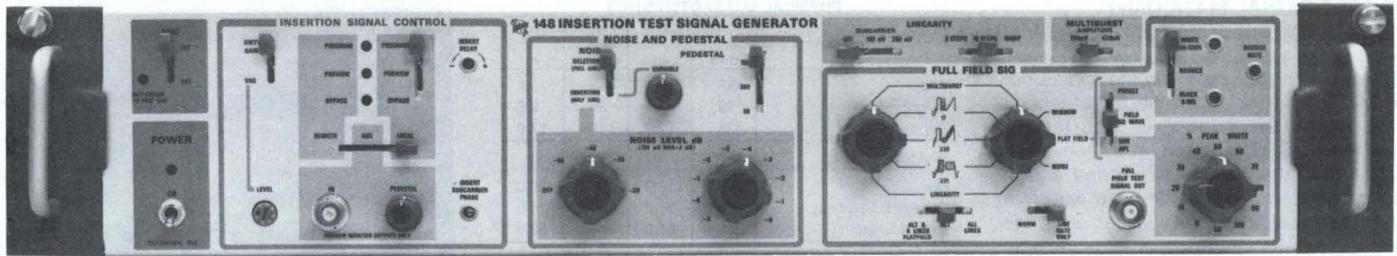
Color Bars per FCC \$76.699



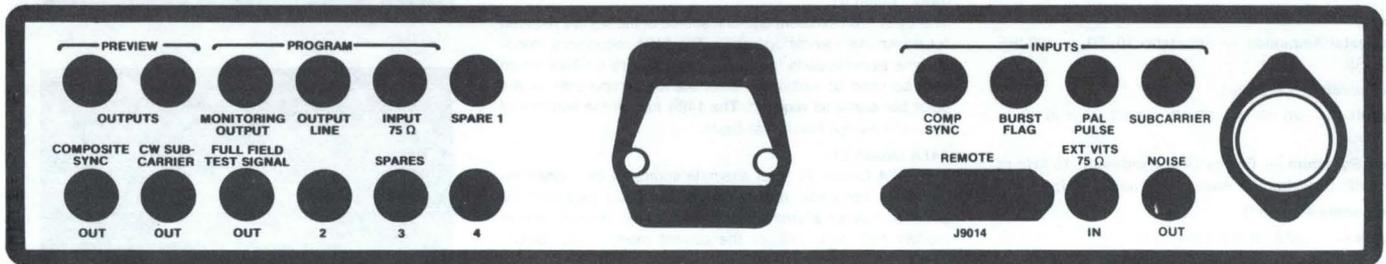
Full amplitude multiburst



Reduced amplitude multiburst minimizes the effects of nonlinear distortions



Rackmount version; cabinet version has carrying handle less mounting hardware



148/R148 rear panel

## 148

**Insertion Test Signals (Per EBU, CCIR Recommendation 473-2, Annex 1)**

**Full-Field Test Signals (Per CCIR Recommendation 567)**

**Easily Reprogrammable**

**Safe In-Service ITS Insertion (Per EBU Specifications)**

**Noise Measurement Width**

**APL Bounce Signal**

**Source Identification Code**

**Operates With Sound In Syncs**

**Locks With Mixed Sync (Per EBU Homologation Specifications for ITS Generators) Subcarrier, PAL Pulse, Burst Flag, Comp Sync**

The Tektronix 148 Insertion Test Signal (ITS) Generator provides all the test signals you need to test and measure PAL video transmission systems. Test signals are available as both full-field composite video and ITS inserted into the incoming program signal's vertical blanking interval. All timing information for ITS insertion is derived from the incoming composite video signal.

### VERTICAL INTERVAL INSERTION/ DELETION AND PROGRAM CONTROL

The 148 inserts ITS only when gen-locked to an incoming composite video signal. Since ITS insertion/deletion involves active circuit elements in the program line, program line fail safe operation is provided in the event of instrument malfunction, loss of sync, or power failure. You also have access to local and remote control manual override capability.

A preview monitor output permits observation of the ITS deletion/insertion program before anything is actually done to the program signal. Preview/program operation can be locally or remotely controlled.

Provisions are made for adding an externally generated ITS to the program line.

### INSERTION SIGNAL CONTROL FEATURES

#### Free Running Operation

A warning light indicates absence of incoming synchronizing information and ITS deletion and insertion is automatically discontinued.

#### Program Level

A front panel switch lets you select a preset gain, normally adjusted for unity gain between program input and program output. Or, you can use a front panel level adjustment to normalize the incoming program signal to provide 1 volt at the program output.

#### Local-Remote Control of Program and Preview

You can shift control of program or preview modes from the front panel (local) to a position remote from the 148. When operating under either local or remote control, front panel lights indicate program line status, since the front panel program status switch position may not correspond to the operating mode selected.

#### Program-Preview-Bypass

This three-position switch is used to select one of three modes: Program, Preview, or Bypass.

**Program:** In this switch position, ITS is inserted on program line output according to internal selection of test signals and their time addresses.

**Preview:** In this switch position, ITS is inserted only on program, as viewed on the preview monitor output. Preview is used for verification prior to inserting these signals on program output.

**Bypass:** In this switch position, incoming program material bypasses 148 functions and output is unchanged.

#### Auxiliary

A noncomposite video signal (such as a sweep generator) applied to the auxiliary input appears at the preview monitor output connector with composite blanking and sync added. A pedestal control provides a dc offset so the auxiliary signal excursion may be positioned between the black and white limits of the resulting composite video signal. Remote control is not available.

#### ITS Subcarrier Phase

A recessed front-panel control adjusts phase of color subcarrier on internally generated signals to be correct in relation to the phase of incoming burst.

#### Insertion Delay

A recessed front-panel control provides a fine horizontal timing adjustment for inserted signals.

### CHARACTERISTICS

#### PROGRAM CHANNEL

**Input Level** — Adjusted to unity gain.

**Variable Input Level** —  $\pm 30\%$ .

**Input Return Loss** —  $\geq 30$  dB to 7 MHz.

**Output Dc Level** —  $< 50$  mV (no signal).

**Isolation Between Program Preview Outputs** —  $\geq 46$  dB to 5 MHz.

**Isolation Between Program and Program Monitor Outputs** —  $\geq 34$  dB to 5 MHz.

**Inserted Signal Level** — Within  $\pm 1\%$  of nominal.

**Frequency Response, Program, and Preview Channels** —  $\pm 1\%$ , 50 kHz to 5 MHz.  $+1\%$ ,  $-5\%$ , 5 MHz to 8 MHz.

**2T Pulse to Bar Ratio** — Within 0.25%.

**Field Time Tilt** —  $<0.5\%$ .

**Line Time Tilt** —  $<0.25\%$ .

**Differential Phase at any APL, Standard Input** — Program output  $<0.15^\circ$ . Preview output  $<0.3^\circ$ .

**Differential Gain at any APL, Standard Input** — Program output  $<0.2\%$ . Preview output  $<0.4\%$ .

**Line Time Amplitude Nonlinearity** —  $<0.5\%$ .

**Random Noise Output Program Channel** —  $<-75$  dB RMS.

**Residual Subcarrier on Noninserted Lines** —  $<0.7$  mV.

**Hum, Transients on Noninserted Lines** —  $\geq 60$  dB down.

**Spurious Signals During Blanking Time** — Inactive line time  $\geq 40$  dB down. Active ITS lines  $\geq 60$  dB.

**Signal Attenuation in "Delete" Mode** — 2T pulse  $>-70$  dB. Subcarrier (color bars)  $>-60$  dB.

**Crosstalk into Program Channel from Internal Signals** — 2T pulse  $<-70$  dB, subcarrier (color bars)  $<-60$  dB.

**Unwanted Pedestal at Time of ITS Insertion** — Program and Preview Channel.  $<5$  mV.

**Insert Delay Adjustment Range** —  $\pm 0.5$   $\mu$ s front panel.

## FULL-FIELD OPERATION

The Tektronix 148 provides full-field test signals separate from program. These signals are generated with or without external synchronizing information and will be locked to the external synchronizing signal when a program signal or external synchronizing signals are present.

Full-field signals available include: Multiburst, Linearity, Flat Field, Window, Noise, Line 17, Line 330, and Line 331. Select these eight signals using two switches that permit any one of the signals to be produced on all active lines. You can also designate that any two signals be alternated on all active lines, or any two signals be paired on two successive lines and then alternated with six lines of adjustable flat field.

When operating the 148 in the flat field mode, you may select a white level preset between 85 and 100% and a black level preset between 0 and 15%. Automatic change between white and black is available and occurs at a period adjustable from 1.0 s to 10.0 s.

Eleven APL levels between 0 and 100% of white can be used in the flat field or alternation mode. In the alternation mode, flat field lines are alternated with other selected signals, such as multiburst or linearity.

All full-field signals are available with or without vertical sync and blanking selectable from the front panel.

## PULSE AND BAR SIGNAL

Highly precise 2T and T pulses are generated by two nine-pole Kastelein Filters. The 148's digital programmer provides the high degree of timing accuracy required to eliminate jitter and long-term drift. This programmer also determines exact signal element-to-element spacing and element duration. The programmer is adjustable in 2  $\mu$ s increments.

The  $\sin^2$  pulse may be either 2T (200 ns HAD) or T (100 ns HAD). The transitions of the bar are controlled by either Kastelein Filter, and frequency spectrum is limited to 5.0 MHz or 10.0 MHz. The shape of these transitions is integrated  $\sin^2$ .

The envelope of the modulated  $\sin^2$  pulse is formed by a nine-pole Kastelein filter.

The modulated  $\sin^2$  pulse (20T) is used in measuring relative gain and delay errors between chrominance and luminance signals. The 20T modulated  $\sin^2$  pulse has a 2.0  $\mu$ s HAD. Greater sensitivity to chrominance-luminance delay errors may be obtained by using reduced pulse width.

**2T Pulse Amplitude** — Within 1% of luminance bar.

**2T HAD** — 200 ns.

**2T Ringing** — Amplitude  $<0.5\%$ ; duration  $<2$  cycles.

**Time Location** — Internally programmable in 2  $\mu$ s increments.

**Luminance Bar Amplitude** — 700 mV  $\pm 1\%$ .

**T Bar Risettime** — 100 ns  $\pm 15\%$ .

**T Bar Time Location** — Start and stop internally programmable in 2  $\mu$ s increments.

**20T Modulated Pulse Peak Chrominance to Peak Luminance Amplitude Difference** —  $<3.5$  mV.

**20T Modulated Pulse HAD** — 2.0  $\mu$ s.

**20T Modulated Pulse Residual Subcarrier** —  $<3.5$  mV on insertion line.

**20T Modulated Pulse Relative Chroma-Luminance Time Delay** —  $<5$  ns.

## WINDOW SIGNAL

The window signal is the same as the pulse and bar except that it occupies the center 205 lines of each field. This signal lets you measure both line time and field time distortions, and is especially useful for observing picture monitors. Where field rate distortion is present, the window signal will be affected to a much greater extent than the pulse and bar signal.

**Amplitude** — 700 mV.

**Risettime** — Internally programmable at either 2T pulse and T window, or T pulse and 2T window.

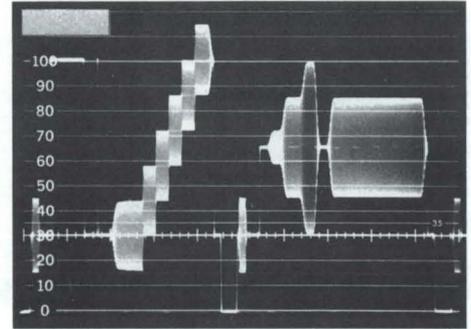
## LINEARITY SIGNAL

You can select three Linearity Test Signals: 5 step, 10 step, or ramp (either modulated or unmodulated). The subcarrier component is phase-locked to color burst. Use this signal for measuring differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal nonlinearity, and burst phase and amplitude errors.

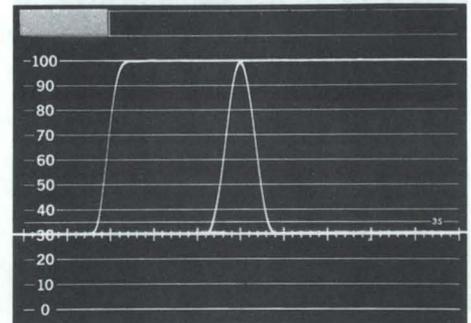
**Luminance Component** — Peak amplitude 700 mV within 1%, 5 step, 10 step, or ramp.

**Riser Shape** —  $\sin^2$  shape with a nominal 200 ns risetime.

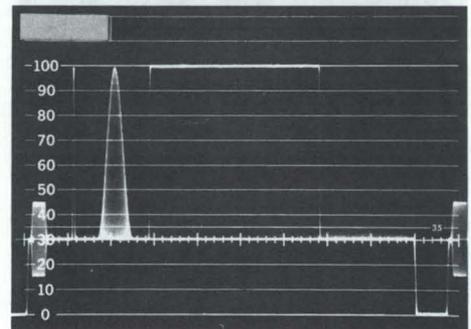
**Chrominance Component** — Amplitude is selectable at 0 mV, 140 mV, or 280 mV.



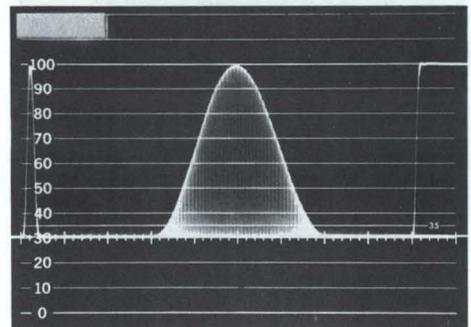
Full-field alternation of 2 signals on all active lines (CCIR recommendation 569, Figure 3)



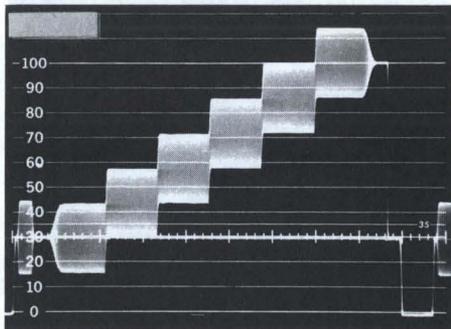
2%  $\sin^2$  pulse superimposed on bar by double exposure



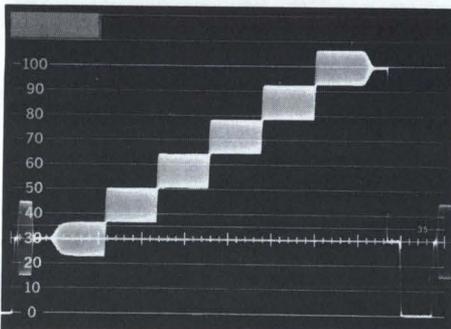
Window Signal with 2T and modulated 20T  $\sin^2$  pulses



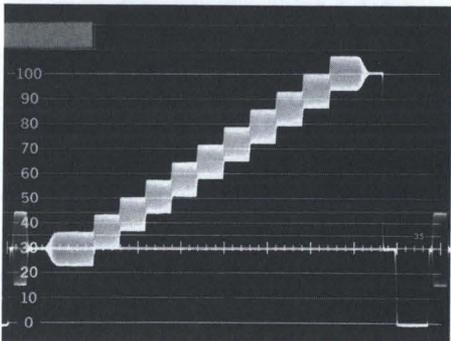
Modulated 20T pulse magnified



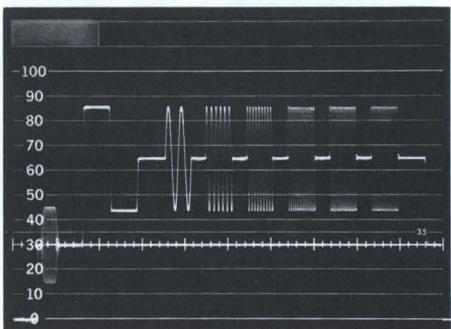
Linearity signal, 5 step, 280 mV subcarrier



Linearity signal, 5 step, 140 mV subcarrier



Linearity signal, 10 step, 140 mV subcarrier



420 mV multiburst. Notice burst starts and stops precisely at the same level.

## FLAT-FIELD SIGNAL

The flat-field signal with VITS inserted is used primarily for system testing at discrete average picture levels.

The flat-field signal is a composite video signal that, during the active portion of each field, has a constant luminance level. The luminance level is selectable in eleven increments from 0 to 100% of white. An alternate selection provides automatic change between black and white with a period variable from 1 to 10 s.

**Luminance Level of the Flat-Field Signal** — Within 2% of the indicated level, except the 100% level, which is within 1%.

**Risetime** — 200 ns.

## FIELD SQUAREWAVE SIGNAL

The field squarewave signal is used to measure field time distortions. In this mode, the Tektronix 148 provides a composite video signal with 205 active lines at 700 mV, approximating a 50 Hz squarewave. Use this signal to detect low frequency phase and gain distortions, even those passing through clamper amplifiers.

**Amplitude** — Within  $\pm 1$  mV of white reference.

**Number of White Lines** — 65 through 270, and 377 through 582. All remaining active lines are black.

**Risetime** — 200 ns.

## MULTIBURST SIGNAL

The multiburst signal is generated by a function generator controlled by a digital programmer. This design eliminates the need for individual start/stop oscillators on each burst and individual amplitude and ac axis adjustments. Each burst start time is completely stable, and each burst packet consists of an exact number of cycles, regardless of the frequency. Each burst starts at  $0^\circ$  of the first cycle and ends at  $360^\circ$  of the last cycle. Location of the white flag with relation to the bursts is programmable and may be used for source identification.

**White Reference Amplitude** — 700 mV  $\pm 1\%$  and 420 mV  $\pm 1\%$ .

**Burst Amplitude** — Amplitude selectable at normal or reduced. Internal adjustment presets normal amplitude value.

**Burst Frequencies** — 0.5, 1, 2, 4.0, 4.8, and 5.8 MHz within 3%. Each burst frequency is independent and internally adjustable.

**Timing** — Each burst starts at  $0^\circ$  of the first cycle and ends at  $360^\circ$  of the last cycle.

## NOISE SIGNAL

The 148 offers a unique signal-to-noise measuring technique for in-service testing during the vertical interval. The noise present in the middle portion of an internally selected line is deleted, and noise generated by a calibrated source is inserted for comparison. You can vary a calibrated attenuator until inserted noise and incoming noise appear the same on a waveform monitor. The noise values measured are independent of interpretation errors to within 2 dB.

When measuring transmission noise, you may delete the noise on an entire line at the point from which the noise is to be measured using one 148. Further down the transmission system, you can use a second 148 to match the noise level in the manner described previously. Repeat this process to determine the transmission noise level for several sections of the transmission system.

Noise may be measured at 50 mV, 350 mV, or 700 mV luminance levels. The calibrated noise generator provides flat (white) noise. External noise filters are required with the Tektronix 148 when making noise measurements.

**Noise Pedestal Amplitude** — 50 mV  $\pm 5$  mV, 350 mV within 2%, 700 mV within 2%.

**Variable Pedestal** —  $\pm 5\%$  variation provided for half line insertion in order to exactly match pedestal level of incoming signal.

**Noise Levels** —  $-20$  dB to  $-59$  dB in 1 dB steps (0 dB = 700 mV RMS).

**Flat Noise Spectrum** — Energy unit bandwidth, 15 kHz to 5 MHz  $\pm 6$  dB. (Spectrum extends well beyond 5 MHz.)

**Output Impedance** — 75  $\Omega$ .

**Return Loss** —  $\geq 30$  dB.

## INSERTION TEST SIGNALS

The signals used as vertical interval test signals on Line 17, 330, and 331 (per CCIR recommendation 569, 473-2, Annex 1), are also available full field. The elements of these signals are specified as follows:

### LUMINANCE BAR

**Amplitude** — 0.7 V  $\pm 1\%$ .

**Shape and Time of Rise and Fall** —  $\approx 100$  ns. May be derived from the shaping network of the  $\sin^2$  pulse or of the staircase waveform.

**Tilt** —  $< -0.5\%$  for 10  $\mu$ s.

### STAIRCASE SIGNAL

**Level of the Uppermost Tread of Staircase** — Within  $\pm 1\%$  of luminance bar amplitude.

**Number of Risers** — Five.

**Shape of Risers** —  $\sin^2$  shape with a nominal 200 ns risetime.

**Line-time Nonlinearity** — The difference in amplitude between the largest and smallest risers is  $< 0.5\%$  of the largest amplitude.

**Superimposed Subcarrier Frequency and Phase** — 4.43361875 MHz  $\pm 10$  Hz;  $60^\circ \pm 5^\circ$  to the B-Y axis referred to the burst (when present).

**Risetimes and Falltimes of Subcarrier Superimposed on Staircase** —  $\approx 1$   $\mu$ s.

**Inherent Differential Gain** —  $< 0.5\%$ .

**Inherent Differential Phase** —  $< 0.2^\circ$ .

**Amplitude of Superimposed Subcarrier** — 0.28 V p-p  $\pm 2\%$  of luminance-bar amplitude.

### 2T PULSE

**Amplitude** —  $\pm 1\%$  of luminance bar amplitude.

**Half-Amplitude Duration** — 200  $\pm 6$  ns.

### 20T COMPOSITE PULSE\*

**Amplitude** — Within  $\pm 1\%$  of luminance bar amplitude.

**Half-Amplitude Duration** — 2  $\pm 0.06$   $\mu$ s.

**Inherent Chrominance/Luminance Gain Inequality** —  $< 0.5\%$ .

**Inherent Chrominance/Luminance Delay Inequality** —  $< 10$  ns.

**Subcarrier Leak** —  $< 3.5$  mV p-p on insertion lines.

**Harmonic Content of Subcarrier** —  $< -40$  dB.

**Chroma Phase** —  $60^\circ$  standard. Internally adjustable to any phase.

### CHROMINANCE BAR

**Peak-to-Peak** — Within  $\approx \pm 1\%$  of luminance bar amplitude.

**Pedestal** —  $0.35\text{ V} \pm 1\%$ .

**Inherent Chrominance/Luminance Cross Modulation** — 0.5% of pedestal amplitude.

**Envelope Risetime** —  $\approx 1\ \mu\text{s}$ .

### THREE-LEVEL CHROMINANCE BAR\*\*

**Position of Transitions** — 7H/32, 9H/32, and 14H/32.

**Peak-to-Peak Amplitudes** — 1st section, within  $\pm 1\%$  of  $1/5$  of the luminance bar (nominal value 0.14 V). 2nd section, within  $\pm 1\%$  of  $3/5$  of the luminance bar (nominal value 0.42 V). 3rd section, within  $\pm 1\%$  of the luminance bar (nominal value 0.7 V).

**Pedestal** —  $0.35\text{ V} \pm 1\%$ .

**Chrominance/Luminance Cross Modulation** —  $< 0.5\%$  of pedestal amplitude.

**Envelope Risetime** —  $\approx 1\ \mu\text{s}$ .

### CHROMINANCE REFERENCE

**Peak-to-Peak Amplitude** —  $0.42\text{ V} \pm 1\%$  of luminance bar amplitude.

**Pedestal** — 350 mV within 1%.

**Envelope Risetime** —  $\approx 1\ \mu\text{s}$ .

### SOURCE IDENTIFICATION CODE

The Tektronix 148 is a source identification code generator with up to 25 pulses available in any combination on Line 16 or 329.

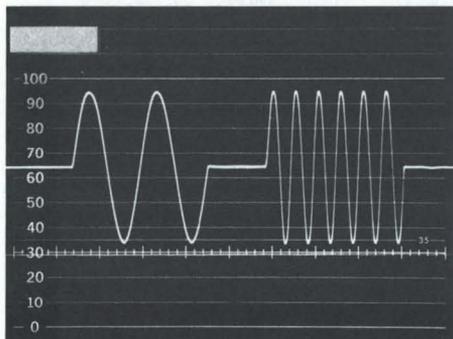
**Pulse Width** —  $1\ \mu\text{s}$ .

**One Level** — 630 to 700 mV above blanking.

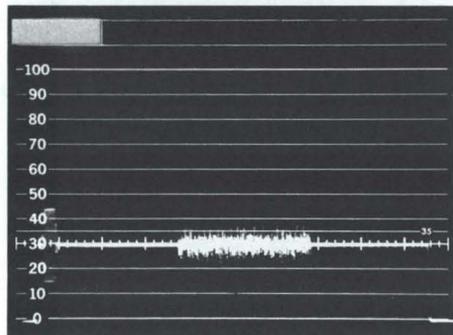
**Zero Level** — Within 25 mV of blanking.

\*10T composite pulse available by internal jumper repositioning.

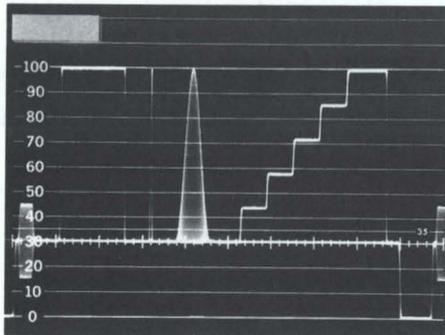
\*\*700 mV chrominance bar, available as an alternative to 3 level bar by simple internal jumper repositioning.



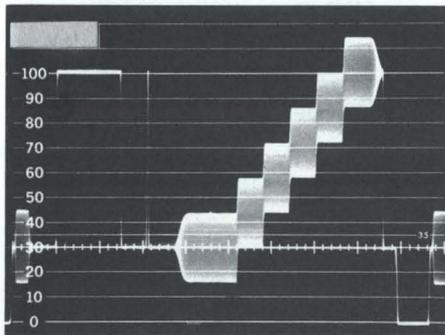
Multiburst magnified to show start/stop transitions



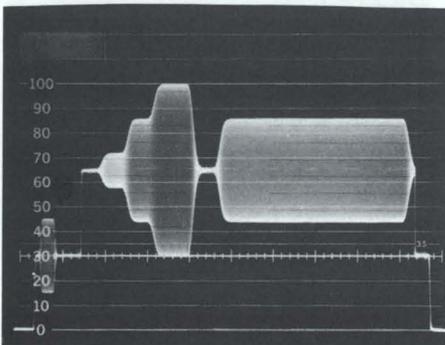
Half line adjustable noise comparison signal inserted on a full line



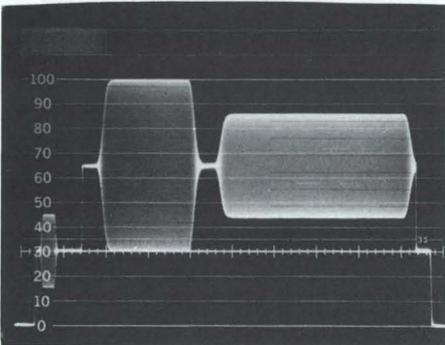
Line 17



Line 330



Line 331



Line 331 with single level chrominance bar

### OTHER CHARACTERISTICS

**Power Requirements** — 90 to 136 V ac or 180 to 272 V ac; 48 Hz to 66 Hz, 55 W maximum at 115 V ac and 60 Hz. Factory set at 230 V ac.

**Inputs** — External ITS, Program, Auxiliary, Composite Sync, Subcarrier, Pal Pulse, and Burst Flag.

**Outputs** — Program, Program Monitor, Preview Monitor (two each), Full Field, Composite Sync, Subcarrier, and Noise.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of  $0^\circ\text{C}$  to  $+50^\circ\text{C}$ .

### PHYSICAL CHARACTERISTICS

Dimensions	148		R148	
	mm	in	mm	in
Width	463	18.2	483	19.0
Height	97	3.8	88	3.5
Depth	485	19.1	499	19.7
<b>Weights</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net Weight	86.0	19.0	91.0	20.0
Shipping Weight $\approx$	159.0	35.0	163.0	36.0

### INCLUDED ACCESSORIES

75  $\Omega$ , BNC termination (011-0103-02); 2 each BNC-T adaptors (103-0030-00); 7 1/2 ft power cable, three wire (161-0036-00). R148 includes rackmounting hardware. (351-0195-01).

### ORDERING INFORMATION

148 Test Signal Generator .....	\$7,165
R148 Test Signal Generator (Rackmount) .....	\$7,165

### OPTIONAL ACCESSORIES

#### Noise Measurement Filters

External filters are required with the 148 Generator when making noise measurements. For systems using 625/50 standards:

<b>Low Pass 5.0 MHz 625/50</b>	
Order 015-0213-00 .....	\$125
<b>Noise Weighing 5.0 MHz 625/50</b>	
Order 015-0215-00 .....	\$80
<b>Low Pass 6.0 MHz 625/50</b>	
Order 015-0220-00 .....	\$100
<b>Unified Noise Weighing Network</b>	
Order 015-0283-00 .....	\$65
(per CCIR recommendation 568, use only with 5.0 MHz Low Pass Filter 015-0213-00)	



1430 Random Noise Measurement Set Front Panel

## 1430

Conforms to CCIR Recommendation 568

In-Service Testing

Out-of-Service Testing

Program Material Protected by Fail-Safe Provisions

525/60 or 625/50 Standards

The 1430 provides random noise measurement capabilities on an in-service basis using the spatially adjacent noise matching technique with a waveform monitor. A program channel allows deletion of VITS and/or noise on selected lines in the vertical blanking interval, and a monitor channel is provided for making measurements in conjunction with a waveform monitor.

The 1430 has two sections. One section, permanently mounted in the rack, contains inputs and outputs and program protecting material. The second section, containing circuitry and controls, may be easily removed without cable disconnection.

### Monitor Channel

The monitor channel has an output independent from program for waveform comparison of the noise on the incoming signal and noise from the internal noise generator. Front-panel controls determine monitor channel parameters with three operating modes: VITS, Full Field, and Out-of-Service.

In the VITS mode, any line between 10 and 21 in either or both fields may be selected for insertion of the reference noise. The Full Field mode provides insertion on all active lines.

The Out-of-Service mode is provided for measurements on sources that do not have composite sync. In particular, these include transmission circuits not carrying signals at the time testing is conducted. Horizontal sync is added for waveform monitor synchronization.

In all modes the insertion width is internally set at 26  $\mu$ s. Delay between insertion and sync is controlled by the Delay adjustment. A switch and a potentiometer covering a range of 0 to 100 IRE controls the insertion pedestal level.

Monitor channel gain control, with a  $\pm 3$  dB range, allows normalizing the signal for 1 V peak-to-peak signal so that noise measurement relative to 1 V may be made. The internal noise weighting filter may be switched in or out from the front panel for evaluation of the spectral content of the incoming noise. This filter is the monitor channel only and does not affect the program output.

The 1430 may be used on both 625/50 and 525/60 systems but is shipped equipped for 525/60. The 1430 Option 01 is equipped for 625/50. Both models use the unified weighting filter per CCIR Recommendation 568. Insertion loss characteristics are as follows:

Insertion Loss $\approx$	
1 MHz	5.9 dB
2 MHz	10.2 dB
3 MHz	12.0 dB
4 MHz	13.0 dB
5 MHz	13.6 dB

### Program Channel

The Program Channel has a 75  $\Omega$  input impedance and unity gain and output impedance of 75  $\Omega$ . No program impairment is introduced. A relay provides program signal continuity if the 1430 loses power. Internal programming, readily changeable, controls all deletion parameters. Up to three lines between 10 and 21 in either or both fields may be deleted. The deletion may be varied between the first half, second half, or full active portion of the video line. A pedestal may be inserted in the deleted portion of a line at 10, 50, or 100 IRE levels.

## CHARACTERISTICS

### PROGRAM CHANNEL

- Signal Input Level** — 1 V nominal.
- Input Impedance** — 75  $\Omega$  nominal.
- Input Return Loss** — POWER ON:  $\geq 46$  dB to 5 MHz. POWER OFF or BYPASS:  $\geq 40$  dB or 5 MHz.
- Output Impedance (operating)** — 75  $\Omega$  nominal.
- Output Return Loss (all)** —  $\geq 30$  dB to 5 MHz.
- Output Blanking, Dc Level** — 0 V within 50 mV, for blanking pulses.
- Inserted Pedestal Level** — Adjustable to 100, 50, 10, or 1 IRE.
- 2T Pulse to Bar Amplitude** — Within 0.25%.
- Mod Sin<sup>2</sup> Pulse (chrominance and luminance)** — 100% within 0.5%.
- Waveform, Tilt** — Field Rate Squarewave  $\leq 0.5\%$ , 26  $\mu$ s Bar,  $\leq 0.5\%$ .
- Differential Phase (10% to 90% APL, standard input)** — Program output,  $\leq 0.15^\circ$ .
- Differential Gain (10% to 90% APL, standard input)** — Program output,  $\leq 0.2^\circ$ .
- Line Time Amplitude Nonlinearity (10% to 90% APL, standard input)** —  $\leq 0.5\%$ .
- Random Noise** — Program output:  $\geq 75$  dB (RMS) down (using weighting and low pass filters, 5 MHz).
- Hum or Transients on Noninserted Lines** —  $\geq 60$  dB down, (using weighted and low pass filters, 5 MHz).
- Spurious Signals During Blanking Lines** —  $\geq 40$  dB down, low pass (5 MHz).
- Signal Attenuation in Delete Mode** — 2T pulse,  $\geq 70$  dB down, Subcarrier (color bars):  $\geq 60$  dB down. Insertion pedestal 10, 50, and 100 IRE, first half, second half, or entire line (up to 3; 10 to 21) or full field.
- Unwanted Pedestal at Time of VITS Insertion** —  $\leq 0.7$  IRE.
- Time Jitter** —  $\leq 5$  ns.

## NOISE

- Pedestal Level** — Pedestal Amplitude: 10 IRE, 50 IRE, and 100 IRE.
- Pedestal Position** — (Insertion mode only) Delay: 10 to 50  $\mu$ s.
- Noise Amplitude** — 20 dB to  $-59.5$  dB (0 dB = 700 mV RMS).
- Noise Attenuators** — Absolute amplitude: within 1 dB.
- Noise Spectrum** — Energy/unit bandwidth: flat within 6 dB, 15 kHz to 5 MHz.
- Output Impedance** — 75  $\Omega$  nominal.
- Output Return Loss** —  $\geq 30$  dB.
- Noise Weighting and Low Pass Filter** — Per CCIR recommendation 421-2.

## AC POWER

- Line Voltage Range** — 115 V ac: 90 V to 132 V. 230 V ac: 180 V to 264 V. Standard 1430 factory set at 115 V ac. 1430 Option 01 factory set at 230 V ac.
- Maximum Line Current** — 0.25 A.
- Maximum Power Consumption** — 30 W.
- Line Frequency Range** — 48 to 66 Hz.

## PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	483	19.0
Height	44	1.7
Depth	429	16.9
Weights	kg	lb
Net	4.5	10.0
Shipping	7.2	16.0

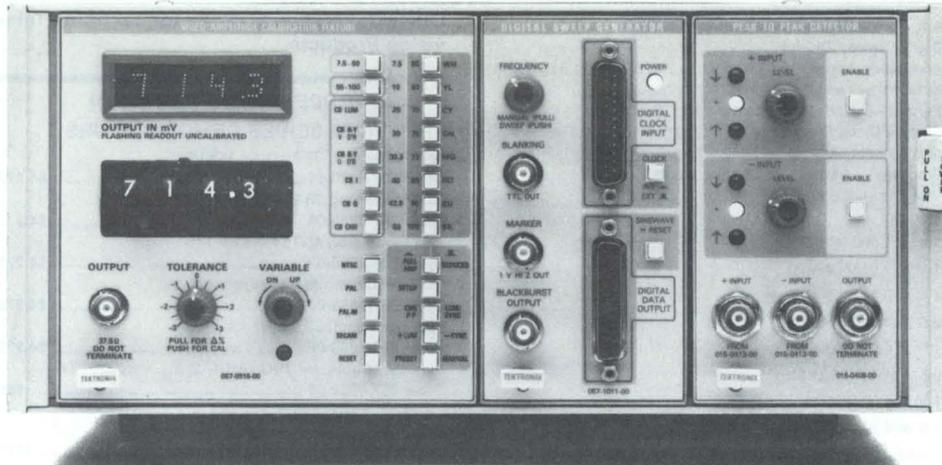
## INCLUDED ACCESSORIES

Three wire power cable (161-0066-00); one pair slide guide (351-0331-03); cover program front panel (200-1481-00).

## ORDERING INFORMATION

<b>1430 Random Noise Measuring Set</b>	
(525/60) .....	<b>\$4,115</b>
<b>Option 01</b> — Random Noise Measuring Set	
(625/50) .....	<b>+\$85</b>

The 1430 and 1430 Option 01 are provided with the 5.0 MHz low pass filter and unified weighting filter per CCIR Recommendation 568.



Video Amplitude Calibration Fixture, Digital Sweep Generator, and P-P Detector shown in a Tektronix TM 504 Mainframe

Accurate calibration and verification of video equipment performance is essential for maintenance of optimum television system quality and thus signal quality.

New products, as well as calibration standards and procedures, have been developed to help provide accurate and NBS-traceable calibration and performance verification of Tektronix television products.

### VIDEO AMPLITUDE CALIBRATION FIXTURE

**Provides a Standard Reference For Amplitude Calibration**

**Preset Values For Common Video Signals**

**NTSC, PAL, PAL-M, SECAM Compatible**

The Video Amplitude Calibration Fixture (VAC) is a precision test fixture used in the measurement of common video signals, and the calibration of video test signal generators and waveform monitors. It provides a simple means of measuring and calibrating luminance and chrominance amplitudes associated with most video signals.

The VAC provides a squarewave amplitude reference from 0.0 to 999.9 mV peak with a resolution of 0.1 mV and an accuracy of 0.05%. Signal amplitude may be selected using a 4-digit front panel lever-switch or from over 500 preset values stored in EPROM. The VAC preset amplitudes are compatible with NTSC, PAL, PAL-M and SECAM television systems.

In the design of the VAC, careful attention was paid to thermal tilt to ensure accurate conversion from dc calibration to squarewave output. Unique choice of output impedance compensates loading effects when calibrating equipment with loop-through inputs.

The calibration of the VAC requires only a digital voltmeter with an accuracy of 0.01%.

The VAC operates in any of two compartments of the Tektronix TM 500 or TM 5000 Series power modules (except TM 501).

### CHARACTERISTICS

#### Output Signal

**Front Output Connector** — 37.5 Ω; BNC connector located on front panel.

**Rear Interconnect** — 0.0 Ω; Rear edge connector pins 27A and 28A.

**Amplitude Range (Tolerance Disabled)** — 0 mV to 999.9 mV ± (0.05% + 0.1 mV); p-p squarewave amplitude.

**Amplitude Range (Tolerance Enabled)** — 0 mV to 999.9 mV ± (0.5% + 0.1 mV) + TOLERANCE reading; p-p squarewave amplitude.

**Resolution** — 0.1 mV.

**Risetime** — Less than 1 μs.

**Frequency** — NTSC, PAL-M, 270 Hz nominal; PAL, SECAM, 275 Hz nominal.

#### ENVIRONMENTAL

**Normal Operating Temperature** — +15°C to +35°C.

**Operating Temperature Range** — 0°C to +50°C.

**Weights** — Net: 1.4 kg, (3.0 lb). Net Shipping: 4.5 kg, (10.0 lb).

#### INCLUDED ACCESSORIES

75 Ω Terminator (±0.025%), (011-0102-01); 0.06% attenuator, (011-0134-00); subcarrier harmonic, rejection filter, (015-0407-00).

**Order 067-0916-00 Video Amplitude Calibration Fixture** ..... **\$2,250**

#### OPTIONAL ACCESSORIES

**72 in Low Loss 75 Ω Cable** Order 012-0159-01 ..... **\$30**

### PEAK-TO-PEAK DETECTOR

**NBS-Traceable Frequency Response Standard**

**Ultra Flat Response**

**Detector Amplifier Corrects Detector Diode Gain and Offset Errors**

The 015-0408-00 Detector Amplifier, combined with a 015-0413-00 Detector Head, comprise an NBS-traceable peak-to-peak detector system for baseband video frequency response testing. This system allows precise comparison of sinewave amplitudes at frequencies throughout the video spectrum. Typical response is accurate to as low as ±0.02% (±0.002 dB).

The frequency response of an analog generator may be calibrated using the peak-to-peak detector system as a transfer standard. The generator may then be used as a frequency response transfer standard to calibrate frequency response and chrominance-luminance gain of test equipment such as waveform monitors and vectorscopes.

A second detector head may be ordered for differential measurements.

### CHARACTERISTICS

**Input Signal Range** — 0.25 V to 1.0 V p-p.

**Envelope Gain Unit** — ±0.1% for 1% signal change.

**Input Impedance** — 75 Ω.

#### Frequency Response

Frequency	Performance Requirements	Supplemental Information		
		Typical Response	Transfer Uncertainties	
			TEK	NBS
25 kHz	+0.1, -0.7%	+0, -0.25%	±0.05%	±0.01%
50 kHz	+0.1, -0.3%	+0, -0.1%	±0.05%	±0.02%
100 kHz	±0.1%	±0.05%	±0.05%	±0.02%
200 kHz	±0.1%	±0.02%	±0.05%	±0.05%
500 kHz	±0.1%	±0.02%	±0.05%	±0.05%
1 MHz	0.0% (Reference)	±0.02%	±0.05%	±0.05%
2 MHz	±0.1%	±0.02%	±0.05%	±0.1%
5 MHz	±0.1%	±0.02%	±0.05%	±0.1%
10 MHz	±0.15%	±0.05%	±0.05%	±0.1%
20 MHz	±0.2%	±0.1%	±0.05%	±0.2%
30 MHz	±0.5%	±0.2%	±0.1%	±0.2%
50 MHz	±2.0%	±1.0%	±0.2%	±0.5%

#### INCLUDED ACCESSORIES

Detector head, (includes data sheet with NBS-traceability curves), (015-0413-00); 72 in low loss 75 Ω cable, (012-0159-01).

**Order 067-0408-00**

**Peak-to-Peak Detector** ..... **\$1,265**

#### OPTIONAL ACCESSORIES

**Extra Detector Head** (for differential measurements).

Order 015-0413-00 ..... **\$195**

Digital Sweep Generator on next page.

## DIGITAL SWEEP GENERATOR

### Digitally Derived Sweep Signal

### 10-Bit Digital Data For Use With 1900-Series Digital Test Signal Generators to Reconstruct Analog Sweep

### Frequency Range 55.9 kHz to 7.16 MHz Field Sweep or (Manually Adjustable) CW

The Digital Sweep Generator provides 10-bit, 14.31818 MHz, digital data words derived from a cosine lookup table. The output signal sweeps from 55.9 kHz to 7.16 MHz in each field with high spectral purity and amplitude accuracy when used with the DAC in a 1900 Series generator. A front panel connector provides SMPTE\*\* compatible balanced ecl data. Data is continuous through blanking so that it can be used with non-composite video detectors. Sync and burst may be inserted by a 1900 Series generator using the blanking output on the DSG if desired. The digital sweep generator may be locked to a 1900 Series generator using TRS and clock outputs from the 1900 Series generator. Alternatively, the 1900 Series generator may be genlocked to the black burst output from the sync generator in the digital sweep generator. A separate marker output provides identification of 1 MHz intervals, as well as 3.58 MHz and 4.43 MHz, during the sweep.

The digital sweep generator is enclosed in a single wide TM 500 package. The front panel includes an LED power indicator, two 25-pin digital data connectors, three BNC connectors for blanking, markers, and black burst outputs, and one variable control to manually set CW frequencies. Digital interfaces of the DSG conform to the signal levels, clock rate and pinout of the proposed SMPTE standard.

When the Digital Sweep Generator is used in conjunction with a 1900 and an 015-0408-00 peak-to-peak detector (included accessory), it will provide an NBS-traceable analog frequency response standard, and completes an effort to provide NBS-traceable performance verification of Tektronix television generators, waveform monitors, and other television equipment.

\*\*The proposed SMPTE standard "Digital Format for a Parallel Interface (System M/NTSC)," draft of July, 1979.

## CHARACTERISTICS

### Digital Sweep Output

**Frequency Range** — 55.93 kHz to 7.159 MHz in 55.93 kHz increments; Field Sweep, or CW digital data.

**Format** — SMPTE Standard parallel 10-bit signal.

**Sample Clock Frequency** — 14.31818 MHz (4 fsc) ± 100 Hz; also accepts external 14.3 MHz clock from 1900.

**Blanking** — Vertical: 22-23 lines. Horizontal: 10.8 μs.

**Weights** — 0.8 kg, 1.8 lb.

### Markers

1 V at 1.006747 MHz

1 V at 2.013494 MHz

1 V at 3.020241 MHz

0.5 V at 3.579545 MHz

1 V at 4.026988 MHz

0.5 V at 4.418501 MHz

1 V at 4.977805 MHz

1 V at 5.984552 MHz

Marker frequencies are multiples of 55.93 kHz.

### ENVIRONMENTAL

**Temperature Range** — Operating: 0°C to +50°C. Storage: -40°C to +65°C.

**Altitude** — Operating: To 4752 m (15,000 feet). Storage: To 15 240 m (50,000 feet).

**Weights** — Net: 0.6 kg, (1.3 lb). Net Shipping: 1.3 kg, (2.8 lb).

### INCLUDED ACCESSORIES

ECL data cable assemblies, (175-3671-00); 72 in low loss 75 Ω cable, (012-0159-01); p-p detector, (015-0408-00).

### Order 067-1011-00 Digital Sweep

Generator ..... **\$3,310**

### OPTIONAL ACCESSORIES

Detector Head Order 015-0407-00 ..... **\$120**

Tektronix Calibration Fixtures (067-XXXX-0X part numbers) are designed for calibration and verification of specific products. Some fixtures may not be supported at the same level as standard Tektronix products. Your local Tektronix Sales Office can advise you regarding availability and support.

## Other Calibration Fixtures for Tektronix Television Products

### ORDERING INFORMATION

#### 1450 SERIES DEMODULATORS

Test Modulator, 37 MHz for 1450-1.	
Order 067-0886-01 .....	<b>\$4,275</b>
Test Modulator, 38.9 MHz for 1450-1.	
Order 067-0886-02 .....	<b>\$4,275</b>
Test Modulator, 45.75 MHz for 1450-1.	
Order 067-0886-03 .....	<b>\$4,275</b>
Test Modulator, 38.9 MHz for 1450-2.	
Order 067-0886-04 .....	<b>\$4,275</b>
Test Modulator, 38.9 MHz for 1450-3.	
Order 067-0886-05 .....	<b>\$4,275</b>
Extender Cable, for TDC/14501,-2,-3.	
Order 067-0899-00 .....	<b>\$90</b>

### GENERATORS

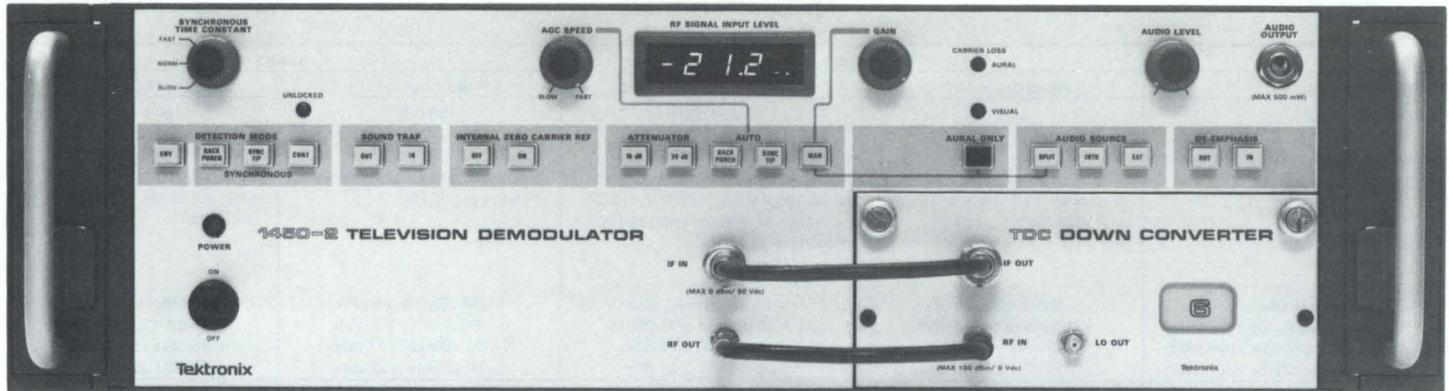
Diagnostic Prom Order 067-0964-00 .....	<b>\$125</b>
Digital Sweep Generator Order 067-1011-00 .....	<b>\$3,310</b>
Video Amplitude Calibrator Order 067-0916-00 .....	<b>\$2,250</b>

### 690SR PICTURE MONITOR

Minimum Load Unit Order 067-0998-00 .....	<b>\$175</b>
Rigid Module Extender Order 067-0999-00 .....	<b>\$50</b>
Flexible Interface Module Extender	
Order 067-1000-00 .....	<b>\$125</b>
CRT Scale, 11 X 15 line for 690SR, Option 40/42.	
Order 067-1034-00 .....	<b>\$150</b>
Pattern Generator Order 067-1039-00 .....	<b>\$3,000</b>
CRT Scale, 14 X 17 line for 690SR.	
Order 067-1054-00 .....	<b>\$150</b>
CRT Scale, 15 X 20 line for 690 SR.	
Order 067-1055-00 .....	<b>\$150</b>

### 1980 ANSWER

Service Kit for the 1980, Order 067-1115-00 .....	<b>\$3,000</b>
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The 1450-1 is compatible with System M Television Transmission, and the 1450-2 is compatible with System B/G.

## 1450-1/1450-2/1450-3

### Measurement-Quality Performance for Negligible Distortion

### Synchronous Detection Eliminates Quadrature Distortion

### Envelope Detection for Accurately Determined Differential Phase

### Surface Acoustic Wave Filter Provides Precise Nyquist Slope; Excellent Long — Short-Term Stability

### Digital Readout of Input Power Level for Easy, Accurate Field Strength Readings

### Constant-Bandpass Characteristics Over Wide Dynamic Range

### Any Single VHF or UHF Channel Operation

### UHF and VHF Tunable Down Converters (System M only)

### Conforms to EIA Standard RS-462 (System M only)

The 1450-1 (System M), 1450-2 (System B/G) and 1450-3 (System I) Demodulator Mainframes are combined with a Tektronix Television Down Converter (TDC) to provide an accurate link between your transmitter's RF signals and video baseband measuring equipment. Unique components work together to identify and eliminate any possible demodulation distortion in reproduced signal characteristics. You see a transparent picture of your transmitter's performance and signal output.

### Tunable or Fixed-Channel Down Converters

For demodulating an RF signal at a TV channel frequency, the 1450-1 (M) and 1450-2 (B/G) Demodulator Mainframes must be used with a Tektronix TDC. Three compatible TDCs are available for each system and provide a selection between tunable and fixed-channel performance. The TDC Fixed-Channel Down Converter supports your specified system channel number. Tunable Down Converters available for System M VHF and UHF channels are the TDC1 and TDC2 respectively.

Demodulation of the transmitter IF signal may be accomplished by using only the mainframe.

### Synchronous Detection Envelope Detection

The 1450-1 and 1450-2 allow you to select either synchronous or envelope detection. Each method has advantages, yet both are required for full measurement capability. For instance, synchronous detection is necessary for measurements that can be seriously affected by quadrature distortion.

Both the 1450-1 and the 1450-2 have two synchronous video detectors operating in phase quadrature. One detects the in-phase signal; the other detects the quadrature component of the video signal. (The quadrature component is a measure of change in visual carrier phase resulting from a change of video level.)

However, if incidental phase modulation is present on the picture carrier, the amount of differential phase measured on a synchronously detected signal will be erroneous. Because of this, an envelope detector is necessary to determine the actual differential phase present. The envelope detector of the 1450-1 and 1450-2 has linear transfer characteristics down to 3% carrier and so provides optimum modulation depth indication.

### Tektronix-Developed Surface Acoustic Wave Filter

The 1450-1 (System M) and 1450-2 (System B/G) feature a surface acoustic wave (SAW) filter developed by Tektronix. It provides more precise Nyquist slope characteristics without group delay distortion, improves long- and short-term stability, and lowers maintenance costs.

In conventional demodulators, the more precisely the bandpass characteristics approach an ideal Nyquist curve, the more complex the filter network required. In the 1450-1 and 1450-2 Mainframes however, the bandpass characteristics are determined by just a single component, the SAW filter. Precision is the result.

Conventional tuned IF circuitry must be meticulously adjusted and is subject to change with mechanical and thermal shock. But the SAW filter is in a sealed unit and accurately provides the critical selectivity characteristics of the demodulator — and requires no adjustments.

### Constant-Bandpass Characteristics

The Tektronix 1450-1 and 1450-2 offer constant-bandpass characteristics over the entire dynamic range of input signal level. Amplifiers in the mainframe operate at a constant gain, and pin-diode attenuators are used to adjust the overall gain of the demodulator. This more sophisticated approach to automatic gain control (AGC) is necessary to maintain constant-bandpass characteristics over the entire dynamic range of input power ( $-69$  dBm to  $-3$  dBm). 30 dB of additional attenuation, available in 10 dB steps, can shift the range for higher input power levels. In addition to automatic AGC, demodulator RF/IF gain control can be set for manual operation.

### Digital Reading of Input Power

With the accurate (to 0.1 dB) digital readout of the 1450-1 and 1450-2, you get measurements of input power you can depend on at transmitter sites, remote sites, or, for calibrated field strength measurements.

### Split and Intercarrier Sound

For making measurements or adjustments on aural transmitters, the 1450-1 and 1450-2 feature both split and intercarrier sound channels. The split carrier channel, which will operate without the presence of the visual carrier, may be used when making measurements on the aural transmitter only.

Four audio outputs give added measurement capability: a 600  $\Omega$  output, two low impedance outputs for driving a speaker or headphones, and a calibrated output for making deviation measurements with an AC voltmeter or an oscilloscope.

### Quadrature Distortion

Quadrature distortion occurs when a single sideband signal is demodulated with an envelope detector.

Quadrature distortion most severely affects the chrominance signal, causing a loss of brightness in highly saturated colors, especially those at high luminance levels. Narrow white picture elements against the dark backgrounds are reproduced at reduced brightness.

Synchronous detection of the television RF signal eliminates quadrature distortion, allowing the true performance of the transmitter to be determined.

**CHARACTERISTICS**  
(1450-1/1450-2)

RF Characteristics	1450-1		1450-2	
	Fixed Channel TDC	Tunable TDC1 or TDC2	Fixed Channel TDC	Tunable TDC1 or TDC2
RF Input Impedance	50 Ω (N)*	50 Ω (N)*	50 Ω (N)*	50 Ω (N)*
Return Loss with 0 dB attenuation	≥20 dB	≥10 dB	≥20 dB	≥10 dB
Return Loss with ≥20 dB attenuation	≥30 dB	≥30 dB	≥30 dB	≥30 dB
Frequency	Any System M assigned carrier frequency ±20 kHz	(TDC1) All System M VHF assigned carrier frequencies, ±27 kHz. (TDC2) All System M UHF assigned carrier frequencies, ±27 kHz	System B or G assigned carrier frequency ±20 kHz.	System B (TDC1) or G (TDC2) assigned carrier frequency ±27 kHz.
Level Range (0 dB from mainframe attenuator)	-69 dBm to -3 dBm	-65 dBm to +1 dBm	-69 dBm to -3 dBm	-65 dBm to +1 dBm
(10 dB from mainframe attenuator)	-59 dBm to +7 dBm	-55 dBm to +11 dBm	-59 dBm to +7 dBm	-55 dBm to +11 dBm
(20 dB from mainframe attenuator)	-49 dBm to +17 dBm	-45 dBm to +21 dBm	-49 dBm to +17 dBm	-45 dBm to +21 dBm
(30 dB from mainframe attenuator)	-39 dBm to +27 dBm	-35 dBm to +31 dBm	-39 dBm to +27 dBm	-35 dBm to +31 dBm
AGC Range	66 dB	66 dB	66 dB	66 dB
Noise Figure VHF	≤10 dB	TDC1, ≤19 dB	≤10 dB	TDC1, ≤19 dB
UHF	≤11 dB	TDC2, ≤19 dB	≤11 dB	TDC2, ≤19 dB
Output IF Image Rejection Ratio	≥60 dB	≤60 dB	(VHF) ≥60 dB (UHF) ≥50 dB	≥50 dB
Adjacent Channel Cross Modulation	≥60 dB	≥60 dB	≥60 dB	≥60 dB
Alternate Channel Cross Modulation	≥60 dB	≥60 dB	≥60 dB	≥60 dB
Variation in Frequency Response with AGC	(VHF) ≤±0.1 dB (UHF) ≤±0.15 dB	≤0.3 dB	(VHF) ±0.1 dB (UHF) ±0.15 dB	≤0.4 dB 7 MHz Bandpass
Readout Accuracy	±2 dB	±2 dB	±2 dB	±2 dB
Readout Resolution	±0.1 dB	±0.1 dB	±0.1 dB	±0.1 dB

\*In 50 Ω (N): +27 dBm = 5 V RMS +31 dBm = 8 V RMS  
 -3 dBm = 158 mV RMS +1 dBm = 251 mV RMS  
 -69 dBm = 80 μV RMS -65 dBm = 126 μV RMS

**CHARACTERISTICS, 1450-1 Only**  
IF

**Input Impedance ( $Z_{in}$ )** — 50 Ω (BNC).

**Return Loss** — >18 dB.

**IF Level Range** — -20 dBm to -64 dBm. (Signal to noise ratio deteriorates as signal level decreases.)

**IF Frequency** — Visual: 37, 38.9, or 45.75 MHz ±127 kHz (if specified by the mainframe/TDC options). Aural: 4.5 MHz below visual.

**VIDEO**

**Video Output** —  $Z_0$ : 75 Ω (BNC, 2 each). Return Loss: ≥34 dB. Level 1 V p-p sync tip to peak white.

**Dc Level** — Back Porch AGC: Blanking level at 0 V ±50 mV. Sync Tip AGC: Referenced to blanking level, sync tip is at -286 mV ±5.7 mV.

**Line Time Distortion** —  $2T = 0.5\%$  in wideband synchronous mode only.  $2T = 1\%$  in all other modes.

**Field Time Distortion** — = 0.5%.

**Line Time Nonlinearity** — ≤1%.

**Differential Gain** — Synchronous: ≤1%. Envelope: ≤4%. Peak Chroma Level: ≤100 IRE.

**Differential Phase** — ≤1°.

**Zero Carrier Reference Gate** — Width: 30 μs ±10%. Delay: 20 μs ±10% from leading edge of sync. Carrier Cutoff: ≥50 dB. Zero Carrier: ±0.5 IRE. Timing Factory: Set to line 20 of both fields, internally selectable from lines 10 through 25 of both fields.

**Chrominance/Luminance Delay** — ≤±20 ns.

**Chrominance/Aural/Carrier Intermod** — ≥50 dB down.

**Aural Signal Rejection** — ≥46 dB.

**Video Signal to Noise Ratios** — Low Frequency (p-p video/p-p hum): ≥60 dB. Mid Frequency Coherent (p-p video/p-p noise): ≥50 dB. White Noise (p-p video/RMS noise): ≥60 dB (10 kHz to 5 MHz).

**Quadrature Output** —  $Z_0$ : 75 Ω (BNC). Return Loss: ≥34 dB; Quadrature Phase: 90° ±2° (with respect to Video Out).

**EXT Zero Carrier Reference Drive Input** —  $Z_{in}$ : ≈5 kΩ (BNC). Level Required: ≈+1 V (accepts input from Tektronix 1440).

**AUDIO**

**Frequency Response** — De-emphasis Out Flat: ±0.4 dB (30 Hz to 15 kHz). De-emphasis In Standard: 75 ns. De-emphasis Curve: ±0.4 dB.

**Harmonic Distortion** — ≤0.2% (30 Hz to 15 kHz at full output with ±25 kHz deviation).

**Audio Signal to Noise Ratio** — Intercarrier Mode: ≥55 dB with ±25 kHz deviation. Split Carrier Mode: ≥75 dB with ±25 kHz deviation. External Aural Intercarrier In: ≥75 dB with ±25 kHz deviation. Aural Only Mode: ≥75 dB with ±25 kHz deviation.

**Deviation Output** —  $Z_0$ : 600 Ω (BNC). Level: 50 mV/kHz ±1% (20 kHz/V ±1%).

**Aural Intercarrier In** —  $Z_{in}$ : 50 Ω (BNC). Return Loss: ≥20 dB. Level: -30 dBm ±5 dB. Frequency: 4.5 MHz ±1 kHz.

**Aural Intercarrier Output** —  $Z_0$ : 50 Ω (BNC). Return Loss: ≥20 dB. Level Nominal: -6 dBm up to 0 dBm.

**600 Ω Balance Line Output** — Level +10 dBm (internally adjustable from ≤-10 dBm to +15 dBm). Connector XLR.

**8 Ω Speaker Output** — Level up to 5 W RMS, front panel adjustable. Connector Barrier block.

**Headphone Output** — Level up to 50 mW into 8 Ω headphone (stereo or mono style). Connector phone jack.

**Remote Connector** — Alarm output SPDT relay contact rated at 28 V, 3 A. External synchronous/envelope switch. Ground for envelope detection.

**Electromagnetic Susceptibility** — Up to 10 V/meter.

**Damage Level at RF Input** — 1 W maximum (any attenuator setting).

**Rear Panel Outputs** — Video (BNC), 2 each Quadrature. BNC Deviation, BNC 4.5 MHz. BNC 600 Ω (balanced) 8 Ω speaker.

**Rear Panel Inputs** — 50 Ω RF. N; 4.5 MHz, BNC; External zero carrier, BNC; remote alarm jack.

**CHARACTERISTICS, 1450-2 Only**

**Input Impedance ( $Z_{in}$ )** — 50 Ω (BNC).

**Return Loss** — >18 dB.

**Level Range** — -20 dBm to -64 dBm. (Signal to noise ratio deteriorates as signal level decreases.)

**Frequency** — Visual: 38.9 MHz ±127 kHz. Aural: 5.5 MHz below visual.

**VIDEO**

**Video Outputs** —  $Z_0$ : 75 Ω (BNC, 2 each). Return Loss: ≥34 dB. Level: 1 V p-p sync tip to peak white.

**Dc Level** — Back Porch AGC. Blanking level at 0 V ±50 mV. sync tip AGC. Referenced to blanking level, sync tip is at -300 mV ±6 mV.

**Line Time Distortion** — ≤0.5%, wideband IF, synchronous detection. 1.0% in all other IF, detection mode combinations.

**Field Time Distortion** — ≤0.5%.

**Line Time Nonlinearity** — ≤1%.

**Differential Gain** — Synchronous: ≤1%. Envelope: ≤4%.

**Chrominance/Luminance Delay** — ≤±20 ns.

**Chrominance/Aural Carrier Intermod** — ≥50 dB down.

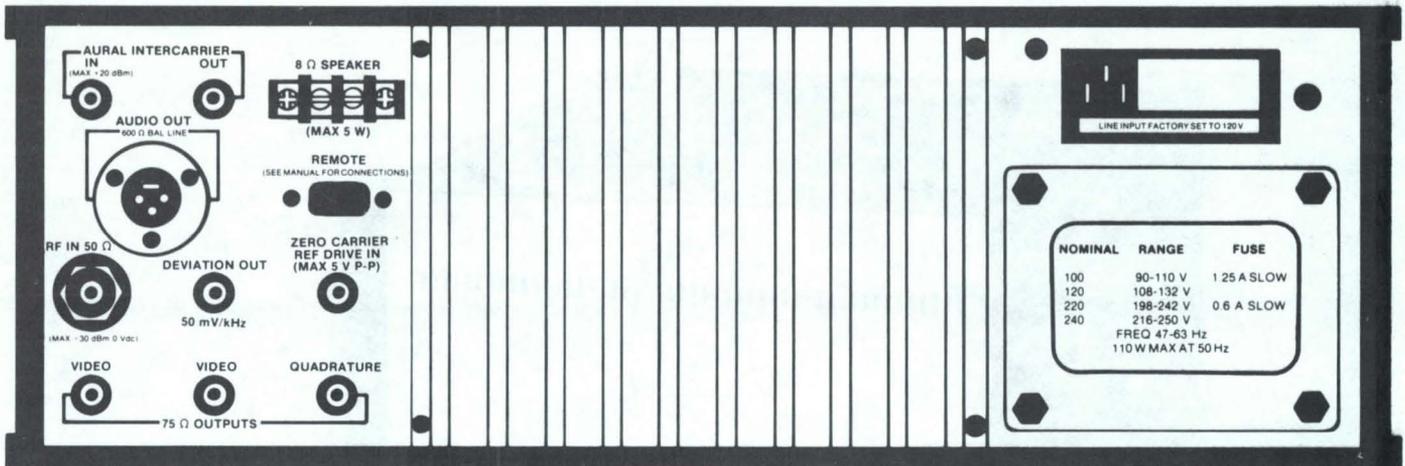
**Aural Signal Rejection** — ≥46 dB.

**Video Signal to Noise Ratio** — Low Frequency (p-p video/p-p hum): ≥60 dB. Mid Frequency Coherent (p-p video/p-p noise): ≥50 dB. White Noise (p-p video/RMS noise): ≥60 dB (10 kHz to 5.5 MHz).

**Quadrature Output** —  $Z_0$ : 75 Ω (BNC). Return Loss: ≥34 dB. Quadrature Phase: 90° ±2° (with respect to VIDEO OUT).

**Zero Carrier Reference Gate** — Width: 30 μs ±10%. Carrier Cutoff: ≥50 dB. Zero Carrier: ±3.5 mV. Timing Factory Set to Line: 16/329 of both fields, internally selectable from lines 10/323 through 25/338 of both fields.

**EXT Zero Carrier Reference Drive Input** —  $Z_{in}$ : ≈5 kΩ (BNC). Level Required: ≈±1 V (accepts input from Tektronix 1460).



**AUDIO**

**Frequency Response** — De-emphasis Out Flat:  $\pm 0.4$  dB (30 Hz to 25 kHz). De-emphasis In Standard: 50  $\mu$ s. De-emphasis curve:  $\pm 0.5$  dB.

**Harmonic Distortion** —  $\leq 0.2\%$  (30 Hz to 15 kHz at full output with  $\pm 50$  kHz deviation).

**Audio Signal to Noise Ratio** — Intercarrier mode:  $\geq 55$  dB with  $\pm 50$  kHz deviation and 1 kHz modulation. Split carrier:  $\geq 75$  dB with  $\pm 50$  kHz deviation and 1 kHz modulation. EXT aural intercarrier: IN  $\geq 75$  dB with  $\pm 50$  kHz deviation and 1 kHz modulation. Aural Only:  $\geq 75$  dB with  $\pm 50$  kHz deviation and 1 kHz modulation.

**Deviation Output** —  $Z_0$  600  $\Omega$  (BNC). Level: 50 mV/kHz  $\pm 1\%$ ; 20 kHz/V  $\pm 1\%$ .

**Aural Intercarrier IN** —  $Z_{in}$ : 50  $\Omega$  (BNC). Return Loss:  $\geq 20$  dB. Level:  $-30$  dBm  $\pm 5$  dB. Frequency: 5.5 MHz  $\pm 1$  kHz.

**Aural Intercarrier Output** —  $Z_0$ : 50  $\Omega$  (BNC). Return Loss:  $\geq 20$  dB. Level Nominal:  $-6$  dBm up to 0 dBm.

**600  $\Omega$  Balanced Line Output** — Level:  $+10$  dBm (internally adjustable from at least  $-10$  dBm to  $+15$  dBm). Connector XLR.

**8  $\Omega$  Speaker Output** — Level up to 5 W RMS, front panel adjustable. Connector Barrier block.

**Headphone Output** — Level: up to 50 mW into 8  $\Omega$  headphone (stereo or mono style). Connector Phone jack.

**Remote Connector** — Alarm Output: SPDT relay contact rated at 28 V 3 A. External Synchronous/Envelope Switch: ground for envelope detection.

**Electromagnetic Susceptibility** — Up to 1 V/meter.

**Damage Level at RF Input** — 1 W maximum (any attenuator setting).

**Rear Panel Outputs** — Video: BNC, 2 each Quadrature; BNC Deviation: BNC, 5.5 MHz. BNC 600  $\Omega$  (balanced), 8  $\Omega$  speaker, remote alarm jack.

**Rear Panel Inputs** — 50  $\Omega$  RF. N: 5.5 MHz, BNC; External zero carrier, BNC; Remote alarm jack.

**ORDERING INFORMATION, SYSTEM M**

**1450-1 Television Demodulator**  
(Order one vision IF option) ..... **\$13,935**

- Option 01** — 37 MHz Vision IF ..... NC
- Option 02** — 38.9 MHz Vision IF ..... NC
- Option 03** — 45.75 MHz Vision IF ..... NC
- Option 10** — Wide Bandwidth Audio  
20 Hz to 55 kHz  $\pm 0.4$  dB ..... **+\$165**

**TDC Fixed Channel Down Converter**  
(stipulate channel number when ordering) ..... **\$3,445**

**TDC-1 Tunable Down Converter**  
System M, VHF Band ..... **\$7,435**

**TDC-2 Tunable Down Converter**  
System M, UHF Band ..... **\$7,435**

Order one vision IF option and Option 11 or 14. If your country is not listed, contact your nearest field office for a quotation.

- Option 01** — 37 MHz Vision IF ..... NC
- Option 02** — 38. MHz Vision IF ..... NC
- Option 03** — 45.75 MHz Vision IF ..... NC
- Option 11** — System M Countries ..... NC
- Option 14** — System M Countries ..... NC

**ORDERING INFORMATION, SYSTEM B/G**

**1450-2 Television Demodulator**  
(Order one vision IF option and one group delay option) ..... **\$13,145**

- Option 02** — 38.9 MHz Vision IF ..... NC
- Option 09** —  $+90/-170$  ns Group Delay ..... NC

**TDC Fixed Channel down Converter**  
(stipulate channel number when ordering) ..... **\$3,445**

Order one vision IF option and Option 12. If your country is not listed, contact your nearest field office for a quotation.

- Option 02** — 38.9 MHz Vision IF ..... NC
- Option 12** — System B/G countries ..... NC

**ORDERING INFORMATION, SYSTEM I**

**1450-3 Television Demodulator** ..... **\$13,145**

**COUNTRIES: SYSTEM M (Option 11)**

Antigua, Barbados, Bermuda, Brazil, Canada, Chile, Colombia, Costa Rica, Cuba, Curacao, Dominican Republic, Ecuador, El Salvador, Guam, Guatemala, Johnston Islands, Korea, Mexico, Micronesia, Netherlands, Antilles, Nicaragua, Panama, Peru, Philippines, Puerto Rico, Samoa, St. Kitts, Surinam, Taiwan, Trinidad/Tobago, Uruguay, U.S.A., Venezuela, Virgin Islands.

**COUNTRIES: SYSTEM M (Option 14)**

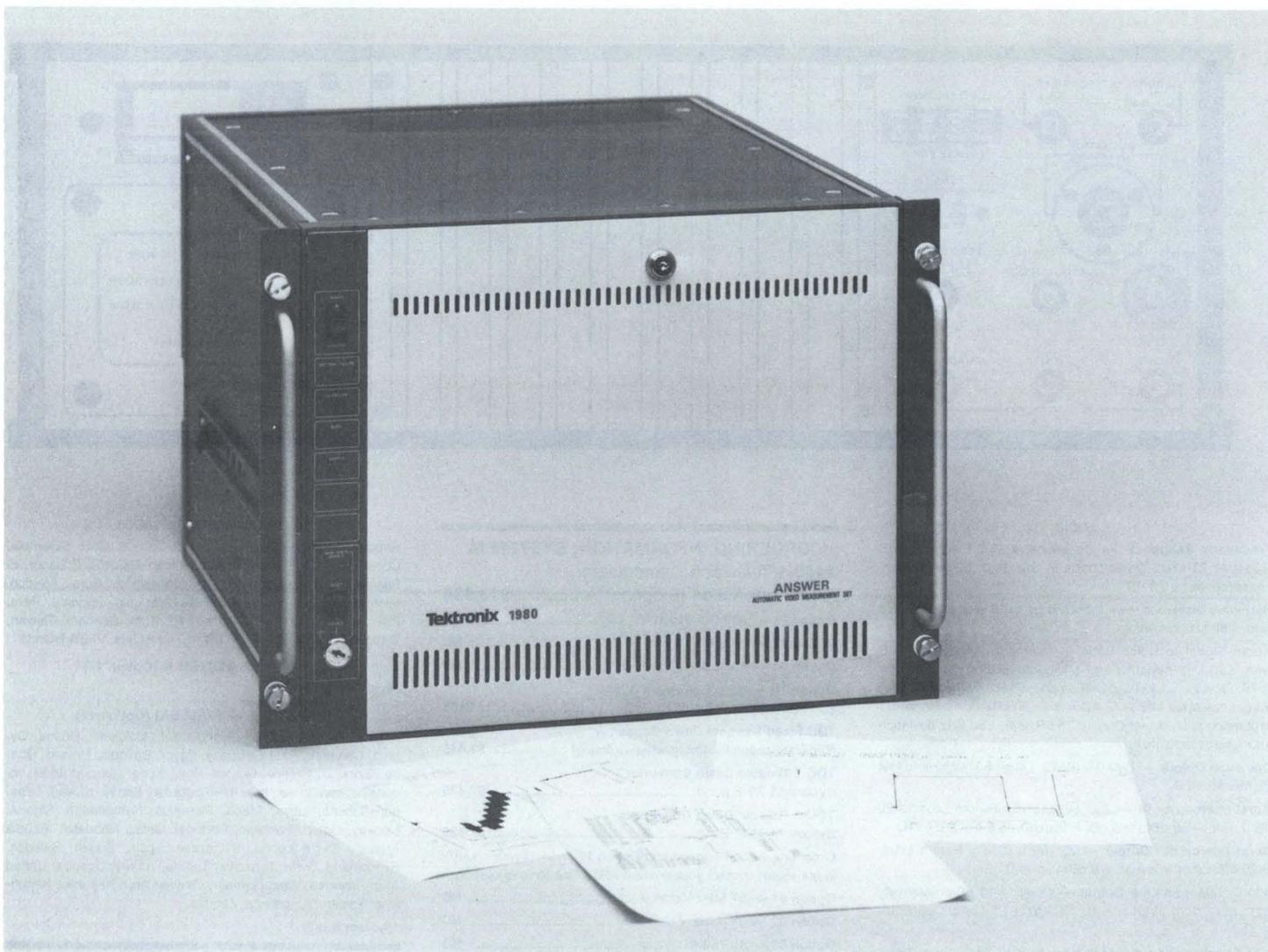
Japan and Okinawa.

**COUNTRIES: SYSTEM B/G (Option 12)**

Algeria, Austria, Bahrain, Bangladesh, Belgium\*, Brunei, Cyprus, Denmark, East Germany, Egypt, Ethiopia, Finland, Ghana, Gibraltar, Greece, Guinea, Hong Kong\*, Iceland, India, Indonesia, Iran, Israel, Italy (UHF), Jordan, Kenya, Kuwait, Lebanon, Liberia, Libya, Malta, Mauritius, Netherlands, Nigeria, Norway, Oman, Pakistan, Portugal, Qatar, Rhodesia, Saudi Arabia\*, Sierra Leone, Singapore, Spain, Sudan, Sweden, Switzerland, Syria, Tanzania, Tunisia, Turkey, Uganda, United Arab Emirates, West Germany, Yemen Arab Republic, Republic of Yemen, Yugoslavia, Zambia.

\*System B only.

DEMODULATOR



## 1980 ANSWER

### Complete Video Measurement Capability

### Waveform Digitizer to Capture Video Signal

### ANSWER BASIC Software for Measurements, Analysis and Report Generation

### Remote Terminal Capability

The 1980 ANSWER Automatic Video Measurement Set provides total video measurement capabilities and offers maximum versatility and testing power. Special features provide quality measurement performance for a wide variety of applications.

#### Programmability

The 1980 can be programmed using ANSWER BASIC (BASIC software, Options 01, 02 or 03) to make specific measurements required for a wide range of video applications. It can be tailored for a specific operation, automatically performing a single measurement or a group of measurements continuously, on operator demand, or at

prescheduled times. The results can be returned in report format, with or without graphics, on a variety of terminals and printers. ANSWER's microprocessor control and ROM memory give you extensive flexibility. Format or standard changes can be made without the expensive modifications or recalibrations associated with analog test equipment.

#### High Measurement Accuracy

The 1980 provides consistent measurement accuracy with high repeatability. Special features like signal offset, gain control, dither generation, and signal averaging can be used to minimize possible errors. Using these features can significantly reduce noise on the incoming signal and provide an effective resolution of 11 bits. This means you can use the 1980 for the most stringent measurement problems and have fast accurate results.

Due to its digital nature ANSWER has very few internal adjustments, providing a high degree of reliability over long periods of time.

#### User-Definable Measurement Limits

Inner (caution) and outer (alarm) limits may be programmed for each measurement parameter.

The "limit-exceeded" signal generated on ANSWER's display is in the form of asterisks. Either of these limit signals may be programmed to initiate data logging, and the outer limit signal may be programmed to activate user interface alarms. Limit files are linked to the input source, allowing different limit values for each source.

#### Amplitude, Phase and Timing Measurement

All type of measurements can be programmed into the 1980, including sync, burst, and bar amplitudes, differential gain and phase, and timing measurements. The 1980 can tell you immediately if video signals are within acceptable or legal limits.

#### Remote Operation

The 1980 can also be operated from a remote terminal over telephone lines. With Option 12 (Autocall), it can even be programmed to automatically telephone a remote terminal under user specified conditions, e.g., an out-of-limits signal. The 1980 can be used in a wide range of applications including unattended and remote transmission systems, and systems under computer control.

## Display Terminal

ANSWER requires the use of a terminal for display. We offer several including the 4006-1 11 inch CRT Graphics Terminal, the 4014-1 19 inch CRT Graphics Terminal, and the 4025 12 inch Raster Scan CRT Terminal, also with graphics. We also offer the 4631 Hard Copy Unit for clean, dry, hard copies.

## Available Measurement Programs

Application programs taking full advantage of the 1980's capabilities can be purchased from Tektronix to make most NTSC and PAL video broadcast measurements.

This flexibility, unavailable in analog instruments, combined with the video measurement capability means that the 1980 can be tailored to a wide range of your applications for the analysis, measurement, and testing of baseband video signals.

## RS-232C Compatibility

ANSWER has RS-232C (ASCII coding) interface capability. This means ANSWER can be adapted to a wide range of applications, including unattended and remote systems and computer control.

## CHARACTERISTICS

### SIGNAL HANDLING

**Inputs** — A and B (user selectable).

**Impedance** — 75 Ω.

### Return Loss

Video: ≥46 dB to 5 MHz.

**Signal Level** — 0.5 to 2 V p-p; sync negative.

**Coupling** — Dc or ac nonfloating (user selectable).

### Clamp

Selection — Fast, slow, or off (user selectable).

Level — Sync tip or back porch.

### Hum Rejection

Fast: >36 dB.

Slow: <1 dB.

### Signal Averaging

Noise Reduction: 15 dB; with 32 line averaging and incoming signal-to-noise ratio of 46 dB or less.

Dynamic Range: 2.5 V maximum; with 0 offset.

Gain Range: 0 to 15.5 times in 0.5 increments.

Offset Range: 0 to 248 LSB ±0.5 LSB (8 LSB increments); referred to input at unity gain.

Noise Floor: -72 dB (0 dB = 714 mV).

### Distortions

Differential Gain Error: ≤0.5%.

Differential Phase Error: ≤0.4°.

Luminance Nonlinearity Error: ≤1.0%.

Amplitude/Frequency Error (0 to 5 MHz): 0 dB ±0.25 dB; 7.16 MHz = ≥-46 dB.

Delay/Frequency Error (0 to 5 MHz): ≤20 ns.

### SYNCHRONIZATION

#### Modes

Internal: Satisfactory operation with 26 dB signal-to-noise ratio (Sound-in-Syncs disabled). Channel A and B (user selectable).  
External: Channel A and B (user selectable).

#### Amplitudes

Internal Mode: 143 mV (20 IRE) minimum; negative going sync on incoming signal.

External Mode: Minimum: 0.2 V p-p into 75 Ω, composite sync.

Maximum: 8.0 V p-p into 75 Ω, composite sync.

### ANALOG TO DIGITAL CONVERSION

**Resolution** — 8 bits; 11 bits effective with dither.

#### Accuracy

RMS: ±0.25 LSB (±0.1%).

Peak: ±0.5 LSB (±0.2%).

**Conversion Rate** — 20 MHz maximum.

**Monotonicity** — All 256 codes present and in sequence with no polarity reversals.

#### Sampling Rate

NTSC: 910 x horizontal frequency.

PAL: 1135 x horizontal frequency.

*Note: User selectable means that the function is controlled from the keyboard.*

### DIGITAL PROCESSING

#### Signal Memory

Video Acquisition Memory Capacity: 32 k samples.

Video Acquisition Memory Controller Sampling Modes: Line rate, field rate or block sampling between two points on signal.

Save Value: Multiples of 8.

Skip Value: Multiples of 2.

Picture Monitor Bright-Up Pulse Output: Amplitude: ≈240 mV.

Termination: Internal in 75 Ω.

#### Real Time Clock

Internal Reference Stability: 10 P/M total over +10°C to +50°C; crystal controlled.

External Input Frequency: 1 MHz.

External Input Amplitude: 0.3 to 4.0 V.

#### Microcomputer

User Memory: 32 k words.

Nonvolatile Memory: 8 k words.

**Software Control** — TEK ANSWER BASIC.

### DIGITAL INTERFACE

#### Access Ports

Interface: RS-232C; (ASCII code).

Number: 5; 3 DCE\* (full duplex). 2 DTE\*\* (full duplex).

#### Baud Rate

Five Ports: Up to 9600; user programmable.

**Automatic Call-Up** — RS-866 (optional).

**User Operation** — Via keyboard (ASCII).

\*DCE = Data Communication Equipment

\*\*DTE = Data Terminal Equipment

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Storage: -55°C to +75°C. Operating: 0°C to +50°C.

**Altitude Range** — Storage: Sea level to 15 240 m (50,000 ft). Operating: Sea level to 4572 m (15,000 ft).

### PHYSICAL CHARACTERISTICS

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	429	16.9	483	19.0
Height	355	14.0	355	14.0
Depth	593	24.0	644	22.0
Weights≈	kg	lb	kg	lb
	Net	25.0	55.0	

## 1980 ANSWER Option 01 NTSC Applications Software

### Automatic Operation

### Programmability

### All Digital Circuitry

The 1980 ANSWER Option 01 Applications software is programmed to make both NTC 7 and FCC measurements on all industry standard VITS and full-field signals. Amplitude, phase, and timing parameters can all be determined quickly and accurately. Automatic measurements allow quick evaluation of VIT or full-field signals. NTC 7 and FCC measurement routines provide detailed analysis of signal amplitude, phase, and timing.

Simple display format means measurement results are easy to read and understand. User-definable measurement limits quickly identify an out-of-tolerance condition. Programmability accommodates present and future needs without additional hardware.

### Automatic Operation

ANSWER is programmed with 47 individual measurements, many of which are combined into easy-to-use amplitude, phase, and timing routines. All of these operations are completely automatic and may be invoked using simple, one-word commands. You tell ANSWER whether to run a whole measurement routine, a partial measurement routine, or a single measurement—periodically or on command. Results are ready within minutes and offer a high repeatability you can depend on.

### In-Service Measurements

ANSWER measures virtually all signal parameters on an in-service basis. Many of these measurements, including timing, do not even require the presence of a VIT signal. This full in-service capability minimizes the need for out-of-service measurements, so time may be spent on maintaining the system rather than on isolating system problems.

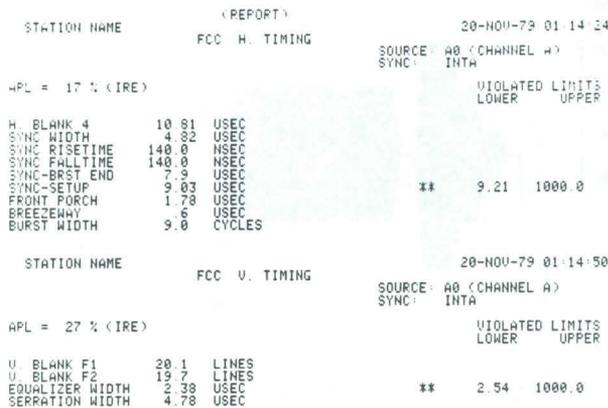


Figure 1. ANSWER measurement printout.

**Measurement Routines**

All measurement accuracies specified are valid over the entire dynamic range with an unweighted signal-to-noise ratio of 46 dB on the incoming signal. All measurements, except those so indicated may be made-in-service.

These routines may be initiated with a remote RS-232C ASCII compatible input device. Measurement of groups of parameters instead of a complete routine may be selected with the remote input device.

The following inservice measurements are factory programmed in the 1980 ANSWER, Option 01.

**CHARACTERISTICS, OPTION 01**

**AMPLITUDE AND PHASE MEASUREMENTS**

- Bar Amplitude Range**\*1 — 30 to 130 IRE units  $\pm 0.5$  IRE.
- Sync Amplitude Range**\*2 — 20 to 80 IRE units  $\pm 0.5$  IRE.
- Burst Amplitude Range**\*2 — 10 to 90 IRE units  $\pm 0.5$  IRE.
- Average Picture Level Range**\*2 — -20 to 120% of 100 IRE  $\pm 3\%$ .
- Reference Black Level Range** — -20 to 130 IRE units  $\pm 0.5$  IRE (VIR signal).
- Risetime Distortion**\*1 — 0 to 40%  $\pm 0.5\%$ .
- Pulse to Bar Ratio Range**\*1 — 10 to 125%  $\pm 0.5\%$ .
- T Step Ringing Range** — 0 to 25%  $\pm 2\%$  instead of T (NTC 7 and 2T).
- Relative Chroma Gain Range**\*1 — 25 to 175%  $\pm 0.5\%$ .
- Relative Chroma Time**\*1 —  $\pm 300$  ns  $\pm 10$  ns.
- Amplitude/Frequency Range**\*1 — 0 to 120 IRE  $\pm 1$  IRE or  $\pm 2\%$ , whichever is greater.
- Luminance Nonlinearity Range**\*1 — 0 to 50%  $\pm 0.5\%$ .
- Chrominance Nonlinear Gain Ranges** — 20 IRE chroma, 5 to 35 IRE: 80 IRE chroma, 45 to 160 IRE  $\pm 0.5$  IRE (VITS for NTC 7).
- Chrominance Nonlinear Phase Range**\*1 — 0 to 180°  $\pm 1^\circ$ .
- Differential Gain Range**\*1 — 0 to 180%  $\pm 0.4\%$ .
- Differential Phase Range**\*1 — 0 to 100%  $\pm 0.5\%$ .
- Chrominance-Luminance Intermodulation Range** — 0 to 5 IRE  $\pm 0.5$  IRE (VITS for NTC 7).
- Signal to Noise Ratio Range**\*2 — 25 to 72 dB within 1 dB.
- Low Frequency Periodic Noise Range**\*2 — 0 to 60 dB within 1 dB.
- Relative Burst Gain Range**\*1 —  $\pm 50\%$   $\pm 0.5\%$ .
- Relative Burst Phase Range**\*1 —  $\pm 180^\circ$   $\pm 0.4^\circ$ .

\*1 VITS for NTC 7 and FCC.  
\*2 VITS not required.

**OUT-OF-SERVICE MEASUREMENTS**

- Field Time Distortion Range** — 0 to 40%  $\pm 0.5\%$ .
- Long Time Distortion Range**  
Overshoot Range: 20 to 100 IRE  $\pm 1$  IRE. 0 to 20 IRE  $\pm 0.5$  IRE.  
Settling Time: 1 to 30 s  $\pm 2\%$  of bounce rate.
- Distortion**  
Dynamic Picture Gain Range:  $\pm 25\%$   $\pm 1.0$  IRE.  
Dynamic Sync Gain Range:  $\pm 25\%$   $\pm 1.0$  IRE.

**DEMODULATOR OUTPUT MEASUREMENTS (CARRIER REFERENCE PULSE PRESENT)**

- Blanking Level Range** — 65 to 85% of maximum carrier  $\pm 0.5\%$  (VITS not required).
- Reference White Level Range**\*1 — 2.5 to 22.5% of maximum carrier  $\pm 0.5\%$ .

\*1 VITS for NTC 7 and FCC.

**FCC AND RS-170A TIMING MEASUREMENTS**

- For all timing measurements, blanking level is 0 IRE. VITS are not required for timing measurements. RS-170A information, where different, is given in parentheses.
- H Sync Width Range** — 1 to 8  $\mu$ s  $\pm 25$  ( $\pm 15$ ) ns.
  - Front Porch Duration Range** — 0.5 to 2  $\mu$ s  $\pm 25$  ( $\pm 20$ ) ns.
  - Sync to Start of Video Duration Range** — 8 to 15  $\mu$ s  $\pm 25$  ( $\pm 20$ ) ns.
  - Sync to Burst Start Duration Range** — 4 to 30 cycles  $\pm 20^\circ$ .
  - Sync to End of Burst Duration Range** — 6 to 15  $\mu$ s  $\pm 20$  ns  $\pm 0.05$  burst cycle.
  - H Blanking Width Range** — 8 to 30  $\mu$ s  $\pm 25$  ( $\pm 50$ ) ns.
  - Color Burst Width Range** — 6 to 13 cycles  $\pm 1$  cycle amplitude detection  $\pm 0.5$  IRE.
  - Breezeway Width Range** — -2.0 to 3.5  $\mu$ s, ( $T_0$  is the -4 IRE point on the trailing edge of H sync  $\pm 25$  ns  $\pm 0.5$  burst cycle).

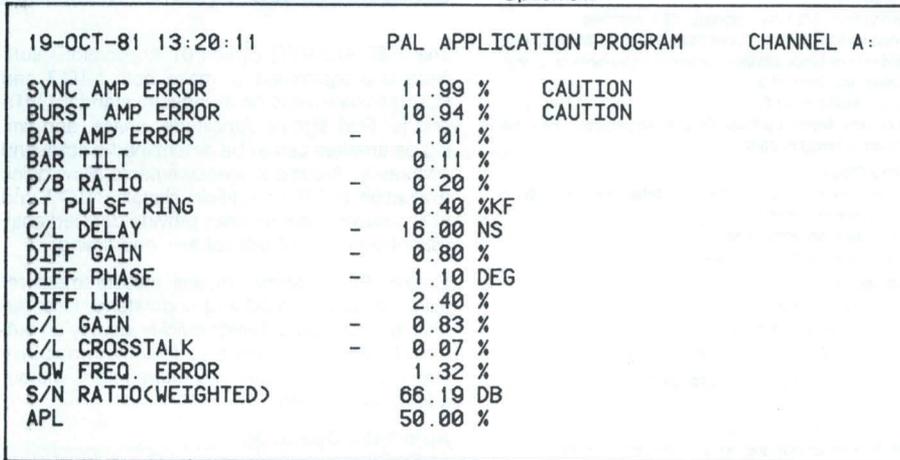


Figure 2. Report generated by user request or at prescheduled time.

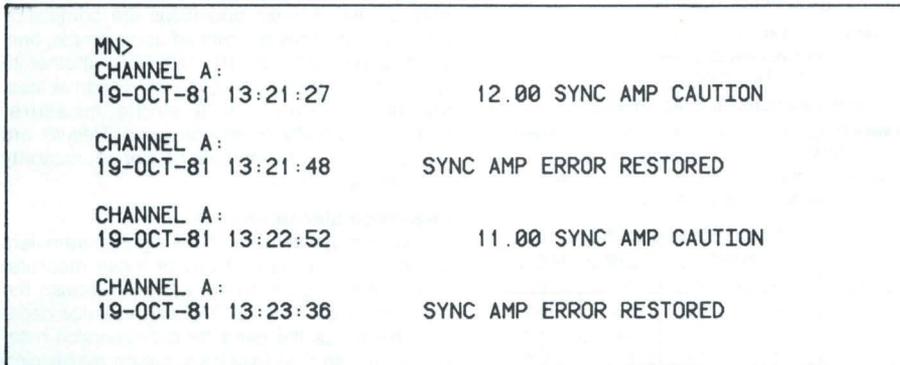


Figure 3. Error report in monitor mode

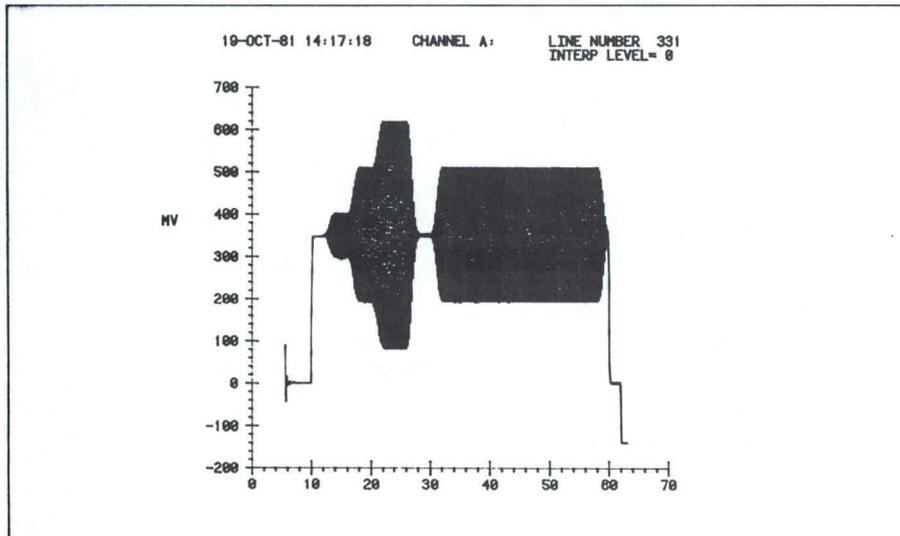


Figure 4. Copy of screen display of line 331

**H Sync Risetimes and Falltimes** — 0.14 to 0.3  $\mu\text{s} \pm 20$  ns.  
0.31 to 1.0  $\mu\text{s} \pm 30$  ns.

**Equalizing Pulse Width Range** — 1 to 20  $\mu\text{s} \pm 25$  ( $\pm 15$ ) ns.

**Serration Width Range** — 1 to 20  $\mu\text{s} \pm 25$  ( $\pm 15$ ) ns.

**Vertical Blanking Width Range** — 20 to 50 lines  $\pm 140$  ns.

### MEASUREMENT LIMITS

**Inner Limits** — Two per measurement.

**Outer Limits** — Two per measurement.

**Limits Values** — Default values standard. Other user defined limits may be stored in nonvolatile memory. Limits may be linked to input source.

**Limits Memory Required** — Eight words per set of four limits.

**Limits Outputs** — To the selected RS-232C port(s).

**Front Panel LED Indicators** — Battery Failure, Sampling in Progress, I/O Failure, Busy.

## 1980 ANSWER Option 02, PAL Applications Software

[Automatic Monitoring of PAL Video Signals](#)

[Automatic Report Generation](#)

[Operator Initiated Individual Measurements](#)

[Signal Plots for Analysis](#)

[Remote Operation](#)

PAL Applications Software makes automatic or operator-initiated measurements on ITS and full-field signals. Amplitude, phase and timing parameters can all be determined quickly and accurately.

### Automatic Monitoring

The Option 02 program will continuously monitor a signal, make standard measurements, compare them against user defined limits, and print alarm messages when these limits are exceeded. The program can even be set up to report alarms only when n out of m measurements are outside the limits, where n and m are defined by the user.

### Measurement Routines

All measurement accuracies specified are valid over the entire dynamic range with an unweighted signal-to-noise ratio of 45 dB on the incoming signal. Any number and combination of these routines may be selected at one time. In monitor mode, all these measurements are made sequentially.

### CHARACTERISTICS Option 02

**Sync Amplitude Error Range\*** — 100 to -50%  $\pm 1.25\%$ .

**Burst Amplitude Error Range** — 80 to -50%  $\pm 1.25\%$ .

**Luminance Bar Amplitude Error Range\*** — 30 to -70%  $\pm 0.5\%$ .

**Bar Tilt Range\*** — 40 to -40%  $\pm 0.5\%$ .

**2T Pulse/Bar Ratio Error Range\*** — 25 to -90%  $\pm 1.0\%$ .

**2T Pulse K Rating Range\*\*** — 0 to 10% Kf  $\pm 0.5\%$  Kf.

**Chrominance Luminance Gain Inequality Range\*** — 75 to -75%  $\pm 0.5\%$ .

**Chrominance Luminance Delay Inequality Range\*** — 300 ns to -300 ns  $\pm 20$  ns

**Chrominance/Luminance Intermodulation Range\*** — 50 to -50%  $\pm 0.5\%$ .

**Luminance Nonlinearity Range\*** — 0 to 50%  $\pm 1\%$ .

**Differential Gain Range\*** — 0 to 50%  $\pm 0.5\%$ .

**Differential Phase Range** — 0 to 180°  $\pm 0.4^\circ$ .

**Continuous Random Noise Range\*** — (Weighted) -68 to -28 dB  $\pm 1$  dB.

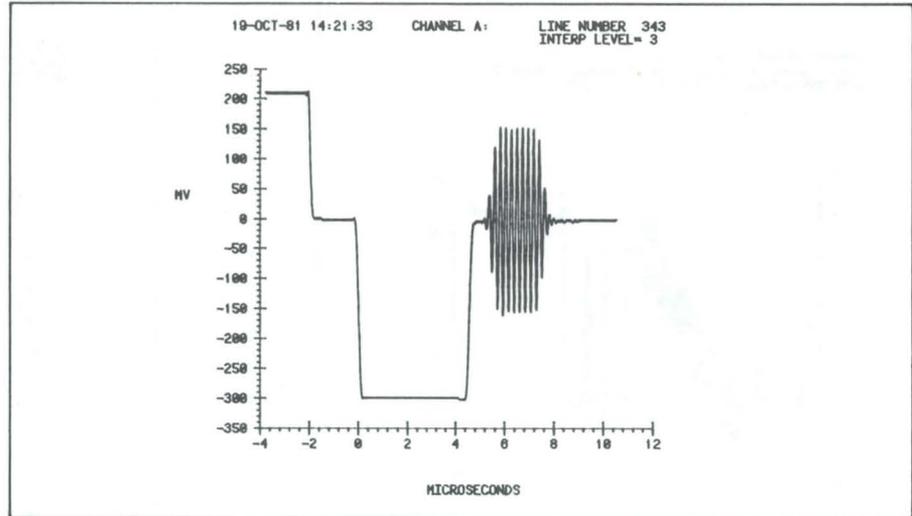


Figure 5. Copy of screen display showing horizontal sync and color burst.



Figure 6. Measurement results are displayed in an easy-to-read format indicating the time, signal source, measurement, and whether the measured value exceeded caution (\*) or alarm (\*\*) limits. This same format is also used for printing errors during the monitoring process, and for reporting manual measurements.

**Low Frequency Error Range** — 0.3 to 25%  $\pm 0.5\%$ .

**Average Picture Level Range** — 0 to 110%  $\pm 3\%$ .

\* In accordance with CCIR Reg. 569.

\*\* Not specified in CCIR Reg. 569. In accordance with CCIR Reg. 567.

## 1980 Option 03, NTSC Transmitter Monitoring Software

[Unattended Monitoring of NTSC Video Signals from Studios, STLs, Earth Stations, and Transmitters](#)

[Waveform Plots for Analysis and Documentation](#)

[Remote Operation](#)

[Automatic Logging](#)

[Operator Initiated Individual Measurements](#)

[User Specified Alarms](#)

The NTSC Transmitter Monitoring Software 1980 ANSWER Option 03 makes automatic or operator-initiated measurements on VITS and full field signals. Amplitude, phase, and timing parameters can all be determined quickly and accurately.

### Automatic Monitoring

The Option 03 application program can continuously monitor video signals, make standard measurements as selected by a user, compare them against user defined limits, and print alarm messages should these limits be exceeded. A confirmation message will be generated when the value no longer exceeds the limit.

### Studio and Visual Transmitter Signals

Both transmitter output and studio signals can be monitored. When a limit is exceeded on the primary channel (e.g., transmitter output), the measurements are made on the secondary channel (e.g., studio or transmitter input) for comparison. Measurement results from both sources are logged.

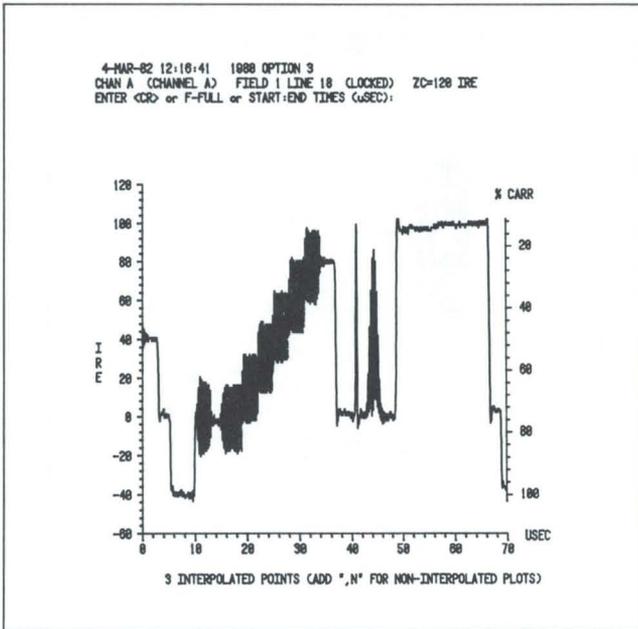


Figure 7. Any line of video can be graphed on graphic display terminals and hard copy devices locally, or at remote locations.

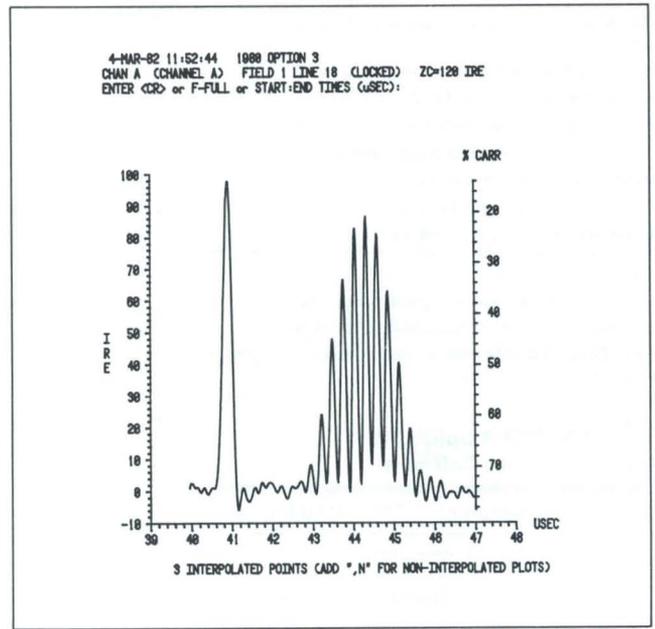


Figure 8. Any portion of a line can be expanded for detailed analysis.

**Automatic Logging**

A complete set of measurements will automatically be made and the results printed at times scheduled by the operator at up to 24 different times for a 24-hour period.

**Individual Measurements**

At any time, the operator can select one or more measurements to be made once or continuously. In this mode, the measured value will be printed each time the measurement is made. Results are available within seconds with accuracy and repeatability seldom achievable with manual measurements.

**User-Definable Measurement Limits**

Upper and lower limits, caution and fail are provided. These limits are readily set as appropriate for the primary and secondary signals to be measured, independently of each other as needed.

**Waveform Plots**

For further analysis of distortions, the waveform can be plotted on a graphic terminal or plotter, even at long distances. Any portion of the waveform can be selected for display on the full screen. This allows small distortions to be examined in detail. Hard copy plots also make useful support documents for the measurement reports.

**Measurement Routines**

All measurement accuracies are valid on a video signal having S/N of 45 dB or better. From 26 dB to 45 dB the effects of noise masking will gradually diminish until it disappears at 45 dB. Any number and combination of these routines may be selected at one time for monitoring or making manual measurements.

**CHARACTERISTICS, Option 03  
AMPLITUDE AND PHASE MEASUREMENTS**

**Bar Amplitude**

Zero-Carrier Pulse Present: 0 to 90% of maximum carrier  $\pm 0.4\%$ .  
Nonzero-Carrier Pulse: 0 to 200 IRE  $\pm 0.5$  IRE.

**Burst Amplitude** — 0 to 200% of sync  $\pm 1.3\%$  or  $\pm 0.5$  IRE whichever is greater (VITS not required).

**Color Bar**

Amplitude Error: 100%  $\pm 1.0\%$  or 1 IRE whichever is greater.  
Phase Error: 0 to 180°  $\pm 1^\circ$ .  
Chrominance-Luminance Gain Ratio: 0 to 200%  $\pm 2\%$ .  
Chrominance-Luminance Delay (Relative Chroma Time) — 0 to 300 ns  $\pm 20$  ns.

**Chrominance-Luminance Gain Ratio** (Relative Chroma Gain) — 0 to 160% of Bar  $\pm 1\%$ .

**Differential Gain** — 0 to 100%  $\pm 0.5\%$ .

**Differential Phase Range** — 0 to 180°  $\pm 0.4^\circ$ .

**Luminance Nonlinearity Range** — 0 to 50%  $\pm 1\%$ .

**Relative Burst Gain Range** — 0 to 100%  $\pm 0.5\%$ .

**Relative Burst Phase Range** — -180 to 180°  $\pm 0.4^\circ$ .

**Sync Amplitude Range** (VITS not required)

Bar Present: 20 to 80% of Bar  $\pm 0.5\%$ .

No Bar Present: 20 to 80 IRE  $\pm 0.5$  IRE.

**Multiburst Flag Amplitude Range**

Zero-Carrier Pulse Present: 0 to 90% of maximum carrier  $\pm 0.5\%$ .

Bar Present: 20 to 130 IRE of Bar  $\pm 0.5$  IRE.

No Bar Present: 20 to 130 IRE  $\pm 0.5$  IRE.

**Multiburst Amplitude Range** — 0 to 100% of flag  $\pm 3\%$ .

**Blanking Level Range** — 0 to 90% of maximum carrier  $\pm 0.5\%$  (zero carrier pulse required).

**Sync Variation Range**

Zero-Carrier Pulse Present: 0 to 50% of maximum carrier  $\pm 0.5\%$ .

Bar Present: 0 to 50% of Bar  $\pm 0.5\%$ .

No Bar Present: 0 to 50 IRE  $\pm 0.5$  IRE.

**Blanking Variation Range**

Zero-Carrier Pulse Present: 0 to 50% of maximum carrier  $\pm 0.5\%$ .

Bar Present: 0 to 50% of Bar  $\pm 0.5\%$ .

No Bar Present: 0 to 50 IRE  $\pm 0.5$  IRE.

**Vertical Interval White Range**

Zero-Carrier Pulse Present: 0 to 90% of maximum carrier  $\pm 1\%$ .

Bar Present: 0 to 100% of Bar  $\pm 1\%$ .

No Bar Present: 0 to 100 IRE  $\pm 1$  IRE.

**Maximum Picture White Range**

Zero-Carrier Pulse Present: 0 to 90% of maximum carrier  $\pm 1\%$ .

Bar Present: 0 to 100% of Bar  $\pm 1\%$ .

No Bar Present: 0 to 100 IRE  $\pm 1$  IRE.

**Minimum Picture Black** — -40 to 100 IRE  $\pm 1$  IRE.

**LINEAR WAVEFORM DISTORTION MEASUREMENTS**

**Line Time Distortion Range** — 0 to 40% of Bar  $\pm 0.5\%$ .

**Pulse-to-Bar Ratio** — 10 to 125% of Bar  $\pm 1\%$ .

**HORIZONTAL INTERVAL TIMING MEASUREMENTS**

**Breezeway Width Range** — 2 to 3.5  $\mu s \pm 25$  ns ( $\pm 0.5$  burst cycles).

**Color Burst Range** — 6 to 13 cycles  $\pm 1$  cycle.

**Front Porch Duration Range** — 0.5 to 2  $\mu s \pm 25$  ns.

**Horizontal Blanking Width Range** — 8 to 30  $\mu s \pm 25$  ns.

**Sync Risetime and Sync Falltime** — 0.14 to 3.0  $\mu s \pm 20$  ns, 0.31 to 1.0  $\mu s \pm 30$  ns.

**Sync Width Range** — 1 to 8  $\mu s \pm 25$  ns.

**Sync to End of Burst Duration Range** — 6 to 15  $\mu s \pm 20$  ns.

**SCH Phase Range** — -90 to 90°  $\pm 7^\circ$ .

**VERTICAL INTERVAL TIMING MEASUREMENTS**

**Equalizing Pulse Width Range** — 25 to 200% nominal horizontal sync width  $\pm 0.5\%$ .

**Serration Width Range** — 1 to 20  $\mu s \pm 25$  ns.

**Blanking Width Range** — 19 to 29 lines  $+0.16$  line,  $-0.03$  line.

**SIGNAL-TO-NOISE MEASUREMENTS**

**Unweighted SNR Range** — 26 to 72 dB  $\pm 1$  dB, 66 to 72 dB  $\pm 2.5$  dB.

**Luminance Weighted SNR Range** — 26 to 72 dB  $\pm 1$  dB.

**Chrominance Weighted SNR Range** — 26 to 72 dB  $\pm 1$  dB.

**Low Frequency SNR Range** — 26 to 60 dB  $\pm 1$  dB.

**INCLUDED ACCESSORIES**

Left rackmounting adaptor (367-0279-00); right rackmounting adaptor (367-0280-00); tracks (351-0104-03); 15 ft RS-232C modem connecting cable (012-0939-00); rubber cabinet feet (348-0068-00); power cord (161-0066-01); rack slides (351-0623-00).

**ORDERING INFORMATION**

<b>1980 ANSWER</b> with Option 01, NTSC Applications Software .....	<b>\$26,000</b>
<b>1980 ANSWER</b> with Option 02, PAL Applications Software .....	<b>\$26,000</b>
<b>1980 ANSWER</b> with Option 03, NTSC Transmitter Monitoring Software .....	<b>\$26,000</b>
Option 12 — Automatic Call Equipment .....	<b>+\$500</b>

**OPTIONAL ACCESSORIES**

<b>Service Kit</b> Order 067-1115-00 .....	<b>\$3000</b>
<b>PAL Replacement Circuit Board Kit</b> Order 020-0519-01 .....	<b>\$20,000</b>
<b>Additional Modem Cable for RS336 Port</b> (provided as part of Option 12) Order 012-0939-00 .....	<b>\$115</b>



1440 NTSC Automatic Video Corrector: VIR signal referenced.

## 1440

### Reduces Operating Costs

### Extends Transmitter Tube Life and Reduces Maintenance Costs

### Maintains Consistent High Quality Color Pictures

### Automates Transmitter Modulation Level Control

### Maintains Correct Sync-To-Video Ratios During Line Voltage Fluctuations

### Automatic VIRS Referenced Correction of:

- Overall Video Signal Amplitude
- Chrominance to Luminance Gain Ratio
- Black Level
- Chrominance Phase
- Burst Gain
- Sync Gain

### Sync and Burst Regeneration (Optional 1440 Only)

### White Clip Automatic Clip Level Tracking (Optional 1440 Only)

### Optional Closed Loop Capabilities for Greater Efficiency and Economy in Transmitter and VTR Operations

The 1440 VIRS Automatic Video Corrector gives fully automatic correction of video gain, chrominance to luminance gain ratio, black level (set up), chroma phase, burst amplitude, and sync amplitude errors. With this corrector in your facility, the quality of the program signal is rigidly maintained. Ordinary changes and even many severe distortions are automatically corrected.

The 1440 is an in-line NTSC processing amplifier that uses the VIRS (Vertical Interval Reference Signal) to automatically correct video gain, chrominance to luminance gain ratio, setup level, burst phase relative to chroma (hue), burst gain, and sync gain.

Video gain correction is referenced to the 50 IRE level of the VIRS. Chrominance to luminance gain ratio and burst phase corrections are referenced to the amplitude and phase of the VIRS chrominance respectively. Setup level correction is referenced to the 7.5 IRE level of the VIRS. Sync and burst gain corrections are controlled relative to their standard amplitudes.

#### Automatic Correction

Automatic Video Correctors sample six parameters of the reference signal in the vertical interval and then automatically change their operating characteristics until correct values for the Reference Signal are achieved. Distortions in the full field signal are simultaneously corrected by the automatic changes that restore the Reference Signal to its original characteristics. The corrector has no front or rear panel controls other than the power switch and the preset pedestal width adjustments. Operating modes other than full automatic correction are indicated by front panel lights. Oscilloscope test points are provided for program input and program output.

#### Program Protection and Operating Considerations

In most cases the automatic operation is straightforward. Reference signal distortions will cause correcting action to occur.

Since the 1440 is automatic, it continues to operate as a unity gain device without distorting program video if the reference is lost. If burst is lost with reference present, monochrome correcting continues. An excellent source of VIR is the 1441.

A bypass relay located in the corrector interface unit ensures continuity of the program line through the Automatic Corrector. The relay automatically bypasses the program line to maintain a constant program delay line in the event of a power failure. The remote control unit can also activate this bypass relay. The program delay in all modes is 145 ns.

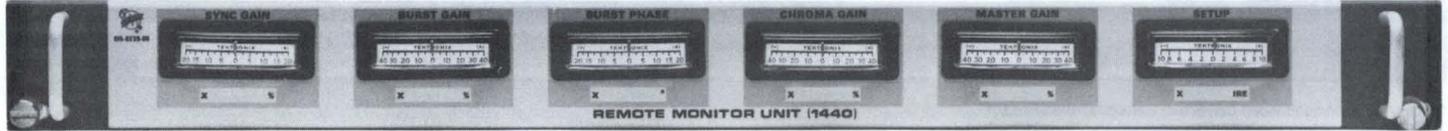
#### Auxiliary Units

In most applications, the usefulness of automatic correction is enhanced by a Tektronix Remote Control Unit. You can conveniently select corrector modes and manually correct six signal parameters with this unit. The remote unit allows easy adjustment of the parameter's preset values for operation in the absence of a reference signal. Automatic correction value adjustments are also provided.

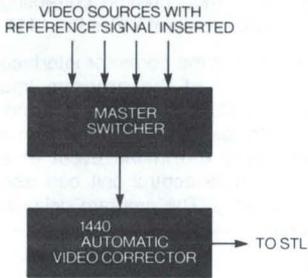
The Tektronix Remote Monitoring Unit provides meter indications of the amount of correction applied to the signal. For 1440 systems order 015-0239-00.



AUTOMATIC VIDEO CORRECTOR

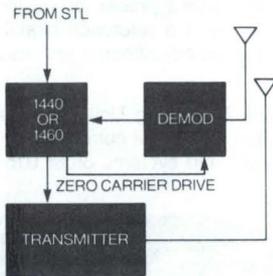


### Open loop operation



As a corrector (open loop) — The 1440 Monitor the video signal at its program line input and automatically corrects distortions.

### Closed loop operation



### CHARACTERISTICS

- Input Impedance** — 75  $\Omega$  nominal.
- Input Return Loss** — 46 dB to 5 MHz, operating; 40 dB to 5 MHz, bypass mode.
- Video Delay** — 145 ns.
- Output Impedance** — 75  $\Omega$ .
- Output Return Loss** — 36 dB to 5 MHz.
- Linear Waveform Distortions (Maximum)** Field Time: 0.5%, Line Time: 0.5%, Short Time: T Pulse/Bar: 2%. 2T Pulse/Bar: 1%.
- Nonlinear Waveform Distortions** — Differential Gain (10-90% APL): 0.5%. Differential Phase (10-90% APL): 0.5%. Dynamic Gain (10-90% APL): picture 0.5%, sync 0.5%. Chrominance/Luminance Intermodulation: 0.5%. Line Time Nonlinearity: 0.5%.
- Relative Signal Timing Errors** — Sync-burst, burst video, sync-video jitter, and burst jitter: none.

**Video Signal to Random Noise Ratio, Unweighted** —  $\geq 60$  dB to 5 MHz.

**Spurious Subcarrier** — -60 dB.

**Field Time Tilt Correction** — 25% tilt on input signal — will be reduced to  $\leq 1\%$ .

**Clamping Characteristics** — 10-90% APL or 90-10% APL. Recovery within one line to within five IRE (1440) without overshoot. Slow clamp option provided to reduce keyboarding when used with noisy signals. Hum Reduction: 1 V hum on input signal can be reduced to  $\leq 25$  mV.

**Maximum Correction Ranges** — Video Level at Input:  $\pm 6$  dB. Sync Level at Input:  $\pm 3$  dB. Chrominance/Luminance Gain:  $\pm 3$  dB. Burst Level:  $\pm 6$  dB Burst/Chrominance Phase:  $\pm 25^\circ$ . Black Level Setup:  $\pm 10$  IRE.

**Reduced Correction Ranges** — Video Level:  $\pm 2$  dB. Sync Level:  $\pm 3$  dB. Chrominance/Luminance Gain:  $\pm 3$  dB. Burst/Chrominance Phase:  $\pm 25^\circ$ . Black Level Setup:  $\pm 5$  IRE.

**Dc Error-Signal Output** — Source Impedance: 10 k $\Omega$ . Open Circuit Voltage: 10 V for remote metering and telemetry. Six Outputs: video gain, sync gain, burst gain, relative chroma gain, burst phase, and setup.

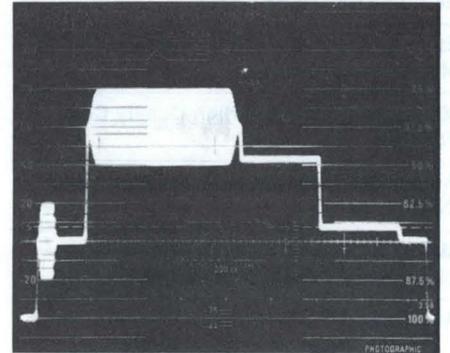
**Chroma/Luminance Gain Correction (+3 dB to -3 dB) -2T pulse/bar ratio** — 110% maximum and 92% minimum. T Pulse/Bar Ratio: 125% maximum and 85% minimum. 2T Pulse Preshoot: 5% maximum. T Step Overshoot: 5% maximum. T Step Risetime: 95 ns minimum and 155 ns maximum. Chrominance/Luminance Delay: 10 ns minimum and 10 ns maximum. VIR Signal Correction Rate: 0.35 s (90% correction without overshoot).

### POWER SUPPLY

- Line Voltage Range** — 115 V ac  $\pm 10\%$  and 230 V ac  $\pm 10\%$ .
- Crest Factor** —  $\geq 1.35$ .
- Maximum Line Current** — 0.5 A.
- Maximum Power Consumption** — 35 W.
- Line Frequency Range** — 48 to 66 Hz.

### PHYSICAL CHARACTERISTICS

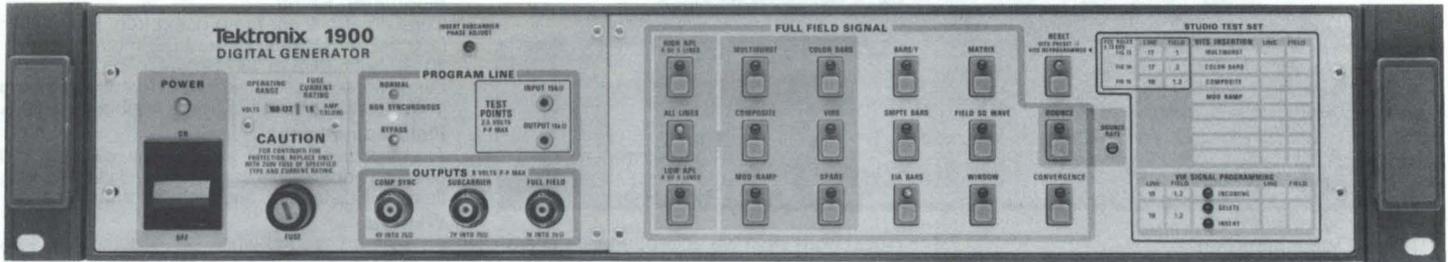
Dimensions	mm	in
Width	483	19.0
Height	881	3.5
Depth	412	16.2
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	7.6	16.7
Domestic Shipping	11.0	24.1
Export Shipping	16.8	37.0



Vertical interval reference signal (VIRS).

### ORDERING INFORMATION

- 1440 NTSC Automatic Video Corrector** ..... **\$6,205**
- OPTIONAL ACCESSORIES**
- Remote Control Unit for 1440** (Includes 2 connectors). Order 015-0240-00 ..... **\$775**
  - Remote Monitor Unit for 1440** (Includes 1 connector). Order 015-0239-00 ..... **\$865**
  - Six Foot Extender Cable** with connectors for use between the 1440. Order 012-0131-00 ..... **\$275**
  - Three Foot Extender Cable** with connectors, for use between the 1440 chassis and the rear rackmounting section. Order 012-0137-00 ..... **\$90**



- 1900 Digital Generator**
- 10 Bits**
- Vits**
- Digital**
- Remote Control**
- Outputs always SCH Phased**

The 1900 Digital Generator Series and VITS inserters are designed for state-of-the-art performance testing of NTSC video systems and equipment. Available in three different versions, these generators support a wide range of transmitter, studio, common carrier, and equipment manufacturing applications. The three 1900 versions available are the Transmitter Test Set, the Studio Test Set, and the NTC 7 Test Set. Each version provides a special test signal complement, and all three provide the following features:

10-bit digital signal generation to increase test signal accuracy and long-term stability.

PROM memory to allow easy signal modification when industry signal formats change.

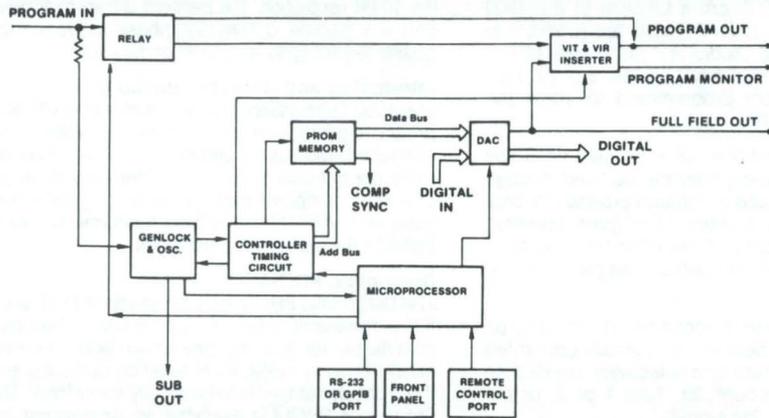
SMPTE Color Bars, Sin x/x, and Multipulse signals to facilitate the alignment of color monitors and enhance testing of frequency response and group delay. Each version of the 1900 contains one or more of these new test signals.

VITS and VIRS generation and insertion meet vertical interval testing requirements and provide a reference signal for automatic video correctors.

Digital signal output to allow accurate alignment of D to A converters; digital signal input to allow alignment of A to D converters and to facilitate conversion of user-generated digital signals to an analog format.

An External VITS input connector is provided on the rear panel to permit an externally-generated VIT signal to be gated and selectively inserted on any of lines 10 through 21, field 1 or 2, or the incoming program line signal.

RS-232C of ground closure interfaces allow wide-ranging remote control functions and application versatility.



All-digital signal generation, microprocessor control, and precision 10-bit D to A conversion make the 1900 Generator the industry's most versatile and accurate NTSC video test instrument.

### All Digital Signal Generation

The 1900's generator functions are controlled by an internal microprocessor and its associated PROM memory. Test signals are stored as 10-bit digital words and converted to analog form by 10-bit precision DAC to ensure signal accuracy as well as long term stability.

Since the 1900's signals are stored in PROM, test signal format changes are accomplished by replacing the appropriate test signal memory. No recalibration is required, and changing industry test signal standards will not cause obsolescence.

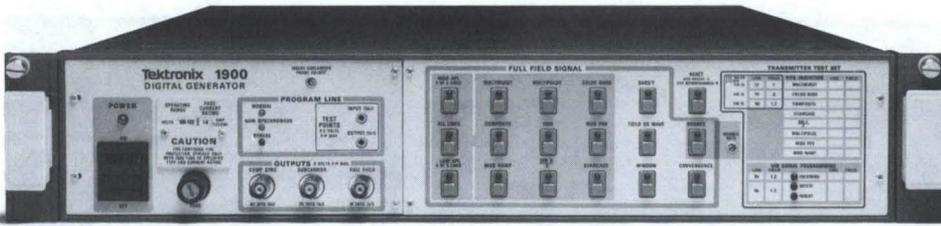
### Genlock and Program Line Control

The 1900 Series may be genlocked to the incoming program signal or to a black-burst signal. This assures accurate timing and phasing of the inserted VITS and the full-field signals to the incoming reference signal. When the 1900 is genlocked, loss of incoming color burst will cause the generator to lock its sync and subcarrier to the leading edge of incoming sync. If there is a loss of sync, the 1900 will enter into an internal oscillator state that is controlled by a crystal in a constant temperature oven. When in the internal mode, H sync is locked to subcarrier and SCH phased.

Normally, with loss of incoming sync, the program line signal is bypassed to prevent nonsynchronous VITS insertion. Through pin jumper programming, the 1900 can be set to enter into a transmitter-protect mode. In this mode, sync and burst or a full field signal (user selectable) will appear at the program line output to maintain continuity until normal operation is restored.

Full sync and burst regeneration capabilities are also included in the 1900 Series. When the incoming program signal is monochrome, burst regeneration is inhibited. Normal sync and burst regeneration occurs when the incoming program signal is color.

Phasing of the inserted burst to program signal phase is accomplished with front panel screw-driver adjustment. As the 1900 is fully SCH phased, the leading edge of the regenerated sync will occur 19 subcarrier cycles before the 50% point of the leading edge of the regenerated burst. No sync phasing adjustment is required and program signal because SCH phasing is always maintained.



### VITS and VIRS Insertion

The 1900 Digital Generator series offers full VITS and VIRS insertion capabilities. The inserted VITS, either FCC or NTC 7, are a function of the 1900 test set version in use. FCC VITS are available in the Transmitter and Studio Test Sets, while NTC 7 VITS are provided in the NTC 7 Test Set. All 1900 versions are factory programmed to insert the standard FCC or NTC 7 VITS.

For special applications, all VITS and VIRS line and field programming may be modified through the RS-232C interface or through ground closures with the Remote Control Unit (part number 015-0374-00). Phasing of the inserted VITS chrominance is handled through a front panel screw-driver adjustment.

An External VITS input connector is provided on the rear panel to permit an externally-generated VIT signal to be gated and selectively inserted on any of lines 10 through 21, field 1 or 2, or the incoming program line signal.

### Digital Word Input and Output

The 1900 Series features a digital word input and output. The digital word output provides a 10-bit digital word of the selected test signal. This highly accurate digital test signal may be used to evaluate and align D to A converters and is a useful feature as the error incurred in digitizing an analog signal for this purpose is eliminated.

The digital word input will accept a user-generated digital word (up to 10-bits) for conversion to analog with the precision DAC in the 1900 Series. It's 10-bit resolution, 0.6 percent differential gain, and 0.3 degree differential phase performance guarantee a highly accurate conversion.

### Interfacing and Remote Functions

The 1900 Digital Generators include RS-232C and ground closure interface capabilities. With these interfaces, the 1900 compatible with its own remote control unit, a number of terminal devices, or a host computer system. All test signal selections and VITS/VIRS insertion functions are controllable through these interfaces.

### Diagnostic PROM

The Diagnostic PROM may be used for fault isolation in the event of failure. This PROM is designed specifically for locating processor faults, however, all I/O ports, RAM, VITS insertion functions and the front panel keyboard are fully exercised. The Diagnostic PROM is available as an optional accessory to the 1900 Series.

### STANDARD FULL FIELD SIGNALS

There are a wide range of test signals common to all 1900 Generator versions. All of the following test signals are included with each version:

### Modulated Ramp

Consists of a linear ramp going from 0 to 80 IRE (100 IRE on Options 01 and 02) modulated with 40 IRE Subcarrier at 180 degrees. The modulated ramp allows measurement of differential gain and phase distortions and is also available as a VITS.

### Field Squarewave

Approximates a 60 Hz squarewave with sync and blanking added. This signal is useful in measuring field time distortions and clamper performance.

### Window

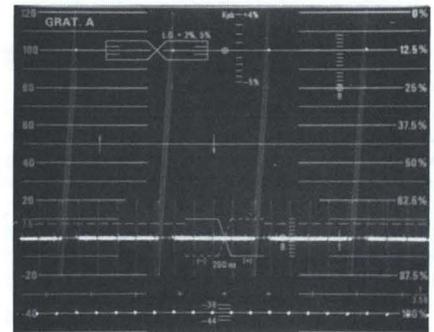
An 18 microsecond white bar occurring on lines 72 through 202 of the field. This signal is used in measuring line-time and short-time distortions and picture monitor smear and ringing.

### VIRS

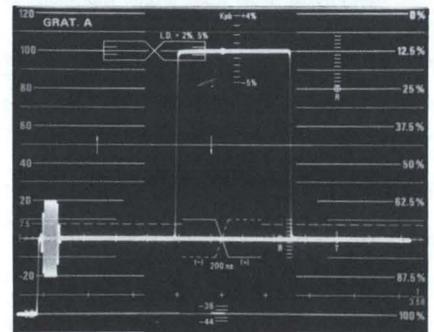
Consists of 70 IRE, 50 IRE, and 7.5 IRE pedestals. Chrominance modulation on the 70 IRE level is 40 IRE at a 180° phase. Also available on line 19 in vertical blanking.

### APL

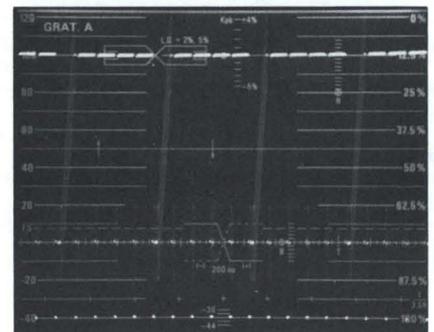
In addition to these standard full-field signals, each generator test set offers 4 out of 5 lines High or Low APL, and 4 out of 5 lines Bounce. The bounce rate is front panel adjustable.



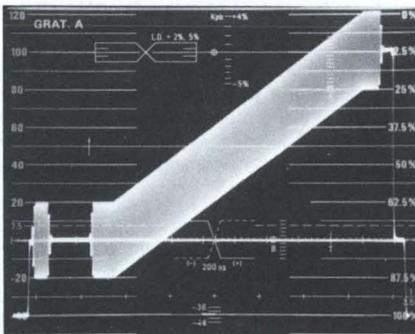
Low APL



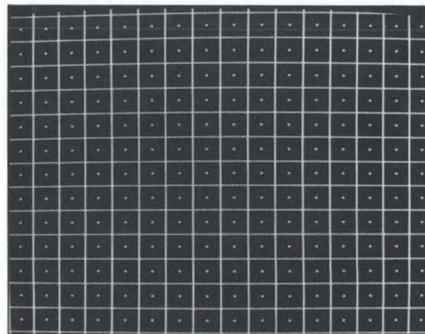
Window



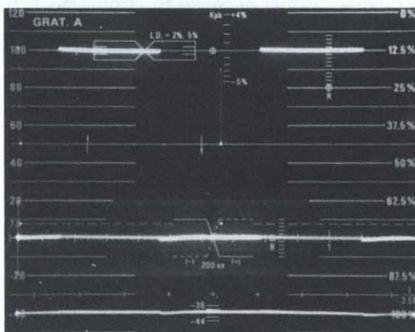
High APL



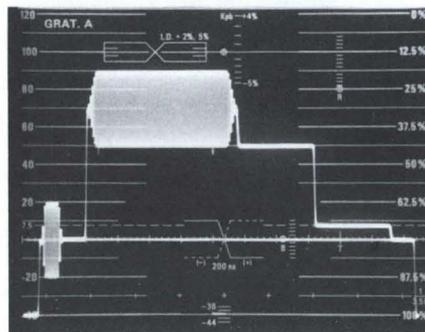
Modulated Ramp



Convergence Pattern



Field Squarewave



Vertical Interval Reference Signal (VIRS)

**TRANSMITTER TEST SET**

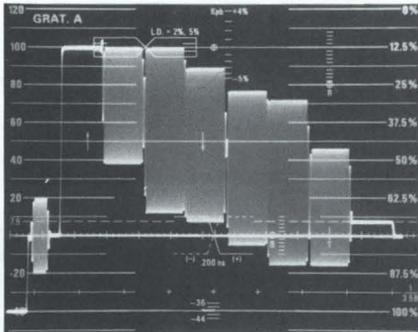
This 1900 Test Set is especially designed for testing broadcast TV transmitters. It contains all the common generator signals plus the following additional signals:

**Multiburst**

Consists of a 100 IRE white flag and six 60 IRE p-p packets of sinewave bursts on a 40 IRE pedestal. Bursts are risetime controlled to reduce out of band harmonics. This signal conforms to FCC 73.699. Multiburst is used to check the television system frequency response. Multiburst is also available as a VITS.

**Multipulse**

Consists of white flag, a 2T pulse, a 25T (1.25 MHz) modulated pulse, and four 12.5T (2 MHz, 3 MHz, 3.58 MHz, 4.1 MHz) modulated pulses. The white flag and all pulse elements are 70 IRE riding on a 10 IRE pedestal. The multipulse signal is especially useful for checking frequency response and group delay characteristics. Multipulse is also available as a VITS.



Color Bars Per FCC 73.699

**Color Bars**

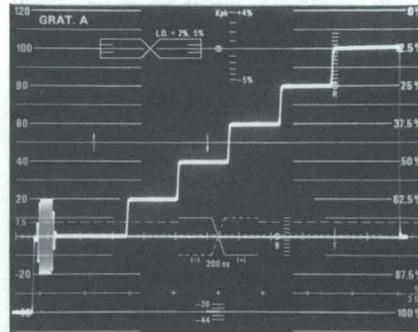
Consist of eight equal intervals arranged in descending order of luminance. The signal conforms to FCC 73.699. When the incoming program signal is monochrome, VITS chrominance only is inhibited. The color bars are used for testing the luminance, hue, and saturation parameters of the television system. Color bars are also available as VITS.

**Convergence**

(Crosshatch and dot pattern) is helpful when adjusting color picture monitor convergence and linearity.

**Composite**

Consists of 5-step modulated staircase, a 2T sine squared pulse, a 12.5T modulated pulse, and a 100 IRE white bar. This signal conforms to FCC 73.699. The composite signal allows measurement of linear and nonlinear distortions including chrominance to luminance gain and delay, transient response, differential gain and phase, and line-time distortions. Composite is also available as a VITS.



5 Step Staircase

**Modulated Pedestal**

Consists of three chrominance levels (20, 40, and 80 IRE) modulated on a 50 IRE pedestal, followed by 50 IRE pedestal having no modulation.

Phase of the chrominance is 90°. The modulated pedestal allows measurement of chrominance to luminance intermodulation and chrominance nonlinear gain and phase distortions. Modulated pedestal is also available as a VITS.

**Staircase**

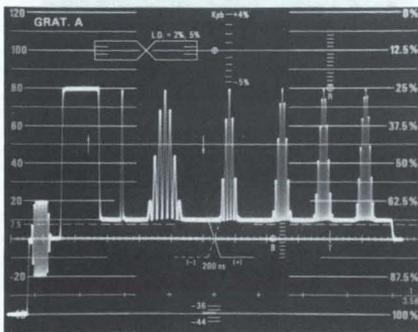
Consists of 5 equal steps of unmodulated luminance information going from 0 to 100 IRE. The staircase signal allows measurement of differential luminance gain distortion. Staircase is also available as a VITS.

**Bars/Y**

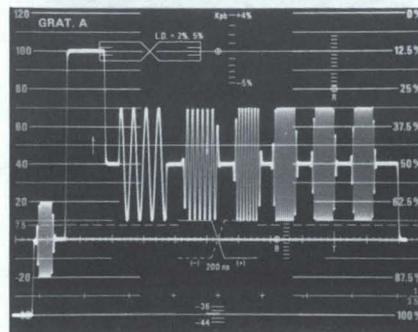
A split field signal consisting of color bars followed by luminance levels only (gray scale). The Bars/Y signal is useful for simultaneously evaluating picture monitor gray scale tracking and color performance.

**Sin x/x**

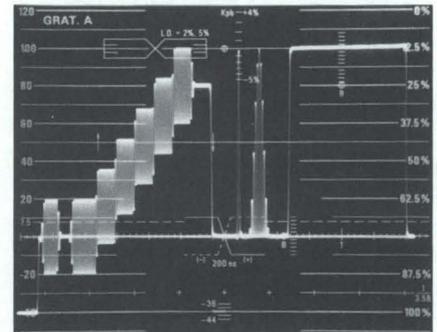
Consists of two Sin x/x pulses and an 26 usec bar. Used in the frequency domain, this signal provides an easy means for measuring the frequency response of television systems. Sin x/x is also available as a VITS.



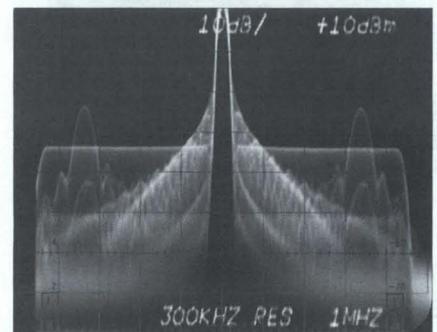
Multipulse



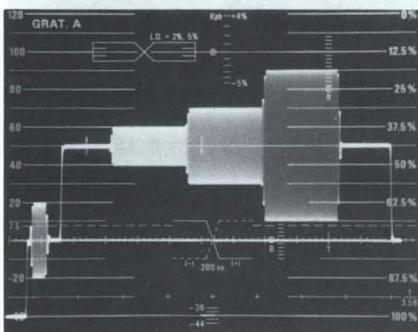
Multiburst Per FCC 73.699



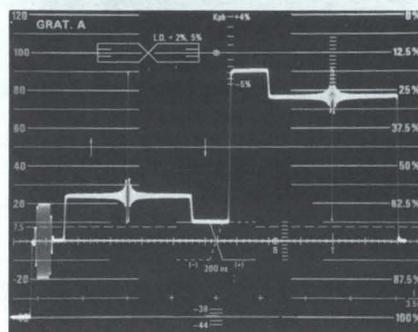
Composite Per FCC 73.699



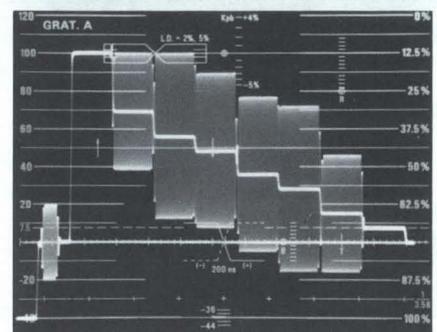
Sin x/x-Frequency Domain



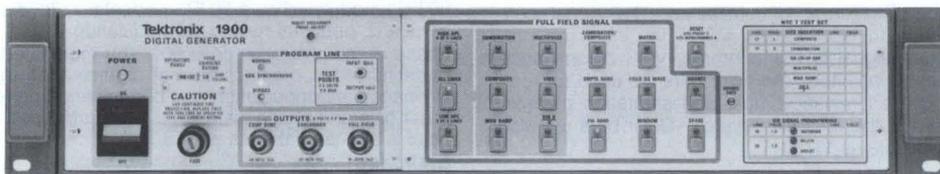
Modulated Pedestal



Sin x/x



Color Bars/Y Reference



NTC 7 Test Set Option 02

### STUDIO TEST SET (OPTION 01)

This 1900 Generator version is designed for use in TV studio environments. In addition to the common test signals, the Studio Test Set provides following additional test signals:

#### Color Bars

See Transmitter Test Set.

EIA Bars is a split-field signal consisting of standard color bars for the first 3/4 lines of the field, then IWQB for the remaining 1/4 lines of the field.

SMPTE Bars is a split-field signal consisting of Standard EIA color bars for the first 2/3 of the field, reverse blue bars for the next 1/12 of the field, and IWQB with pluge for the remaining 1/4 of the field. The SMPTE Bars signal is extremely useful in color monitor alignment.

#### Composite

See Transmitter Test Set.

#### Multiburst

See Transmitter Test Set.

#### Bars/Y

See Transmitter Test Set.

Convergence (Crosshatch and dot pattern) is helpful when adjusting color picture monitor convergence and linearity.

Matrix is a split-field signal consisting of a Multiburst signal for the first 1/4 of the field, followed by a Composite signal for the second 1/4. The third quarter consists of 40 lines of EIA bars followed by 20 lines of Reversed Blue Bar. The bottom 1/4 is a Modulated Ramp Signal.

### NTC 7 TEST SET (OPTION 02)

Featuring NTC 7 VITS, this test set is designed for common carrier and network center applications. It offers the signals common to all generator versions plus following additional signals:

Multipulse consists of a 100 IRE white flag, a 2T pulse, a 25T 1-MHz modulated pulse, and four 12.5T (2-MHz, 3-MHz, 3.58-MHz, and 4.2 MHz) modulated pulses. The multipulse signal is useful in checking frequency response and group delay characteristics. Multipulse is also available as a VITS.

Composite consists of a 100 IRE bar, 2T sine-squared pulse, 12.5T modulated pulse, and a 5-step modulated staircase. This signal conforms to NTC 7 Specifications. The composite signal allows measurement of linear and nonlinear distortions such as chrominance to luminance gain and delay, transient response, differential gain and phase, and line time distortions. Composite is also available as a VITS.

**Combination** consists of multiburst for the first portion of the line and modulated pedestal for the last portion. This signal conforms to NTC 7 specifications. The combination signal is used for frequency response, chrominance to luminance intermodulation, and chrominance nonlinear gain and phase measurements. Combination is also available as a VITS.

#### SMPTÉ Bars

See Studio Test Set.

#### EIA Bars

See Studio Test Set.

#### Sin x/x

See Transmitter Test Set.

**Matrix** is a split field signal consisting of successive quarters of the following signals: Modulated Ramp; EIA bars; Reversed Blue Bars and the Multipulse Signal.

### CHARACTERISTICS

#### PROGRAM CONTROL SYSTEM

##### VITS INSERTER

##### PROGRAM LINE INPUT

**Input Level** — 1 V ± 3 dB (0.7 to 1.4 V).

**Input Impedance** — 75 Ω nominal.

**Return Loss** — Power On: ≥ 46 dB to 5 MHz.

Power Off/Bypass: ≥ 40 dB to 5 MHz.

##### PROGRAM LINE/MONITOR OUT

**Impedance** — 75 Ω nominal.

**Return Loss** — ≥ 36 dB to 5 MHz.

**Hum Rejection** — ≥ 10 dB, (jumper selectable to 20 dB), referenced to 1 V hum.

**Keyboard (no noise)** — < 0.25 IRE.

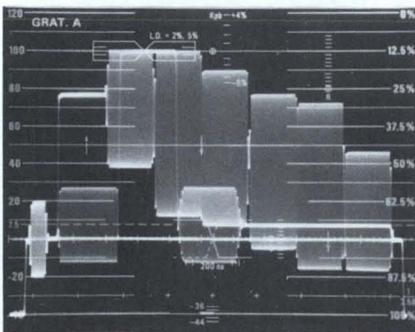
**Video Gain** — Unity gain ± 0.5%.

**Dc Output Level** — 0 V ± 100 mV.

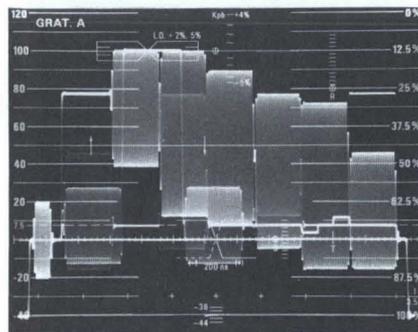
**Pedestal Offset** — 0 V Hum: ≤ 2 mV.

1 V Hum: ≤ 10 mV.

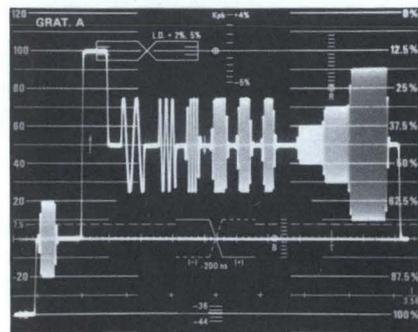
DIGITAL GENERATORS



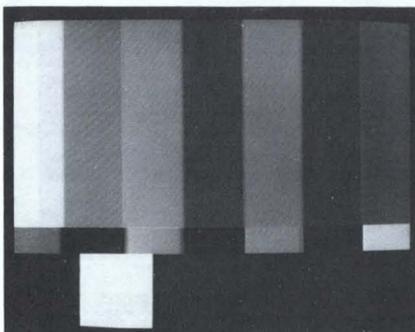
EIA Color Bars



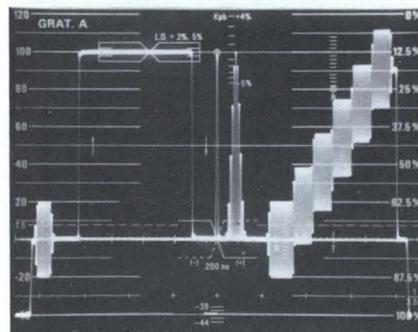
SMPTE Color Bars



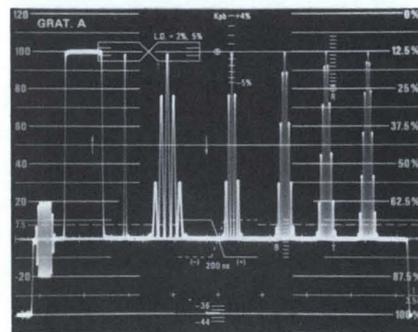
Composite Per NTC 7 and CCIR Recommendation 473-2



SMPTE Color Bars



Combination Per NTC 7 and CCIR Recommendation 473-2



Multipulse

**Isolation** — Program Line to Program Monitor:  $\geq 40$  dB to 5 MHz, referenced to 1 V.

**Pulse to Bar Ratio** — T/2 100%  $\pm 2\%$ . 1T: 100%  $\pm 0.5\%$ . 2T 100%  $\pm 0.25\%$ .

**Waveform Tilt** — Field Tilt:  $\leq 0.5\%$ . Bar Tilt:  $\leq 0.5\%$ .

**Differential Phase** — (10-90 APL)  $\leq 0.15^\circ$ .

**Differential Gain** — (10-90 APL)  $\leq 0.2\%$ .

**Line-Time Amplitude Nonlinearity** —  $\leq 0.25\%$ .

**Random Noise Output** —  $\geq 75$  dB (RMS) down, referenced to 1 V.

**Residual Subcarrier** —  $\geq 60$  dB down, referenced to 1 V.

**Hum** —  $\geq 60$  dB down, referenced to 1 V.

**Spurious Signals During Blanking** — Up to 5 MHz:  $\geq 40$  dB down ( $\leq 10$  mV). Above 5 MHz:  $\geq 46$  dB down ( $\leq 5$  mV).

**Delete Mode Signal Attenuation** — 2T Pulse:  $\geq 70$  dB down, referenced to 0.714 V. Subcarrier:  $\geq 60$  dB down, referenced to 0.714 V.

**Crosstalk (Internal to Program Line)** — 2T:  $\geq 70$  dB down, referenced to 0.714 V. Subcarrier:  $\geq 60$  dB down, referenced to 0.714 V.

**Insert Delay Range** —  $\pm 8$   $\mu$ s (16  $\mu$ s total) in 70 ns increments (internal DIP switch).

**Insert Subcarrier-Phase Adjust Range** — Minimum  $10^\circ$  total.

**Instrument Delay (program input to program output)** — 25 ns typical.

#### GEN LOCK

**Input** — Burst Amplitude: 40 IRE  $\pm 6$  dB. Sync Amplitude: 40 IRE  $\pm 6$  dB. Sync Source: Composite video or black burst (sync negative going). Return Loss:  $\geq 46$  dB to 5 MHz.

**Performance** — Burst Lock: 3.579545 MHz  $\pm 20$  Hz. Burst Loss: Clock referenced to leading edge of sync. Sync Lock: 15.73426 kHz  $\pm 0.079$  Hz. Sync and Burst Loss: Clock is referenced to internal temperature controlled crystal oscillator. Oscillator: (Free running) Subcarrier frequency: 3.579545 MHz  $\pm 10$  Hz. Sync frequency: 15.73426 kHz  $\pm 0.04$  Hz.

#### TEST SIGNALS

##### All 1900 Versions

**Modulated Ramp Signal** — Luminance Amplitude: 0 to 100 IRE  $\pm 0.7$  IRE. Linearity: Within 1%. Chrominance: Amplitude: 40 IRE  $\pm 0.5$  IRE. Differential Gain:  $\leq 0.6\%$ . Differential Phase:  $\leq 0.3^\circ$ . Envelope Risettime: 400 ns  $\pm 40$  ns. Phase: Same as burst  $0.3^\circ$ .

**Field Squarewave Signal** — Field Timing: Lines (white): lines 72 to 202. Lines at blanking: all remaining active lines. Field Tilt: 0.5% maximum. Line Tilt: 0.5% maximum. Amplitude: 100 IRE  $\pm 0.7$  IRE. Risettime: 250 ns  $\pm 25$  ns.

**Window Signal** — White Bar Amplitude: 100 IRE  $\pm 0.7$  IRE. Risettime: 250 ns  $\pm 25$  ns. Field Tilt: 0.5% maximum. Line Tilt: 0.5% maximum. Field Timing: Lines 72 to 202.

**VIRS (Vertical Internal Reference Signal)** — Chrominance Reference: Amplitude: 40 IRE  $\pm 0.4$  IRE. Phase: Same as burst  $\pm 0.3^\circ$ . Envelope Risettime: 1  $\pm 0.1$   $\mu$ s. Average Level of Chrominance Signal: 70 IRE  $\pm 0.7$  IRE. Luminance Reference — 50 IRE Level: 50 IRE  $\pm 0.5$  IRE. Black Reference: 7.5 IRE  $\pm 0.5$  IRE.

**APL Signal Bounce, Flat Field Signals** — Ac Bounce: 0 and 100 IRE on 4 out of 5 lines. Rate adjustable from  $\approx 1/30$  Hz. Amplitude: 100 IRE  $\pm 0.7$  IRE. Risettime: 250 ns  $\pm 25$  ns.

#### FULL FIELD OUTPUT

**Amplitude** — 1.2 V maximum p-p into 75  $\Omega$ .

**Blanking Level** — DAC Dc Restorer Disabled: 0 V  $\pm 50$  mV. DAC Dc Restorer Enabled: 0 V  $\pm 2$  mV.

**Field Period** — 16.68 ms.

**Line Period** — 63.56  $\mu$ s.

**Sync Risettime and Falltime** — 140 ns  $\pm 15$  ns.

**Front Porch Duration** — 1.5  $\mu$ s,  $\pm 100$  ns.

**Line Blanking Interval** — 10.9  $\mu$ s  $\pm 100$  ns at the 20 IRE point.

**Breezeway** — 0.6  $\mu$ s,  $\pm 50$  ns, at 50% of sync to 50% of burst amplitude.

**Back Porch Duration** — 4.7  $\mu$ s to the 20 IRE point.

**Line Sync** — 4.7  $\mu$ s,  $\pm 50$  ns, at 50% amplitude point.

**Vertical Serration** — Duration: 4.7  $\mu$ s,  $\pm 50$  ns, at 50% amplitude point. Sequence: 3 lines. Period: 262.5 lines.

**Equalizing Pulse** — Duration: 2.33  $\mu$ s,  $\pm 50$  ns, at 50% amplitude point. Sequence: 3 lines.

**Burst** — Risettime and falltime: 400 ns  $\pm 40$  ns. Delay From Line Sync: 5.308  $\mu$ s  $\pm 35$  ns (19 cycles of subcarrier). HAD of Envelope: 2.51  $\mu$ s  $\pm 100$  ns (9 cycles of subcarrier). Amplitude: 285.7 mV  $\pm 8.57$  mV.

**Residual Subcarrier** — (Luminance and Blanking)  $\geq 52$  dB below 1 V (2.5 mV).

**Spurious Subcarrier on Outputs** —  $\geq 52$  dB below 1 V (2.5 mV).

**Chrominance Subcarrier Frequency** — Free Running: 3.579545 MHz  $\pm 10$  Hz. Locked Mode: Locked to incoming burst or the leading edge of sync if burst is not present.

**Output Impedance** — 75  $\Omega$  nominal.

**Return Loss** —  $\geq 36$  dB to 5 MHz.

**Isolation (Front and Rear Panel Outputs)** —  $\geq 40$ dB.

#### SYNC AND SUBCARRIER SIGNAL OUTPUT

##### Composite Sync

**Amplitude** — 4 V, negative going,  $\pm 10\%$  into 75  $\Omega$ .

**Return Loss** —  $\geq 30$  dB to 3.58 MHz.

**Risettime and Falltime** — 140 ns  $\pm 20$  ns, measured from 10% to 90% amplitude points.

**Line Period** — 63.556  $\mu$ s.

**Line Sync Duration** — 4.7  $\mu$ s  $\pm 50$  ns.

**Equalizer Pulse** — Duration: 2.3  $\mu$ s  $\pm 50$  ns, measured at 50% amplitude. Sequence Duration: 3 lines each.

**Vertical Sync Pulse** — Serration: 4.7  $\mu$ s  $\pm 50$  ns; measured at 50% amplitude point. Sequence Duration: 3 lines.

**Field Period** — 262.5 H lines, 16.6835 ms nominal.

##### Subcarrier

**Amplitude** — 2 V p-p  $\pm 10\%$  into 75  $\Omega$ .

**Return Loss** —  $\geq 30$  dB to 5 MHz.

**Frequency** — Locked to incoming burst or to leading edge of incoming sync if burst is not present. If sync is not present, frequency is determined by the internal oscillator.

#### TRANSMITTER TEST SET-TEST SIGNALS

##### Multiburst Signal

**White Reference Bar** — Amplitude: 100 IRE  $\pm 0.7$  IRE. Risettime: 250 ns  $\pm 25$  ns.

**Multiburst Packets** — Amplitude: 60 IRE p-p  $\pm 1$  IRE. Average Level: 40 IRE. Frequencies: 500 kHz, 1.25 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz, 4.1 MHz. Risettimes: 500 kHz, 140 ns; the remaining, 400 ns  $\pm 40$  ns. Harmonic Content:  $\geq 40$  dB down.

##### Sin x/x Signal

**Pulse to Bar Ratio** — 100%  $\pm 1\%$ .

**Spectrum** — Flat to 4.5 MHz  $\pm 0.2$  dB, -3 dB at 4.75 MHz.

**Pulse and Bar Height** — 80 IRE  $\pm 1$  IRE.

**Main Pulse Zero Crossing** — 210 ns  $\pm 21$  ns.

**Small Lobe Zero Crossing** — 105 ns  $\pm 15$  ns.

**Bar Risettime** — 250 ns  $\pm 25$  ns.

##### Multipulse Signal

**White Reference Bar** — 80 IRE  $\pm 0.7$  IRE.

**Risettime** — 150 ns  $\pm 25$  ns.

**Pulse to Bar Ratio** — 100%  $\pm 1\%$ .

**Pulse Half Amplitude Duration** — 2T HAD: 250 ns  $\pm 20$  ns. 25T HAD: 3.14  $\mu$ s  $\pm 300$  ns. 12.5T HAD: 1.57  $\mu$ s  $\pm 150$  ns.

**Modulation Frequencies** — 1st pulse: 1.25 MHz. 2nd pulse: 2 MHz; 3rd pulse: 3 MHz. 4th pulse: 3.58 MHz. 5th pulse: 4.1 MHz.

**Group Delay** —  $\leq 10$  ns.

**Other Baseline Perturbation** —  $\leq 0.5$  IRE.

##### Convergence Signal

**Peak Level** — 77 IRE  $\pm 1$  IRE.

**Crosshatch Vertical Lines** — Unblanked Pulses: 17 per active lines. Pulse Polarity: positive. Line pulse HAD: 225 ns  $\pm 25$  ns. Dot Pulse HAD: 350 ns  $\pm 35$  ns.

**Crosshatch Horizontal Lines** — Unblanked Pulses: 14 per frame. Pulse Polarity: positive. Line Pulse Risettime: 140 ns  $\pm 15$  ns. Line Pulse Duration: 2 lines (1 line each field). Dot Pulse Duration: 3 lines (1 line on one field, two lines on the other field).

##### Full Field Color Bars Signal — 241 lines/field

**Composite Signal** — Modulated 5-step staircase: Luminance Amplitude, FCC: 80.4 IRE  $\pm 0.7$  IRE; NTC7:90-2. IRE  $\pm 0.6$  IRE. Riser Amplitude:  $1/5$  of step amplitude Risettime: 250  $\pm 25$  ns. Chrominance Phase: same as burst  $\pm 0.3^\circ$ . Chrominance Amplitude: 40 IRE  $\pm 0.5$  IRE (3.6 mV). Inherent Differential Phase:  $\leq 0.3^\circ$ . Inherent Differential Gain:  $\leq 0.5\%$ . Envelope Risettime, FCC: 375  $\pm 37.5$  ns. NTC 7: 400  $\pm 40$  ns.

**2T Pulse** — Pulse to Bar Ratio: 100%  $\pm 0.5\%$ . HAD: 250 ns  $\pm 25$  ns. Ringing Amplitude:  $\leq 1.0$  IRE.

**Modulated Sine Square Pulse** — Pulse to bar peak amplitude: 100%  $\pm 0.5\%$ . HAD: 1.563  $\mu$ s  $\pm 150$  ns. Chrominance-/Luminance Delay  $\leq 10$  ns. Chrominance/Luminance Gain Inequality:  $\pm 0.5$  IRE ( $\pm 1\%$ ). Other Perturbations on Baseline:  $\leq 0.5$  IRE. Harmonic Distortion of Subcarrier:  $\geq 40$  dB down. Phase:  $60.8^\circ \pm 1^\circ$ .

**Bar** — Amplitude: 100 IRE  $\pm 0.7$  IRE. Risettime, FCC: 250  $\pm 25$  ns; NTC 7: 125  $\pm 14$  ns.

##### Modulated Pedestal Signal

**Pedestal** — Amplitude: 50 IRE  $\pm 0.5$  IRE. Risettime: 250 ns  $\pm 25$  ns. Tilt:  $\leq 0.5\%$ .

**Chrominance** — Amplitudes: 20.01 IRE p-p,  $\pm 0.5$  IRE; 40.02 IRE p-p,  $\pm 0.5$  IRE; 80.04 IRE p-p,  $\pm 0.6$  IRE.

**Phase** — Relative to Burst:  $90^\circ \pm 0.5^\circ$ . Relative to Other two Levels:  $0^\circ \pm 0.3^\circ$ . Harmonic Distortion:  $\geq 40$  dB down.

**Risettime** — 400 ns  $\pm 40$  ns.

##### Staircase Signal

**Luminance** — Amplitude: 100 IRE  $\pm 0.7$  IRE.

Linearity:  $1/5$  of 5-step amplitude  $\pm 0.5\%$ . Risettime: 250 ns  $\pm 25$  ns.

**Chrominance** — No modulation.

**BARS/Y Signal** — Modulated bars first 181 active lines/field; unmodulated bars last 60 lines of the field.

## STUDIO TEST SET-TEST SIGNALS

### Color Bars Signal

**Luminance and Chrominance** — Absolute amplitudes of luminance signal, setup, and sync are within 1% or 1.5 mV, whichever is greater, with respect to blanking. Chrominance amplitudes are within 1% of their given value.

**Luminance Rise Time** — Full Field: 250 ns ± 25 ns. EIA: 140 ns ± 15 ns.

**Chrominance Rise Time** — 400 ns ± 40 ns.

**Bar Duration** — Full Field: 6.5 μs/bar (8 bars).

EIA: 7.5 μs/bar (7 bars).

**Time Difference Between Luminance and Chrominance** — ≤ 20 ns.

**Residual Subcarrier** — At least 52 dB below 1 V.

**Spurious Subcarrier** — At least 52 dB below 1 V.

**Other Spurious Outputs** — At least 52 dB below 1 V except 40 dB for 2nd harmonic.

**Field Timing** — Full Field Color Bars: -241 lines per field.

**Bars/Y** — Modulated bars first 181 active lines per field: unmodulated bars last 60 lines of the field.

**EIA Bars** — EIA color bars first 181 active lines per field: IWQ last 60 lines of the field.

**SMPT Bars** — EIA color bars first 161 active lines per field; reverse blue bars for 20 lines; and IWQ with pluge for the last 60 lines of field.

**Composite Signal** — Same as Transmitter Test Set: Test Signals.

**Multiburst Signal** — Same as Transmitter Test Set: Test Signals.

**Convergence Signal** — Peak Level: 77 IRE ± 1 IRE.

**Crosshatch Vertical Lines** — Unblanked pulses: 17 per active lines. Pulse polarity: positive. Line pulse HAD: 225 ns ± 25 ns. Dot pulse HAD: 350 ns ± 35 ns.

**Crosshatch Horizontal Lines** — Unblanked Pulses: 14 per frame. Pulse polarity: positive. Line pulse risetime: 140 ns ± 15 ns.

Line pulse duration: 2 lines (1 line each field). Dot pulse duration: 3 lines (1 line on one field, two lines on the other field).

## NTC 7 TEST SET-TEST SIGNALS

### Multipulse Signal

**White Reference Bar** — 100 IRE ± 0.7 IRE.

Risetime: 250 ns ± 25 ns.

**Pulse to Bar Ratio** — 100% ± 1%.

**Pulse Half-Amplitude Duration** — 2T HAD: 250 ns ± 20 ns. 25T HAD: 3.14 μs ± 300 ns.

12.5T HAD: 1.57 μs ± 150 ns.

**Modulation Frequencies** — 1st pulse, 1 MHz; 2nd pulse, 2 MHz; 3rd pulse, 3 MHz; 4th pulse, 3.58 MHz; 5th pulse, 4.2 MHz.

**Group Delay** — ≤ 10 ns.

**Other Baseline Perturbation** — ≤ 0.5 IRE.

### Composite Signal

**Modulated 5-step Staircase** — Luminance amplitude: FCC: 80.4 IRE ± 0.7 IRE; NTC 7: 90.2 IRE ± 0.6 IRE. Luminance Riser Amplitude: 1/5 of 5-step amplitude ± 0.5%. Risetime: 250 ns ± 25 ns. Chrominance phase: Same as burst ± 0.3°. Chrominance Amplitude: 40 IRE ± 0.5 IRE (3.6 mV). Inherent Differential Gain: ≤ 0.5%. Inherent Differential Phase: ≤ 0.3°. Envelope Rise Time: FCC: 375 ± 37.5 ns; NTC 7: 400 ns ± 40 ns.

**2T Pulse** — Pulse to Bar Ratio: 100% ± 0.5%.

HAD: 250 ns ± 25 ns. Ringing amplitude: ≤ 1.0 IRE.

**Modulated Sine Square Pulse** — Pulse-to-bar peak amplitude: 100% ± 0.5%. HAD: 1.563 μs ± 150 ns. Chrominance/Luminance Delay: ≤ 10 ns. Chrominance/Luminance Gain Inequality: ± 0.5 IRE (± 1%). Other Perturbation on Baseline: ≤ 0.5 IRE.

**Bar** — Amplitude: 100 IRE ± 0.7 IRE. Risetime: FCC: 250 ± 25 ns; NTC 7: 125 ± 14 ns.

### Combination Signal

**Multiburst White Reference Bar** — Amplitude: 100 IRE ± 0.7 IRE. Risetime: 250 ns ± 25 ns. Overshoot: ≤ 1%. Tilt: ≤ 0.5%.

**Multiburst Packets** — Amplitude: 50 IRE p-p ± 0.5 IRE. Average Level: 50 IRE ± 0.5 IRE.

Frequencies: 500 kHz, 1 MHz, 2 MHz, 3 MHz, 3.58 MHz, 4.2 MHz. Packets Rise Time NTC 7 (500 kHz and 1 MHz): 140 ± 14 ns; all others, 400 ± 40 ns. Harmonic Content: ≥ 40 dB down.

**Modulated Pedestal Signal: Pedestal Amplitude** — 50 IRE. Risetime: 250 ± 25 ns. Tilt: ≤ 0.5%.

**Chrominance Amplitude** — 20.01 IRE ± 0.5 IRE; 40.02 IRE ± 0.5 IRE; 80.04 IRE ± 0.6 IRE.

Phase: relative to burst, 90° ± 0.5°, relative to the other two levels 0° ± 0.3°. Harmonic distortion: ≥ 40 dB down. Risetime: 400 ± 40 ns.

**SMPT Bars Signal** — Same as Studio Test Set: Test Signals.

**EIA Bars Signal** — Same as Studio Test Set: Test Signals.

**Sin x/x Signal** — Same as Studio Test Set: Test Signals.

## RS-232C INTERFACE

**Baud Rate** — 300 bits/sec., full duplex input and output.

**Input** — Serial asynchronous data.

**Output** — Serial asynchronous data.

**Data Code** — ASCII.

**Character Length** — 9 bits per character including a start and one stop bit.

**Parity** — Input: No parity is required and if present it is ignored. Output: No parity is sent.

## DIGITAL INPUT INTERFACE

**Digital Format** — Parallel, 12 balanced signal pairs consisting of 10 data bits per sample, a clock, and a timing reference signal.

**Encoding Format** — Positive binary.

**Sampling Frequency** — 4 times color subcarrier nominal (14.31818 MHz).

**Sampling Phase Angle** — Referenced to I and Q axis.

**Input Logic Levels** — 10k ECL compatible. High: -1.105 to -0.81 V @ 25°C. Low: -1.85 to -1.475 V @ 25°C.

**Dynamic Range** — 10 bits/sample. Blanking level (0 IRE) is at digital word 240. Reference white (100 IRE) is at digital word 800. (5.6 LSB/IRE).

**Setup Time** — Data needs to be valid at least 10 ns before the 50% point of the negative transition of the clock pulse.

**Hold Time** — Data needs to be valid for at least 10 ns after 50% point of the negative transition of the clock pulse.

## DIGITAL OUTPUT INTERFACE

**Digital Format** — Parallel, 12 balance signal pairs consisting of 10 data bits per sample, a clock, and a timing reference signal.

**Encoding Format** — Positive binary.

**Sampling Frequency** — 4 times color subcarrier nominal (14.31818 MHz).

**Sampling Phase Angle** — Referenced to I and Q axis.

**Logic Levels** — ECL compatible. High: -0.96 to -0.81 V. Low: -1.85 to -1.65 V.

**Dynamic Range** — 10 bits/sample. Blanking level (0 IRE) is at digital word 240. Reference white (100 IRE) is at digital word 800. (5.6 LSB/IRE).

**Clock Timing** — The 50% point of the positive edge of the clock pulse precedes the data by 5 ns ± 5 ns.

## POWER SUPPLY

**Line Voltage Range** — 90 to 110 V ac; 99 to 121 V ac; 108 to 132 V ac, 180 to 220 V ac; 198 to 242 V ac and 216 to 250 V ac.

**Crest Factor** — ≥ 1.35.

**Maximum Power Consumption** — 130 W.

**Line Frequency** — 47 Hz to 63 Hz.

## PHYSICAL CHARACTERISTICS

Dimensions	Rackmount		Cabinet	
	mm	in	mm	in
Width	482	18.9	444	17.5
Height	89	3.5	96	3.8
Depth	522	20.5	522	20.5
<b>Weights</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net	12.2	27	11.6	25.5
Shipping ≈	19.1	42	16.7	37

## ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating range: 0° to +50°C.

Storage: -40°C to +65°C.

**Altitude** — Operating range: to 4500 m (15,000 ft).

Storage: to 15 200 m (50,000 ft).

## INCLUDED ACCESSORIES

Power Cord, 3-wire, (161-0066-00); Slide Section pair, drawer (for rackmounting), (351-0636-00).

## ORDERING INFORMATION

**1900 Transmitter Test Set** (cabinet model) ..... **\$9,600**

**R1900 Transmitter Test Set** (rackmount model) ..... **\$9,600**

**Option 01** — Studio Test Set ..... **+\$5,200**

**Option 02** — NTC 7 Test Set ..... **+\$5,200**

**Option 03** — Special Test Set # 1 (CBC) ..... **NC**

## INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal European 220 V/16A, 50 Hz ..... **NC**

**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**

**Option A3** — Australian 240 V/10A, 60 Hz ..... **NC**

**Option A4** — North American 240 V/15A, 50 Hz ..... **NC**

## OPTIONAL ACCESSORIES

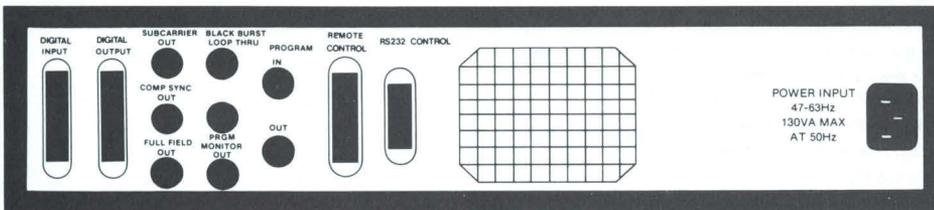
### 1900 and R1900

**Remote Control Unit**, Order 015-0374-00. .... **\$425**

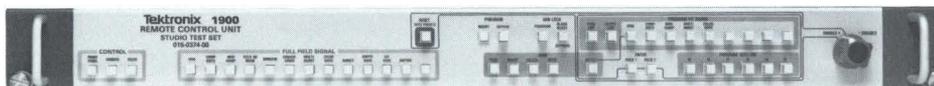
**1900 to Remote Control Unit 1.83 m (6 ft) Interconnecting Cable**, Order 012-0108-00. .... **\$150**

**1900 to Remote Control Unit 6.7 m (22 ft) Interconnecting Cable**, Order 012-0251-00. .... **\$285**

**Diagnostic PROM for Instrument Service**, Order 067-0964-00. .... **\$125**



Rear Panel



Remote Control Unit

The following are a selected group of professional video dealers that are authorized to sell Television products. For other Tektronix products, please contact your nearest Tektronix field office listed on page 9 of this catalog.

**Alaska**

NVS Systems, Inc.  
Anchorage, AK 99502

**Alabama**

Pro Video Systems, Inc.  
Birmingham, AL 35209

**California**

Broadcast Marketing Associates  
San Jose, CA 95131

California Video Sales, Inc.  
Sacramento, CA 95841

General Electronic Systems, Inc.  
Berkeley, CA 94702

Hoffman Video Systems  
Los Angeles, CA 90015

Merlin Engineering Works, Inc.  
Palo Alto, CA 94303

Omega Video, Inc.  
Lawnsdale, CA 90260

Pacific Video Products, Inc.  
Anaheim, CA 92806

R.E. Snader and Associates, Inc.  
Mill Valley, CA 94941

Tri-Tronics, Inc.  
Burbank, CA 91505

**Colorado**

Ceavco Audio-Visual Company, Inc.  
Denver, CO 80215

Video Teknix, Inc.  
Denver, CO 80219

**Florida**

Florida Video Systems, Inc.  
Miami, FL 33168

Hubbard Communications, Inc.  
St. Petersburg, FL 33702

**Georgia**

Gray Communications Consultants  
Albany, GA 31705

**Illinois**

Harris Corporation  
Quincy, IL 62305

Roscor Corporation  
Morton Grove, IL 60053

Swiderski Electronics, Inc.  
Elk Grove Village, IL 60007

**Massachusetts**

Cramer Video, Inc.  
Needham, MA 02194

Lake Systems Corporation  
Newton, MA 02160

**Maryland**

Professional Products, Inc.  
Bethesda, MD 20814

**Michigan**

General Television Network  
Oak Park, MI 48237

Thalner Electronic Labs, Inc.  
Ann Arbor, MI 48103

**Minnesota**

Emmons Associates, Inc.  
Burnsville, MN 55337

Todd Communications, Inc.  
Minneapolis, MN 55435

Video Midwest, Inc.  
Minneapolis, MN 55435

**Missouri**

Television Engineering Corporation  
Chesterfield, MO 63017

Video Masters, Inc.  
Kansas City, MO 64141

VMI Company  
St. Louis, MO 63141

**North Carolina**

Technical Video Systems, Inc.  
Winston-Salem, NC 27101

**New Jersey**

A.F. Associates, Inc.  
Northville, NJ 07647

Central Dynamics Corporation  
Mahwah, NJ 07430

Landy Associates, Inc.  
Cherry Hill, NJ 08034

Tele-Measurements, Inc.  
Clifton, NJ 07014

Turner Engineering, Inc.  
Mountain Lakes, NJ 07046

**New York**

Camera Mart, Inc.  
New York, NY 10019

Camera Service Center, Inc.  
New York, NY 10019

Laumic Company, Inc.  
New York, NY 10016

MPCS Video Industries, Inc.  
New York, NY 10019

Reves AV Systems, Inc.  
New York, NY 10017

Sonocraft Corporation  
New York, NY 10001

**Ohio**

Kavco, Inc.  
Dayton, OH 45414

Midwest Corporation  
Cincinnati, OH 45203

**Oklahoma**

Diversified Electronics Communications  
Tulsa, OK 74145

**Oregon**

Videosons, Inc.  
Portland, OR 97214

**Pennsylvania**

Alpha Video and Electronics Company  
Carnegie, PA 15106

Electromedia, Inc.  
Pittsburgh, PA 15213

Lerro Electrical Corporation  
Philadelphia, PA 19132

Peirce-Phelps, Inc.  
Philadelphia, PA 19131

**Texas**

Auto-Tronics  
Houston, TX 77057

Broadcast Systems, Inc.  
Austin, TX 78758

Magnetic Media Corporation  
Dallas, TX 75248

MZB and Associates  
Dallas, TX 75234

**Utah**

Skaggs Video Sales  
Salt Lake City, UT 84127

**Virginia**

AVEC Electronics Corporation  
Norfolk, VA 23510

**Washington**

Bennett Engineering Associates, Inc.  
Mercer Island, WA 98040

Custom Video Systems, Inc.  
Seattle, WA 98155

Northwest Electronics, Inc.  
Spokane, WA 99220

**Wisconsin**

Video Images  
Milwaukee, WI 53214

**Tektronix, Inc.**

**Television Products**  
Communications Division  
P.O. Box 500  
Delivery Station 58-699  
Beaverton, OR 97077

# SPECTRUM ANALYZERS & SWEPT FREQUENCY SYSTEMS

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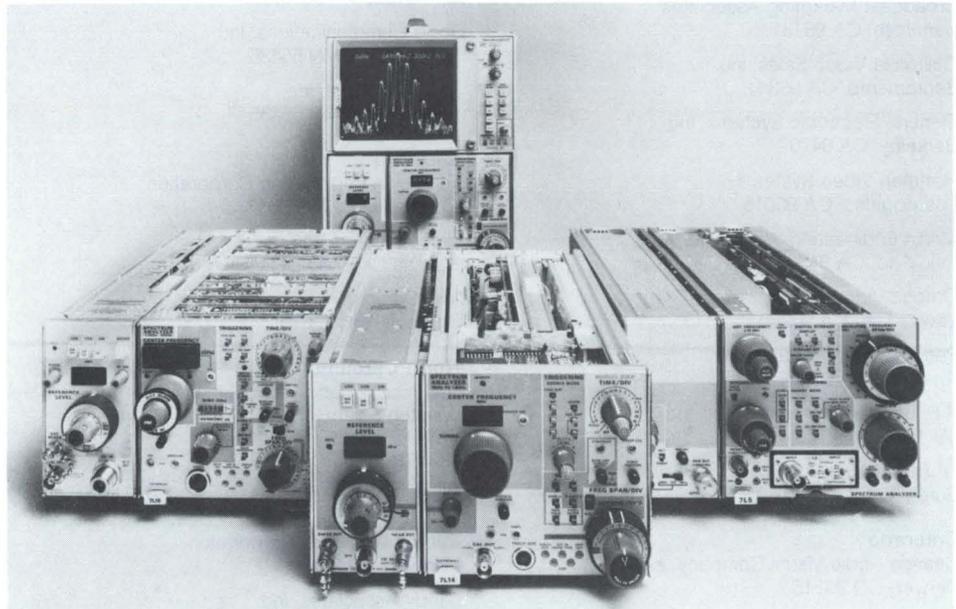
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## 7000 Series Plug-in Versatility

**No one plug-in spectrum analyzer meets every need. So there's a choice of five...to best meet yours.**

These easy-to-use plug-in models cover 20 Hz to 60 GHz, with individual ranges appropriate for applications from audio/baseband to microwave measurement. A variety of features let you select the capability you need. They share the versatility that is basic to the Tektronix plug-in concept — there are over 30 other test and measurement plug-ins.

**7000 Series characteristics make spectrum analysis easier.**

The 7L plug-in family displays CRT readout for referencing and easy documentation. And each analyzer is compatible with any Tektronix 7000 Series oscilloscope mainframe including the 7854 digitizing GPIB unit which offers programmable solutions to complex measurements.\*



**Three models provide digital storage.**

For high performance with convenience, there's our digital storage family of plug-ins, the 7L5, 7L14, and 7L18. They cover 20 Hz to 60 GHz, with performance in the microwave frequencies that is comparable to what you expect in the baseband region.

Digital storage provides clean, flicker-free displays, plus valuable functions such as digital averaging and peak detection, waveform comparison and subtraction and a MAX HOLD function to measure long term amplitude and frequency changes.

**Here's high performance with economy.**

The VHF/UHF 7L12 plug-in brings you capabilities similar to the 7L14, but without digital storage and with minimum resolution of 300 Hz instead of 30 Hz.

And to 5000 Series mainframe owners, Tektronix offers spectrum analysis capability with the 5L4N.\* It covers 20 Hz to 100 kHz. Ideal for accurate audio frequency, distortion, and noise measurements.

**Match your needs with unmatched value.**

All these instruments point up both the immediate and long-term value of the Tektronix plug-in concept. If you already own a 7000 Series mainframe, you select only the analyzer plug-ins that cover your requirements, without paying for more capability than you need. And with all Tektronix spectrum analyzers, come a large choice of accessories, worldwide service and technical support.

\* For detailed information on the comprehensive 7000 Series and 5000 Series of instruments, refer to pages 230 to 308 respectively.



## Performance for the Lab that goes into the Field

The Tektronix 492 and 496 are two spectrum analyzers that go where you go. Their compact size, light weight, and rugged design combine to offer unmatched portability in laboratory quality analyzers.

Single-handle carry and portable form factor make them ready to travel. The 492 and 496 move as easily in the field as in the design lab or systems test area. They even fit under an airplane seat.

You can count on the same exceptional performance no matter where you're working. If its antenna test measurements, point-to-point transmission maintenance, or any number of critical field applications, the 492 and 496 work with you.

For on-site applications reduced warmup time means reduced measurement time. Long-term frequency drift of 5 kHz/10 minutes after 30 minute warm up for the 492 and 492P; 2 kHz/10 minutes after 30 minute warm up for the 496 and 496P.

### Here's Proof of Their Performance

The Tektronix 492 has the widest amplitude calibrated frequency range of any spectrum analyzer on the market: 50 kHz to 220 GHz using external waveguide mixers above 21 GHz. The VHF/UHF 496 covers from 1 kHz to 1.8 GHz.

They offer 80 dB dynamic range on-screen and excellent sensitivity, with an average noise level of  $-123$  dBm at 100 Hz resolution bandwidth for the 492,  $-127$  dBm at 30 Hz resolution bandwidth for the 496. Low phase noise  $-70$  dBc at only 3 kHz offset—for accurate small-signal analysis. High stability for signal source spectral purity analysis, with residual FM of no more than 50 Hz peak-to-peak for the 492, 10 Hz peak-to-peak for the 496. For precise measurement of signal differences, there's amplitude comparison in super-fine 0.25 dB



steps. And the 496 provides 1 kHz frequency resolution in  $\Delta F$  mode. All this and more in one compact package that goes where you go.

### Programmability/IEEE (GPIB) Compatibility

The GPIB interface enables full control of all measurement settings. Additional control of horizontal (span) and vertical display (1 to 15 dB/div) and smart functions (such as signal search) provide added measurement versatility. A desktop computer or computer controller (4052A or 4041) and 492P or 496P Spectrum Analyzer provide repetitive measurements, data collection, and consistent, rapid results. Automated testing and monitoring may include data correction and analysis enabling complex measurements such as total harmonic distortion and power spectral density. The thermal printer of the 4041 or hard copiers for 4052A simplify documenting tests and spectral displays in hard copy form.

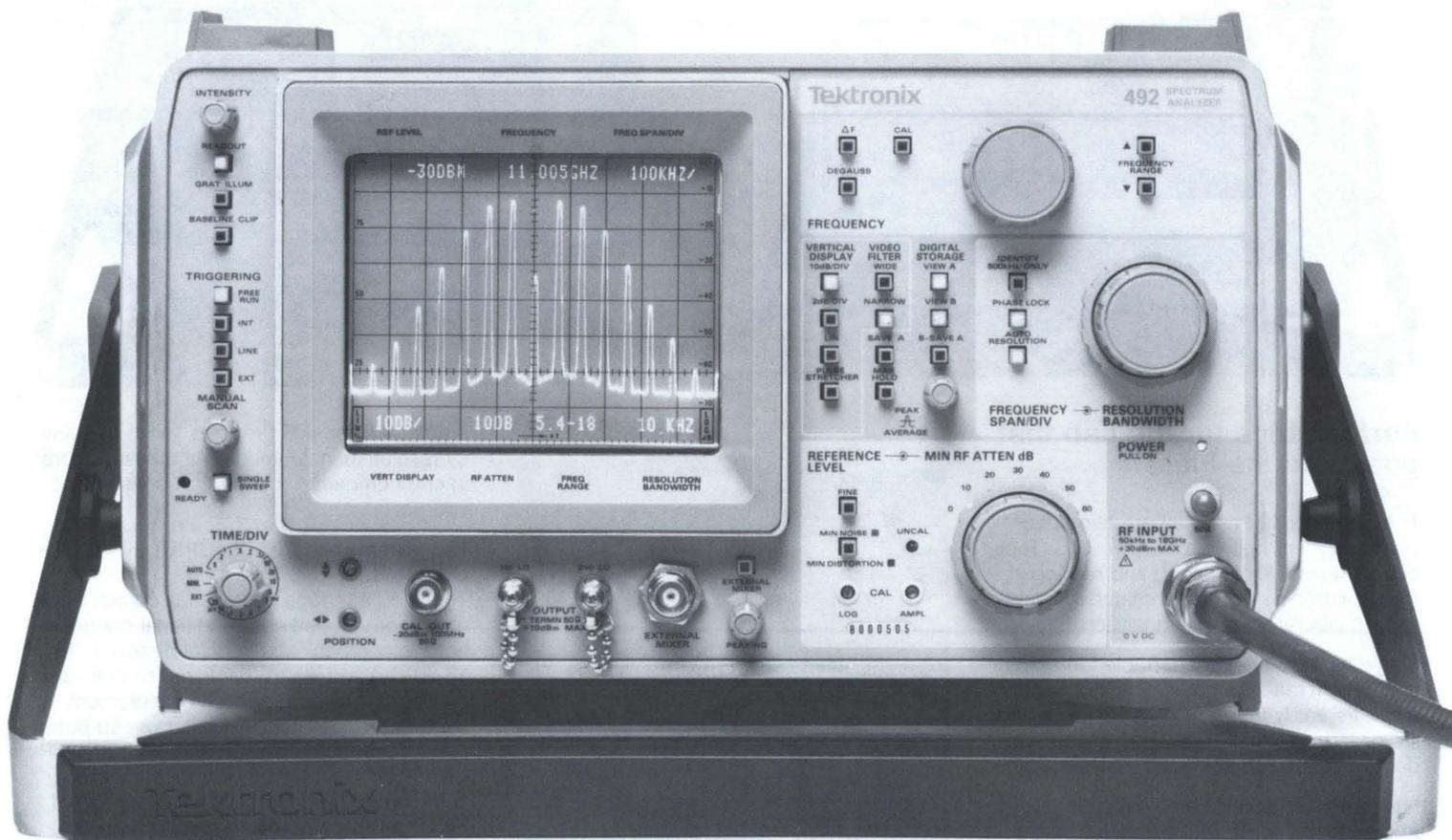
### Programmability Now - or Later

Most manual 490 Series spectrum analyzers can be converted into fully programmable, GPIB compatible analyzers. Conversion may be performed via the Tektronix Service Center near you.

### Easy to Use - Anywhere

Tektronix designed the 492 and 496 to handle your measurement task with microprocessor-aided ease. Setting frequency, span and reference level is a simple three-knob operation. Most-used functions are automatically controlled. Digital storage and signal processing eliminate time-consuming display adjustments. And constant tuning rate helps you position a signal quickly and accurately. All part of the convenience and capability the 492 and 496 deliver, on site or on the bench.

Tektronix offers service training classes on the 490 Portable Spectrum Analyzers. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



The 492P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**492** **492P** **GPIB**  
**IEEE-488**

**Microprocessor Aided Controls**

**Automatic Modes**

**Portable Form Factor  
(Compact Size/ Light Weight)**

**50 kHz to 220 GHz Frequency Range**

**Amplitude Comparison in 0.25 dB Steps**

**CRT Readout of all Important Parameters**

**Fully Calibrated in Amplitude and Frequency**

**80 dB Dynamic Range**

**Wide Range of Options**

**GPIB/Fully Programmable (492P)**

**Three-knob Operation**

**Environmentalized per MIL-T-28800B**

**Digital Storage and Signal Processing**

**Freedom from Spurious Responses  
Through Preselection**

**Lab Quality You Can Get a Handle On**

The 492 is a high performance, rugged, state-of-the-art instrument of compact size, with microprocessor logic control. Full programmability via GPIB (IEEE Standard 488-1978) compatibility is available in the 492P version.

Three-knob operation provides use as simple as 1, 2, 3 through microprocessor coupled functions such as resolution bandwidth, video bandwidth, sweep time, frequency span, RF attenuation, and reference level. Measurement accuracy is enhanced through the use of  $\Delta$  dB mode, which switches in 0.25 dB steps.

Digital storage and processing facilitate trace comparisons and add measurement capability through the MAX HOLD function for frequency drift and amplitude change measurements. Arithmetic operations can be performed between traces or between a trace and a reference. Digital noise averaging mode results in trace smoothing. With digital storage, the display is steady and without flicker, even at the lowest sweep speeds; plus, trace values may be retained as long as power is on.

**492P Makes Spectrum Analysis Automatic, and Easy.**

Two instruments in one, the 492P is a fully programmable version of the 492 Spectrum Analyzer. It incorporates all of the 492's lab quality performance and ease of use features when used as a manual instrument. Push the "Reset to

Local" button and the 492P becomes a 492—with operation from the front panel. But, most important, the 492P opens the way to automated spectrum analysis and documentation via its IEEE Standard-488 (GPIB) interface. This versatility makes the 492P useful in many applications in the lab, factory or field.

Programmability/GPIB features can be added to 492 Spectrum Analyzers, serial number B030000 and above. This means if you want to postpone a programmability/GPIB decision because of budget constraints, or for any other reason, you can convert your 490 Series Spectrum Analyzer later. Conversions are made at designated Tektronix Service Centers.

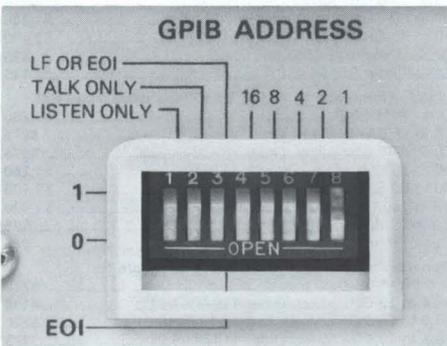




When used with the Tektronix 4052A Graphic Computing System controller and 4631 Hard Copy Unit, or with the 4662 Digital Plotter, the 492P can provide test results in both graphic and numeric form for the evaluation of microwave signal sources.

### Remotely Controllable via GPIB

Switches on the rear panel select the mode of operation as a GPIB instrument. In the normal TALKER/LISTENER mode, the 492P listens to and executes commands from a GPIB controller. All important front panel settings can be operated remotely. Some functions are controlled with more detail through the GPIB than possible from the front panel.



### Easy to Use

The 492P is designed for ease of operation via the GPIB, just as the 492 is designed for front panel operational ease. Most commands for program control are simple abbreviations of the front panel nomenclature.

The 492P's high level command language and the similarity of commands and responses simplify programming and make program listings easily readable for editing.

### Put it to Work

With the programmable 492P on your measurement team, repetitive measurements can be done the same way every time. Your throughput will increase—and your confidence in results. And, the internal processing and high level programming language makes software develop-

ment faster. You get high power results with easy programming. When you look at the total performance capability of the 492P, you'll recognize its value: ease of operation both as a programmable and manual instrument. Wide frequency range. The versatility to go where you go. Into the lab for automated testing; into the field for data collection.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 26 for additional information.

### CHARACTERISTICS

The following characteristics and features apply to the 492/492P Spectrum Analyzers after a 30 minute warmup period unless otherwise noted.

#### FREQUENCY RELATED

**Center Frequency Range** — 50 kHz to 21 GHz standard, amplitude specified coverage to 140 GHz with optional Tektronix waveguide mixers. (Frequency calibrated to 220 GHz).

**Frequency Accuracy** —  $\pm 5$  MHz  $+20\%$  of span/div or  $\pm 0.2\%$  of the center frequency  $+20\%$  of span/div whichever is greater, after 2 hour warmup.

**Readout Resolution** — Within 1 MHz.

**Frequency Span Per Division** — 10 kHz to 500 MHz plus zero and full band maximum span, down to 500 Hz with Option 03 in 1-2-5 sequence.

**Span Accuracy** —  $\pm 5\%$  of span/div, measured over center 8 divs.

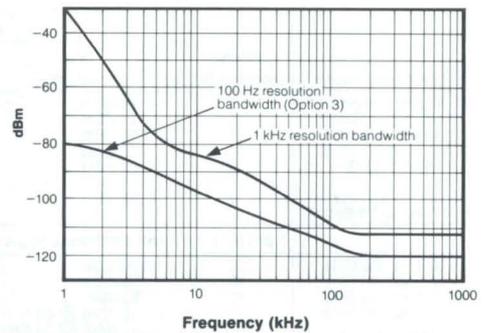
**Resolution Bandwidth ( $-6$  dB Points)** — 1 MHz to 1 kHz (100 Hz for Option 03) in decade steps, plus an AUTO position. Resolution is within 20% of selected bandwidth.

**Resolution Shape Factor (60/6 dB)** — 7.5:1 or less.

**Residual FM** — 1 kHz p-p for 2 ms time duration, improves to (50 Hz) for 20 ms with phaselock Option 03.

**Long Term Drift (At Constant Temperature and Fixed Center Frequency)** — 200 kHz/hour unphaselocked, 15 kHz/10 minutes (Option 03 after 30 minutes warmup, phaselocked for fundamental mixing), 3 kHz/10 minutes (Option 03 after 1 hour warmup, phaselocked for fundamental mixing).

**Noise Sidebands** — At least  $-75$  dBc at 30x resolution offset from the center frequency ( $-70$  dBc for 100 Hz resolution bandwidth or less, Option 03).



Typical low end frequency performance for the 492 with Option 01.

#### AMPLITUDE RELATED

**Reference Level Range** — Full screen, top of graticule  $-123$  dBm to  $+40$  dBm ( $+40$  dBm, includes maximum safe input of  $+30$  dBm and 10 dB gain of IF gain reduction) for 10 dB/div and 2 dB/div log modes. 1 W maximum safe input in the linear mode.

**Reference Level Steps** — 10 dB, 1 dB, and 0.25 dB for relative level ( $\Delta$ ) measurements in LOG mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.

**Reference Level Accuracy** — Accuracy is a function of changes in RF attenuation, resolution bandwidth, display mode and reference level. See amplitude accuracies of these functions. The RF attenuator steps 10 dB for reference level changes above  $-30$  dBm ( $-20$  dBm when Min Noise is active) unless Min RF attenuation is greater than normal. The IF gain increases 10 dB for each Reference Level change below  $-30$  dBm ( $-20$  dBm when Min Noise is active).

**Display Dynamic Range** — 80 dB at 10 dB/div, 16 dB at 2 dB/div and 8 divisions in linear mode.

**Display Amplitude Accuracy** —  $\pm 1$  dB/10 dB to maximum of  $\pm 2$  dB/80 dB;  $\pm 0.4$  dB/2 dB to maximum of  $\pm 1$  dB/16 dB,  $\pm 5\%$  of full screen in LIN mode.

**Resolution Bandwidth Gain Variation** —  $\pm 0.5$  dB.

#### SPURIOUS RESPONSES

**Residual (No Input Signal Referenced to Mixer Input)** —  $-100$  dBm or less.

**Harmonic Distortion (cw Signal, MIN Distortion Mode)** — At least  $-60$  dBc for full screen signal in the MIN Distortion mode to 21 GHz. At least  $-100$  dBc for preselected Option 01. 1.7 to 21 GHz.

**Third-Order Intermodulation Distortion (MIN Distortion Mode)** — At least  $-70$  dBc from two on-screen signals within any frequency span. At least  $-100$  dBc for two signals spaced more than 100 MHz apart from 1.8 to 18 GHz for preselected Option 01.

**LO Emissions (Referenced to Input Mixer)** —  $-10$  dBm maximum;  $-70$  dBm maximum to 18 GHz for Option 01.

#### INPUT SIGNAL CHARACTERISTICS

**RF Input** — Type N female connector.

**Input Impedance** — 50  $\Omega$ .

**Maximum VSWR\* with  $\geq 10$  dB Attenuation**

Frequency Range	Typical	Specified Maximum
Dc to 2.5 GHz	1.2:1	1.3:1
2.5 GHz to 6.0 GHz	1.5:1	1.7:1
6.0 GHz to 18 GHz	1.9:1	2.3:1
18 GHz to 21 GHz	2.7:1	3.5:1

\* At Type N female connector to internal mixer, with 10 dB attenuation

**Input Level (Optimum Level for Linear Operation)** —  $-30$  dBm referenced to input mixer. Full screen not exceeded and MIN Distortion control settings.

**1 dB Compression Point** —  $-28$  dBm from 1.7 to 2 GHz for Option 01; otherwise  $-18$  dBm.

**Maximum Safe Input Level (RF Attenuation at Zero dB)** —  $+13$  dBm without Option 01.  $+30$  dBm (1 W) with Option 01.

**Maximum Input Level (With 20 dB or more RF Attenuation)** —  $+30$  dBm (1 W) continuous, 75 W peak for  $1 \mu$ s or less pulse width and 0.001 maximum duty factor (attenuation limit). Dc must never be applied to RF input.

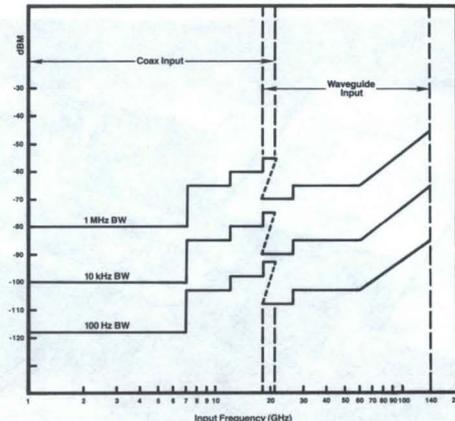
**SENSITIVITY AND FREQUENCY RESPONSE**

Frequency Range	Mixing Number (n)	Average Noise Level for 1 kHz Resolution		Frequency Response With 10 dB Attenuation	
		No Preselection	Preselected Option 01	No Preselection	Preselected Option 01
50 kHz to 1.8 GHz*1	1	-115 dBm	-110 dBm		± 2.5 dB
50 kHz to 4.2 GHz*1	1	-115 dBm	-110 dBm	± 2.5 dB	
1.7 GHz to 5.5 GHz	1	-115 dBm	-110 dBm	± 1.5 dB	± 2.5 dB
3.0 GHz to 7.1 GHz	1	-115 dBm	-110 dBm	± 1.5 dB	± 2.5 dB
5.4 GHz to 18 GHz	3	-100 dBm	-95 dBm (12 GHz) -90 dBm (18 GHz)	± 2.5 dB	± 3.5 dB
15 GHz to 21 GHz	3	-95 dBm	-85 dBm	± 3.5 dB	± 5.0 dB
100 MHz to 18 GHz*3				± 3.5 dB	± 4.5 dB
WITH TEKTRONIX OPTIONAL HIGH PERFORMANCE WAVEGUIDE MIXERS					
18 GHz to 26 GHz	6	-100 dBm		± 3.0 dB	
26 GHz to 40 GHz	10	-95 dBm		± 3.0 dB	
40 GHz to 60 GHz	10	-95 dBm		± 3.0 dB	
60 GHz to 90 GHz	15	-95 dBm @ 60 GHz -85 dBm @ 90 GHz		± 3.0 dB*2	
90 GHz to 140 GHz	23	-85 dBm @ 90 GHz -75 dBm @ 140 GHz		± 3.0 dB*2	

\*1 Low frequency end performance does not include effects due to zero Hz feedthrough. Frequency response ± 1.5 dB, 100 kHz to 1.8 GHz.

\*2 Over any 5 GHz bandwidth.

\*3 Includes frequency band switching error of 1 dB maximum.



**OUTPUT SIGNAL CHARACTERISTICS**

**Calibrator (Cal Out)** — -20 dBm ± 0.3 dB, 100 MHz ± 1.7 kHz.

**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm; 2nd LO -22 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times.

**Vertical Out** — Provides 0.5 V ± 5% of signal per division of video above and below the center line.

**Horizontal Out** — Provides 0.5 V either side of center. Full range -2.5 V to +2.5 V ± 10%.

**Pen Lift** — TTL, +5 V nominal to lift pen.

**IF Out** — Output of the 10 MHz IF. Level is approximately -16 dBm for a full screen signal at -30 dBm input reference level. Nominal impedance 50 Ω.

**492P Only: IEEE Standard 488-1978 Port ( GPIB )** — In accordance with IEEE Standard 488.

**GENERAL CHARACTERISTICS**

**Sweep Time** — 20 μs to 5 s/div (10 s/div in auto) in 1-2-5 sequence.

**CRT Readout** — Displays reference level, center frequency, frequency range, vertical display mode, frequency span/div resolution bandwidth and RF attenuation.

**CRT** — 8x10 cm, P31 Phosphor.

**Input Voltage** — 90 to 132 V ac or 180 to 250 V ac, 48 to 440 Hz.

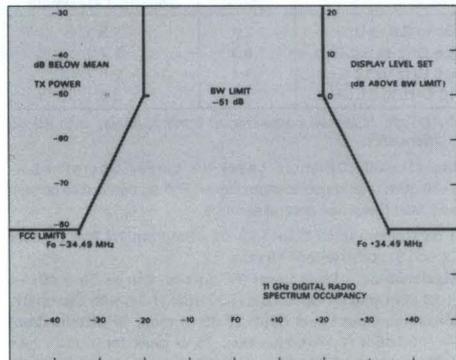
**Power** — 210 W maximum with all options, at 115 V and 60 Hz.

**Environmental Characteristics** — Per MIL-T-28800B Type III, Class 3, Style C.

**Configuration** — Portable, 20 kg (44 lb) (all options), 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

**INCLUDED ACCESSORIES**

50 Ω coaxial cable, N to N connectors, 6 ft (012-0114-00); 50 Ω coaxial cable, BNC to BNC connectors, 18 in (012-0076-00); adaptor, N male to BNC female (103-0045-00); CRT mesh filter (378-0726-01); fuse 2 A, fast blow (159-0021-00); fuse 4 A fast blow (2) (159-0017-00); power cord, 115-V (161-0118-00); cord clamp (343-0170-00); CRT visor (016-0653-00); diplexer assembly (015-0385-00); CRT light filter, amber (378-0115-01); CRT light filter, blue (378-0115-00); CRT light filter, gray (378-0115-02). 492P also includes GPIB cable, 2 m, double shielded (012-0630-03).



CRT mask for digital radio application. Ask about the modified 492 optimized for digital radio measurements.

**ORDERING INFORMATION**

492 Spectrum Analyzer .....	\$21,300
492P Fully Programmable/GPIB Spectrum Analyzer .....	\$27,500
492 to 492P Conversion — Conversion made by your Tektronix Service Center. For 492's with Options 01, 02, 03, 08. Order 040-1038-02 .....	\$6,800
For 492's with Options 01, 02, 03. Order 040-1037-02 ..	\$6,800
Option 01 — Internal Preselection .....	+\$3,900
Provides calibrated preselected filtering of input to first mixer for each frequency band.	
Option 02 — Digital Storage .....	+\$1,900
Provides multiple memory display storage with SAVE A, MAXIMUM HOLD, B MINUS SAVE A, display averaging, and storage bypass.	
Option 03 — Frequency Stabilization/100 Hz Resolution .....	+\$3,500
Provides first local oscillator stabilization by phase locking the oscillator to an internal reference. Also provides 100 Hz resolution.	
Option 08 — Delete External Mixer Capability .....	-\$1,750
Deletes internal switching front panel connector and external diplexer to connect and use external waveguide mixers.	
Option 20 — General Purpose 12.4 to 40 GHz Waveguide Mixer Set .....	+\$740
Includes three mixers (12.4 to 18 GHz, 18 to 26.5 GHz, and 26.5 to 40 GHz) and attaching hardware to extend the upper frequency.	
Option 21 — High Performance 18 to 40 GHz Waveguide Mixer Set .....	+\$1,970
Includes two mixers (18 to 26.5 GHz and 26.5 to 40 GHz) and attaching hardware to extend the upper frequency.	
Option 22 — High Performance 18 to 60 GHz Waveguide Mixer Set .....	+\$3,220
Includes three mixers (18 to 26.5 GHz, 26.5 to 40 GHz, and 40 to 60 GHz) and attaching hardware to extend the upper frequency.	
Option 30 — Rackmount. 19 inch rack width with front panel input/outputs .....	+\$790
Option 31 — Rackmount. 19 inch rack width with rear panel input/output capability .....	+\$840
Option 32 — Benchmount. Adds side and top panels, carrying handles and feet for a stackable bench top configuration .....	+\$940
INTERNATIONAL POWER CORD AND PLUG OPTIONS	
Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC
Option A5 — Switzerland 220 V/10A, 50 Hz .....	NC

**PERIPHERAL PRODUCTS FOR 492P SPECTRUM ANALYZER**

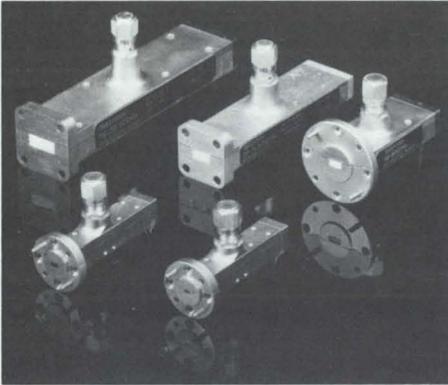
4041 System Controller .....	\$4,995
4052A Graphic Computing System Controller .....	\$9,900
4611 Hard Copy Unit .....	\$4,550
4631 Hard Copy Unit .....	\$5,950
4662 Interactive Digital Plotter .....	\$4,800
4924 Digital Cartridge Tape Drive .....	\$2,990
4932 GPIB Extender .....	\$1,195

**OPTIONAL ACCESSORIES**

The following listed accessories may be ordered in any combination.

High Performance Waveguide Mixers	
18 to 26.5 GHz Mixer. Order WM490K .....	\$975
26.5 to 40 GHz Mixer. Order WM490A .....	\$975
40 to 60 GHz Mixer. Order WM490U .....	\$1,250
60 to 90 GHz Mixer. Order WM490E .....	\$2,400
90 to 140 GHz Mixer. Order WM490F .....	\$2,600
High Performance 18 to 40 GHz Waveguide Mixer Set	
Order WM490-2 .....	\$2,010
18 to 26.5 GHz Mixer. Order WM490K .....	\$975
26.5 to 40 GHz Mixer. Order WM490A .....	\$975
Cable. Order 012-0649-00 .....	\$25
Case. Order 016-0465-01 .....	\$45
High Performance 18 to 60 GHz Waveguide Mixer Set	
Order WM490-3 .....	\$3,260
18 to 26.5 GHz Mixer. Order WM490K .....	\$975
26.5 to 40 GHz Mixer. Order WM490A .....	\$975
40 to 60 GHz Mixer. Order WM490U .....	\$1,250
Cable. Order 012-0649-00 .....	\$25
Case. Order 016-0465-01 .....	\$45
High Performance 18 to 90 GHz Waveguide Mixer Set	
Order WM490-4 .....	\$5,660
18 to 26.5 GHz Mixer. Order WM490K .....	\$975
26.5 to 40 GHz Mixer. Order WM490A .....	\$975
40 to 60 GHz Mixer. Order WM490U .....	\$1,250
60 to 90 GHz Mixer. Order WM490E .....	\$2,400
Cable. Order 012-0649-00 .....	\$25
Case. Order 016-0465-01 .....	\$45
High Performance 18 to 140 GHz Waveguide Mixer Set	
Order WM490-5 .....	\$8,260
18 to 26.5 GHz Mixer. Order WM490K .....	\$975
26.5 to 40 GHz Mixer. Order WM490A .....	\$975
40 to 60 GHz Mixer. Order WM490U .....	\$1,250
60 to 90 GHz Mixer. Order WM490E .....	\$2,400
90 to 140 GHz Mixer. Order WM490F .....	\$2,600
Cable. Order 012-0649-00 .....	\$25
Case. Order 016-0465-01 .....	\$45
General Purpose 12.4 to 40 GHz Waveguide Set	
Order 016-0640-00 .....	\$710
12.4 to 18 GHz Mixer. Order 119-0097-01 .....	\$180
18.0 to 26.5 GHz Mixer. Order 119-0098-01 .....	\$220
26.5 to 40 GHz Mixer. Order 119-0099-01 .....	\$275
Cable. Order 012-0748-00 .....	\$20
Case. Order 016-0465-02 .....	\$45
Microwave Comb Generator	
Order 067-0885-00 .....	\$1,800
75 Ω to 50 Ω Minimum Loss Attenuator	
Order 011-0112-00 .....	\$60
Dc Block BNC to BNC Order 015-0221-00 .....	\$85
FET Probe P6201 to 900 MHz Order 010-6201-01 .....	\$1,090
1405 TV Sideband Adaptor (525/60 Markers) .....	\$5,460
TR 503 Tracking Generator .....	\$6,400
For more information on the TR 503 see page 212.	
C-5C Camera .....	\$525
TV Trigger Synchronizer Order 015-0261-01 .....	\$330
Hard Case (Transit) Order 016-0658-00 .....	\$625
Soft Case Order 016-0659-00 .....	\$125
Lab Cart Model 3 .....	\$525

Note: 490 Series Spectrum Analyzers are compatible with all Tektronix C-50 Series cameras. Battery Pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 Cameras.



**490 Series Waveguide Mixers**

The 490 Series Tektronix Waveguide Mixers cover from 18 to 140 GHz with at least -75 dBm sensitivity. They are designed specifically for use with the TEKTRONIX 492/492P and 7L18 Spectrum Analyzers.

The two microwave mixers cover ranges 18 to 26.5 GHz and 26.5 to 40 GHz. They have field replaceable diodes and frequency response of ±3 dB when used with the spectrum analyzers indicated above.

The three millimeter wave mixers cover ranges 40 to 60 GHz (also specified at ±3 dB frequency response), 60 to 90 GHz and 90 to 140 GHz.

The units are all gold plated brass, conforming to MIL-G-45204 Class 1, Type 1 specifications and will withstand harsh environments. Each set comes complete with a container for spare diodes, a 28 inch cable, a 32 page instruction manual and a wood storage box with foam cutout storage locations for all five mixers.

**CHARACTERISTICS**

- For All Waveguide Mixers** — Maximum cw RF input level: +10 dBm (10 mW).
- Maximum PULSED RF Input Level** — 1 W peak with 0.001 maximum duty factor and 1 μs maximum pulse width.
- L.O. Requirement** — +7 dBm minimum, +15 dBm maximum, +10 dBm typical.
- Bias Requirement** — -2.0 to +0.5 V with respect to the mixer body through a current limiting resistor, to provide 0 to 20 mA of bias current.
- For the 18 to 60 GHz Waveguide Mixers** — 3 dB compression point (saturation): -10 dBm (typical).
- Conversion Loss** — 30 dB typical (when used in the proper spectrum analyzer frequency band).

**ORDERING INFORMATION**

When ordering, please use the nomenclature given below:

18 to 26.5 GHz: WM 490 K .....	\$975
26.5 to 40 GHz: WM 490 A .....	\$975
40 to 60 GHz: WM 490 U .....	\$1,250
60 to 90 GHz: WM 490 E .....	\$2,400
90 to 140 GHz: WM 490 F .....	\$2,600
18 to 40 GHz set (items 1,2): WM 490-2 .....	\$2,010
18 to 60 GHz set (items 1,3): WM 490-3 .....	\$3,260
18 to 90 GHz set (items 1,4): WM 490-4 .....	\$5,660
18 to 140 GHz set (items 1,5): WM 490-5 .....	\$8,260

**ELECTRICAL CHARACTERISTICS**

Frequency Range	Sensitivity* <sup>1</sup> (dBm)	Frequency Response* <sup>2</sup>	Amplitude Accuracy* <sup>3</sup>
18 to 26.5 GHz	-100	±3 dB	±6 dB
26.5 to 40 GHz	-95	±3 dB	±6 dB
40 to 60 GHz	-95	±3 dB	±6 dB

\*<sup>1</sup> Equivalent average noise level at 1 kHz bandwidth.  
 \*<sup>2</sup> Maximum amplitude variation across each waveguide mixer band (with peaking control optimized) in response to a -30 dBm CW input signal to the waveguide mixer.  
 \*<sup>3</sup> Maximum reference level error with respect to the internal calibrator. Amplitude accuracy can be improved 3 dB by measuring amplitude response in each band with respect to a known external waveguide signal source level.

Frequency Range	Typical Sensitivity* <sup>4</sup> (dBm)	Typical* <sup>5</sup> Frequency Response	3 dB Compression Point (Saturation)
60 to 90 GHz	-95 at 60 GHz -85 at 90 GHz	±3 dB	-15 dBm at 60 GHz -5 dBm at 90 GHz
90 to 140 GHz	-85 at 90 GHz -75 at 140 GHz	±3 dB	-5 dBm at 90 GHz 0 dBm at 140 GHz

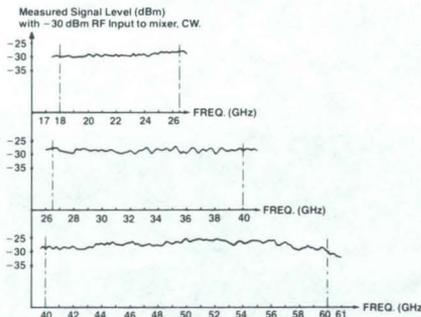
\*<sup>4</sup> Equivalent average noise level at 1 kHz bandwidth.  
 \*<sup>5</sup> Over any 5 GHz bandwidth.

**PHYSICAL CHARACTERISTICS**

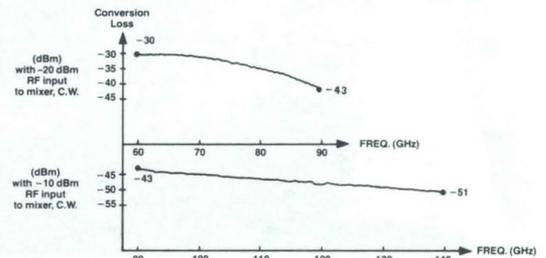
Frequency Range	Length	Width	Height	Weight	Flange
18 to 26.5 GHz	8.97 cm (3.53 in)	2.22 cm (.875 in)	3.68 cm (1.45 in)	180 g (6.5 oz)	UG-595/U
26.5 to 40 GHz	6.93 cm (2.73 in)	1.90 cm (.750 in)	3.35 cm (1.32 in)	100 g (3.7 oz)	UG-599/U
40 to 60 GHz	4.52 cm (1.78 in)	1.84 cm* <sup>6</sup> (.725 in)* <sup>6</sup>	2.45 cm* <sup>6</sup> (.980 in)* <sup>6</sup>	80 g (2.9 oz)	UG-383/U-M
60 to 90 GHz	4.31 cm (1.70 in)	0.89 cm* <sup>6</sup> (.350 in)* <sup>6</sup>	2.29 cm* <sup>6</sup> (.900 in)* <sup>6</sup>	40 g (1.5 oz)	UG-387/U
90 to 140 GHz	4.31 cm (1.70 in)	0.89 cm* <sup>6</sup> (.350 in)* <sup>6</sup>	2.29 cm* <sup>6</sup> (.900 in)* <sup>6</sup>	40 g (1.5 oz)	UG-387/U-M

\*<sup>6</sup> Excludes contribution to dimension due to the diameter of the round waveguide flange. Overall length contribution of flange is included.

**Typical Frequency Response for 18-60 GHz Waveguide Mixers.**



**Typical Frequency Response for 60-140 GHz Waveguide Mixers.**



**490 Series Spectrum Analyzers Rackmount/Benchmount Options**

The following options denote mechanical configurations of the 492/492P/496/496P. Option 30 is a rackmount configuration for the 490 Series with standard front panel input/outputs. Option 31 is a rackmount configuration with rear panel input/output capability. Option 32 adds side covers and trim to an Option 31 making it into a stackable bench top configuration.

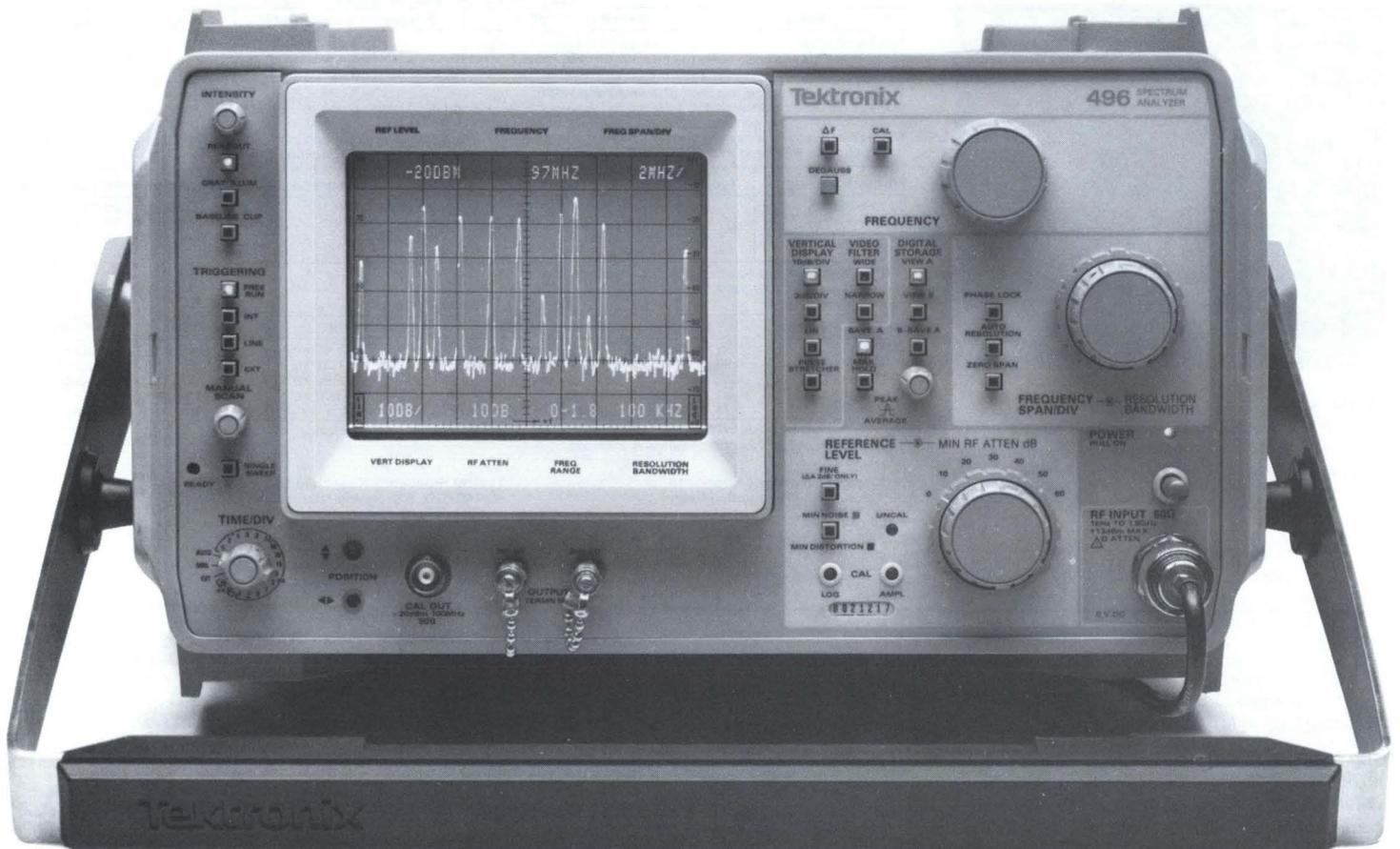
The Option 30 and 31 Rackmount is a standard 19 inch rack width and comes with standard rackmount fittings. A spectrum analyzer accesso-

ries storage drawer is also included. Dimensions are 22.23 x 42.9 x 63.5 cm (8.75 x 16.89 x 25.00 in). Weight is 24.5 kg (54 lb); including the spectrum analyzer.

The Option 32 Benchmount is approximately the same size as the Rackmount but is dressed with side and top panels and carrying handles and feet. The Benchmount provides a convenient surface for stacking other instruments. Dimensions are 23.5 x 45.7 x 63.5 cm (9.25 x 17.9 x 25.00 in). Weight is 25.9 kg (57 lb); including the spectrum analyzer.

See Ordering Information on previous and following pages.

SPECTRUM ANALYZERS



The 496P complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**496 496P GPIB**  
IEEE-488

**Microprocessor Aided Controls**

**Automatic Modes**

**Portable Form Factor  
(Compact Size/Light Weight)**

**1 kHz to 1800 MHz Coverage**

**Amplitude Comparison in 0.25 dB Steps**

**1 kHz Frequency Resolution in ΔF Mode**

**CRT Readout of all Important Parameters**

**Fully Calibrated in Amplitude and Frequency**

**80 dB Dynamic Range**

**GPIB/Fully Programmable (496P)**

**Three-knob Operation**

**Environmentalized per MIL-T 28800B**

**Digital Storage and Signal Processing**

The 496 provides high performance spectrum analysis and measurements in the 1 kHz to 1.8 GHz range. Its high stability and 80 dB dynamic range meet your demands for proof-of-performance measurements, on site or on the bench.

The 496 offers state of the art performance and rugged portability. Resolution bandwidth can be varied from 1 MHz to 30 Hz over the entire frequency range. Automatic phase lock stabilization reduces incidental FM to 10 Hz p-p; phase noise sidebands are at least -75 dBc at 30 times the resolution offset. Frequency drift with phase lock is typically 1 kHz in 10 minutes after 30 minute warmup. And the 496 provides 1 kHz frequency resolution in ΔF mode.

**Easy to use.  
Anywhere.**

Simple 1,2,3 knob adjustment sets center frequency, frequency span and reference level. Power on sequence automatically normalizes operational settings and provides maximum input protection.

Digital storage eliminates time-consuming display adjustments. SAVE A, B MINUS SAVE A, MAX HOLD and AVERAGE modes let you compare, subtract, save maximum values or noise average (smooth) your spectral displays. Constant tuning rate lets you position the signal quickly and accurately at any frequency span.

Microprocessor-aided controls take care of the rest. Most-used functions are automatically controlled.

**The 496 Goes Where You Go**

Light weight and compact size combine to provide unmatched portability in a laboratory quality spectrum analyzer. With its single-handle carry, the 496 is easily moved around the design lab or systems test area, to the field, or wherever it may be needed.

It even fits under an airplane seat.

**Automate your Spectrum Analysis with the 496P**

The 496P is the fully programmable/GPIB compatible version of the 496 Spectrum Analyzer. Operation, features and benefits of the 496P are essentially the same as the 492P. See discussion on pages 201 and 202. 496 Spectrum Analyzer specifications also apply to the 496P.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 26 for additional information.

Manual instruments can be converted to programmable instruments at a later time. Contact your Tektronix Sales Engineer for details.

## CHARACTERISTICS

The following characteristics and features apply to the 496/496P Spectrum Analyzers after a 30-minute warm up period unless otherwise noted.

### FREQUENCY RELATED

**Center Frequency Range** — 1 kHz to 1800 MHz.

**Frequency Accuracy** —  $\pm 5$  MHz +20% of span/div\*\*.

**\*Frequency Readout Resolution** — Within 1 MHz. 496P TUNE Command Accuracy (Span/div  $\leq 50$  kHz) —  $\pm 7\%$  or  $\pm 100$  Hz, whichever is greater.

**\*Delta Frequency Readout Accuracy (Span/Div  $\leq 50$  kHz)** —  $\pm 5\%$  of the Delta Frequency Readout.

**Residual FM (short term), Phase Lock ON** —  $\leq 10$  Hz p-p over 20 ms.

**Residual FM (short term), Phase Lock OFF** —  $\leq 1$  kHz p-p over 20 ms.

**Long Term Drift (at constant temperature and fixed center frequency)** — Phase Lock ON  $\leq 3.3$  kHz/10 minutes. Phase Lock OFF  $\leq 33$  kHz/10 minutes.\*\*

**Resolution Bandwidth (-6 dB)** — 30 Hz, then 100 Hz to 1 MHz in decade steps, plus an AUTO position. Resolution bandwidth is within 20% of selected bandwidth.

**Resolution Shape Factor (60 dB/6 dB)** — 7.5:1 or less. 15:1 or less for 30 Hz Resolution Bandwidth.

**Noise Sidebands** — At least 75 dBc at 30 times the Resolution Bandwidth offset from the Center Frequency (70 dBc for 100 Hz Resolution Bandwidth or less).

**Frequency Span/Div Range** — From 50 Hz/div to 100 MHz/div in a 1-2-5 sequence.

**Maximum Span** — When selected, the entire effective frequency range is scanned and displayed.

**Zero Span** — When selected, the horizontal axis of the CRT is calibrated in time (instead of frequency). The span/div readout is changed to time/div.

**Frequency Span/Div Accuracy** — Within 5% of the selected span/div over the center eight divisions of the ten-division CRT display.

*\* $\Delta F$  mode provides measurements to the nearest kHz plus direct center frequency readout to the nearest kHz between 1 kHz and 500 kHz.*  
*\*\*After 2 hour warmup.*

### AMPLITUDE RELATED

**Reference Level Range (full screen, top of graticule)** — -123 dBm to +40 dBm (+40 dBm includes maximum safe input of +30 dBm and 10 dB of IF gain reduction) for 10 dB/div and 2 dB/div LOG modes. 20 nV/div to 2 V/div (1 W maximum safe input) in LIN mode.

**Reference Level Steps** — 10 dB, 1 dB, and 0.25 dB for differential ( $\Delta$ ) measurements in LOG mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.

**Reference Level Accuracy** — Accuracy is a function of changes in RF attenuation, Resolution Bandwidth, Display Mode and Reference Level. See amplitude accuracies of these functions. The RF attenuator steps 10 dB for reference level changes above -30 dBm (-20 dBm when Minimum Noise is active) unless Minimum RF attenuation is greater than normal. The IF gain increases 10 dB for each 10 dB Reference Level change below -30 dBm (-20 dBm when Minimum Noise is active).

**Display Dynamic Range** — 80 dB at 10 dB/div, 16 dB at 2 dB/div, and 8 divisions in LIN mode.

**Display Amplitude Accuracy** —  $\pm 1.0$  dB/10 dB to a maximum cumulative error of  $\pm 2.0$  dB over the 80 dB window and  $\pm 0.4$  dB/2 dB to a maximum cumulative error of  $\pm 1.0$  dB over the 16 dB window. LIN mode is 5% of full scale.

**Differential Amplitude** — Delta A mode provides differential measurement in 0.25 dB increments.

**Display Flatness** —  $\pm 1.5$  dB, 1 kHz to 1800 MHz measured with  $\geq 10$  dB RF attenuation.

### Sensitivity

Resolution Bandwidth	Average Noise Level
30 Hz	-126 dBm
100 Hz	-123 dBm
1 kHz	-115 dBm
10 kHz	-105 dBm
100 kHz	-95 dBm
1 MHz	-85 dBm

### SPURIOUS RESPONSE

**Residual (no input signal)** — -100 dBm or less referenced to mixer input.

**Third-Order Intermodulation Distortion (Minimum Distortion mode)** — At least -70 dBc below any two on-screen signals within any frequency span.

**Harmonic Distortion (cw signal, Minimum Distortion mode)** — At least -60 dBc for a full-screen signal.

**Zero Frequency Spur (referenced to input mixer)** — 20 dBm or less.

**LO Emissions (referenced to input mixer)** — -70 dBm maximum.

### INPUT SIGNAL CHARACTERISTICS

**RF Input** — Type N female connector.

**Input Impedance** — 50  $\Omega$ ; vswr 1.3 maximum (1.2 typical) with 10 dB or more RF attenuation.

**Input Level (optimum level for linear operation)** — -30 dBm referred to input mixer. Full screen not exceeded and MIN DISTORTION control setting.

**1 dB Compression Point** — -18 dBm, no RF attenuation.

**Maximum Input Level (RF attenuation at 0 dB)** — +30 dBm.

**Maximum Input Level (with 20 dB or more RF attenuation)** — +30 dBm (1 W) continuous 75 W peak, pulse width 1  $\mu$ s or less with a maximum duty factor of 0.001 (attenuation limit). Dc must never be applied to RF input.

### OUTPUT SIGNAL CHARACTERISTICS

**Calibrator (Cal Out)** — -20 dBm  $\pm 0.3$  dB at 100 MHz  $\pm 1.7$  kHz.

**1st and 2nd LO** — Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm, 2nd LO -16 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50  $\Omega$  at all times.

**Vertical Out** — Provides 0.5 V  $\pm 5\%$  of signal per division of video above and below the centerline.

**Horizontal Out** — Provides 0.5 V either side of center. Full range -2.5 V to +2.5 V  $\pm 10\%$ .

**Pen Lift** — TTL compatible, nominal +5 V to lift pen.

**IF Out** — Output of the 10 MHz IF. Level is  $\approx -16$  dBm for a full screen signal at -30 dBm input reference level. Nominal impedance 50  $\Omega$ .

**496P Only: IEEE Standard 488-1978 Port (GPIB)** — In accordance with IEEE Standard 488.

**Probe Power** — Provides operating voltages (+5 V, +15 V, -15 V, and ground) for active probes.

### GENERAL CHARACTERISTICS

**Sweep Time** — 20  $\mu$ s/div to 5 s/div in 1-2-5 sequence (10 s/div in Auto).

**CRT Readout** — Displays: Reference Level, Frequency, Frequency Span/Div, Vertical Display, RF attenuation, and Resolution Bandwidth.

**CRT** — 8 x 10 cm. P31 Phosphor.

**Configuration** — Portable, 20 kg (44 lb), 17.5 x 32.7 x 49.9 cm (6.9 x 12.9 x 19.7 in) without handle or cover.

**Input Voltage** — 90 to 132 V ac or 180 to 250 V ac, 48 to 440 Hz.

**Power** — 210 W maximum, 3.2 A, at 115 V and 60 Hz.

**Environmental Characteristics** — Per MIL-T-28800B, Type III, Class 3, Style C.

### INCLUDED ACCESSORIES

Power cord, 115-V (161-0118-00); 50  $\Omega$  coaxial cable, N to N connectors, 6 ft (012-0114-00); 50  $\Omega$  coaxial cable, BNC to BNC connectors, 18 in (012-0076-00); adaptor, N male to BNC female (103-0045-00); cord clamp (343-0170-00); fuse 4 A fast blow (2) (159-0017-00); fuse 2 A, fast blow (159-0021-00); CRT visor (016-0653-00); CRT mesh filter (378-0726-01); CRT light filter, blue (378-0115-00); CRT light filter, amber (378-0115-01); CRT light filter, gray (378-0115-02);. 496P also includes GPIB cable, 2 meter, double shield (012-0630-03).

### ORDERING INFORMATION

**496 Spectrum Analyzer** ..... \$22,950

**496P Fully Programmable/GPIB Spectrum Analyzer** ..... \$26,950

**496 to 496P Conversion (040-1046-02)** — Conversions made by your Tektronix Service Center. Contact your Spectrum Analyzer Sales Engineer or Service Center for details.

**Option 30** — Rackmount 19 inch rack width with front panel input/outputs ..... +\$790

**Option 31** — Rackmount 19 inch rack width with rear panel input/output capability ..... +\$840

**Option 32** — Benchmark adds side and top panels, carrying handles and feet for a stackable benchtop configuration ..... +\$940

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC

**Option A2** — UK 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A4** — North American 240 V/15A, 60 Hz ..... NC

**Option A5** — Switzerland 250 V/10A, 50 Hz ..... NC

### PERIPHERAL PRODUCTS FOR 496P SPECTRUM ANALYZER

**4041 System Controller** ..... \$4,995

**4052A Graphic Computing System Controller** ..... \$9,900

**4611 Hard Copy Unit** ..... \$4,550

**4631 Hard Copy Unit** ..... \$5,950

**4662 Interactive Digital Plotter** ..... \$4,800

**4924 Digital Cartridge Tape Drive** ..... \$2,990

**4932 GPIB Extender** ..... \$1,195

### OPTIONAL ACCESSORIES

**75  $\Omega$  to 50  $\Omega$  Minimum Loss Attenuator** Order 011-0112-00 ..... \$60

**Dc Block BNC to BNC** Order 015-0221-00 ..... \$85

**P6201 FET Probe to 900 MHz** Order 010-6201-01 .... \$1,090

**1405 TV Sideband Adapter (525/60 Markers)** ..... \$5,460  
 For more information on the 1405 see page 213.

**TR 503 Tracking Generator** ..... \$6,400

For more information on the TR 503 see page 212.

**C-5C Camera** ..... \$525

**TV Trigger Synchronizer** Order 015-0261-01 ..... \$330

**Hard Case (transit)** Order 016-0658-00 ..... \$625

**Soft Case** Order 016-0659-00 ..... \$125

**Lab Cart Model 3** ..... \$525

*Note: The 490 Series spectrum analyzers are compatible with all Tektronix C-50 Series cameras. Battery pack 016-0270-02 is required for C-50, C-51, C-52 and C-53 Cameras.*

## 7L14

### Digital Storage and Averaging

### Automatic Phase Lock

### Swept Frequency Measurements with TR 502

### Input Limiter for Extra Input Protection

The Tektronix 7L14 is the VHF/UHF member of the 7000 Series Digital Storage Family replacing the 7L13. It provides high performance in the 10 kHz to 1.8 GHz range. Measurements for RFI/EMI, FM, TV, avionics, navigation, two-way and other communications systems are made with accuracy and convenience.

Resolution bandwidth can be varied from 30 Hz to 3 MHz over the entire frequency range. Automatic phase lock ensures excellent stability — incidental FM is  $\leq 13$  Hz p-p. Phase noise sidebands are no greater than  $-70$  dBc at 25 resolution bandwidths away.

All this gives you the critical accuracy necessary for design and proof-of-performance measurements. Check broadband RF networks, filter networks, amplifiers, and more...easily and economically.

Digital storage expands 7L14 capability — you can compare waveforms — such as a filter response to a standard — simultaneously using independent A and B memories. A Max Hold function makes it easy to measure amplitude and frequency drift such as in an oscillator. Or capture short duration signals such as in spectrum occupancy monitoring.

An input limiter provides automatic overload protection of the first mixer. Signals up to one watt can be connected to the input for any setting of the RF input attenuator. In addition, the input is ac-coupled for protection from dc and large voltages at line frequency (50/60 Hz). Frequency coverage down to 1 kHz can be obtained by deleting the built-in limiter. Talk to your Tektronix Sales Engineer for details.

### CHARACTERISTICS

The following characteristics and features apply to the 7L14 Spectrum Analyzer after a warm up period of 20 minutes.

#### FREQUENCY RELATED

**Center Frequency Range** — 10 kHz to 1.8 GHz.

**Readout Resolution** — Within 1 MHz.

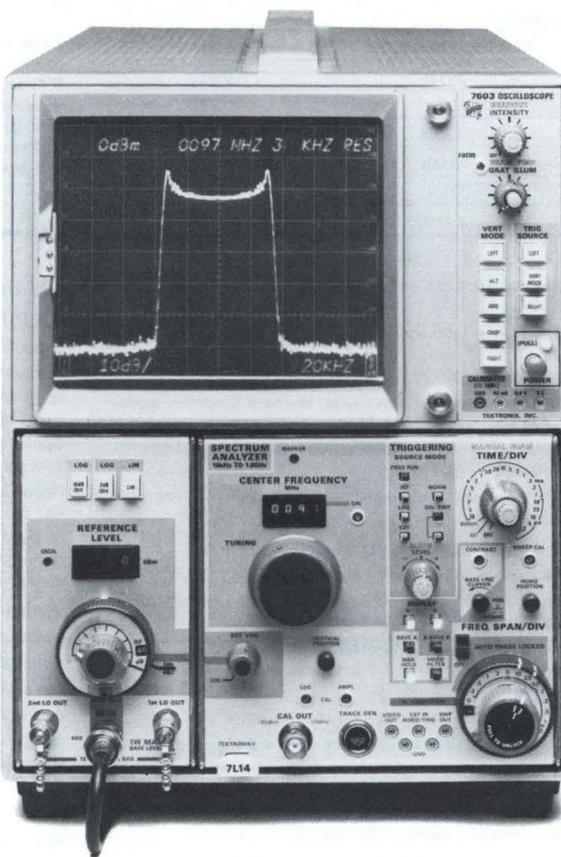
**Readout Accuracy** —  $\pm(5$  MHz + 20% of frequency span/div).

**Frequency Span** — 200 Hz/div to 100 MHz/div in calibrated steps in a 1-2-5 sequence.

**Accuracy** — Within 5% of the span selected.

**Linearity** — Within 5% of the span selected.

**Maximum Span** — Provides 1.8 GHz of span.



**Sensitivity** — At 50 MHz, applicable from 100 kHz to 1.8 GHz.

Resolution Bandwidth	Averaged Input Noise Level
30 Hz	-130 dBm
300 Hz	-120 dBm
3 kHz	-110 dBm
30 kHz	-100 dBm
300 kHz	-90 dBm
3 MHz	-80 dBm

**RF Attenuator** — Calibrated in 10 dB steps.

**Accuracy** —  $\pm(0.25$  dB + 1.2% of dB reading).

#### IF Gain

**Range** — 70 dB (80 dB when operating in 30 Hz resolution bandwidth).

**Step Accuracy** —  $\pm 1$  dB per 10 dB step to  $\pm 2$  dB maximum over entire range.

#### SPURIOUS RESPONSES

**Residual** —  $< -100$  dBm (referenced to the 1st mixer input).

**Second Order Intermodulation Products** — 100 kHz  $-1.8$  GHz; down 70 dB or more from two  $-40$  dBm signals, within any frequency span.

**Third Order Intermodulation Products** — 100 kHz  $-1.8$  GHz; down 70 dB or more from two  $-30$  dBm signals, within any frequency span.

#### GENERAL CHARACTERISTICS

**Noise Sidebands** —  $-70$  dBc minimum at frequency offsets  $\geq 25$  x resolution bandwidth settings.

**Sweep** — Triggered, manual, external.

**Sweep Time** — 10 s/div to 1  $\mu$ s/div in a 1-2-5 sequence.

**Accuracy** —  $\pm 5\%$  of selected Time/div.

**Triggering Modes** — Internal, External, Ext in Horiz/Trig and Line.

**Sensitivity** —  $\pm 0.6$  div of internal signal (p-p) and/or  $\pm 0.6$  V (p-p) of external signal.

**Shipping Weight** — 10.8 kg (24 lb).

#### INPUT SIGNAL CONNECTORS

**RF Input** — Maximum Input Power Level:  $+30$  dBm. Maximum Input Power Level to the RF Attenuator  $\geq 10$  dB: 1 W average (including dc), 100 W peak simultaneously. Input Impedance: 50  $\Omega$ ; vswr 1.35 maximum with 10 dB of RF attenuation.

**External Horizontal/Trigger Input Connector** — Input Voltage Range: Typically 0 V to 10 V for 10 div sweep. Typically 0.5 V (p-p) to trigger the sweep circuits. 40 V peak maximum.

#### OUTPUT SIGNAL CONNECTORS

**Cal Out** —  $-30$  dBm,  $\pm 0.3$  dB at 50 MHz,  $\pm 0.01\%$ .

**1st Lo Out, 2nd Lo Out, Swp Out and Video Output**

#### ENVIRONMENTAL CHARACTERISTICS

The 7L14 meets its electrical characteristics over the environmental limits per MIL-T-28800 Type 3 Class 6, Style E instruments. The 7L14 is operable over the limits of a MIL-T-28800 Class 5 instrument. The 7L14 is physically and electrically compatible with all Tektronix 7000 Series Mainframes.

#### INCLUDED ACCESSORIES

Spectrum Analyzer Graticule. 50  $\Omega$  Coaxial Cable, with BNC connectors, 6 ft (012-0113-00); BNC male to female adaptor (103-0058-00); Amber Light Filter (378-0684-01); Light Filter (378-0625-07); Clear plastic implosion shield with Log, Lin, Ref, and F (frequency) direction markings (337-1439-01) for 7603 Oscilloscope and (337-1159-02) for other 7000 Series Oscilloscopes.

#### ORDERING INFORMATION

7L14 Spectrum Analyzer ..... \$17,900

7603 Mainframe (shown) ..... \$2,700

R7603 Mainframe (Rackmount) ..... \$3,100

#### MAINFRAME OPTIONS

Option 06 — Internal SA Graticule ..... +\$50

Option 08 — Protective Front Cover (Cabinet Only) .. +\$100

Option 77 — P7 Phosphor and Internal SA Graticule .. +\$35

Frequency Range to 2.5 GHz: ask about the 7L14 Mod 139U.

Tektronix offers service training classes on the 7L14 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

7L18

Digital Storage and Averaging

Automatic Phase Lock

Built-in Preselector

30 Hz Resolution to 12 GHz, 300 Hz to 60 GHz with Optional Waveguide Mixers Above 18 GHz

The Tektronix 7L18 makes your most demanding microwave measurements with accuracy and ease. In application after application — microwave relay, ECM, satellite communications and microwave development — the 7L18 is helping make state-of-the-art measurements with the cleanest displays possible.

It delivers close-in 30 Hz resolution to 12 GHz, with  $\leq 10$  Hz residual FM peak-to-peak on local oscillator fundamental bands. Amplitude calibration is maintained from 1.5 to 60 GHz for absolute power measurements, using high-performance Tektronix waveguide mixers above 18 GHz. This is the kind of performance you'd expect from a baseband analyzer, but the 7L18 provides it in the microwave spectrum — and does so with versatility and ease typical of our 7000 Series plug-ins. Make high-performance microwave measurements without paying for more frequency coverage than you need.

Digital storage and digital signal processing features all help simplify operation. MAX HOLD helps you easily measure amplitude or frequency drift, such as oscillator drift resulting from time or temperature change. Digital averaging reduces on-screen noise — helps you measure low-level signals or spectral purity.

A built-in tracking preselector eliminates spurious responses in all coaxial bands. And for harmonic measurements, it increases dynamic range to 100 dB by rejecting signals outside its bandwidth. If you design, test or evaluate state-of-the-art microwave systems, choose the 7L18 for high performance, and 7000 Series versatility.

CHARACTERISTICS

The following characteristics and features apply to the 7L18 Spectrum Analyzer after a warm up period of 30 minutes unless otherwise specified.

FREQUENCY RELATED

Center Frequency

Range — 1.5 GHz to 18 GHz in five bands (coaxial input). 12.5 GHz to 60.5 GHz in six bands (with external waveguide mixers).

Readout Resolution — Within 1 MHz with direct input and 10 MHz with waveguide mixers.

Readout Accuracy —  $\pm (5 \text{ MHz} + 20\% \text{ of frequency span/div})$  times the oscillator harmonic (n) of the band in use.

Frequency Span — 200 Hz/div to 500 MHz/div in a 1-2-5 sequence.

Accuracy — Within 5% of the span selected over center 8 division.

Linearity — Within 5% over the center 8 divisions of a 10 division display.

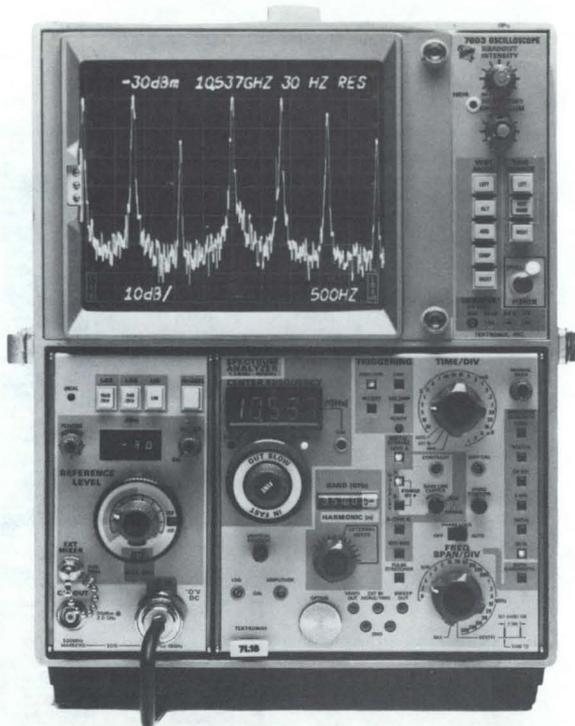
Maximum Span — Depends on mixing mode. Span width =  $n \times 2 \text{ GHz}$  where n is the mixing mode. Maximum span full screen is 8.5 GHz with internal mixer (9.5 to 18 GHz band).

Zero Span — Provides fixed frequency operation for time domain display.

Resolution Bandwidth

Range — 30 Hz to 3 MHz, in decade steps plus auto bandwidth.

Accuracy (6 dB down) — Within 20% of the resolution selected.



Shape Factor (60/6 dB) — 4:1 or less for 3 MHz to 300 Hz; 12:1 or less for 30 Hz resolution.

Residual FM —  $\leq 10 \text{ Hz (p-p)} \times n$  when phase locked.  $\leq 10 \text{ kHz (p-p)} \times n$  when not phase locked.

Stability — At a fixed temperature after two hour warm up; within 2 kHz/hour  $\times n$  when phase locked; within 50 kHz/10 minutes  $\times n$  when not phase locked.

Tracking Preselector — Internal and automatic 1.5 to 18 GHz, for rejection of harmonic mixing, image, and multiple responses.

AMPLITUDE RELATED

Display Modes

Log 10 dB/div — Provides 80 dB display dynamic range. Accuracy within  $\pm 1 \text{ dB}/10 \text{ dB}$  to 2 dB maximum over 80 dB display dynamic range.

Log 2 dB/div — Provides 16 dB display dynamic range. Accuracy within  $\pm 0.4 \text{ dB}/2 \text{ dB}$  to 1.0 dB maximum over any 16 dB range.

LIN — Within 10%, of full screen, over 8 div.

Reference Level — +40 dBm to -110 dBm in 10 dB calibrated steps (+30 dBm is the maximum safe input level).

RF Attenuator — 60 dB range calibrated in 10 dB steps. Accuracy within  $\pm 0.3 \text{ dB}$  or 1% of dB reading (whichever is greater) to 4 GHz;  $\pm 0.5 \text{ dB}$  or 2% of dB reading (whichever is greater) from 4 GHz to 18 GHz.

IF Gain Range — 90 dB.

Step Accuracy —  $\pm 1 \text{ dB}$  per 10 dB step to  $\pm 2 \text{ dB}$  maximum over entire range.

Sensitivity and Frequency Response with Internal Mixers — Averaged noise level specified for 300 Hz resolution bandwidth. Frequency response with 10 dB input attenuator setting.

Frequency Range (GHz)	Mixing Mode	Averaged Noise Level (dBm Max)	Worst Case* Frequency Response Optimum Peaking (dB Max)
1.5 to 3.5	1-	-119	$\pm 1.8$
2.5 to 4.5	1+	-119	$\pm 1.8$
3.5 to 7.5	2-	-109	$\pm 2.5$
6.5 to 12.5	3+	-107	$\pm 4.0$
9.5 to 18.0	5-	-92	$\pm 4.0$

\*Includes mixer frequency response, RF attenuator frequency response, internal preselector frequency response, mixing mode gain variation, RF input VSWR.

Sensitivity and Frequency Response with External Mixers — (Averaged noise level specified for 3 kHz resolution bandwidth.)

Frequency Range (GHz)	Mixing Mode	Averaged Noise Level (dBm Max)	Response (dB Max)
12.5 to 18.0	6+	-85	—
18.0 to 26.5**	7+	-90	$\pm 3$
26.5 to 40.0**	10+	-85	$\pm 3$
40.0 to 60.5**	15+	-75	$\pm 3$

\*\*High performance mixer line.

SPURIOUS RESPONSES

Residual —  $\leq -110 \text{ dBm}$ , referred to band 1, with no input attenuation, and with no signal present at the input. Calibrator related may be -100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from any two full screen signals, when if gain is not set to gain reduced position (red sector).

Mixed — All harmonic mixing, image, and multiple responses down 70 dB or more to 18 GHz.

GENERAL CHARACTERISTICS

Noise Sidebands — When phase locked, for fundamental (n = 1) conversion, -70 dBc minimum at frequency offsets  $\geq 20 \times$  resolution bandwidth settings.

Sweep — Triggered, auto, manual, external.

Sweep Time — 20 s/div to 1  $\mu$ s/div in a 1-2-5 sequence.

Accuracy — Within 6% of selected time/div.

Triggering Modes — Internal, external, line, free run, single sweep.

Sensitivity — 0.5 div internal, 0.5 V external (50 V maximum).

Shipping Weight — 11.7 kg (26 lb).

INPUT SIGNAL CONNECTORS

RF Input — Maximum Input Power Level to the RF Attenuator: 1 W average and 200 W peak. Burnout, 1 W or more at the input. Input Impedance: 50  $\Omega$  nominal (1.5 GHz to 18 GHz); VSWR 1.35 maximum with 10 dB of RF attenuation. Input Compression Point:  $\geq -28 \text{ dBm}$  from 1.5 to 1.8 GHz.  $\geq -18 \text{ dBm}$  from 1.8 to 18 GHz (both with zero RF attenuation).

External Horizontal/Trigger Input Connector — Requires 0 V to 10 V  $\pm 1 \text{ V}$  for 10 div sweep. Requires 0.5 V (p-p) to trigger the sweep circuits. 50 V peak maximum.

OUTPUT SIGNAL CONNECTORS

Cal Out — -30 dBm,  $\pm 0.5 \text{ dB}$  at 25°C at 2.0 GHz  $\pm 0.01\%$ .

Sweep Out and Video Out

INCLUDED ACCESSORIES

Spectrum Analyzer Graticule (337-1439-01); Spectrum Analyzer Graticule (337-1159-02); Adaptor, BNC female to N male (103-0045-00); 50  $\Omega$  Coaxial Cable, 10 in (012-0208-00); Plug-in to Mainframe Securing Kit (016-0637-00).

ORDERING INFORMATION

7L18 Spectrum Analyzer ..... \$19,200

7603 Mainframe (shown)\* ..... \$2,700

R7603 Mainframe (Rackmount) ..... \$3,100

Option 06 — Internal SA Graticule ..... +\$50

Option 08 — Protective Front Cover ..... +\$100

(Cabinet Only) ..... +\$100

Option 77 — P7 Phosphor and Internal SA Graticule ..... +\$35

\*Suggested Mainframe: 7603 Option 08/Option 06 for maximum transportability. Has protective front cover (Option 08) and Spectrum Analyzer Graticule (Option 06). See 7000 Series pages for oscilloscope specifications and options.

OPTIONAL ACCESSORIES

General Purpose Waveguide Mixers Set

Order 016-0640-00 ..... \$710

12.4 to 18 GHz Mixer Order 119-0097-01 ..... \$180

18 to 26.5 GHz Mixer Order 119-0098-01 ..... \$220

26.5 to 40 GHz Mixer Order 119-0099-01 ..... \$275

Cable Order 012-0748-00 ..... \$25

Case Order 016-0465-01 ..... \$40

High Performance Waveguide Mixers

18 to 40 GHz Set WM490-2 ..... \$2,010

18 to 60 GHz Set WM490-3 ..... \$3,260

18 to 26.5 GHz Mixer WM490K ..... \$975

26.5 to 40 GHz Mixer WM490A ..... \$975

40 to 60 GHz Mixer WM490U ..... \$1,250

Cable Order 012-0649-00 ..... \$25

Case Order 016-0465-01 ..... \$45

## 7L5

Digital Storage and Averaging

Synthesizer Tuning

Three-knob Operation

Swept Frequency Measurements with  
Option 25

Preset Reference Level and Dot Frequency  
for Extra Input Protection

Selectable Input Impedance

Reference Level Selection in 1 dB and 10 dB  
Steps

Absolute Calibration in dBm, dBV, or  
Volts/div

The Tektronix 7L5 provides lab grade, easy-to-use low-frequency measurement capability. The 7L5 can cover 20 Hz to 5 MHz in one display. Resolution bandwidth can be varied from 10 Hz to 30 kHz, with residual FM of no more than 1 Hz peak-to-peak. Comparing baseband channel performance is easy because the 7L5 switches from a single channel to a 60-channel supergroup without retuning. You see all channel amplitudes at a glance, side-by-side.

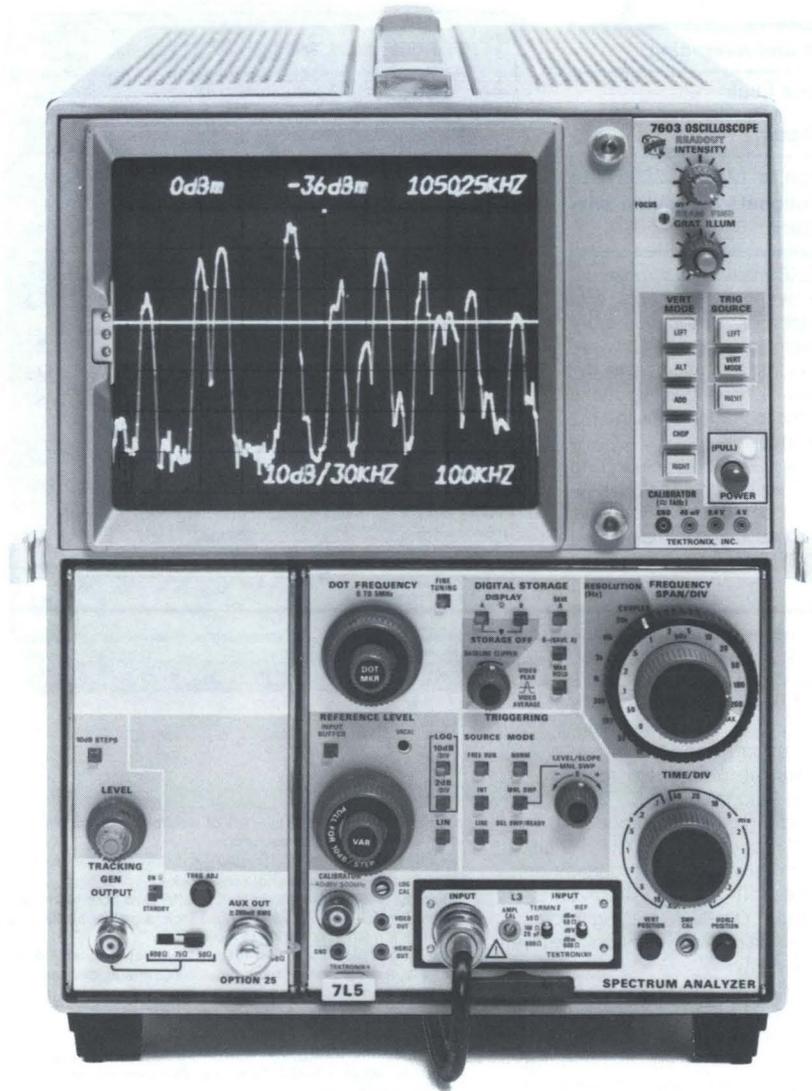
Digital storage proves particularly useful in the 7L5. With digital averaging and peak detection, you can accurately measure low level signals, such as intermodulation distortion products, in the presence of noise. With MAX HOLD, you can capture short duration signals and random transient phenomena that would otherwise be lost.

The 7L5 combines high performance with easy-to-use three-knob operation —

- 1) Set frequency span
- 2) Set center frequency
- 3) Set reference level...and measure!

Sweep speed and resolution bandwidth are set automatically.

Digital tuning and synthesizer stability let you set center frequency with six-digit accuracy immediately upon turn-on. Reference level can be set in 1 dB and 10 dB steps, eliminating the need to interpolate amplitude levels. And for measuring wide relative amplitude differences, the 7L5 offers 80 dB spurious-free display dynamic range.



7L5 Option 25 Spectrum Analyzer with L3 Plug-in Module in a 7603 Option 06 Mainframe with internal spectrum analyzer graticule

The 7L5 makes accurate baseband communications measurements such as noise, spurious response, distortion, and transient interference, all with the certainty of 10 Hz resolution. By adding an Option 25 Tracking Generator, you can measure filter shape.

This highly capable audio/baseband analyzer finds a place in many areas of use, including measurement of communications system basebands, power line distortion, EMI/RFI, and computer systems.



Probe-compatible plug-in input modules provide a variety of impedances for the 7L5. The L3 may be switch-selected to 50 Ω, 600 Ω or 1 MΩ. The L3 Option 1 is switch-selectable to 75 Ω, 600 Ω or 1 MΩ.

**CHARACTERISTICS**

The following characteristics and features apply to the 7L5 Spectrum Analyzer after a warmup period of 10 minutes.

**FREQUENCY RELATED**

**Center Frequency**

**Range** — Input frequency range is 20 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 10 kHz or 250 Hz steps.

**Accuracy** — 0°C to 50°C ±(20 Hz + 10<sup>-5</sup> of dot frequency); 20°C to 30°C ±(5 Hz + 2 × 10<sup>-6</sup> of dot frequency).

**Frequency Span** — 50 Hz/div to maximum (500 kHz/div) in a 1-2-5 sequence.

**Accuracy** — Within 5%.

**Linearity** — Within 5% over the center 8 divisions.

**Zero Span** — Provides fixed frequency operation for time domain display.

**Resolution Bandwidth**

**Range** — 10 Hz to 30 kHz in 8 steps. Coupled position electronically couples resolution to span/div selection so that both are controlled by the same knob.

**Accuracy (6 dB down)** — Within 20% of resolution selected (30 Hz to 30 kHz). 10 Hz is 100 Hz ±20 dB, 30 kHz to 10 Hz.

**Shape Factor (60/6 dB)** — 10:1 or better for 10 Hz to 1 kHz and 5:1 or better for 3 kHz to 30 kHz.

**Signal Level Change Between any Two Bandwidths** — ≤0.5 dB, 30 kHz to 100 Hz and ≤2.0 dB, 30 kHz to 10 Hz.

**Residual FM** — ≤1 Hz (p-p) for frequency spans of 50 Hz/div to 2 kHz/div. ≤40 Hz (p-p) for frequency spans of 5 kHz/div to 500 kHz/div.

**Stability** — ≤5 Hz/hour.

**AMPLITUDE RELATED**

**Display Modes**

**Log 10 dB/div** — Provides 80 dB display dynamic range.

**Accuracy** — Within 0.08 dB/dB to 2 dB maximum over 80 dB display dynamic range.

**Log 2 dB/div** — Provides 16 dB display dynamic range.

**Accuracy** — Within 0.15 dB/dB to 1 dB maximum over 16 dB display dynamic range.

**LIN** — 20 nV/div to 200 mV div in a 1-2-5 sequence.

**Accuracy** — Within 5%.

**Reference Level** — +21 dBm to -128 dBm (50 or 75 Ω input impedance), +10 dBm to -139 dBm (600 Ω input impedance), +8 dBV to -141 dBV (1 MΩ input impedance). Calibrated in 1 dB and 10 dB steps.

**Display Flatness** — 0.7 dB maximum from 20 Hz to 5 MHz, (add 0.5% quantization error in digital storage).

**Sensitivity** — Equivalent input noise for each resolution bandwidth setting is measured in video average mode with 10 s/div sweep rate and input buffer control off. Sensitivity is degraded an additional 8 dB when the input buffer is on.

Resolution Bandwidth	Averaged Noise Level
10 Hz	-148 dBV
30 Hz	-146 dBV
100 Hz	-143 dBV
300 Hz	-138 dBV
1 kHz	-133 dBV
3 kHz	-128 dBV
10 kHz	-123 dBV
30 kHz	-118 dBV

**Spurious Responses**

**Residual** — ≤ -143 dBV (non calibrator related, referenced to the input).

**Intermodulation Products** — Within any frequency span for two on screen signals of any input level, third order down 75 dB or more and second order down 72 dB or more; of any input level up to -53 dBV or of any input level with input buffer on, second and third order down 80 dB or more.

**GENERAL CHARACTERISTICS**

**Sweep** — Triggered, manual, auto.

**Sweep Time** — 10s/div to 0.1 ms/div in a 1-2-5 sequence.

**Accuracy** — Within 5% of selected time/division.

**Triggering** — Sources are free run, internal and line. Modes are normal, manual sweep and single sweep.

**Sensitivity** — ≥1.5 div of internal signal for both normal and single sweep modes over the approximate frequency range of 30 Hz to 500 kHz.

**Shipping Weight** — 7.6 kg 17 lb.

**INPUT SIGNAL CONNECTORS**

**MAXIMUM INPUT POWER LEVEL**

**1 MΩ/28 pF** — 15 V (p-p) for ac or pulse signals with risetimes of 2 V/μs or faster (pulses or ac beyond this specification may open an input fuse). 40 V (dc plus peak ac) for signals with risetimes slower than 2 V/μs.

**600 Ω (Internally Terminated)** — 12 V dc or RMS (+24 dBm).

**50 Ω (Internally Terminated)** — 3.5 V dc or RMS (+24 dBm).

**Input Impedance** — Switch selectable 1 MΩ in parallel with 28 pF, 50 Ω (75 Ω for L3 Option 1) termination, or 600 Ω termination.

**OUTPUT SIGNAL CHARACTERISTICS**

**Calibration** — 500 kHz squarewave within ±0.15 dB of -40 dBV into the plug-in impedance.

**Video Out** — 50 mV/div ±5% (about the CRT center) with source impedance of 1 kΩ.

**Horizontal Out** — 0 to about -6 Vdc sawtooth with a source impedance of 5 kΩ.

**7L5 Option 25 TRACKING GENERATOR**

The 7L5 with Option 25 Tracking Generator, provides selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 20 Hz to 5.0 MHz. The output frequency can be adjusted so it tracks within 10 Hz of the spectrum analyzer frequency. The frequency span and rates are controlled with the spectrum analyzer. The output level is controlled from the tracking generator. Output level is calibrated and controlled in 10 dB and 1 dB steps over a 63 dB range. An Aux Output may be used to drive a frequency counter. The 7L5 with Option 25 is a three-wire unit for the 7000-Series mainframe.

**OPTION 25 CHARACTERISTICS**

**Frequency Range** — 20 Hz to 5.0 MHz.

**Output Impedance** — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

**Amplitude** — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

**Range**

50 Ω: 0 dBm to -63 dBm

75 Ω: -6 dBm to -69 dBm

600 Ω: -17 dBm to -80 dBm

**Accuracy** — (Maximum Output calibrated at 500 kHz)

50 Ω: 0 dBm ±0.25 dB

75 Ω: -6 dBm + 0.4, -0.2 dB

600 Ω: -17 dBm +0.5, -0.1 dB

**Attenuator**

Range: 0 to 63 dB in 10 dB or 1 dB steps.

Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

**Flatness**

50 Ω and 75 Ω: Within 0.5 dB p-p.

600 Ω: Within 1.0 dB p-p.

Total System Flatness (7L5 with L3 Plug-in Module and Option 25)

50 Ω and 75 Ω: Within 1.0 dB p-p.

600 Ω: Within 1.25 dB p-p.

**Dynamic Range (7L5 with Option 25)** — ≥110 dB.

**Residual FM (p-p)**

Spans to 2 kHz/div: 2 Hz (7L5 with Option 25).

Spans 5 kHz/div or greater: 40 Hz (7L5 with Option 25).

**Stability** — 25 Hz/5 minutes after 10 minute warm-up decreasing to 25 Hz/hour maximum after 1 hour.

**Spurious Suppression, 20 Hz to 5.0 MHz (harmonic and non-harmonic)**

— 40 dB or more with respect to the carrier.

**Auxiliary Output** — ≥200 mV RMS into 50 Ω.

**INCLUDED ACCESSORIES**

Graticule, Spectrum Analyzer, (337-1159-00); (7000 Series), and (337-1439-01); (7603), filter, light blue, (378-0684-00).

**ORDERING INFORMATION**

<b>7L5 Spectrum Analyzer (Requires L3 Plug-in Module)</b> .....	<b>\$9,990</b>
<b>Option 25</b> — Tracking Generator .....	<b>+\$1,500</b>
For a separate tracking generator, (One-wide field modification to be attached to an existing 7L5).	
Order 040-0810-00 .....	<b>\$1,700</b>
<b>L3 Plug-in Module (1 MΩ, 50 Ω, 600 Ω) ..</b>	<b>\$1,500</b>
<b>Option 01</b> — L3 Plug-in Module (1 MΩ, 75 Ω, 600 Ω) .....	<b>NC</b>
<b>7603 Mainframe</b> .....	<b>\$2,700</b>
<b>R7603 Mainframe (Rackmount)</b> .....	<b>\$3,100</b>
<b>Option 06</b> — Internal S A Graticule .....	<b>+\$50</b>
<b>Option 08</b> — Protective Front Cover (Cabinet Only) .....	<b>Add +\$100</b>
<b>Option 77</b> — P7 Phosphor and Internal SA Graticule ..	<b>+\$35</b>
<b>*7704A Oscilloscope</b> .....	<b>\$4,260</b>
<b>*R7704 Oscilloscope</b> .....	<b>\$7,090</b>

\*Suggested Mainframe. See 7000 Series pages for oscilloscope specifications and options.

**OPTIONAL ACCESSORIES**

<b>Tracking Generator</b> , one-wide field modification kit, to be attached to an existing 7L5.	
Order 040-0810-00 .....	<b>\$1,700</b>
<b>75 Ω to 50 Ω Minimum Loss Attenuator (Ac Coupled)</b> .	
Order 011-0112-00 .....	<b>\$60</b>
<b>P6105 10X Probe</b> , (2 m). Order 010-6105-03 .....	<b>\$111</b>

**BALANCED INPUT TRANSFORMER**

**Frequency Range** — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

**Flatness** — 0.25 dB p-p maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

**Common-Mode Rejection** — 25 dB minimum (50 kHz to 3 MHz).

**Output Termination** — Switchable between 124 Ω, 135 Ω, and NONE for bridging or external termination.

**Connectors** — WECO (0.37 in with 0.090 center) on 0.625 in spacing for balanced input. BNC for single-ended output.

**Balanced Input Transformer** Order 013-0182-00 .....

Tektronix offers service training classes on the 7L5 Spectrum Analyzer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

**7L12**

**Automatic Phase Lock**

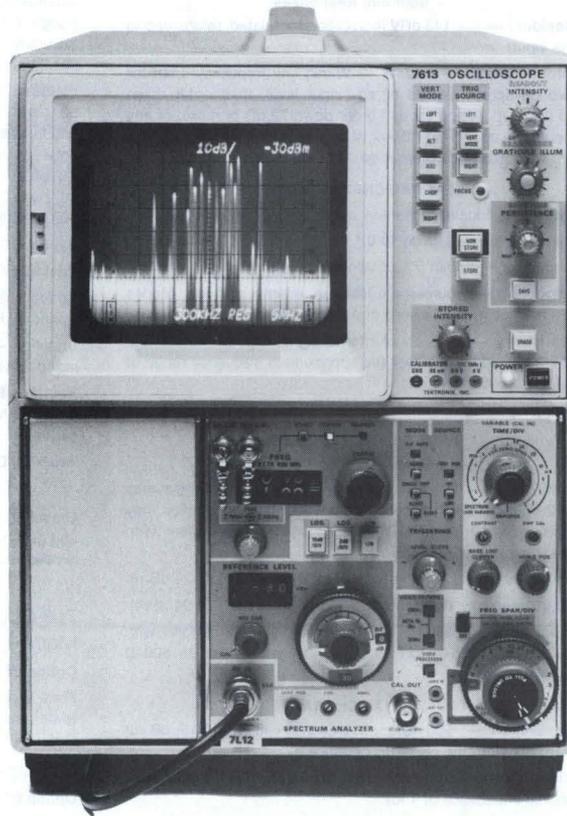
**Swept Frequency Measurements with the TR 502**

The 7L12 is a popular instrument for use in applications not requiring the resolution, low-end coverage, and digital storage of the 7L14. Resolution bandwidth can be varied from 300 Hz to 3 MHz, with -115 dBm sensitivity at 300 Hz. Automatic phase lock results in good stability; residual FM is  $\leq 200$  Hz peak-to-peak.

The 7L12 meets the measurement requirements of many AM, FM, two-way radio and other communications systems. And because it's 7000 Series compatible you get the versatility of using the mainframe of your choice and over 30 test and measurement plug-ins.

The 7L12 has 70 dB spurious-free display dynamic range; low level noise measurements are made accurately, easily.

Ease-of-use features include fully-calibrated displays and, as with all 7000 Series analyzers, CRT readout of all key parameters. Additional front-end protection is available with a dc block accessory. With its companion TR 502 Tracking Generator, the 7L12 handles swept frequency measurements from 100 kHz to 1.8 GHz. And because the 7L12 is only a "two-wide" plug-in you get time or frequency displays by adding a vertical amplifier plug-in. Choose the 7L12 for economical high-performance in VHF/UHF bands.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.

**CHARACTERISTICS**

The following characteristics and features apply to the 7L12 Spectrum Analyzer after a warm up period of 40 minutes.

**FREQUENCY RELATED**

- Center Frequency Range** — 100 kHz to 1.8 GHz.
- Readout Accuracy** —  $\pm$  (8 MHz + 1% of dial readout).
- Frequency Span** — 500 Hz/div to 100 MHz/div in calibrated steps in 1-2-5 sequence.
- Accuracy** — Within 5% over center 8 divisions.
- Linearity** — Within 5% over center 8 divisions.
- Maximum Span** — Provides 1.8 GHz of span.
- Zero Span** — Provides fixed frequency operation for time domain display.
- Resolution Bandwidth**
- Range** — 300 Hz to 3 MHz, in decade steps.
- Accuracy (6 dB Down)** — Within  $\pm 20\%$  of the resolution selected.
- Shape Factor (60/6 dB)** — 4:1 or less.
- Signal Level Change Over the Five Bandwidths** —  $< 0.5$  dB at 20°C.

- Residual FM** — 200 Hz (p-p) when phase locked. 20 kHz (p-p) maximum in 5 seconds when not phase locked.
- Stability** — At a fixed temperature after two hour warm up; within 50 kHz/hour phase locked; within 100 kHz/hour not phase locked.

**AMPLITUDE RELATED**

- Display Modes**
- Log 10 dB/Div** — Provides 70 dB display dynamic range.
- Accuracy** — Within 1 dB/10 dB to 1.7 dB maximum over 70 dB display dynamic range.
- Log 2 dB/Div** — Provides 14 dB display dynamic range.
- Accuracy** — Within  $\pm 0.4$  dB/2 dB to 1.0 dB maximum over 14 dB display dynamic range.
- LIN** — Within 8% over 8 center divisions. Deviation between display modes  $\pm 2$  dB from 2 dB/div to 10 dB/div, 0.5 divisions from 2 dB/div to LIN.
- Display Flatness** —  $\pm 1.7$  dB over any selected frequency span, with respect to the display level at 50 MHz.
- Sensitivity for a cw Signal** — The following sensitivity characteristics apply at 50 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and to 4 dB at 1.8 GHz.

Resolution Bandwidth	Averaged Noise Level
300 Hz	-115 dBm
3 kHz	-108 dBm
30 kHz	-100 dBm
300 kHz	- 90 dBm
3 MHz	- 80 dBm

**SPURIOUS RESPONSES**

- Residual** —  $< -99$  dBm (referenced to the 1st mixer input).
- Second Order Intermodulation Products** — Down 70 dB or more from two -40 dBm signals, within any frequency span.
- Third Order Intermodulation Products** — Down 70 dB or more from two -30 dBm signals, within any frequency span.
- RF Attenuator** — Calibrated in 10 dB steps.
- Accuracy** —  $\pm 25$  dB or 1.2% of dB reading; whichever is greater.
- IF Gain** — Range: 70 dB.
- Step Accuracy** —  $\pm 1$  dB per 10 dB step to  $\pm 1.5$  dB maximum over entire range.

**GENERAL CHARACTERISTICS**

- Sweep Time** — 10 ms/div (SPECTRUM position) to 1  $\mu$ s/div are provided in 1-2-5 sequence. A VARIABLE control provides continuous variation between steps. Accuracy within 5%.
- Triggering Modes** — (P-P) AUTO, NORM, SINGLE SWEEP.
- Sensitivity** —  $\leq 0.5$  division for the (p-p) AUTO mode,  $\leq 0.3$  division for the NORM mode,  $\leq 1.5$  division for the SINGLE SWEEP mode.
- Input Signal Connectors**
- RF Input**
- Maximum Input Power Level Linear Operation** — RF attenuator at 0 dB; -30 dBm.
- Safe Input Levels** — RF attenuator at 0 dB; +13 dBm. RF attenuator at 60 dB; +30 dBm (1 W average, 100 W peak).
- Input Impedance** — 50  $\Omega$ .
- Horizontal Input** — Requires a 10 V  $\pm 1$  V signal.
- Output Signal Connectors**
- CAL OUT** — -30 dBm,  $\pm 0.3$  dB at 50 MHz,  $\pm 0.01\%$ .
- 1st LO OUT, 2nd LO OUT, VERT OUT**
- Shipping Weight** — 7.6 kg 17 lb.

**INCLUDED ACCESSORIES**

Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, (337-1439-01); for 7403N and 7603 Oscilloscopes and (337-1159-02) for other 7000 Series oscilloscopes. Amber light filter, (378-0684-01); light filter, (378-0625-07); 50  $\Omega$ , coaxial cable, with BNC connectors, 6 foot, (012-0113-00); BNC Male to N Female adaptor, (103-0058-00).

**ORDERING INFORMATION**

- 7L12 Spectrum Analyzer ..... **\$10,100**
- Extended Frequency Range to 2.5 GHz. Ask about the modified 7L12.
- 7613 Variable Persistence Mainframe . **\$5,025**
- R7613 Variable Persistence Mainframe (Rackmount) ..... **\$5,425**
- Option 06 — Internal SA Graticule ..... **+\$50**
- Option 08 — Protective Front Cover (Cabinet Only) ..... **+\$100**
- 7603 Mainframe ..... **\$2,700**
- R7603 Mainframe (Rackmount) ..... **\$3,100**
- Option 06 — Internal SA Graticule ..... **+\$50**
- Option 08 — Protective Front Cover (Cabinet Only) ..... **+\$100**
- Option 77 — P7 Phosphor and Internal SA Graticule ..... **+\$35**
- 7K11 CATV Preamplifier (page 213) ... **\$1,050**
- Blank Plug-In Panel Order 016-0155-00 ..... **\$45**

5L4N

5000 Series Flexibility

Selectable Input Impedance

Absolute calibration in dBm, dBV, or Volts/div

Single-Ended or Differential (Balanced) Input

Built-in Log Sweep

Built-in Tracking Generator

The Tektronix 5L4N provides high performance for audio tests and many other low frequency applications.

Its performance and versatility make the 5L4N the choice of many educators needing to demonstrate frequency-related theory in practical application areas such as speech, music, vibration, audio and broadcasting. Display dynamic range and sensitivity make the 5L4N especially suitable for low-level noise and distortion studies.

The 5L4N has full 80 dB display dynamic range and built-in log sweep. Resolution bandwidth can be varied from 10 Hz to 3 kHz, with -134 dBm sensitivity at 10 Hz. Residual FM is  $\leq 2$  Hz peak-to-peak.

Other features include a built-in tracking generator, auto resolution and selectable input impedance, with appropriate calibration.

The 5L4N fits any 5100 Series oscilloscope mainframe. This series will also accommodate any of 13 other test and measurement plug-ins. The 5L4N occupies only two compartments so that, with the addition of a vertical amplifier plug-in, basic oscilloscope functions may also be obtained.

CHARACTERISTICS

The following characteristics and features apply to the 5L4N Spectrum Analyzer after a warm up period of 30 minutes.

FREQUENCY RELATED

Center Frequency

Range — 20 Hz to 100 kHz.

Readout Accuracy —  $\pm 3$  kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Frequency Span — 20 Hz/div to 10 kHz/div in calibrated steps in a 1-2-5 sequence.

Accuracy — Within 4%.

Log Span — 100 Hz to 100 kHz; also 20 Hz to 20 kHz via internal switch.

Zero Span — Provides fixed frequency operation for time domain display.

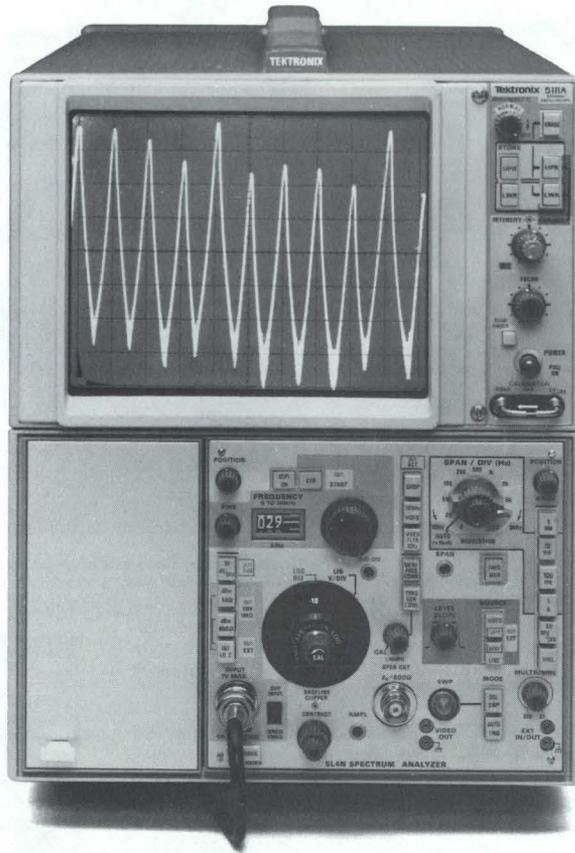
Resolution Bandwidth

Range — 10 Hz to 3 kHz continuously variable. An Auto position provides the best resolution for the frequency span and sweep rate selected, including the Log span mode.

Signal Level Change Over Resolution Bandwidth Range — 2 dB or less.

Residual FM — 2 Hz (p-p) or less.

Stability — At a fixed ambient temperature, within 30 Hz/10 minutes.



5L4N Spectrum Analyzer shown with 016-0452-00 Blank Plug-in Panel in a 5111A Storage Oscilloscope.

AMPLITUDE RELATED

Display Modes

Log 10 dB/div — Provides 80 dB display dynamic range.

Accuracy — within 0.05 dB/dB to 2 dB maximum over 80 dB display dynamic range.

Log 2 dB/div — Provides 16 dB display dynamic range.

Accuracy — 0.1 dB/dB to 1.0 dB maximum over 16 dB display dynamic range.

Lin — Within 3% of full scale over 8 div.

Reference Level

Log 10 dB/div — -10 dBm/dBV to -70 dBm/dBV.

Accuracy — With respect to the level for -40 dBm/dBV reference, is within 0.4 dB/10 dB to 1 dB maximum.

Log 2 dB/div — -10 dBm/dBV to -130 dBm/dBV.

Accuracy — With respect to the level for -40 dBm/dBV reference, is within 0.4 dB/10 dB to 1 dB maximum at -70 dBm/dBV and 2 dB at -130 dBm/dBV.

Lin — Calibrated steps in 1-2-5 sequence, from 50 mV/div to 20 nV/div.

Accuracy — Within 5% per decade to a total of 12% over full range.

Display Flatness —  $\pm 0.2$  dB with respect to the level of a -40 dBV signal at 5 kHz, over any selected frequency span.

Sensitivity for a cw Signal — Signal + noise = twice noise. The following characteristics are applicable with the input internally terminated, or with a 600  $\Omega$  or less source impedance.

Display Mode	Resolution Bandwidth	
	3 kHz	10 Hz
dBV	-123 dBV	-147 dBV
dBm 50 $\Omega$	-110 dBm	-134 dBm
dBm 600 $\Omega$	-121 dBm	-145 dBm
Linear	+680 nV	+45 nV

SPURIOUS RESPONSES

Residual — Not more than -130 dBm/dBV with reference to the input, line related spuri not more than -120 dBm/dBV. There may be a high voltage spur, from some mainframes, at  $\approx 30$  kHz  $\leq$  -100 dBV.

Intermodulation Distortion — Down 70 dB or more from two -10 dBm/dBV signals, down 75 dB or more from two  $\leq$  -20 dBm/dBV signals, within any frequency span.

GENERAL CHARACTERISTICS

Sweep — Internal, external, manual, single.

Sweep Time — 1 s/div to 1 ms/div in decade steps (increased up to X10 with multiplier control).

Accuracy — Within 5%.

Triggering — Internal at least 1.0 div, external at least 250 mV. Slope and level selection are provided. Auto-trigger provides a sweep baseline when a trigger signal is absent. Line triggering provided.

External Sweep — Requires 0 V to 500 mV  $\pm 50$  mV, from a 1 k $\Omega$  or less source to sweep the full span.

Input Signal Connectors — The input connector is a floating two-conductor BNC connector. A switch selects the type (differential or single-ended) of input.

Differential Input Characteristics — Full screen limit is  $\approx 300$  mV to 400 mV. Common-mode rejection ratio is 70 dB or more. Common mode range is  $\pm 10$  V.

Maximum Allowable Input — Low input impedance: 50 V (dc + peak ac) or 250 mW at 50  $\Omega$  and 125 mW at 600  $\Omega$  (power limit of input resistors). High Input Impedance: Center conductor 100 V dc. A 30 V peak ac or pulse of 30 V or more with a risetime of 4 V/ $\mu$ s or faster may open an input fuse. Outer conductor,  $\pm 10$  V.

Single-ended Input Characteristics — Maximum signal input for linear operation is -10 dBm/dBV.

Maximum Allowable Input — Same as center conductor limitation described for differential characteristics.

Shipping Weight — 6.3 kg (14 lb).

OUTPUT SIGNAL CONNECTORS

Tracking Generator — A 600  $\Omega$  signal source with frequency equal to the analyzer input frequency, within 3 Hz. Calibrated output is -40 dBV  $\pm 0.2$  dB (10 mV) open circuit, or -46 dBV when terminated into 600  $\Omega$ . The open circuit output level can be varied from  $\approx 0.001$  V to 0.1 V.

5 kHz Frequency Comb — 600  $\Omega$  source of 5 kHz  $\pm 0.005\%$  markers for span calibration.

Video Out — Provides 250 mV  $\pm 3\%$  of the video signal per displayed division (0 V to 2 V). Source impedance is about 1 k $\Omega$ .

External In/Out — Provides 500 mV  $\pm 25$  mV/div of span, from 0 to 5 V, when using internal or manual sweep.

INCLUDED ACCESSORIES

Adaptor, floating BNC to dual BNC (013-0156-00); BNC to pin jack adaptor cable (175-1178-00); log graticule, 20 Hz to 20 kHz (331-0429-00).

ORDERING INFORMATION

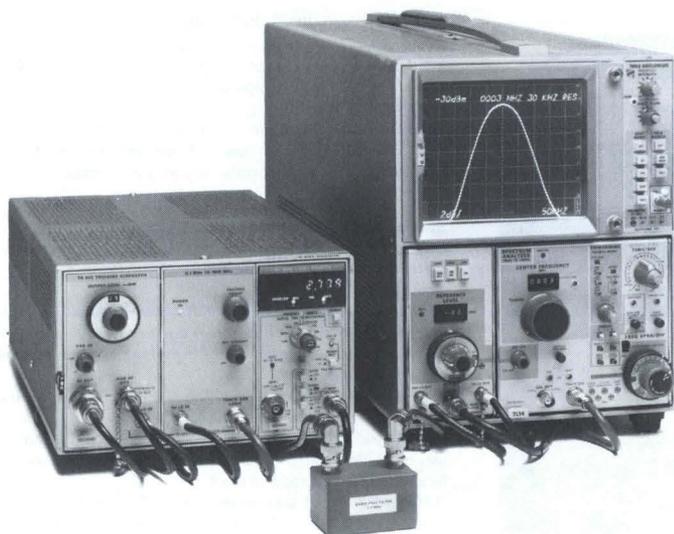
5L4N Spectrum Analyzer .....	\$5120
We recommend that the plug-in 5L4N be ordered with a storage mainframe.	
5111A Storage Oscilloscope (Cabinet) .....	\$2300
Option 02 — Protective Front Cover .....	+ \$25
R5111A Storage Oscilloscope (Rackmount) .....	\$2350

OPTIONAL PLUG-INS FOR TIME DOMAIN USE

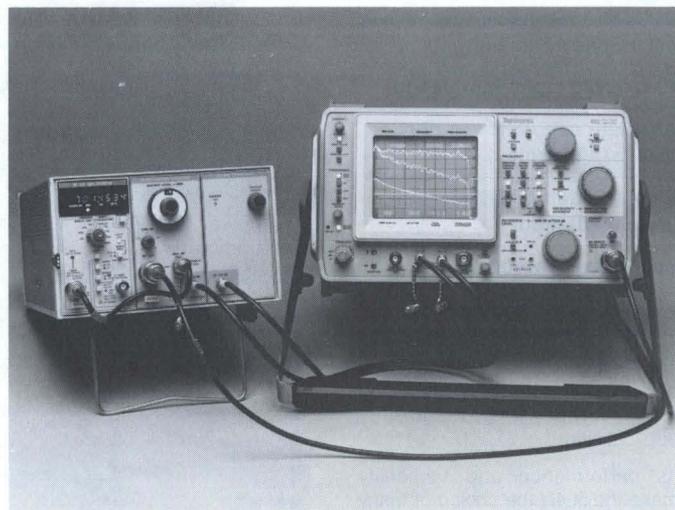
5A15N Single Trace Amplifier .....	\$510
5B10N Time Base Amplifier .....	\$500

OPTIONAL ACCESSORIES

P6006 10 X Probe (6 ft). Order 010-0160-00 .....	\$88
Blank plug-in panel. Order 016-0452-00 .....	\$18



For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DC 508A Option 07 Digital Counter, in a TM 503 Option 07 Power Module, with a 7L14 Spectrum Analyzer in 7603 Option 06 Mainframe.



TR 503 Tracking Generator used with a DC 508A Option 01 Digital Counter, in a TM 503 Power Module, with a 492 Spectrum Analyzer.

## TR 502/TR 503

### TR 502 Has Automatic Counter Dot Marker When Used with DC 508A Option 07 and 7L14

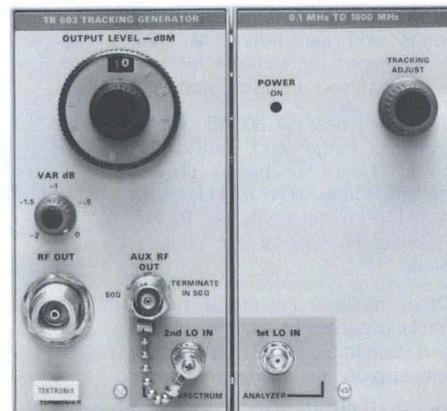
The TR 502 works with the 7L12 and 7L14 and the TR 503 works with the 492/492P or 496/496P Spectrum Analyzers to provide constant level, calibrated rf sources for swept frequency tests to 1.8 GHz.

The low residual FM of these systems enhances narrow bandwidth frequency response measurements. When used as a cw signal source with the analyzer in a manual mode, these systems have excellent frequency stability.

The tracking generators are two-wide units compatible with the TM 500 Modular Instrument Series.

The TR 502/TR 503 AUX RF OUTPUT may be used to drive a frequency counter. Frequencies up to 1.8 GHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.



#### OUTPUT CONNECTORS

**RF Out** — 0 to -61 dBm signal source that tracks input frequency of spectrum analyzer. Output level is set by Output Level control and VAR dB control.

**Aux RF Out** — For use with frequency counter.

#### INCLUDED ACCESSORIES

**TR 502** — Two 50  $\Omega$  coaxial cables, (012-0649-00); logic interface cable, (012-0648-00); adaptor N male to BNC female, (103-0045-00); retainer plug-in, (343-0604-00); adaptor 3 mm male to BNC female, (015-1018-00).

**TR 503** — Two 50  $\Omega$  coaxial cables, 28.5 in, (012-0649-00); adaptor, N male to BNC female, (103-0045-00); retainer plug-in, (343-0604-01).

#### CHARACTERISTICS

	TR 503/492/492P 496/496P	TR 502/7L14	TR 502/7L12
<b>Frequency Range</b>	100 kHz - 1.8 GHz	100 kHz - 1.8 GHz	100 kHz - 1.8 GHz
<b>Output Level</b>	(Maximum) 0 dBm $\pm$ 0.5 dB	0 dBm $\pm$ 0.5 dB	0 dBm $\pm$ 0.5 dB
<b>Range</b>	0 to -59 dB in 10 dB and 1 dB steps	0 to -59 dB in 10 dB and 1 dB steps	0 to -59 dB in 10 dB and 1 dB steps
<b>Flatness</b>	$\pm$ 0.75 dB from 100 kHz to 1.8 GHz	Within $\pm$ 2 dB maximum from 100 kHz to 1.8 GHz (Typically $\pm$ 1.5 dB)	Within $\pm$ 3.0 dB maximum from 100 kHz to 1.8 GHz (Typically $\pm$ 2.0 dB)
<b>Dynamic Range</b>	$\geq$ 110 dB	$\geq$ 110 dB	$\geq$ 100 dB
<b>Residual FM</b>	50 Hz p-p	13 Hz p-p	200 Hz p-p
<b>Output Impedance</b>	50 $\Omega$ Nominal, VSWR 2:1 or less to 1.8 GHz	50 $\Omega$ nominal, VSWR 2:1 or less to 1.8 GHz	50 $\Omega$ nominal, VSWR 2:1 or less to 1.8 GHz
<b>Auxiliary Output</b>	0.1 V into 50 $\Omega$ load -7 dBm minimum	0.1 V RMS into 50 $\Omega$ Load	0.1 V RMS into 50 $\Omega$ Load
<b>Spurious Signoff</b>	Harmonic: -20 dBc Non Harmonic: -40 dBc	Harmonic 20 dBc Non Harmonic 40 dBc	Harmonic 20 dBc Non Harmonic 40 dBc

#### ORDERING INFORMATION

**TR 502 Tracking Generator** ..... \$6,400

#### Suggested Complementary Items

**TM 503 Option 07** — Power Module ..... +\$380

**DC 508A Option 07** — Digital Counter ..... \$1,970

**Blank Panel Order 016-0195-03** ..... \$25

**10 dB, 3 mm attenuator Order 307-0553-00** ..... \$30

(Used in the 2nd LO input line to improve TR 502/7L12 isolation)

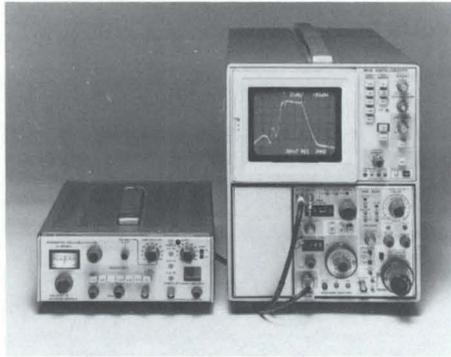
**TR 503 Tracking Generator** ..... \$6,400

#### Suggested Complementary Items

**TM 503** — Power Module ..... \$325

**DC 508A Option 01** — Digital Counter ..... \$1,925

**Blank Panel Order 016-0195-03** ..... \$25



1405/7L12 TV Sideband Analyzer System

## 1405 TV Sideband Adaptor

**Response of Transmitter Under Test Within ±0.2 dB**

**Frequency Response of Rf and If Circuits for Transmitters with Frequency to 1 GHz**

**Video Circuits Can Be Swept**

**For In-service Testing, Use of External Blanking Allows Either Full-field or Single-line Operation**

**Check Aural Fm Deviation with Built-in Bessel Null Technique**

**Flexible Marker System Will Accept Standard Crystals**

To analyze the sideband response of a television transmitter, the 1405 Sideband Adaptor is recommended for use in tandem with the Tektronix 7L12, 7L14, 496 and 492 Spectrum Analyzers. It generates a composite video signal, which is applied as modulation to a television transmitter. The output is displayed on the spectrum analyzer and appears as a response curve, to within ±0.2 dB, of the transmitter being tested.

The 1405/Spectrum Analyzer combination will display frequency-response characteristics of RF and IF circuits for transmitters with frequencies to 1 GHz. Video circuits can also be analyzed.

### CHARACTERISTICS

The following characteristics apply to the 1405 and 1405/7L12 or 7L14 combination. They are applicable over the environmental specification limits for the 1405 and 7000 Series Mainframes.

#### FREQUENCY (FREQUENCY OFFSET)

**Range** — Will tune and provide a swept video output for a 7L12 or 7L14 center frequency range of 0 to 1 GHz.

**Frequency Dial Accuracy** — Dial reading is within 10 MHz of transmitter frequency when properly tuned.

**Fine Tuning Range** — From ±0.5 MHz to ±1.25 MHz, depending upon transmitter frequency setting.

**Tuned Frequency Drift** — <1 MHz per hour after a 30 minute warm up.

### OUTPUT SIGNAL LEVEL

**Amplitude (Sync Off)** — 100 IRE equals 0.714 V p-p when terminated in 75 Ω.

**Output Impedance** — 75 Ω ±1% a 100 IRE and ±2% from 0 to 90 IRE.

**Variable** — 0 to 100 IRE in 10 IRE steps.

**Accuracy (at 200 kHz)** — ±1 IRE at 100 IRE; ±2 IRE from 10 IRE to 90 IRE.

**Output Level During Blanking** — 0 V ±0.01 V at 0 IRE; 0 V ±0.04 V at 100 IRE from 0 to 1 MHz; 0 V ±0.02 V at 100 IRE above 1 MHz.

**Cw Output Harmonics** — Third harmonic content down 40 dB from 0.1 MHz to 5 MHz; down 35 dB from 5 MHz to 10 MHz.

### FLATNESS

**1405** — Within ±0.1 dB from 100 kHz to 10 MHz, within ±0.2 dB from 10 MHz to 15 MHz, within ±0.4 dB from 50 kHz to 20 MHz.

**1405 Plus 7L12 or 7L14, for Transmitter Frequency >20 MHz** — Within ±0.2 dB from 100 kHz to 10 MHz of picture carrier, increasing to ±0.3 dB at 15 MHz; within ±0.5 dB from 50 kHz to 20 MHz.

**For Transmitter Frequency of 0 to 20 MHz** — Within ±0.5 dB from 100 kHz to 15 MHz.

**System Span** — ≥200 kHz per division.

**Video Frequency Range** — 15-0-15 MHz.

### AVERAGE PICTURE LEVEL (APL)

**Variable** — 0 to 100 IRE in 10 IRE steps.

**Accuracy** — ±2 IRE.

**Three Preset Levels** — Preset A: 0 to 50 IRE. Preset B: 25 IRE to 75 IRE. Preset C: 50 IRE to 100 IRE.

**Horizontal Sync, Blanking, and Pedestal Duration** — Within NTSC (PAL — Option 01) limits (no vertical interval is provided). Transition time is 0.24 μs ±10%, from 10% to 90% points.

**Composite Sync Source Blanking** — 0 V turns cw on > -5 V turns cw off.

**Line Strobe** — TTL pulse from 0 to 5 V turns cw on.

### AURAL OUTPUT

**Output Frequency** — 10.396 kHz, ±0.01% (crystal controlled). Option 01, 9.058 kHz.

**Cw Output** — Amplitude variable up to ≥+12 dBm into 600 Ω. Harmonics down 45 dB or more.

**Crystal Requirements** — Series resonant: R<sub>1</sub> <2000 Ω; Q >5000; Case, HC/6U or HC/25U.

### MARKER CRYSTAL INSTALLATION

Because of the various international standards the 1405 Option 01 is shipped with the marker crystals installed. Frequencies installed are 0.75, 1.25, 2.25, 4.43, 5.00, and 5.75 MHz. Additional crystals are shipped with the unit.

*Note: Option 01 instruments are connected for a nominal power line voltage of 240 V. They are furnished with the standard North American plug unless Options A1, A2, A3, A4, or A5 is specified.*

### ORDERING INFORMATION

**1405 TV Sideband Adaptor**  
**525/60 Markers** ..... **\$5,460**  
**Option 01** — TV Sideband Adaptor (625/50 Markers) . +\$200

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland 250 V/10A, 50 Hz ..... **NC**

#### OPTIONAL ACCESSORIES

Rackmount-conversion kit for mounting 1405 or 1405 Option 01 in standard 19 in rack.  
 Order 016-0489-00 ..... **\$330**



## 7K11 CATV Preamplifier

**75 ohm Input Impedance and Calibration in dBmV**

**Extra Sensitivity for CATV and Field Intensity Measurements**

This 7000 Series plug-in preamplifier for use with the 7L12 or 7L14, is tailored to CATV and field intensity measurement applications, where extra sensitivity is required for demanding measurements. The 7K11 handles 12 channels without overload.

The 7K11 provides a 75 ohm input impedance and calibration in dBmV. Its low noise figure makes it especially suitable for signal-to-noise and low-level radiation measurements.

### CHARACTERISTICS

(with 7L12 or 7L14)

**Frequency Range** — 30 MHz to 890 MHz.

**Display Flatness** — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, -2.5 dB over the full frequency range.

**Sensitivity** — Signal + noise = 2X noise, in LIN mode at 50 MHz. -90 dBmV at 30 Hz, -80 dBmV at 300 Hz, -73 dBmV at 3 kHz, -65 dBmV at 30 kHz, -55 dBmV at 300 kHz, -45 dBmV at 3 MHz. Noise figure is no >5 dB.

**Intermodulation Distortion (with 7L12 or 7L14)** — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

**Reference Level** — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

**Input Impedance** — 75 Ω.

**Calibrator** — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

#### INCLUDED ACCESSORIES

BNC to BNC 50 Ω Cable, 5.5 in (012-0057-01); BNC to F Adaptor (013-0126-00); BNC to BNC 75 Ω Cable, 42 inch (012-0074-00).

**Order 7K11 CATV Preamplifier** ..... **\$1,050**

Limited quantities of the 2701 and 2703 Step Attenuators are still available. Call your nearest Spectrum Analyzer Sales Engineer for information.

SPECTRUM ANALYZERS

**PADS AND ADAPTORS**

- 75  $\Omega$  to 50  $\Omega$  Minimum Loss Attenuator with dc block, 5.7 dB loss. Order 011-0112-00 ..... **\$60**
- 75  $\Omega$  to 50  $\Omega$  Matching Attenuator with 11.25 dB conversion factor from dBm to dBmV with dc block. Order 011-0118-00 ..... **\$60**
- Fixed 10 dB Attenuator with 3 mm fittings for use with TR 502 with 7L12. Order 307-0553-00 ..... **\$30**
- Dc Block BNC to BNC maximum dc potential 50 volts. Order 015-0221-00 ..... **\$85**
- "F" Female to BNC Male Adaptor Order 013-0126-00 .. **\$15**
- BNC Female to "F" Male Order 103-0158-00 ..... **\$8.50**
- Calibrator Jumper 50  $\Omega$  BNC to BNC 5.5 in. Order 012-0214-00 ..... **\$35**
- Jumper Cable BNC to BNC 50  $\Omega$  42 in. Order 012-0057-01 ..... **\$17**
- Jumper Cable BNC to BNC 75  $\Omega$ , 42 in. Order 012-0074-00 ..... **\$17**
- "N" Female to BNC Male Order 103-0058-00 ..... **\$7.00**

**PROTECTIVE VINYL COVERS**

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe.

- 7000 Series 3 Hole Mainframe Cover Order 016-0192-01 ..... **\$20**
- 7000 Series 4 Hole Mainframe Cover Order 016-0531-00 ..... **\$20**
- 5000 Series Mainframe Cover Order 016-0544-00 ..... **\$25**

**RIGID FRONT COVERS**

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

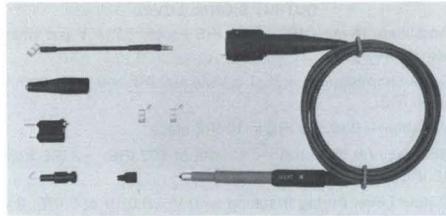
See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613, or the Option 02 Protective Front Cover for 5100 Series Mainframes.

**Protective Front Cover for existing 7603 or 7613 Mainframes:**

- Blue, Order 040-0835-00 ..... **\$175**
- Gray, Order 040-0628-00 ..... **\$150**

**GRATICULES, FILTERS**

- Plastic Implosion Shield and S A Graticule 7613 and 7623 Mainframes. Order 378-0625-07 ..... **\$9.50**
  - Plastic Implosion Shield and S A Graticule 7403 and 7603 Mainframes. Order 337-1439-01 ..... **\$8.00**
  - Plastic Implosion Shield and S A Graticule for all other 7000 Series Mainframes. Order 337-1159-02 ..... **\$8.00**
  - (Internal graticules are available with most 7000 Series mainframes)
  - EMC Metal Screen Mesh Filter for 7500, 7700, 7800, 7900 Series and 7613, 7623, 7633 instruments. Order 378-0603-00 ..... **\$55**
  - EMC Metal Screen Mesh Filter for 7400 Series and 7603 instruments. Order 378-0696-00 ..... **\$55**
  - Audio 20-20 kHz Log Graticule for 5000 Series instruments. Order 331-0429-00 ..... **\$2.50**
- Complete selection of colored filters is available in the accessories section.



**PROBES**

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L5, 7L12, 7L14, 492 and 496 Spectrum Analyzers:

- FET Probe P6201 to 900 MHz. Order 010-6201-01 ... **\$1,090**
  - FET Probe P6202A to 500 MHz. Order 010-6202-03 ... **\$583**
  - Conventional Probe P6056 Dc to 3.5 GHz 6 ft. Order 010-6056-03 ..... **\$154**
  - Conventional Probe P6057 Dc to 1.4 GHz with adaptor. Order 010-6057-03 ..... **\$159**
  - Current Probe P6022 to 150 MHz. Order 015-0135-00 . **\$360**
- Complete specifications are available in the probes and accessories section.

**CAMERAS**

A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 5000, 7000 and 490 Series Spectrum Analyzers are:

- Polaroid Film Pack C-59AP ..... **\$1,260**
  - C-5C Camera ..... **\$525**
- Complete specifications on all cameras are available in the Camera section.



**CARRYING CASES AND MOUNTS**

Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

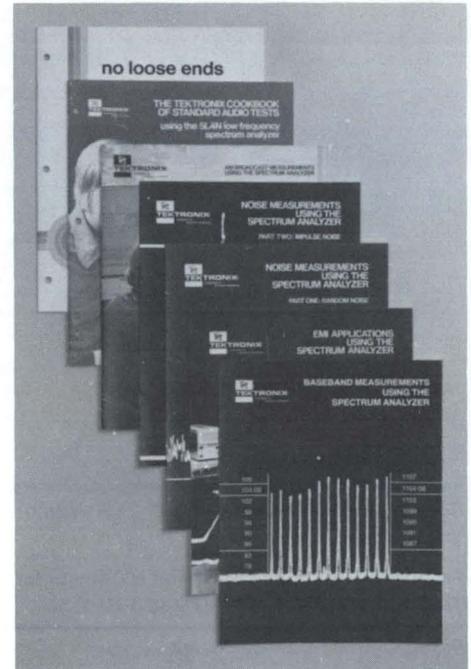
Metal carrying cases are available for the 7L5, 7L12, 7L14 or 7L18 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

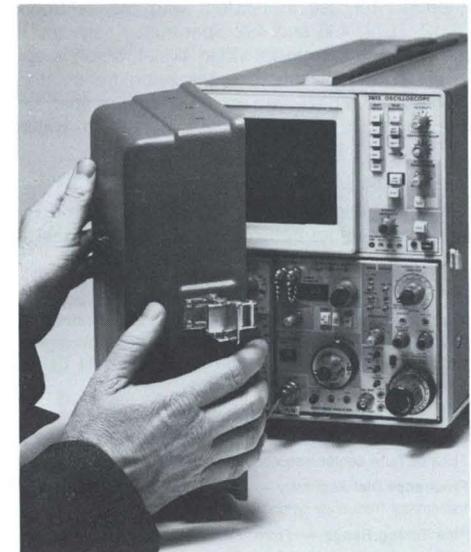
- Securing Kit fits 7L12 or 7L14. Order 016-0637-00 ..... **\$44**
- 3-wide Carrying Case for 7L14, 7L5 Option 25, 7L18. Order 016-0626-00 ..... **\$220**
- 2-wide Carrying Case for 7L12, 7L5. Order 016-0625-00 ..... **\$220**
- Luggage-type Carrying Case for 7603 Option 08, 7613 Option 08. Order 016-0628-00 ..... **\$450**
- (Analyzer must have 016-0637-00 Securing Kit) ..... **\$44**
- Hard Case (transit) for the 490 Series. Order 016-0658-00 ..... **\$625**
- Soft Case for the 490 Series. Order 016-0659-00 ..... **\$125**

Your local Sales Office or representative can quote prices and availability on any of these accessories.



Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMC, AM, FM, two-way radio and television measurements, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Sales Office or representative.



Option 08 protective front cover is shown with 7613 Mainframe.

# INSTRUMENT SYSTEMS DIVISION



Once again, Tektronix is proud to present a broad selection of oscilloscopes, general purpose instruments, and accessories to meet your instrumentation needs. With the important new additions to our product family and our continued emphasis on annual quality improvements, we believe that this year's products are the best we have ever offered.

Phil Robinson  
Vice President and General Manager  
Instrument Systems Division



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The Tektronix Instruments Division designs, manufactures, markets, supports, and services test and measurement products worldwide. The Instruments Division's products are test and measurement instruments and systems for scientists, engineers, and technicians in basic research, product design, manufacturing test, training, maintenance, and service applications in a broad range of industries and public institutions.

Instruments Division products include:

- Fully-automated desktop-, computer- and minicomputer-based signal processing systems.
- The state-of-the-art laboratory 7000 Series plug-in instruments.

- The 5000 Series instruments, that continue the 7000 Series concept of flexibility and expandability with a line of plug-ins and mainframes for the cost-conscious user.

- A complete line of portable oscilloscopes that range from hand-held, battery-operated miniscopes to full-featured, high-performance instruments that have become the standards against which all other portables are measured.

- Two modular and compact product lines of general purpose instrumentation, including the cost-effective TM 500s and the GPIB-compatible and programmable TM 5000s.

- Curve tracers that acquire complete information about a multitude of semiconductor devices and integrated circuits and present it in a quickly comprehended curve.

- A portable digital photometer/radiometer with eight interchangeable probes for measuring illuminance, irradiance, luminance, LED output, and relative intensity.

- Accessories, from cameras to isolation measurement devices, that support all Instruments Division products.

**MODULATED AND INTEGRATED INSTRUMENTS**

There are two basic configurations for test and measurement instruments: modular and integrated. Modular instruments, also called "plug-in" or "laboratory" models, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments (also called "monolithic"), are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all integrated instruments are portable, and some modular systems (such as scopes within the Tektronix General Purpose Instrument line) are designed for easy transport.

**Modular Design Advantages**

Examples of modular design in Tektronix Instrument Division products include the 7000 Series, the 5000 Series, the TM 500 General Purpose Plug-ins and the TM 5000 programmable units.

Versatility is the prime advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit are available by choosing the right plug-ins. Plug-ins can also extend the original instrument's range of functions. Digital multimeters, curve tracers, spectrum analyzers, and logic analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscope mainframes.

Performance is another advantage. In the case of the 7000 Series instrument, modularity gives you the maximum performance available in an oscilloscope. And modularity also allows you to upgrade your instruments to take advantage of advances in technology.

Often modular instruments can be very cost effective too, because within a given product line, they can be shared. For example the TM 500 test and calibration plug-ins used in the lab for design work can be inserted in a portable mainframe and easily carried to the site of a service problem. Or as another example, a few high-performance laboratory plug-ins from the 7000 Series can be shared among several 7000 Series mainframes.

Consider the versatility and performance advantages as you read about the wide range of Tektronix modular instruments: page 230 for the 7000 Series instruments, page 291 for 5000 Series instruments, and page 338 for General Purpose Instruments.

**Integrated Design Advantages**

Integrated instruments are often optimized for a single range of functions. One-piece instrument design can provide reductions in weight, increased ease of use, smaller size, lower power requirements, and often, higher performance/price ratios for your key requirements.

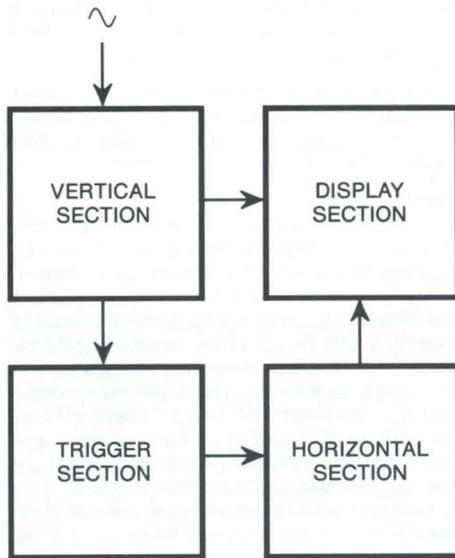
Portability can be essential for some test and measurement applications, and in these cases, an integrated design is often the best choice. Because a wide variety of options and optional accessories extend their ranges of applications, versatility can also be a feature of Tektronix integrated instruments.

Tektronix integrated scopes, either portable or rackmounted, are instruments where the design emphasis is often on the factors of economy, ruggedness, environmental protection, and internal or external battery power. See page 309.

## KEY OSCILLOSCOPE SPECIFICATIONS AND FEATURES

You should choose an oscilloscope by matching both performance and features to measurement applications. Don't choose by performance alone, because when features make measurements easier, the result is likely to be more accurate measurements. And if your applications involve repetitive measurements, features that make the measurement faster will be cost-effective.

The key oscilloscope specifications and features described below may help you make a decision.



### Vertical System Considerations

Because a faithful reproduction of the signal is necessary for measurement accuracy, and because very small signals must often be measured, the key specifications of the vertical system include bandwidth and sensitivity.

Depending on your applications, you might also want to consider oscilloscopes that display more than one signal at a time and those with differential or balanced inputs; these features are also described below.

### Bandwidth and Risetime

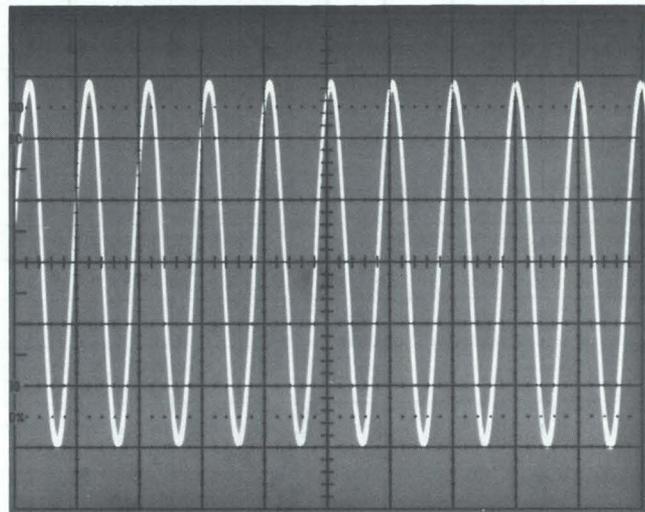
Bandwidth is the range of frequencies that a scope can handle with less than a 3 dB loss in amplitude compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, the bandwidth specification is commonly the highest frequency that can be displayed; dc as the lowest, is implied. The figure below illustrates bandwidth specifications.

While a bandwidth specification is essential for the vertical system(s) of a scope, bandwidth is also sometimes specified for the horizontal system (which gives you a chance to evaluate performance in X-Y measurement applications) and for trigger systems (which permits you to determine the range of possible triggering signals).

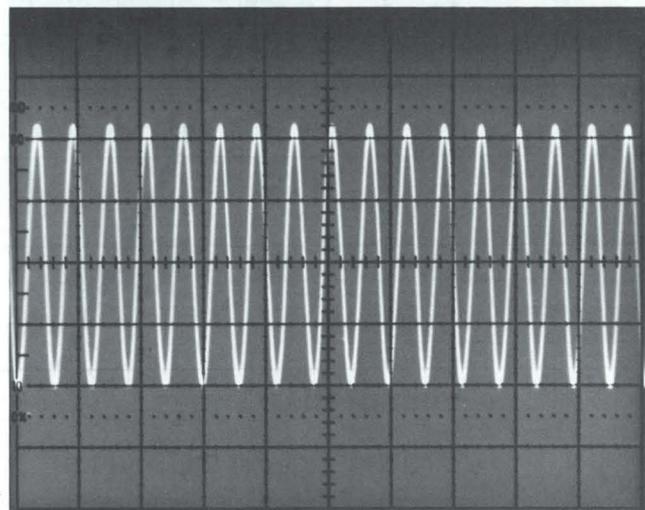
Although bandwidth is the most important spec when making amplitude measurements, risetime is the specification to use if you are making timing measurements.

The frequency response of most scopes is designed so that there is a constant that allows you to relate the bandwidth and risetime of the instrument with this approximation:

$$T_r = \frac{0.35}{BW}$$



0dB: 6 div at 50 kHz



-3 dB: 4.2 div at 100 MHz

Given either specification (bandwidth or risetime), you can derive the other and determine if the instrument is suitable for your applications. The rule of thumb for timing measurements is to use an instrument with a risetime at least five times faster than the measurement you expect to make. A 5:1 ratio gives you a risetime measurement with  $\leq 2\%$  error. Other ratios and measurement errors are shown in the chart below.

Note that very accurate absolute-risetime measurements are not always a requirement. When you are comparing risetimes, for instance, an instrument risetime equal to those being measured is often adequate.

**Sensitivity**

An oscilloscope sensitivity specification describes the input signal level needed to produce a stated deflection of the electron beam within the CRT. Specifications typically are given in mV/cm or mV/div; with this spec you can determine if small signals will be displayed with enough amplitude for you to make measurements quickly and accurately.

Note that at a given state-of-the-art, sensitivity and bandwidth are trade-offs. The small amount of noise in even the best input circuit will mask very small signals. Raising the bandwidth also increases the noise picked up by the amplifiers, requiring a larger signal to create a clear display. As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make cleaner low-level measurements at moderate frequencies.

Although sensitivity specifications are most often associated with oscilloscope vertical channels, this specification can also be provided for horizontal systems and for trigger circuits.

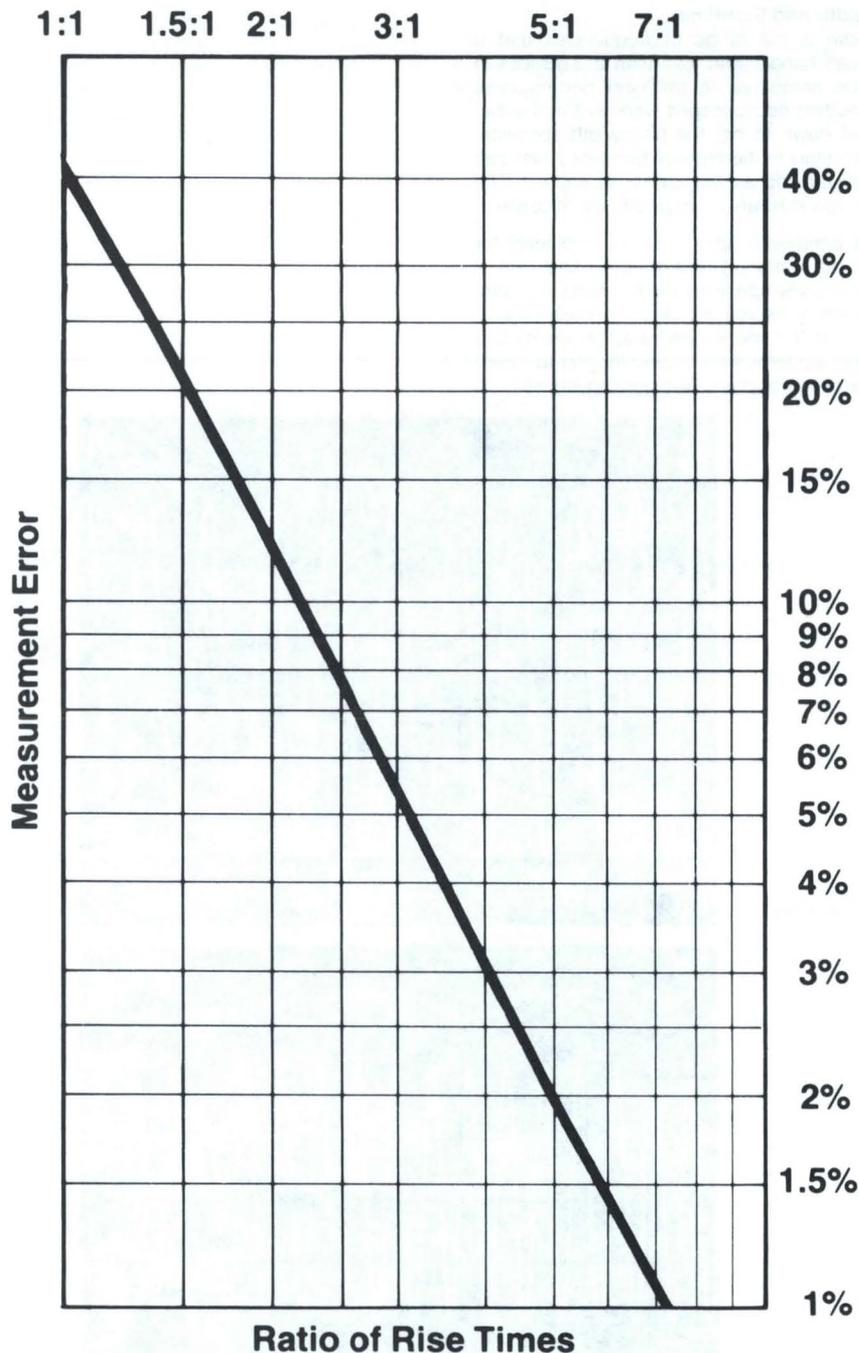
**Multiple Inputs**

It is often quite useful to be able to view more than one input signal without disturbing the connections to your scope. Common applications include: comparisons of a device's input and output signals; checking signals against standards; making timing and/or phase measurements between events. These measurement requirements are usually satisfied by dual-trace oscilloscopes that use electronic switching to alternately connect two input signals to a single deflection system. Dual-trace scopes offer the lowest cost and the best comparison capabilities (because there is a single horizontal amplifier and one set of deflection plates). On the other hand, since a fast transient event might occur on one channel while the beam is tracing the other, dual-beam scopes like the Tektronix 7844 (page 242) and 5113 (page 301) are recommended for viewing one-shot phenomena. The 5113 has two independent vertical systems and a common horizontal system and can display up to eight waveforms in its chop vertical operating mode. The dual-beam 7844 can be equipped with dual-time base plugins and then used to see a single event at different locations in the signal path, at two sweep rates if necessary.

**Vertical System Operating Modes**

Multiple inputs, the Add vertical operating mode, and the ability to invert one channel lets you cancel or reject any signal components equal in amplitude and phase that appears at both inputs. This ability provides a simple and accurate way to measure the difference between two signals, and of rejecting most unwanted signal components common to both inputs (such as power supply hum).

Other vertical operating modes are Alternate (in which a complete waveform from a vertical channel is drawn before switching to draw the other), Chopped (in which the scope draws small parts of the waveforms while switching back and forth between the channels at a fixed rate), and Trigger View.



The Trigger View mode is useful anytime you measure events dependent on an external triggering event. This capability is particularly useful in scopes such as the 465B, where a zero-delay trigger view circuit is provided.

### Horizontal System Considerations

The horizontal system of a modern oscilloscope provides a built-in sawtooth sweep generator. With this constant-speed horizontal deflection, measurements calibrated directly in units of time are possible. (As a consequence, the horizontal system of a scope is often called the time base.) This permits direct measurement of time between events, accurate time measurements on small portions of pulse trains, and even time measurements on single, nonrecurrent events.

### Sweep Speeds

How fast a sweep speed do you need? One rule states that for frequency measurements at moderate frequencies, a sweep capable of displaying one cycle across the full horizontal scale is usually considered adequate. For example, one cycle of a 1 MHz signal can be displayed across 10 div with a 10 ns/div sweep. Don't apply this rule at very high frequencies, however, as scopes seldom have sweeps that fast.

Another approach emphasizes risetime measurements. For maximum accuracy here, the scope should show the step signal (squarewave, pulse, etc.) across most of the full vertical scale with the rising portion of the signal at nearly a 45° slope. For very fast risetimes, this objective is rarely met because of compounding difficulties and the cost of providing extremely fast sweeps which are both linear and accurate.

Though neither rule can be applied at the very limits, fast sweep speeds are readily available: sweeps to 10 ns (1 ns/div, magnified) in the portable 475, 475A and 485; to 200 ps/div with plug-in time bases for laboratory scopes; or to 10 ps/div with sampling plug-ins. (See Sampling Applications below.)

### Delayed Sweep Measurements

Delayed sweep scopes can offer you many measurement advantages. If the scope has two calibrated time bases and the alternate horizontal operating mode (electronic switching of the trace between time bases), then convenient comparisons of the same signal at two different sweep speeds are possible.

If the second time base has an independent trigger, then jitter-free measurements on the delayed sweep are possible.

In every case, timing measurements with delayed sweep are easier to make, and in most cases, there is increased timing measurement accuracy. Many plug-in time bases for laboratory scopes and most portable scopes offer delayed sweep.

### Accuracy

Accuracy in a scope's horizontal system is as important to timing measurements as vertical accuracy is to amplitude measurements. Horizontal accuracy to 1.5% is possible with several 7000 Series plug-in time bases and to 1% with the 475 and 475A Portable oscilloscopes.

### Trigger System Considerations

Besides sensitivity and bandwidth, the flexibility of a trigger system should be a consideration when choosing a scope. Some trigger system features you might need for your measurement applications include:

High and low frequency reject coupling — for stable triggering with noisy signals.

TV triggering — for automatic synchronization with video signals.

Alternate triggering — for steady display of either signal with dual-channel scopes.

Peak-to-peak auto triggering — for quick, convenient triggering with automatic level limits.

Variable trigger holdoff — permits trigger holdoff period to be varied to trigger on repetitive complex waveforms.

Single sweep operation — for special applications such as capturing a transient pulse and for CRT photography.

### CRT System Considerations

CRT system specifications will tell you how well the scope can display waveforms for direct viewing and for photography. A full complement of CRT system controls contributes greatly to the instrument's ease of use.

### CRT Controls

CRT system controls to consider include:

**Beam Finder** — A single pushbutton that allows you to quickly locate any off-screen trace.

**Auto Focus** — Auto focusing on both laboratory and portable scopes reduces the need for manual readjustments with changes in trace intensity; very useful when traces are displayed at different sweep rates as in alternate time base operations.

**Auto Intensity** — Reduces trace intensity adjustments over a wide sweep-speed range.

**External Z-Axis Input** — Permits trace brightness modulation, makes some measurements easier by identifying events with an intensified zone on the trace.

### Writing Speed and Photographic Writing Rate

The writing speed of a scope is the maximum speed at which the CRT's electron beam can move and still produce a visible or photographable trace. The writing speed is dependent on the CRT's phosphor and the electronics. The photographic writing rate is additionally dependent on the camera, the film, and the technique you use. Your Tektronix sales engineer, representative, or distributor will be glad to help you determine the writing speed or photographic writing rate necessary for your applications. For more camera information refer to page 412.

### Selecting a Phosphor

The catalog description of each oscilloscope indicates the phosphors normally supplied or available as options. While a special phosphor may be desirable for a specific measurement application, remember that each phosphor has its own color, persistence, burn resistance, etc. Improvements in one characteristic are usually at the expense of others. The chart below provides comparisons.

COMPARATIVE CRT PHOSPHOR DATA

Phosphor*4		Fluorescence	Phosphorescence Where Different from Fluorescence	Relative Luminance*1	Relative Photographic Writing Speed*2	Decay	Relative Burn Resistance	Comments	Ordering Information Option
JEDEC	WTDS								
P1	GJ	Yellowish-green	—	50%	20%	Medium	Medium	Replaced by P31 in most applications	Special order
P4	WW	White	—	50%	40%	Med-Short	Med-High	Television displays	74
P7	GM	Blue	Yellowish-green	35%	75%	Long	Medium	Long decay, double-layer screen	76
P11	BE	Blue	—	15%	100%	Med-Short	Medium	For photographic applications	78
P31	GH	Green	—	100%	50%	Med-Short	High	General purposes, brightest available phosphor	80
P39	GR	Yellowish-green	—	27%	NA*3	Long	Medium	Photographic applications	40
P43	GY	Yellowish-green	—	40%	NA*3	Medium	Very High	High current density phosphor	Special order
P44	GX	Yellowish-green	—	68%	NA*3	Medium	High	Bistable storage	
P45	WB	White	—	32%	NA*3	Medium	Very High	Monochrome TV displays	

\*1 Measured with Tektronix J16 Photometer and J6523 Luminance Probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.

\*2 P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

\*3 Not available.

\*4 Tektronix is adopting the Worldwide Phosphor Type Designation System (WTDS) as a replacement for the older JEDEC "P" number system referenced in this catalog. The chart lists the comparable new WTDS designations for the most common "P" numbers.

**DIGITAL ADDITIONS**

You can make delay and time interval measurement with digital ease on several Tektronix oscilloscopes. The DM 44 factory-installed option for five of the 400 Series scopes allows you to read the delay time, time interval, or frequency right from an LED readout, with no calculation or interpolation required. The DM 44 also incorporates a digital volt/ohm meter and temperature-measurement capabilities.

The 7B10, 7B15, 7B85 and 7B80 plug-ins for the 7000 Series oscilloscopes also provide  $\Delta$ time measurements. With these plug-ins the time interval measurement can be shown on the screen using the 7000 Series CRT readout capability.

For 7000 Series instruments, there is a wide variety of other digital plug-ins. These include a universal counter/timer, a digital multimeter with a temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special read-out unit to label each test for future reference.

The digital plug-ins offer many advantages over separate test units such as: increased accuracy, scope-controlled digital measurements, measuring convenience and confidence, easier and faster solutions to complex problems, a lower dollar investment, more bench space, and signal conditioning.

**SAMPLING APPLICATIONS**

Sampling is a powerful technique for examining very fast repetitive signals. In principle, sampling is similar to the use of stroboscopic light to study fast mechanical motion. Progressive samples of different portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown (all seemingly at one time) on the screen of a CRT. The graph produced is a replica of the sampled waveforms.

This sampling technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal occurs. The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way.

Sampling scopes are capable of resolving events that occur in less than 30 ps on an "equivalent" time base of less than 20 ps/div with less than 5 mV of peak amplitude.

If your measurement needs require equivalent bandwidths to 14 GHz or sweeps to 10 ps/div, consider the sampling plug-ins described on page 285.

**MODULAR NONSTORAGE OSCILLOSCOPES**

Product	Bandwidth* <sup>1</sup>	Minimum Deflection Factor	Number of Traces	Maximum Sweep Rate	Delayed Sweep	Page	Price* <sup>2</sup>
7104	1 GHz	10 mV/div at BW	up to 4	200 ps/div	X	238	\$20,160
7904 R7903	500 MHz	10 mV/div at BW 10 $\mu$ V/div 1 mA/div	up to 4	500 ps/div	X	240 240	\$8,510 \$8,035
7844	400 MHz	20 mV/div at BW 10 $\mu$ V/div 1 mA/div	up to 4 Dual-Beam	1 ns/div	X	242	\$12,665
7704A Opt 09	250 MHz	20 mV/div at BW 10 $\mu$ V/div 1 mA/div	up to 4	2 ns/div	X	244	\$4,760
7704A	200 MHz	10 mV/div at BW 10 $\mu$ V/div 1 mA/div	up to 4	2 ns/div	X	244	\$4,260
7603	100 MHz	5 mV/div at BW 10 $\mu$ V/div 1 mA/div	up to 4	5 ns/div	X	246	\$2,700
5440	50 MHz	5 mV/div at BW 10 $\mu$ V/div 0.5 mA/div	up to 8	5 ns/div	X	296	\$2,615
5110	2 MHz	1 mV/div at BW 10 $\mu$ V/div 0.5 mA/div	up to 8	100 ns/div	X	301	\$1,425
7603N11S	Ruggedized oscilloscopes system [meets or exceeds MIL-0-24311 (EC) (AN/USM 281 Specs)]	5 mV/div at BW	up to 2	5 ns/div	X	248	\$7,580

\*<sup>1</sup> Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

\*<sup>2</sup> Price does not include plug-ins.

**PORTABLE NONSTORAGE OSCILLOSCOPES**

Product	Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Page	Price
485	350 MHz	5 mV/div at BW	X	1 ns/div	X	312	\$7,690
475A	250 MHz	5 mV/div at BW	X	1 ns/div	X	314	\$4,630
475	200 MHz	2 mV/div at BW	X	1 ns/div	X	314	\$4,300
465B	100 MHz	5 mV/div at BW	X	2 ns/div	X	316	\$3,140
465M	100 MHz	5 mV/div at BW	X	5 ns/div	X	318	\$3,860
2337	100 MHz	5 mV/div at BW	X	5 ns/div	X	320	\$3,145
2336	100 MHz	5 mV/div at BW	X	5 ns/div	X	320	\$2,550
2335	100 MHz	5 mV/div at BW	X	5 ns/div	X	320	\$2,845
2215	60 MHz	2 mV/div at BW	X	5 ns/div	X	322	\$1,450
2213	60 MHz	2 mV/div at BW	X	5 ns/div	X	322	\$1,200
335	35 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div	X	324	\$3,015
305	5 MHz	5 mV/div at BW	X	100 ns/div	X	325	\$2,315
221	5 MHz	5 mV/div at BW	X	100 ns/div	X	326	\$1,765
213	1 MHz	20 mV/div at BW 5 mV/div	X	400 ns/div	X	327	\$2,320
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 $\mu$ s/div	X	328	\$1,710
SC 504* <sup>1</sup>	80 MHz	5 mV/div at BW	X	5 ns/div		384	\$3,000
SC 502* <sup>1</sup>	15 MHz	5 mV/div at BW 1 mV/div	X	20 ns/div		386	\$2,210

\*<sup>1</sup> The SC 502 and SC 504 are oscilloscopes that must be plugged into a TM 500/TM 5000 Mainframe for operation. Please turn to pages 384 and 386 for more information.

## STORAGE

When a conventional oscilloscope cannot capture an event and display it for your measurements because the signal is too slow, or too fast and infrequent, or when you need to compare events that happen at different times instead of simultaneously, consider a storage scope. These are obvious applications, but there are many other situations that also call for the unique advantages of storage including:

- Observing signal changes during circuit adjustments
- Comparing new signals with a standard
- Increasing the brightness of a dim, low-repetition-rate signal for normal viewing
- Reducing flicker or noise in a signal
- Babysitting (unattended monitoring) for a transient event
- Capturing fast signals that occur infrequently or only once
- Capturing a complete display of a slowly occurring signal
- Enhancing other record-keeping techniques like photography

With the right Tektronix storage instrument, the capabilities you need are available, and the storage time can be anywhere from a few minutes to a practically unlimited length of time depending on your choice of instruments.

## Types of Storage Oscilloscopes

Two broad categories of storage instruments are named for the storage medium. CRT storage scopes store the captured waveform when the electron beam writes on a target within the cathode-ray tube. Digital storage scopes quantize the waveform and then store it in a digital memory. In addition there are waveform digitizers; a very special class of storage instruments available in the Tektronix 7000 Series. Within each category there are different technologies and each has its own set of features and benefits.

### Bistable CRT Storage

The phosphor in a bistable CRT storage scope has two stable states: written and unwritten. Once stored, this phosphor allows waveforms to be displayed typically for several hours, or until it is erased by the operator. Bistable storage is the easiest CRT storage type to use. It is also the least expensive CRT storage technology. It features bright, long-lasting displays, but in comparison with other storage technologies, bistable storage displays have less contrast.

The advantages of bistable storage make it particularly useful for mechanical measurements, signal comparisons, and data recording.

Split-screen viewing is another advantage of most bistable storage scopes. The feature allows a reference waveform to be stored on one half the screen while the other half can be used to store the effects of changes made on the circuit. You can also use the split screen to have the reference waveform in the stored mode and the other half of the display in the nonstored mode to monitor an external input.

### Variable Persistence CRT Storage

If you don't need to store waveforms for hours at a time, variable-persistence CRT storage has advantages. The variable-persistence storage CRT has a storage mesh where the electron beam writes the input signal; thereafter, flood guns in the CRT illuminate the phosphor where the storage mesh permits.

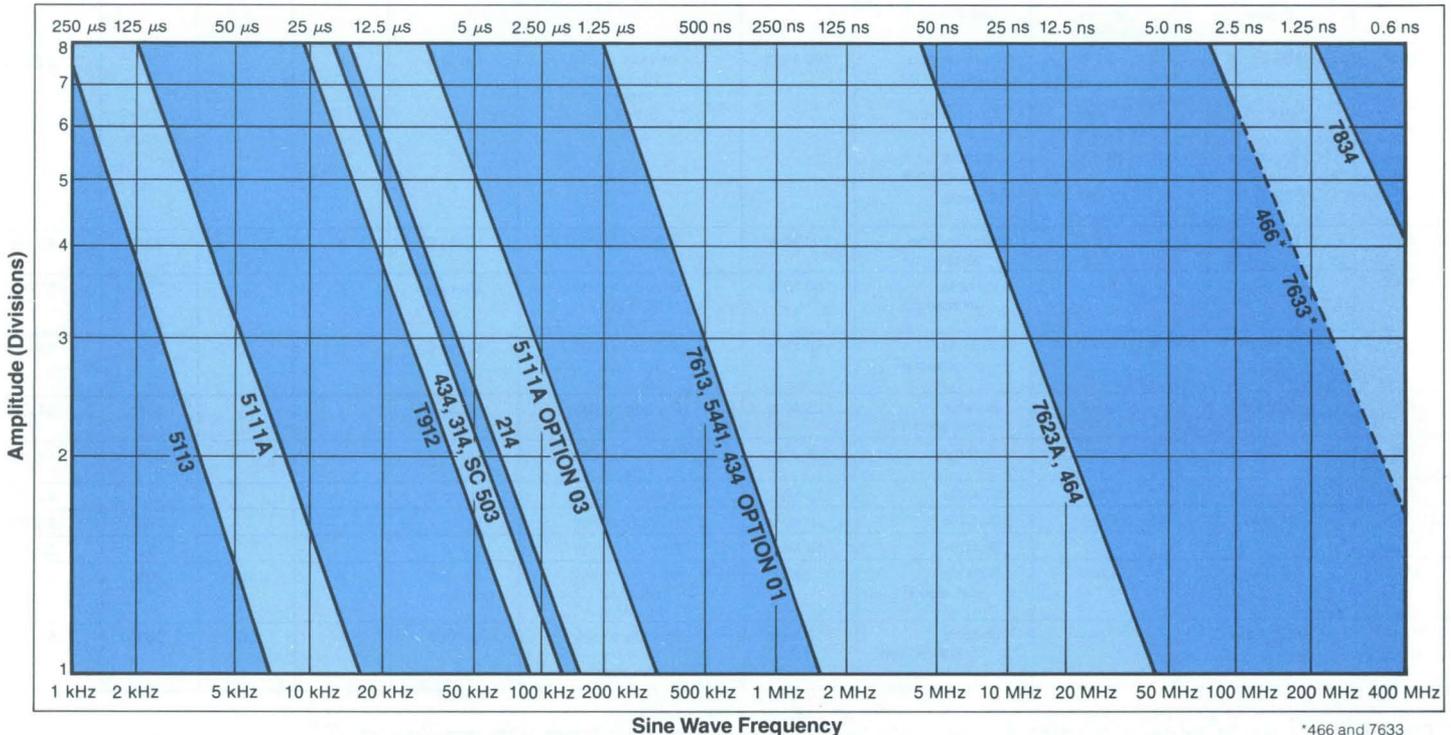
CRT storage controls vary the charge on the mesh, allowing you to control the contrast between the trace and the background and to fine tune how long the trace is stored.

The first capability provides easy viewing with high contrast between the dark background and bright waveforms. And this type of storage provides the best displays when viewing traces with varying intensities (such as delaying and delayed sweeps, or traces with external Z-axis intensity modulation).

Varying the persistence permits you to set up the scope so that the entire waveform can be viewed, yet the stored trace will fade from view just as a new waveform is being stored. Or you can view several traces before the first one fades from view. Then you can see signal response variations as you make changes in a circuit.

## CRT STORAGE PERFORMANCE

### Step Rise Time



\*466 and 7633 limited to 100 MHz vertical bandwidth

Variable persistence can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Aberration or jitter not common to all traces will not be stored or displayed. Low repetition rate, fast risetime signals that are not discernible on conventional CRT's can be easily viewed with this storage technology by allowing each repetition to build up the trace brightness.

Applications for variable persistence storage include spectrum analysis, time-domain reflectometry, sampling, and any other measurements that require displays of low-repetition-rate signals.

**Fast Transfer CRT Storage**

Fast transfer storage scopes use a CRT with a special intermediate mesh target optimized for

speed. This target captures the waveform and then transfers it to another mesh, one optimized for longer-term storage. As the name implies, the fast transfer storage mode provides increased writing speed (see the next heading) for the 466 portable oscilloscope and the 7623A, 7633, and 7834 lab scopes.

The second target can also be designed to offer bistable, variable persistence or both modes in combination with the transfer mesh or by itself. In the 7623A, 7633, and 7834, this combination of capabilities provides unique multi-mode storage instruments. Using front panel controls, you can select the operating mode suited to your specific measurement situation.

**Stored Writing Speed**

For CRT storage scopes, the storage capability specification is the stored writing speed. This figure of merit is expressed in distance per unit of time. Often div/μs is more meaningful in terms of your measurements. But because some scopes have nonstandard sized graticules (i.e., other than 1 cm square major divisions) cm/μs is useful for comparisons.

The specification is dependent on the speed and amplitude of the input signal. If you know the pulse risetime or sinewave frequency of the input signal and the amplitude of the waveform you want to display, you can use the chart on page 221 to determine which writing speed you need.

**CRT STORAGE OSCILLOSCOPES**  
(in order of Stored Writing Speed)

Product	Stored Writing Speed	View Time	Type of Storage	Bandwidth*1	Minimum Deflection Factor	Number of Traces	Delayed Sweep	Plug-in	Page	Price
7834	5500 div/μs	30 s*3	Fast variable persistence	400 MHz	20mV/div at BW 10mV/div at 325 MHz	Up to 4	X	X	252	\$11,705
	776 div/μs	30 min*4 minimum	Fast bistable							
	12 div/μs	30 s*3	Variable persistence							
	0.2 div/μs	30 min*4 minimum	Bistable							
466	3000 div/μs	15 s*3	Fast variable persistence	100 MHz	5mV/div at BW	Up to 2	X		332	\$6,700
	3 div/μs	15 s*3	Variable persistence							
7633	2200 div/μs	30 s*3	Fast variable persistence	100 MHz	5mV/div at BW 10μV/div 1mA/div	Up to 4	X	X	254	\$7,765
	400 div/μs	30 min minimum	Fast bistable							
	3 div/μs	30 s*3	Variable persistence							
	2 div/μs	30 min minimum	Bistable							
7623A	150 div/μs	30 s*3	Fast variable persistence	100 MHz	5mV/div at BW 10μV/div 1mA/div	Up to 4	X	X	255	\$5,950
	50 div/μs	30 min minimum	Fast bistable							
	0.5 div/μs	30 s*3	Variable persistence							
	0.03 div/μs	30 min minimum	Bistable							
464	110 div/μs	15 s*3	Fast variable persistence	100 MHz	5mV/div at BW	Up to 2	X		332	\$5,695
	0.5 div/μs	15 s*3								
7613	5 div/μs	1 hr	Variable persistence	100 MHz	5mV/div at BW 10μV/div 1mA/div	Up to 4	X	X	257	\$5,025
5441	5 div/μs	1 hr	Variable persistence	50 MHz	5mV/div at BW 10μV/div 0.5mA/div	Up to 8	X	X	297	\$4,425
434	5 div/μs	4 hrs	Bistable split screen	25 MHz	10mV/div at BW 1mV/div	Up to 2			334	\$4,840
214	0.5 div/μs	1 hr	Bistable	500 kHz	10mV/div at BW 1mV/div	Up to 2			336	\$2,320
314	0.4 div/μs	4 hrs	Bistable	10 MHz	2mV/div at BW	Up to 2			335	\$3,655
SC 503*2	0.4 div/μs	4 hrs	Bistable	10 MHz	1mV/div at BW	Up to 2			385	\$3,240
T912	0.25 div/μs	4 hrs	Bistable	10 MHz	2mV/div at BW	Up to 2			337	\$2,170
5113	0.2 div/μs	10 hrs	Bistable split screen	2 MHz	1mV/div at BW 10μV/div 0.5mA/div	Up to 8 dual-beam	X	X	301	\$3,350
5111A	0.02 div/μs	10 hrs	Bistable split screen	2 MHz	1mV/div at BW 10μV/div 0.5mA/div	Up to 8	X	X	300	\$2,300

\*1 Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

\*2 The SC 503 is an oscilloscope that must be plugged into a TM 500/TM 5000 Mainframe for operation. Please turn to page 340 for more information.

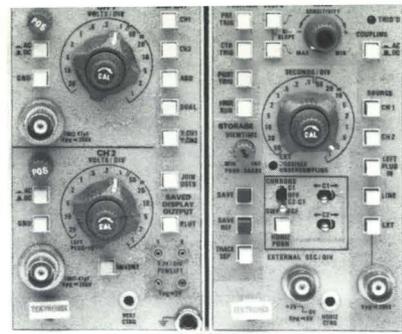
\*3 View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.

\*4 Save intensity at minimum

My phone number is \_\_\_\_\_ Ext \_\_\_\_\_

Send me information on:

- 5D10 Waveform Digitizers for 5000 Series mainframes
- Computer Graphic Products
- GPIB Products
- Signal Processing Systems
- \_\_\_\_\_ Product Applications
- Customer Training for \_\_\_\_\_ Products
- Tektronix Service Programs for \_\_\_\_\_ Products
- Please drop me from your mail list.



5D10 Waveform Digitizer

Name \_\_\_\_\_ Title \_\_\_\_\_

Firm \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

(Please type or print)



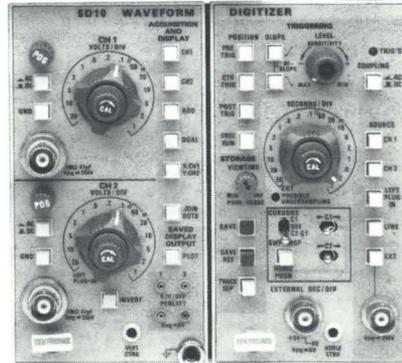
D659

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- Computer Graphic Products
- GPIB Products
- Signal Processing Systems
- \_\_\_\_\_ Product Applications
- Customer Training for \_\_\_\_\_ Products
- Tektronix Service Programs for \_\_\_\_\_ Products
- Please drop me from your mail list.



5D10 Waveform Digitizer

Name \_\_\_\_\_ Title \_\_\_\_\_

Firm \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

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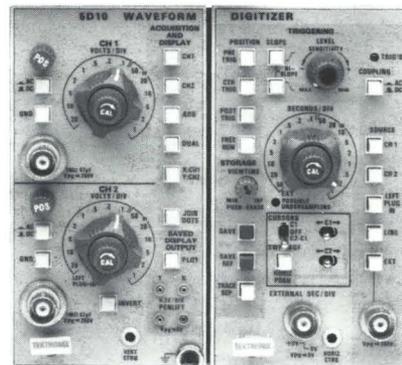
D659

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- GPIB Products
- Signal Processing Systems
- \_\_\_\_\_ Product Applications
- Customer Training for \_\_\_\_\_ Products
- Tektronix Service Programs for \_\_\_\_\_ Products
- Please drop me from your mail list.



5D10 Waveform Digitizer

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Firm \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

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D659

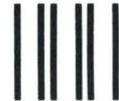


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**Digital Storage**

The fundamental difference between digital storage scopes and CRT storage scopes is that digital scopes quantize the captured waveform and CRT storage scopes do not. Having quantized waveforms in a digital memory gives you measurement capabilities not possible with any other kind of oscilloscope.

With digital storage scopes, you have the advantage of pretrigger viewing. In other words you can look at a waveform both before and after the trigger event. Another feature is babysitting; available because the digital storage scope's trigger can stop, as well as start signal acquisition.

Other digital storage scope advantages include signal processing features like averaging a number of samples of the input signal to reduce the effects of noise; performing calculations on the waveform parameters; or outputting the signal data over RS-232 or GPIB standard interfaces.

Digital storage scopes are typically easy to use and give you crisp, clear displays. Because the data is stored in a digital memory, no fading or blooming of the trace on the CRT phosphor will occur, and storage time is essentially unlimited. This type of storage is excellent for many applications involving single-shot or low-repetition signals, or where the unique advantages of a digitized waveform may be the answer to your measurement needs.

**Quantization Techniques**

Within digital storage scopes there are two main techniques of quantizing signals — and the technique has a direct effect on the applications of the instruments in that only one kind of digital storage scope can capture single-shot signals.

The digital scopes that can capture signals in a single sweep use what is called "real-time sampling". Other digital storage scopes use "equivalent-time sampling". There are two equivalent-time sampling methods and both require many

repetitions of the input signal. In exchange for that requirement you have the ability to measure signals more than ten times faster than can be captured with real-time sampling.

**Digital Storage Scope Specifications**

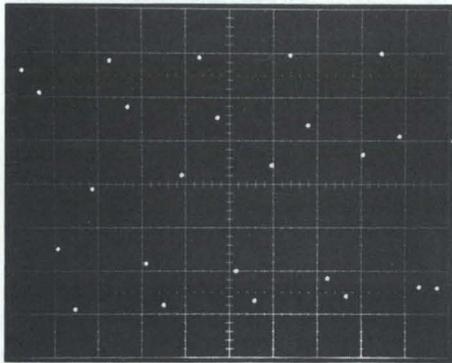
For digital storage oscilloscopes that use real time sampling, there is a useful storage bandwidth specification. It expresses the highest frequency sinewave that can be captured in a single sweep and displayed so that you can make measurements. Both the digitizing rate (how often the scope takes samples) and the display reconstruction technique (how the scope displays what's in its memory) must be taken into account in the useful storage bandwidth. See the examples below.

For Digital scopes using equivalent time sampling, the specification is "equivalent-time bandwidth", the highest frequency signal that can be stored and displayed with less than 3 dB signal amplitude loss. Besides the analog specifications that are common to all oscilloscopes, other specifications of interest to digital scope users are:

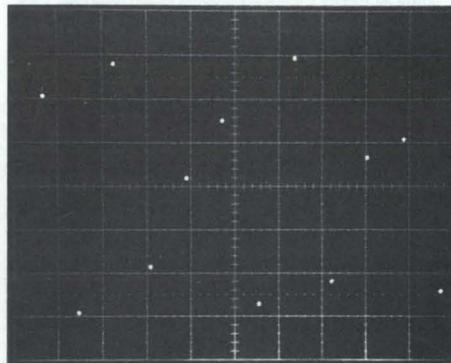
**Maximum Digitizing Rate** — How often the instrument takes samples of the input signal.

**Vertical Resolution** (usually expressed in "bits of resolution") — How finely the instrument can discriminate between signals very much alike in voltage; for example, 8 bits of resolution is 0.391% when expressed as a percentage, and 10 bits is 0.098%.

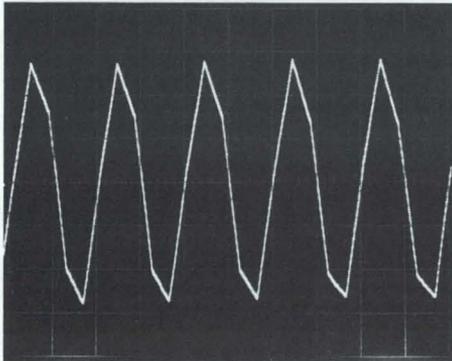
**Data Word Per Waveform or Horizontal Resolution** — How many words of digital memory are used to store the captured waveform; if the signal is stored in 512 data words, the horizontal resolution is 1 in 512 or 0.195%.



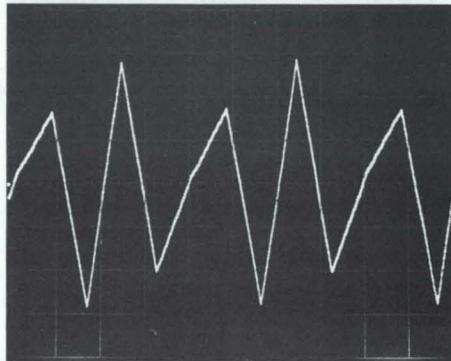
With Dot Display 5 MHz Signal



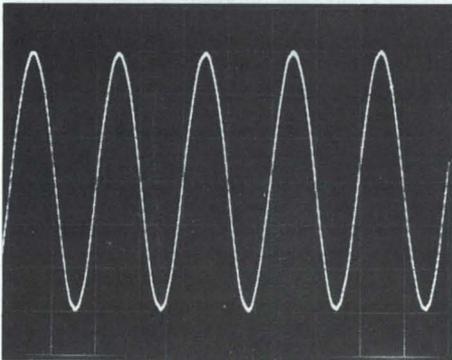
10 MHz Signal



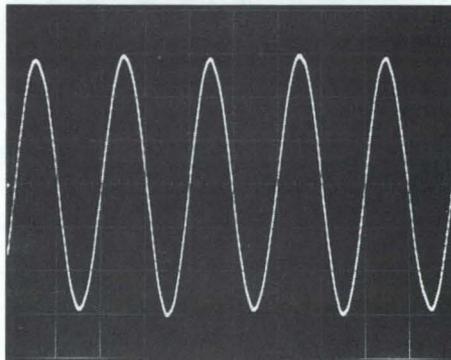
With Pulse Interpolator 5 MHz Signal



10 MHz Signal



With Sine Interpolator 5 MHz Signal



10 MHz Signal

Digitizing Rate — 25 MHz

**DIGITAL OSCILLOSCOPES AND WAVEFORM DIGITIZERS**

Type	Analog BW	Maximum Digitizing Rate	Vertical Resolution	Data Words per Waveform	Maximum Stored Waveforms	Useful* <sup>1</sup> Storage BW (SS)	Equip** <sup>2</sup> Storage BW (rep)	Page	Price
390AD	15 MHz	30 MHz dual channel 60 MHz CH 1	10 Bits	2048 dual channel 4096 CH 1 only	2	15 MHz	15 MHz	261	\$14,530
468	100 MHz	25 MHz	8 Bits	512 in Alt 256 in chop	4	10 MHz	—	331	\$6,500
5223	10 MHz	1 MHz	10 Bits	1024/plug-in	4	100 kHz	10 MHz	294	\$4,930
7854	400 MHz	500 kHz Ext Clock	10 Bits	Up to 1024	Up to 40	50 kHz	400 MHz	259	\$13,750
7912AD	500 MHz	100 GHz	9 Bits	512	1	500 MHz	500 MHz	265	\$24,800
7612D	90 MHz	200 MHz	8 Bits	Up to 2048	Up to 16	80 MHz	80 MHz	263	\$26,400
5D10		1 MHz	8 Bits	1024 Single Trace 512 Dual Trace	3 w/Dual Differential in the left plug-in slot	100 kHz		302	\$2,850
7D20		40 MHz	8 Bits	Up to 1024	6	10 MHz	70 MHz	268	\$7,750

\*Useful Storage Bandwidth is a measure of the highest frequency sine wave that can be stored in a single sweep and displayed in a visually useful manner. This is dependent on both the maximum digitizing rate as well as the display reconstruction technique used.

\*\*Equivalent Storage Bandwidth indicates the highest frequency repetitive signal that can be stored and displayed with less than 3 dB loss of signal amplitude using equivalent time digitizing techniques.

Your local Tektronix Sales Engineer, Representative, or Distributor can help you determine the digital oscilloscope parameters necessary to meet your measurement applications needs.

The Tektronix digital storage scopes are:

468	Portable Storage Oscilloscope. Real-time sampling to 10 MHz and special features like the envelope operating mode, a very useful glitch-catching feature.
5D10	Waveform Digitizing Plug-in for the 5000 Series offering real time sampling to 100 kHz, CRT readout, 8-bit vertical resolution, and up to 1024 data words per waveform.
5223	Digitizing Oscilloscope with 10 bits of vertical resolution, roll mode, X-Y plotter output, and optional GPIB interface.
7D20	Waveform-Digitizing Plug-in with dual samplers (capable of capturing two independent 25-ns-wide transient events) and with displays of six independent signals as well as a reference waveform.
7854	Waveform Processing Oscilloscope with 400 MHz equivalent-time bandwidth, keystroke programming, and calibrated sweep speeds to 500 ps/div.

**WAVEFORM DIGITIZERS**

Along with conventional oscilloscopes, plug-in or integrated, and with storage oscilloscopes, both digital and analog, Tektronix leads the way in waveform acquisition instruments. This commitment to the future of test and measurement instrumentation can be seen today in three programmable waveform digitizers.

The 390AD Programmable Waveform Digitizer is a dual-channel waveform-acquisition digitizer with a maximum sampling rate of 30 MHz (or 60 MHz in single channel operations). Vertical resolution is 10 bits and the memory length is 2048 data words (4096, single channel) with one breakpoint provided to allow changing the digitizing rate during waveform digitizing. More information is available on page 261.

The 7612D Programmable Waveform Digitizer has full dual-channel operations, a maximum sampling rate of 200 MHz, selectable record lengths from 256 to 2048 data words, and the ability to change sampling rates several times during waveform digitizing. See page 263.

The 7912AD Programmable Transient Waveform Digitizer captures waveforms with a scan converter CRT capable of recording 500 MHz single-shot signals. See page 265 for more information if your applications demand equivalent digitizing rates to 100 GHz and 9-bit resolution both vertically and horizontally.

**TM 500 MANUAL INSTRUMENTS**

The Tektronix TM 500 line is a modular system. One-, three-, four-, five-, and six-compartment mainframes accept a broad selection of plug-in instruments. The mainframe provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as important, TM 500 mainframes also provide a signal control and data interface between modules. This allows TM 500 instruments to work either individually or together as integrated measuring systems. The Tektronix General Purpose Instrument line is extensive—more than 35 instruments, including

digital multimeters, counter/timers, power supplies, signal sources, oscilloscopes, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can also apply TM 500's capability to unusual applications.

The TM 500 General Purpose Instrument line has several configurations designed for portability. The TM 515 Traveler Mainframe travels like luggage but works like a lab bench setup. Although it is attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat on most airlines), the TM 515 is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. The TM 503 three-compartment mainframe or the TM 504 four-compartment mainframe, with carrying case or protective cover, provide additional portability for the TM 500 instruments. Again, relatively lightweight, rugged construction, and convenient size are the key to portability.

**TM 5000 PROGRAMMABLE INSTRUMENTS**

The Tektronix TM 5000 products extend the TM 500 concept of configurability to a line of IEEE Standard 488 compatible, fully programmable measurement, stimulus, and interfacing instruments. Tek's TM 5000 programmables are the easiest IEEE Standard 488 test and measurement instruments you can use. Because they are compatible with our TM 500 line of modular instrument, it is possible to configure literally hundreds of customized systems—systems that are programmable, manual, or hybrid—with plug-in, pull-out ease.

Tek's *Standard Code and Formats* make communication between TM 5000 instruments easier than ever before. This same set of *Standard Codes and Formats* is used to communicate with all the Tektronix IEEE Standard 488 instruments, such as the 7854 and 468 oscilloscopes, and the 492P Spectrum Analyzer. TM 5000 commands are mnemonic. Each bus command is in "standard engineering English", matching the front panel nomenclature—ideal for the programmer who realizes the frustrations of working with many of today's instruments.

With the Learn Mode, one keystroke transfers a complete front panel setup to the controller for storage in memory. This greatly increases the productivity of the engineer by reducing setup time where test settings are constantly changing. You can change a routine without having to reprogram the whole system.

All TM 5000 programmables have an internal diagnostics capability designed right in. They perform self-test on power-up, and indicate an error if a malfunction has occurred. Plus they've all been designed for fast troubleshooting using signature analysis. All are UL listed.

As with TM 500, TM 5000 programmable systems take up less than half the space of standard rackmount equipment. This size advantage really pays off—on the bench, on the manufacturing floor, or in the field where portability is essential.

# SIGNAL PROCESSING SYSTEMS

## CONTENTS

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Desktop Computer Based Systems .....	229



Computer - Based 7912AD System



Desktop Computer Based 7854 System

### Precise automatic waveform measurements for demanding applications in research, design, manufacturing and quality assurance

#### Automatically save hours, days, even months of work

Tektronix Signal Processing Systems are specially designed to handle the increasingly complex, expensive, and time-consuming task of waveform characterization.

They're the first measurement systems to offer all the power and flexibility of oscilloscope acquisition, coupled with fully automatic analysis. They're the first systems to feature signal processing software with extensive control over instrumentation,

waveform manipulations, and graphic display. And they're the first to provide system compatibility that allows configuration for many types of test and measurement applications.

With Tektronix Signal Processing Systems you concentrate on test results, not test procedures. There are no human-eye interpretations, hand processing, or complex statistical graphing. Tektronix Systems automatically capture the signals you need, make the measurements you want, then display, store, and document your solutions.

This means work that used to take hours, now takes only minutes. System automation saves you time and money by greatly increasing your productivity. Projects not only get completed on schedule, they get completed on budget.

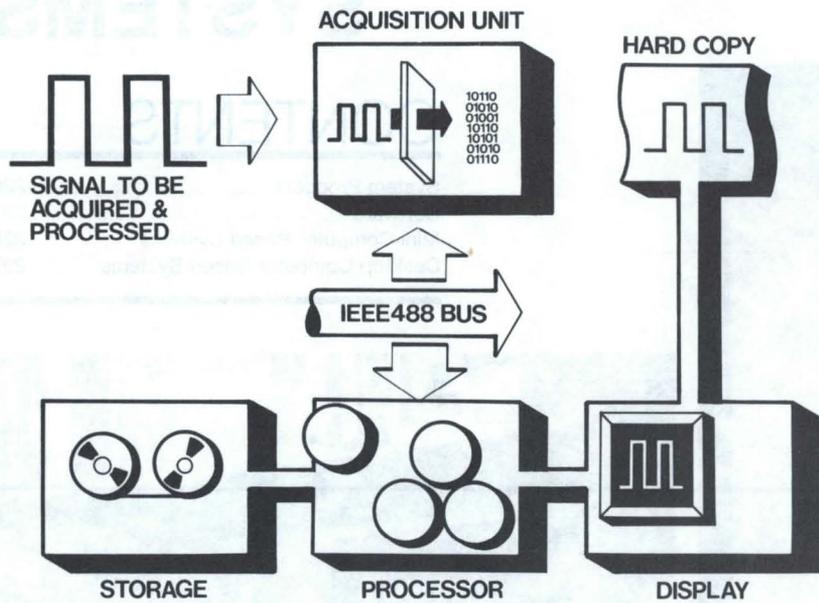
Plus, system automation gives greater measurement accuracy and accountability on your finished product. Since there's less operator involvement in measurements, there's less chance of human error.

From today's research and development tasks to tomorrow's production testing, Tektronix Systems give you all the capabilities needed to characterize your waveforms quickly, efficiently, and automatically.

### For measurement solutions you can't beat the SYSTEM.

# SPS AUTOMATION . . .

## FIVE MAJOR SYSTEM COMPONENTS AND TEK'S COMPREHENSIVE SOFTWARE MEET YOUR MEASUREMENT NEED



**Acquisition**, built around Tektronix GPIB Waveform Digitizers and 7000 Series Oscilloscope Plug-ins, captures analog data, converts and stores it in a digital format acceptable to the system processor.

**Processor**, either minicomputer or desk-top computer, controls the system, accepts the digitized data, and then performs the needed mathematical calculations and operations.

**Mass Storage**, in the form of disk or magnetic tape, keeps a log of the processed data and also stores the test programs.

**Display**, including graphic terminal and **hard copy units**, provides both alphanumeric and graphic presentation of data and permanent documentation.

**Software**, specially developed for ease of use with Tektronix Signal Processing Systems, controls all other system components and performs the desired computations. Commands are high-level BASIC and accessible through a standard terminal keyboard.

## A WIDE RANGE OF SYSTEM PRODUCTS PROVIDES THE SOLUTIONS YOU NEED

### Signal Acquisition — Fast or Slow, Transient or Repetitive

The growing family of GPIB compatible High Performance Waveform Digitizers provides a broad range of acquisition capabilities. They offer the ability to analyze signals ranging from seconds to picoseconds in duration, and risetimes to 25 ps. Plus, all are compatible with a broad range of 7000 Series Plug-ins.

#### 7912AD\*

For high-speed transient signal acquisition, the 7912AD Programmable Digitizer has the capability to capture signals in the millisecond to subnanosecond range with a bandwidth of up to 1 GHz.

#### 7612D\*

For medium-speed signals, the 7612D Programmable Digitizer offers dual channel acquisition, selectable sampling rates within records, and pre- and post-triggering. With the 7612D you can capture transient signals from seconds to sub-microseconds in duration with high resolution.

#### 7854\*

For fast, repetitive signals, the 7854 Oscilloscope is ideal when configured in a system. The 7854 features an on-board microprocessor. This instrument provides the system with the capability to acquire high speed signals with rise times to 25 ps.

\*See High Performance Digitizing Mainframes Section for details.

### 390AD\* *NEW*

For low to medium speed signals. The SONY/TEKTRONIX 390AD offers crystal-controlled 30-MHz sampling on two channels, or 60 MHz sampling on one channel. Features include cursor based measurements, sample rate switching, and direct plotter output capability.

### System Controllers Dedicated to Speed and Precision

Tektronix Signal Processing Systems are divided into two major processor families: the minicomputer family, and the desktop computer family.

The Tektronix minicomputer systems, built around DEC PDP-11 compatible controllers, are designed to handle large amounts of data. They offer flexibility in peripheral selection, processing speed, and up to 128k words of memory space. Plus, the software support is specially developed for waveform manipulations, array processing and display efficiency.

The desktop computer systems are built around the 4052A Desktop Computer—one of the most powerful analytical performers available today. Its built-in extended BASIC software is complemented by special ROM packs featuring commands most often used in signal processing applications.

### Wide-ranging System Peripherals for Full Documentation and Display

Tektronix Signal Processing Systems provide the best in display—the 4012 or the 4052A graphic screen. These terminals provide an excellent medium for displaying graphic and alphanumeric information with high resolution. In addition, a wide range of system peripherals is available, including graphic plotters, hard copy units, disk and magnetic tape storage devices.

### Multiplexer 1360P/S

The 1360 is a microprocessor-based GPIB compatible system instrument that can be used to multiplex electrical signals at bandwidths up to 250 MHz. It includes two separate chassis: the 1360P Programmable Switch Controller and the 1360S Switch Matrix. Up to four 1360S Switch Matrix units may be operated by one 1360P. With one 1360S one may multiplex one output with 33 inputs, two ganged outputs with 17 inputs, or four ganged outputs with nine inputs. With four 1360S units these numbers increase so one may multiplex one output with 129 inputs, two ganged outputs with 65 inputs, or four ganged outputs with 33 inputs.

### Total Support

Complete details and application consultation is available through your local Tektronix Sales Office. SPS Specialists and Application Engineers stand ready to answer all your system questions.

# The next logical step

## ANY SYSTEM IS ONLY AS GOOD AS ITS SOFTWARE SPS SYSTEMS OFFER THE BEST SOFTWARE AVAILABLE

TEK SPS BASIC is a comprehensive, general purpose programming language with enhancements for instrument control and waveform processing. Modular in design, it provides an optimum balance between flexibility, space efficiency, and computing power. Yet it retains the "easy-to-learn, easy-to-use, easy-to-remember" character of traditional BASICs. This makes it an ideal tool for beginning users as well as expert programmers.

TEK SPS BASIC runs on the Tektronix CP1164X Instrument Controller, on the PDP-11/23 Computer, or on any Digital Equipment Corporation PDP-11 Minicomputer. It consists of a Resident Monitor and an expandable library of over 100 non-resident commands. This lets you configure a software system to meet your unique measurement needs.

It's ready to use. TEK SPS BASIC requires a minimum system consisting of a controller with two hard-disk or two flexible-disk drives. Commands can be added to the system from the disk as needed to provide maximum space efficiency in available memory.

Named files can be accessed by TEK SPS BASIC on hard or flexible disk, or magnetic tape and information can be read from files either sequentially or randomly. BASIC commands give you complete file management capability. Files are compatible with DEC's RT11 operating system.

Comprehensive graphics permit waveform plots and X-Y plots between waveforms. Either can be done with single commands. The output is complete with scaled and labeled axes and can be hard-copied to paper.

TEK SPS BASIC data-logging capabilities let you turn tedious and repetitive measurements into automated procedures. Program control can eliminate human intervention, reduce errors, and give you time to concentrate on test results.

Better than seven-digit precision means much higher resolution than possible in conventional oscilloscope measurements. Special data structures retain both numeric and literal information associated with a given waveform. These waveform structures, as well as numeric arrays or portions of numeric arrays, can be operated on arithmetically as easily as can simple numeric variables.

### Advanced Signal Processing

Waveforms can be integrated, differentiated, convolved, correlated, and fast Fourier transformed. Also, polar conversions can be performed.

### Flexible I/O

Information can be read or written in ASCII or binary. ASCII may be used for display on a terminal or to store information for use by another software system. Binary can be used for storing large information blocks for later processing by TEK SPS BASIC. File may be structured either serially or by random access.

### GPIB

With BASIC commands, you can control multiple IEEE Standard 488 interfaces at any level, from setting individual data lines to reading in entire arrays with a single command. The GPIB feature, which can be deleted from the BASIC system to save memory, is integrated with the Resident Monitor to make GPIB control commands more space economic. A high level GPIB driver is also available to facilitate programming for those not thoroughly familiar with GPIB.

There is also available a versatile GPIB software module for RSX11-M. This requires special quotation from SPS Marketing.

### Extended Memory

Extended memory capability is offered in V02XM software. Computers with memory management and up to 128k words of memory can use extended memory to manipulate large data arrays.

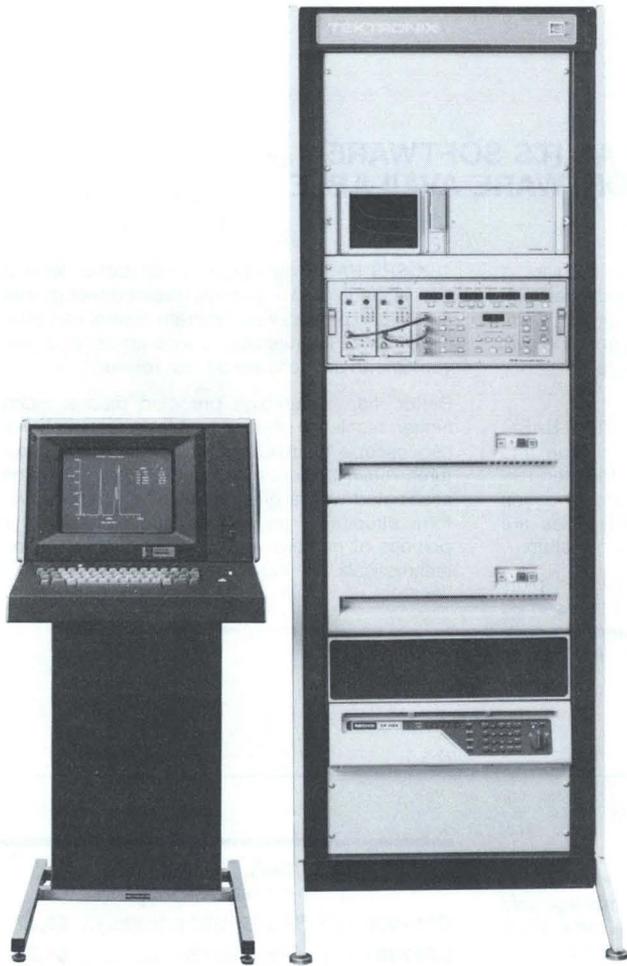
### Software Maintenance

Customers receive a periodic newsletter containing programming hints and responses to user questions. Reported system errors can usually be corrected by customer-applied "patches." These short code sequences are published in the newsletter with instructions for adding them to established systems. Specific problems encountered by customers which appear to be caused by software defect may be addressed by submitting a Software Performance Report (SPR) which will be responded to in writing. (Category B support.)

### ORDERING INFORMATION SOFTWARE PACKAGES

CP57000	TEK SPS BASIC (Monitor)	\$5,475
CP57001	Signal Processing .....	\$1,285
CP57002	Graphics .....	\$975
CP57003	R7912 Transient Digitizer Driver .....	\$1,445
CP57004	Digitizing Oscilloscope (DPO) Driver .....	\$865
CP57005	DPO Envelope Command .....	\$350
CP57006	7912AD Programmable Digitizer Driver .....	\$875
CP57007	High Level Support .....	\$580
CP57008	Assembly Level Support .....	\$2,890
CP57009	GPIB High Level Driver .....	\$750
CP57010	7612D Special Commands .....	\$300
CP57500	Extended Memory (V02XM) TEK SPS Basic (Monitor) .....	\$7,125
CP575XX	Extended Memory Software (V02XM) are priced the same as V02 modules above, except for CP57500.	

For additional information or a demonstration of the TEK SPS BASIC software family, call the Tektronix Sales Office in your area and ask for your SPS Specialist.



The WP3201 is one of the many configurations for the minicomputer-based systems.

**Systems**

Tektronix Minicomputer-based systems offer combinations of Tektronix Waveform Digitizing instruments, flexible instrument controllers, and the most powerful waveform (array) processing BASIC software available on the market. These systems are tailored for medium and large scale experiments and for use in areas where medium or high power, dedicated systems are best suited to the task. System versatility and easy-to-use software allow for a wide variety of tasks to be performed at a multi-purpose test area. Large amounts of data storage and waveform analysis are manageable under the TEK SPS BASIC operating system which handles full arrays of data as easily as single-valued variables.

Instrument control and data communication are accomplished over the IEEE Standard 488 (GPIB) bus, allowing for easy expandability. Multiple instruments performing different functions may be added as needs expand or change. Control or data busses other than GPIB may be added by the user and controlled by TEK SPS BASIC software.

Mass storage includes either floppy or hard disk systems for operating system, non-resident commands, data files and user program storage. Hard copy capability may be added by ordering the Tektronix 4631 option to these systems.

Measurement requirements and technologies are changing rapidly in the dynamic fields of physics, optics, chemistry, biology, and electronics. Improved bandwidths, sensitivities, triggering circuits, and storage capabilities have done a great deal to increase the value of oscilloscopes as general-purpose measurement equipment in these fields. But in more and more applications scope measurements are being supplemented by computations to get the information in a form that is easy to interpret.

**Some Applications**

The development and manufacturing of today's increasingly complex electronic devices require extensive analysis of the signals these devices generate and transmit. For example, performance and calibration of high density cartridge disks can be characterized using Tektronix Signal Processing Systems — providing accurate, reliable results in seconds. Other components, such as semiconductors and optical fibers, have benefited from Tektronix Signal Processing System analysis.

Evaluating equipment designed to be used in hostile environments is a growing challenge for today's test and measurement technology. In the area of lightning effects, Tektronix Signal Processing Systems are used because they can capture randomly occurring events generated in such hostile environments. Other examples include shock and vibration testing, and electromagnetic pulse testing.

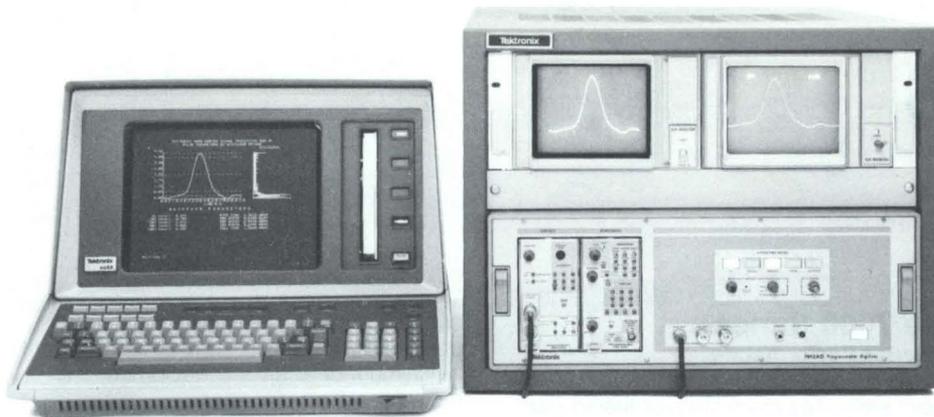
High performance instrumentation and waveform analysis have always been required in research and development for the discovery and quantification of new phenomena. With acquisition bandwidths up to 14 GHz, Tektronix Signal Processing Systems are ideally suited for such fields as laser-related research, fusion research, biochemistry, ballistics and ultrasonics.

**Warranty**

Systems defined as "WP" Systems are installed at the user's site free of charge. On-site warranty is for 90 days from date of system start-up, or 120 days from date of shipment, whichever is shorter. Individual instruments are warranted for one year at a Tektronix Service Center. Post-warranty service is available on a normal charge basis, or system components may be sent to a Service Center for repair.

**AVAILABLE MINI-COMPUTER-BASED SYSTEMS**

	7912AD	7612D
PDP-11/23/Floppy Disk	WP2252	WP3202
CP1164X/Hard Disk	WP2251	WP3201



The WP2110 is one of three desktop computer-based systems.

**Systems**

Tektronix Desktop Computer-based Systems offer combinations of Tektronix Waveform Digitizing instruments and the 4052A Graphic Computing System. These systems are tailored especially for single user, small and medium scale experiments and for use in areas where medium power, dedicated, self contained systems are best suited to the task. Each system contains the flexibility to be easily moved between areas or to perform a variety of tasks at a multi-purpose test bench.

Instrument control and data communication are accomplished over the IEEE Standard 488 (GPIB) bus, allowing for easy expandability. Multiple instruments of the same type or GPIB-interfaced instruments performing different functions may be added as needs change. Data communication with external intelligence for additional flexibility is available via an RS-232C port. Hard-copy capability from the display may be added by ordering the Tektronix 4631 option to these systems. Raw and processed data and user programs may be stored using the integral magnetic tape, or the Tektronix 4907 flexible disk File Manager may be ordered to supplement the system.

**Desktop Graphic Computer and Display**

The Tektronix 4052A Graphic Computer has gained wide acceptance as a powerful data processing tool for system applications. For rapid calculations this desktop computer contains a fast processor with microcoded floating point.

The 4052A, with state-of-the-art graphics capability, can provide hard copies of any combination of text and high density graphics via an optional hardcopy unit. For peripheral support the 4052A uses the GPIB and RS-232C to interface with additional instruments as your needs require. And with memory expandable to 64k bytes, the 4052A can handle lengthy programs and large amounts of data.

**AVAILABLE DESKTOP COMPUTER-BASED SYSTEMS**

	7854	7912AD	7612D
4052A	WP1310	WP2110	WP3110

For complete information on SPS Systems and Digitizers described, contact your SPS Specialist

for data sheets and descriptive literature through your nearby Tektronix Sales Office.

**Desktop Computer Software**

4052A software is an easy-to-learn enhanced form of BASIC which provides the simplicity desired by the beginner and the flexibility and power required by the experienced programmer. Device independent keywords make programming input and output operations easy. Fast matrix functions are also part of 4052A BASIC. Special ROM Packs provide 15 commonly used waveform processing functions—from the location of waveform maximums and minimums to Fast Fourier Transforms. And Tektronix supports the software of the 4052A with an extensive applications software library—including mathematics, statistics and graphics packages—which aids the user in solving measurement problems from modeling to final report generation.

For graphic display control, an entire set of commands allows graphic displays to be created on the 4052A. For example, one ROM Pack command provides the ability to display a complete array of data with a single statement.

**Signal Processing ROM Pack #1 (4052, 4052A, 4054, and 4054A only)**

Adds seven new functions which can be applied to one dimensional data arrays; integration, differentiation (2 and 3 point), fast graphing, locating minimum and maximum, and crossing over a threshold. Functions operate 2-10 times faster than equivalent BASIC routines.

**Order 4052R07 ..... \$350**

**Signal Processing ROM Pack #2 (4052, 4052A, 4054, and 4054A only)**

Extends array handling capabilities by adding commands that perform Fast Fourier Transform (FFT), its inverse (IFT), convolution, correlation, windowing and related utility functions. Functions execute 7-20 times faster than BASIC routines.

**Order 4052R08 ..... \$700**

**Broad Support Completes the Package and Assures You of Continuing Value**

From signal acquisition through final display ongoing support guarantees you the most value for your investment dollar. The many support programs available are yours as a part of your system purchase.

*HANDSHAKE* is a newsletter forum for users of Tektronix programmable instruments and systems. Published quarterly, *HANDSHAKE* has articles of interest concerning applications of measurement and analysis techniques.

*SPS PROGRAMMING UPDATE* is published periodically and sent to users of Tektronix Signal Processing Systems. It contains information to help maintain software and firmware system components. It also contains useful programming hints and software and firmware product information.

Most important of all, a staff of Signal Processing Systems Specialists, located at various offices, stand ready to assist you in all aspects of system specification and performance.

# 7000 SERIES INSTRUMENTS

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### The 7000 Series . . .

#### Superior Performance

The 7000 Series of plug-in laboratory instruments embodies more state-of-the-art performance features than any other oscilloscope-based measurement system. The 7104 Oscilloscope features a 1 GHz bandwidth combined with the fastest rise time and writing speed available today.

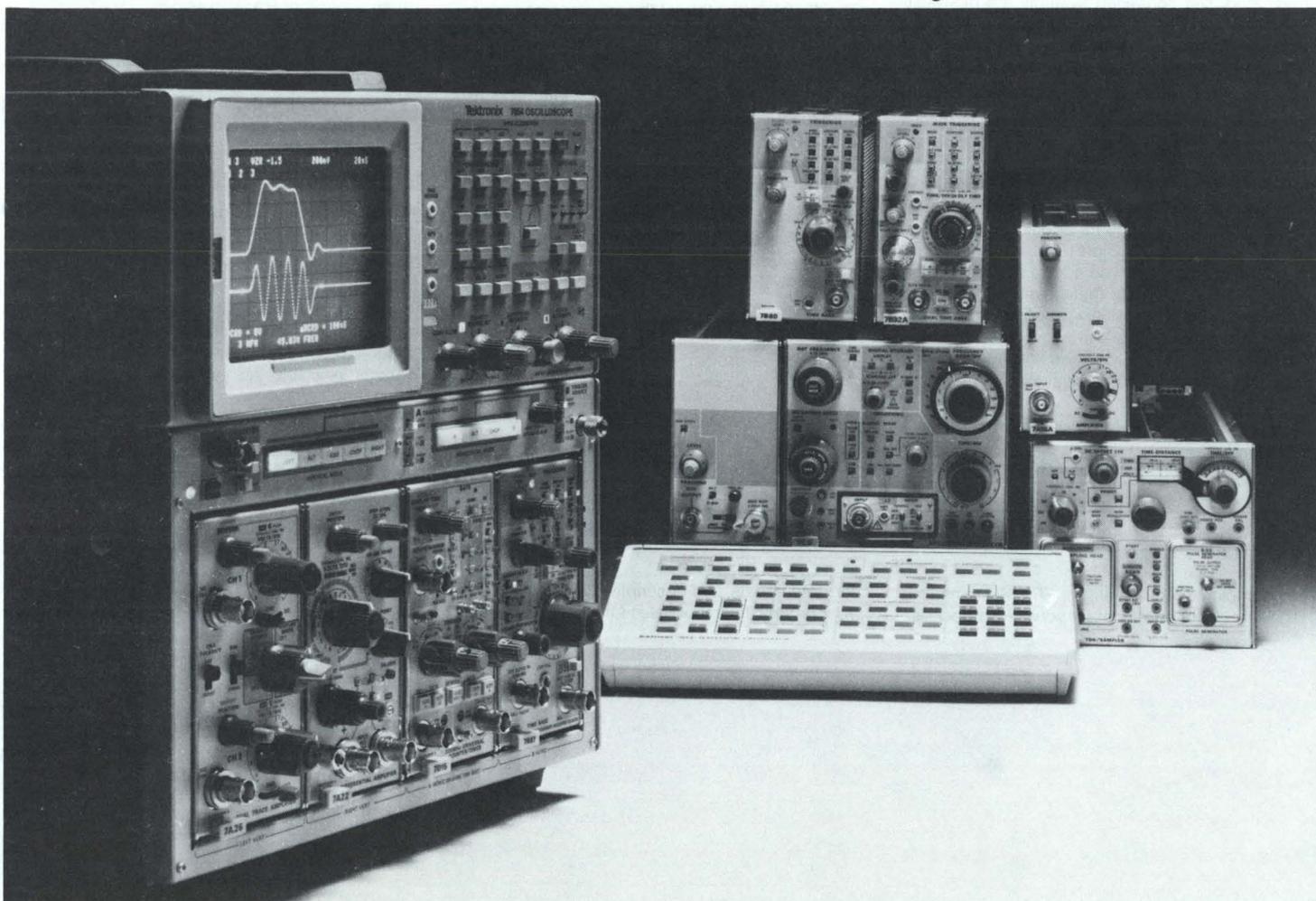
#### Flexibility

A choice of over 40 plug-ins and 19 mainframes gives you the flexibility to configure the scope package to meet your individual

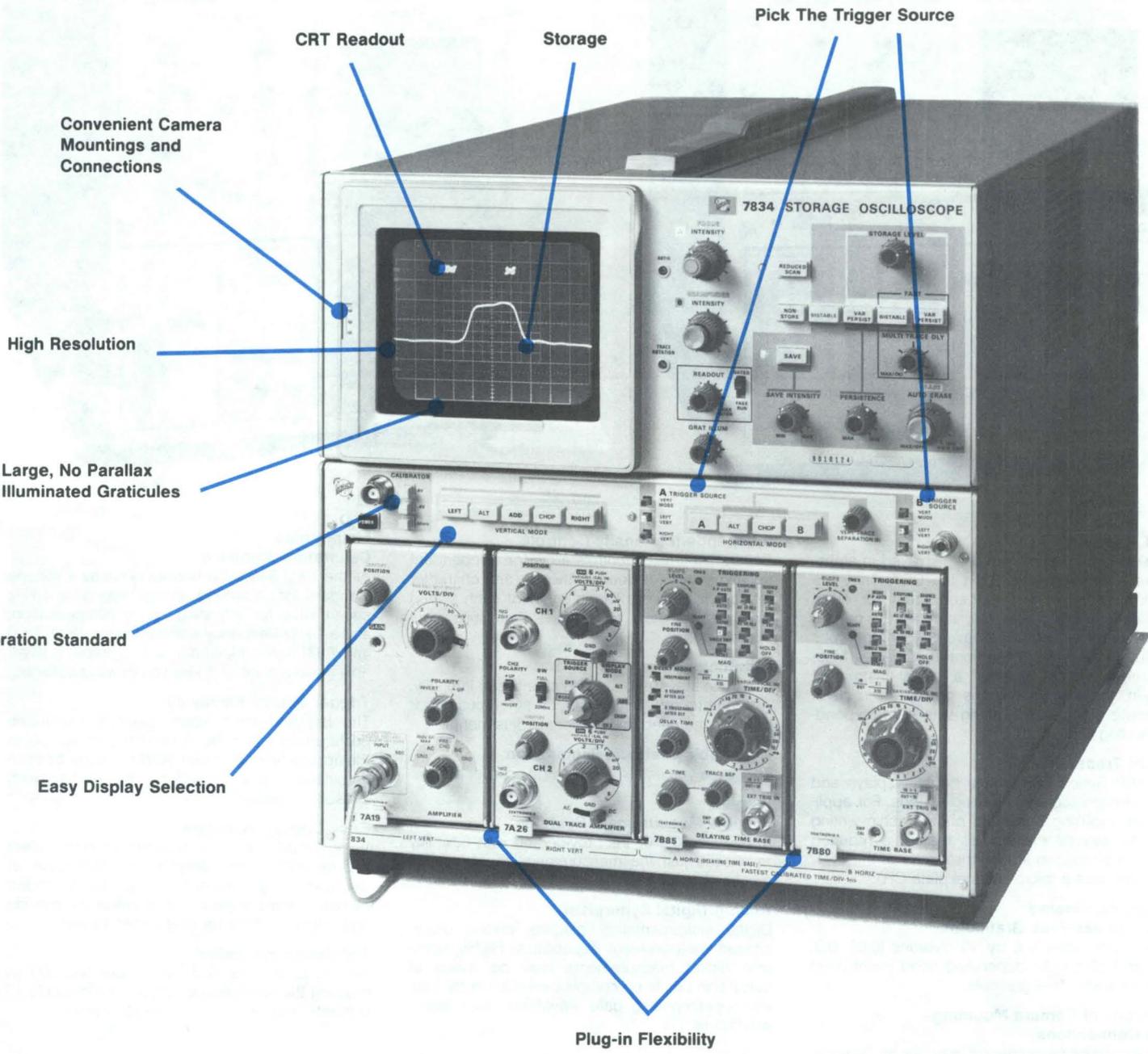
needs. When your needs change, your present package can be reconfigured with a minimum of additional equipment and effort.

#### Expandability

This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Tektronix' most recent developments in plug-in scope capability are: the Waveform Processing Oscilloscope, the 1 GHz High Writing Rate Oscilloscope, and the Programmable Digitizer Plug-In Unit.



SUPERIOR PERFORMANCE, FLEXIBILITY AND EXPANDABILITY

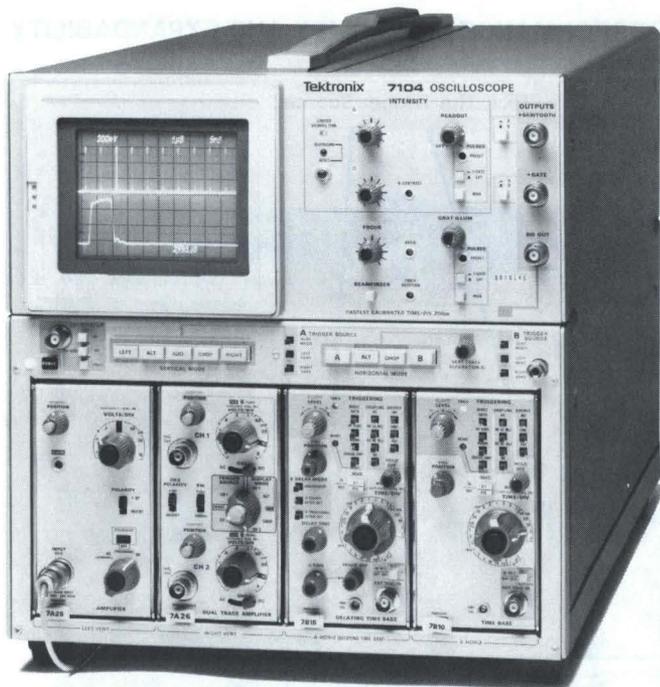


The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix commitment to bringing the ultimate in measurement technology to the laboratory.

Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent cathode-ray-tube mainframes and instrumentation plug-ins.

A system can be tailored for your exact measurement needs. Mainframes in the family offer a choice of popular bandwidth ranges and a wide selection of additional features. Plug-ins—including oscilloscope vertical amplifiers and time bases as well as instruments for a variety of applications—can be selected to round out your tailored system.

In opposition to an industrial world that is frequently faulted for planning obsolescence, this instrument family strategically defers obsolescence. Each mainframe and each plug-in reflects the latest technology at its inception, yet each fits a well-planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to our new developments while protecting your initial investment. Today's system may be expanded to meet future needs at a relatively low cost by the addition of a plug-in or two. When the time comes to add a more powerful mainframe, your older model continues to be useful for a host of applications.



**CRT Readout\***

All significant parameters are displayed in alphanumeric characters right on the CRT. They are readily visible when you need them for quick oscilloscope measurements, and they are permanently recorded on your waveform photographs for future analysis. When your 7000 Series Measurement System includes a digital instrument plug-in, the measurement is presented in clear, accurate digital terms, along with a corresponding analog waveform.

**Bright Traces**

All 7000 Series CRTs have bright displays and excellent photographic writing speeds. For applications requiring maximum photographic writing speeds, several mainframes feature a reduced scan on a reduced area in the center of the CRT, and one uses a micro-channel plate CRT.

**Large, Illuminated and Parallax-Free Graticules**

The display area is 8 by 10 divisions (0.85, 0.9, 1.0, or 1.22 cm/div depending upon mainframe) with a parallax-free graticule.

**Convenient Camera Mountings and Connections**

A standard bezel connector matches all Tektronix Oscilloscope Cameras to 7000 Series Mainframes.

**Independent Intensity Controls**

Separate intensity controls allow for independent adjustment of A sweep, B sweep, and character readout brightness. The intensity of each sweep may be adjusted to a level that suits your application.

**Autofocus**

The trace stays in focus with changes in intensity. After the focus is initially set, an autofocus circuit reduces the need for additional adjustments.

**Adjustable Graticule Illumination**

This gives you easier viewing and sharper photos.

**Plug-ins**

**Flexible Measurement Systems**

More than 40 plug-ins provide you with flexibility to choose just the measurement capability you require.

**Analog/Digital Synergism**

Digital instrumentation plug-ins create unsurpassed measurement capabilities. Highly accurate digital measurements may be made at selectable points on complex waveforms by visually superimposing gate waveforms over signal waveforms.

**Mainframes**

**Calibration Standard**

All the 7000 Series Calibrators serve as a voltage standard for calibrating vertical plug-ins, a 1 kHz squarewave for adjusting probe compensation, and a 1 kHz frequency standard in the 7800, 7900 and 7100 Series Mainframes. The output is available in several dc or 1 kHz squarewave voltages.

**Trigger Source Flexibility**

The left and right trigger selector mainframe pushbuttons route the desired trigger source to the appropriate time base. A VERT mode position automatically routes whichever source has been chosen for vertical inputs.

**Easy Display Selection**

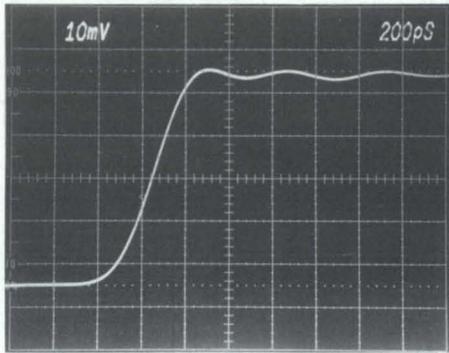
Vertical mode switches allow you to easily select the desired vertical amplifier or interaction of amplifiers (e.g., alternate, chopped, or added modes). Four-compartment mainframes provide equivalent flexibility for time bases as well.

**Mainframe Flexibility**

Numerous options add even more flexibility in creating the oscilloscope system that most closely meets your measurement requirements.

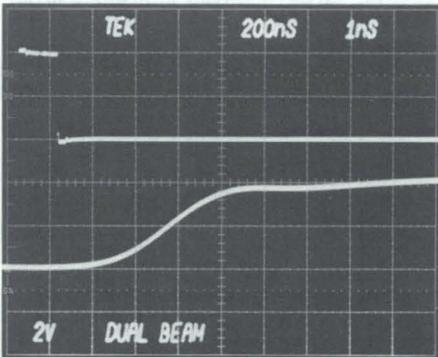
\*Not available in mainframes or plug-ins with "N" suffix.

**Nonstorage 7104**



This 300 ps risetime is displayed on a 7104 Non-Storage Oscilloscope. Readout indicates 10 mV/div vertical sensitivity and 200 pS/div sweep speed.

**Dual Beam 7844**



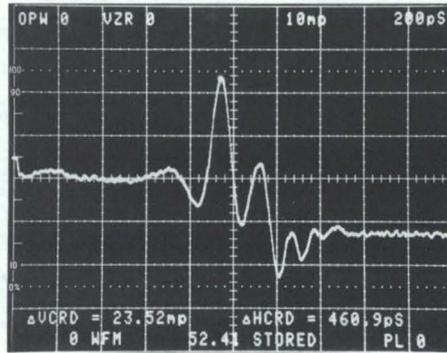
The 400 MHz, dual-beam 7844 Oscilloscope displays one input signal at two sweep speeds (full vertical and horizontal cross-over switching). Also provides full overlap on 8 x 10 cm display.

**400 MHz Dual-Beam**

Dual-beam oscilloscopes are essentially two oscilloscopes in one. Each beam operates separately and independently of the other. They are required for many applications where two transient events must be compared simultaneously. These application areas include stimulation and reaction events in such fields as medicine, biology, chemistry, engineering mechanics, to name just a few.

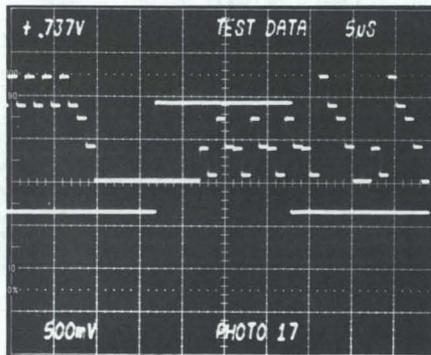
Depending on the plug-ins selected, up to eight traces can be displayed at a time.

**Sampling/Time Domain Reflectometry**



7854 Digital Oscilloscope with 7S12 Plug-in provides digital processing capability for sampling and time domain reflectometry.

**Digital Readout Measurements**



7854 Digital Oscilloscope with 7D12/M2 Plug-in measures +0.737 volts difference between two points on complex waveform. Gate waveform indicates leading and trailing edges where voltage difference is measured.

**Digital Measurement Plug-ins**

The 7000 Series digital plug-ins include: A universal counter/timer, digital multimeter with temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special read-out unit to label each test for future reference. Together with a 7000 Series mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital techniques.

This combination offers many advantages over separate test units. You get: scope-controlled digital measurements, measuring convenience and confidence, increased accuracy, easier and faster solutions to complex problems, a lower dollar investment, more bench space and signal conditioning.

**Sampling**

The 7000 Series sampling plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: A low-cost storage CRT for slow scans, a random mode that lets you see leading edges with pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional displays at the same time on the CRT.

The adjacent sampling waveform shows the power of the 7S12 TDR Plug-in with the 7854 Digital Storage Oscilloscope. First, the 7854 acquired the TDR signal from a prototype connector design, using waveform averaging to eliminate noise on the trace. Then, positioning the 7854 cursors to the area of interest on the waveform, the internal 7854 program calculates an impedance of 52.41  $\Omega$  at the discontinuity.

**Spectrum Analysis**

Unexcelled plug-in performance from 20 Hz to 60 GHz is provided by the 7L5, 7L14 and 7L18 Spectrum Analyzers. Stable, sensitive and spurious-free, these analyzers work in any 7000 Series mainframe. The same mainframe may be used with other plug-ins for oscilloscope measurements.

Some plug-in analyzers have microprocessor-aided controls for easy operation, and digital storage and display capability for recalling and comparing signals. Others offer 30 Hz resolution for viewing close-together signals. Some optional tracking generators are available for swept frequency measurements.

Refer to the Spectrum Analyzer section beginning on page 198 for more information.

**CRT Storage see page 250**

**High Performance Digitizing see page 258**

7000 SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART\*1

PROBE	PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE							PASSIVE VOLTAGE 50 Ω INPUT COMPT			FET PROBES 50 Ω/1 MΩ INPUT COMPATIBLE			CURRENT PROBES		
	P6101 1 Meter	P6106 1 Meter P6053B 3.5 ft	P6055*2 3.5 ft	P6009 9 ft	P6015 10 ft	P6062B 6 ft	P6105 P6108 2 Meter	P6056 6 ft	P6057 6 ft	P6202A*4 2 Meter	P6046 6 ft	P6201*4 6 ft	P6021 w/passive term, 5 ft 10 mV/mA	P6022 w/passive term, 5 ft 10 mV/mA	P6302/ AM 503 6 ft	
FEATURES	Miniature Probe	Fastest Probes Compatible with 1-MΩ Input	Adj Attenuation for Differential Use	1.5 kV Compatibility	40 kV Pk Pulse Compatibility	Selectable Attenuation 1X:10X	Miniature Probe	Fastest 10X Passive Probe Low C	Fastest 100X Passive Probe Low C	10-MΩ Input Impedance Dc Offset	Differential Probe High CMRR	Low Capacitive Loading Ac Coupling Dc Offset	Ac High Current	Ac High Frequency	Dc High Current	
ATTENUATION	1X	10X	10X	100X	1000X	Selectable	10X	10X	100X	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable	
7104	7A19 7A24 7A26 7A29	Nc Nc 34 MHz Nc	Nc Nc 175 MHz Nc	Nc Nc Nc Nc	Nc Nc 125 MHz Nc	Nc Nc 75 MHz Nc	Nc Nc Nc Nc	Nc Nc 100 MHz Nc	500 MHz 350 MHz 950 MHz	480 MHz 350 MHz 800 MHz	300 MHz 300 MHz 185 MHz 450 MHz	100 MHz 300 MHz 90 MHz 100 MHz	430 MHz 310 MHz 195 MHz 660 MHz	Nc Nc 60 MHz Nc	Nc Nc 140 MHz Nc	50 MHz 45 MHz 50 MHz 50 MHz
7900 FAMILY	7A11*1 7A13 7A15A 7A16A 7A18A 7A19 7A22 7A24 7A26	Nc 34 MHz 34 MHz 34 MHz Nc Nc 1 MHz Nc 34 MHz	Nc 105 MHz 75 MHz 200 MHz 70 MHz Nc Nc Nc 175 MHz	Nc 65 MHz Nc Nc Nc 1 MHz Nc Nc Nc	Nc 85 MHz 70 MHz 130 MHz 70 MHz Nc Nc Nc 125 MHz	Nc 65 MHz 60 MHz 80 MHz 60 MHz Nc Nc Nc 75 MHz	Nc 75 MHz 75 MHz 75 MHz Nc Nc Nc Nc Nc	Nc 75 MHz 75 MHz 75 MHz Nc Nc Nc Nc Nc	500 MHz 350 MHz	480 MHz 350 MHz	105 MHz 80 MHz 205 MHz 75 MHz 300 MHz	70 MHz 60 MHz 90 MHz 75 MHz 95 MHz	105 MHz 75 MHz 215 MHz 75 MHz 430 MHz	Nc 55 MHz 50 MHz 45 MHz 150 MHz 70 MHz 45 MHz 50 MHz 1 MHz 1 MHz Nc 55 MHz	150 MHz 90 MHz 70 MHz 40 MHz 150 MHz 70 MHz 40 MHz 50 MHz 1 MHz 1 MHz Nc 140 MHz	45 MHz 45 MHz 40 MHz 45 MHz 45 MHz 40 MHz 40 MHz 50 MHz 1 MHz 45 MHz 45 MHz
7800 FAMILY	7A11 7A13 7A15A 7A16A 7A18A 7A19 7A22 7A24 7A26	Nc 34 MHz 34 MHz 34 MHz Nc Nc 1 MHz Nc 34 MHz	Nc 95 MHz 75 MHz 160 MHz 85 MHz Nc Nc Nc 145 MHz	Nc 65 MHz Nc Nc Nc 1 MHz Nc Nc Nc	Nc 85 MHz 70 MHz 110 MHz 80 MHz Nc Nc Nc 105 MHz	Nc 60 MHz 55 MHz 75 MHz 60 MHz Nc Nc Nc 75 MHz	Nc 75 MHz 75 MHz 75 MHz 85 MHz Nc Nc Nc Nc	Nc 100 MHz 75 MHz 100 MHz 100 MHz 400 MHz 300 MHz	300 MHz	100 MHz 80 MHz 170 MHz 75 MHz 320 MHz	70 MHz 60 MHz 85 MHz 65 MHz 95 MHz	100 MHz 80 MHz 165 MHz 90 MHz 360 MHz	55 MHz 50 MHz 45 MHz 130 MHz 70 MHz 45 MHz Nc 1 MHz Nc 55 MHz	130 MHz 85 MHz 70 MHz 40 MHz 130 MHz 70 MHz 40 MHz 50 MHz 1 MHz 45 MHz 125 MHz	45 MHz 45 MHz 40 MHz 45 MHz 40 MHz 50 MHz 1 MHz 45 MHz 45 MHz	
7704A	7A11 7A13 7A15A 7A16A 7A18A 7A19 7A22 7A24 7A26	Nc 34 MHz 34 MHz 34 MHz 34 MHz Nc Nc 1 MHz Nc 34 MHz	Nc 100 MHz 70 MHz 145 MHz 75 MHz Nc Nc Nc 140 MHz	Nc 65 MHz Nc Nc Nc 1 MHz Nc Nc Nc	Nc 85 MHz 65 MHz 115 MHz 70 MHz Nc Nc Nc 105 MHz	Nc 65 MHz 55 MHz 75 MHz 60 MHz Nc Nc Nc 75 MHz	Nc 70 MHz 70 MHz 100 MHz 75 MHz Nc Nc Nc Nc	Nc 70 MHz 70 MHz 100 MHz 75 MHz 250 MHz 200 MHz	250 MHz 200 MHz	100 MHz 75 MHz 160 MHz 75 MHz 220 MHz	70 MHz 55 MHz 80 MHz 60 MHz 85 MHz	100 MHz 70 MHz 150 MHz 75 MHz 215 MHz	55 MHz 50 MHz 45 MHz 125 MHz 45 MHz Nc 1 MHz Nc 55 MHz	125 MHz 85 MHz 70 MHz 40 MHz 125 MHz 70 MHz 40 MHz 45 MHz 1 MHz Nc 115 MHz	45 MHz 40 MHz 40 MHz 45 MHz 40 MHz 50 MHz 45 MHz 45 MHz	
7600 FAMILY	7A11 7A13 7A15A 7A16A 7A18A 7A22 7A24	Nc 34 MHz 34 MHz 34 MHz 34 MHz Nc Nc	Nc 75 MHz 60 MHz 95 MHz 70 MHz Nc Nc	Nc 55 MHz Nc Nc 1 MHz Nc	Nc 60 MHz 55 MHz 65 MHz 55 MHz 65 MHz	Nc 55 MHz 50 MHz 60 MHz 95 MHz 55 MHz 70 MHz 1 MHz 95 MHz	Nc 70 MHz 60 MHz 95 MHz 70 MHz 70 MHz 1 MHz 95 MHz	Nc 70 MHz 60 MHz 60 MHz 95 MHz 70 MHz 70 MHz 1 MHz 95 MHz	75 MHz 65 MHz 100 MHz 75 MHz	55 MHz 50 MHz 70 MHz 55 MHz	50 MHz 45 MHz 40 MHz 50 MHz 45 MHz 1 MHz 50 MHz	85 MHz 70 MHz 60 MHz 85 MHz 70 MHz 1 MHz 85 MHz	40 MHz 40 MHz 35 MHz 40 MHz 40 MHz 1 MHz 40 MHz			

\*1 The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.

\*2 015-0437-00 Matched pair recommended  
 \*3 Option 09 Mainframe  
 \*4 Requires 1101 Power Supply when used with 7854, 7603, 7633, 7623, or 7613.

Nc = Not compatible  
 If there is no bandpass specified, the probe/plug-in combination is compatible but not recommended.

P6130 up to 250 MHz bandwidth see page 437 for more information. **NEW**

7000 SERIES MAINFRAME/TIME BASE RECOMMENDATIONS

MAINFRAME	7104	7904 R7903	7844/R 7854 7834	7704A R7704	7603/R	7603N11	7633/R 7623A/R	7613/R										
TIME BASE	PERFORMANCE FEATURE								* INDICATES RECOMMENDED COMBINATION									
7B50A	Single time base																	
7B53A	Dual time base with mixed sweep																	
7B53A Option 05	7B53A with tv sync triggering																	
7B80	Single time base (used also as delayed time base)																	
7B85	Single time base with delaying and Δ delay sweep function																	
7B92A	Dual time base with display switching																	
7B10	Single time base (used also as delayed time base)																	
7B15	Single time base with delaying and Δ delay sweep function																	

\*No trace separation on R7704 only.

\*\*No mainframe readout.

7000 SERIES MAINFRAMES AND PLUG-INS DIMENSIONS AND WEIGHTS

Dimensions		7612D	7912AD	7854*	7104	7904	R7903	7844	R7844	7834	7704A	R7704	7603	R7603	7603NMS	7633, 7623A, 7613	R7633, R7623A, R7613	Plug-Ins Single	Double
Width	mm	483	483	305	305	305	483	305	483	305	305	483	221	483	246	221	483	7.1	140
	in	19.0	19.0	12.0	12.0	12.0	19.0	12.0	19.0	12.0	12.0	19.0	8.7	19.0	9.7	8.7	19.0	2.8	5.5
Height	mm	178	178	348	345	343	135	328	178	345	345	178	290	133	292	305	133	127	127
	in	7.0	7.0	13.7	13.6	13.5	5.3	12.9	7.0	13.6	13.6	7.0	11.4	5.3	11.5	12.0	5.3	5.0	5.0
Depth	mm	679	679	627	592	592	579	605	630	589	577	569	610	627	640	597	566	368	368
	in	26.8	26.8	24.7	23.3	23.3	22.8	23.8	24.8	23.2	22.7	22.4	24.0	24.7	25.2	23.5	22.3	14.5	14.5
Weights ≈																			
Net	kg	25.0	22.7	20.4	19.8	14.5	12.3	16.3	15.0	16.1	13.6	20.0	13.6	13.6	20.4	13.6	14.5	0.9	4.1
	lb	55.0	50.0	45.0	43.6	32.0	27.0	36.0	33.0	35.5	30.0	44.0	30.0	30.0	45.0	30.0	32.0	2.0	9.0
Shipping	kg		32.6	28.1	25.4	20.0	23.6	21.3	28.5	21.3	19.5	35.0	20.8	28.2	32.7	19.0	28.2	2.3	5.4
	lb		72.0	62.0	56.0	44.0	52.0	47.0	63.0	47.0	43.0	77.0	46.0	62.0	72.0	42.0	62.0	5.0	12.0

\*7854 Calculator dimensions and weights, width 277 mm (10.9 in), height 69 mm (2.7 in), Depth 165 mm (6.5 in).

OSCILLOSCOPE REFERENCE

7000 SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER			7A11	7A13	7A15A	7A16A	7A17	7A18A	7A19	7A22	7A24	7A26	7A29
PAGE			273	272	270	270	271	271	274	273	274	271	274
Performance Feature			Low-capacitance FET probe amplifier	Differential dc offset, high-freq CMRR amplifier	Low cost conventional input amplifier	Wide bandwidth conventional input amplifier	Low cost, easy to customize amplifier	Dual-channel amplifier	Wide bandwidth 50 Ω input amplifier	Dc-coupled, high-gain differential amplifier	Dual-channel 50 Ω amplifier	Dual-channel amplifier	Widest Bandwidth Single Channel
Minimum Deflection Factor			5 mV/div	1 mV/div	5 mV/div (0.5 mV/div)*2	5 mV/div	50 mV/div	5 mV/div	10 mV/div	10 μV/div	5 mV/div	5 mV/div	10 mV/div
Accuracy*1 Without Probe			2% (integral)		1.5%	2%	2%	—	2%	3%	2%	2%	2%
7100 FAMILY (0 to 35°C)	7104	BW	250 MHz	100 MHz P6053B*9 100 MHz P6106*10 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	600 MHz	1 MHz ± 10%	400 MHz	200 MHz	1000 MHz
		Tr	1.4 ns	3.5 ns P6053B*9 3.5 ns P6106*10 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.6 ns	± 350 ns ± 9%	0.9 ns	1.8 ns	0.38 ns
7900 FAMILY (0 to 30°C)	7904 R7903 7912AD*3,*8	BW	250 MHz	105 MHz P6053B*9 105 MHz P6106*10 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	500 MHz	1 MHz ± 10%	350 MHz	200 MHz	500 MHz
		Tr	1.4 ns	3.4 ns P6053B*9 3.4 ns P6106*10 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.8 ns	350 ns ± 9%	1.0 ns	1.8 ns	0.8 ns
		SIG OUT BW	140 MHz	100 MHz P6053B*9 100 MHz P6106*10 65 MHz P6055	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz	1 MHz ± 10%	140 MHz	140 MHz	300 MHz
7800 FAMILY (0 to 35°C)	7844/R	BW	200 MHz	100 MHz P6053B*9 100 MHz P6106*10 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz*4	1 MHz ± 10%	300 MHz	180 MHz	400 MHz
		Tr	1.8 ns	3.5 ns P6053B*9 3.5 ns P6106*10 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns
	7854*7 7834	BW	200 MHz	95 MHz P6053B*9 95 MHz P6106*10 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz*4	1 MHz ± 10%	300 MHz	180 MHz	400 MHz
		Tr	1.8 ns	3.7 ns P6053B*9 3.7 ns P6106*10 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns
7700 FAMILY	7704A Opt 9 (0 to 30°C)	BW	170 MHz	100 MHz P6053B*9 100 MHz P6106*10 65 MHz P6055	75 MHz	170 MHz	150 MHz	75 MHz	250 MHz*5	1 MHz ± 10%	200 MHz	170 MHz	250 MHz
		Tr	2.1 ns	3.5 ns P6053B*9 3.5 ns P6106*10 5.4 ns P6055	4.7 ns	2.1 ns	2.4 ns	4.7 ns	1.5 ns	350 ns ± 9%	1.8 ns	2.1 ns	1.5 ns
	SIG OUT BW	70 MHz	60 MHz P6053B*9 60 MHz P6106*10 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	1 MHz ± 10%	70 MHz	70 MHz	80 MHz	
	7704A (0 to 50°C)	BW	170 MHz	100 MHz P6053B*9 100 MHz P6106*10 65 MHz P6055	75 MHz	160 MHz	150 MHz	75 MHz	200 MHz	1 MHz ± 10%	200 MHz	150 MHz	200 MHz
Tr		2.1 ns	3.5 ns P6053B*9 3.5 ns P6106*10 5.4 ns P6055	4.7 ns	2.2 ns	2.4 ns	4.7 ns	1.8 ns	350 ns ± 9%	1.8 ns	2.4 ns	1.8 ns	
	R7704 (0 to 50°C)	SIG OUT BW	70 MHz	60 MHz P6053B*9 60 MHz P6106*10 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	1 MHz ± 10%	70 MHz	70 MHz	80 MHz
		BW	150 MHz	100 MHz P6053B*9 100 MHz P6106*10 65 MHz P6055	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	1 MHz ± 10%	160 MHz	140 MHz	175 MHz
	Tr	2.4 ns	3.5 ns P6053B*9 3.5 ns P6106*10 5.4 ns P6055	4.7 ns	2.4 ns	2.4 ns	4.7 ns	2.0 ns	350 ns ± 9%	2.2 ns	2.5 ns	2.0 ns	
		SIG OUT BW	60 MHz	55 MHz P6053B*9 55 MHz P6106*10 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	1 MHz ± 10%	60 MHz	60 MHz	65 MHz
7600 FAMILY	7603/R 7633/R (0 to 50°C)	BW	100 MHz	75 MHz P6016 55 MHz P6055	65 MHz	100 MHz	100 MHz	75 MHz	100 MHz	1 MHz ± 10%	100 MHz	100 MHz	100 MHz
		Tr	3.5 ns	5.0 ns P6016 6.4 ns P6055	5.4 ns	3.5 ns	3.5 ns	4.7 ns	3.5 ns	350 ns ± 9%	3.5 ns	3.5 ns	3.5 ns
	7623A/R 7613/R (0 to 50°C) 7603N11*6 (0 to 50°C)	SIG OUT BW	60 MHz	55 MHz P6016 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	1 MHz ± 10%	60 MHz	60 MHz	65 MHz
		BW	80 MHz	65 MHz	60 MHz	80 MHz	65 MHz	80 MHz	80 MHz	1 MHz ± 10%	80 MHz	80 MHz	80 MHz
	Tr (Calculated)	5.0 ns	6.0 ns	6.7 ns	5.0 ns	6.0 ns	5.0 ns	5.0 ns	350 ns ± 9%	5.0 ns	5.0 ns	5.0 ns	

\*1 Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.

\*2 Obtained with 10X gain at reduced bandwidth of 10 MHz.

\*3 Refer to Transient Digitizer, 7912AD not available with signal outputs

\*4 Bandwidth is 325 MHz to 10 mV/div.

\*5 Bandwidth is 200 MHz at 10 mV/div.

\*6 All 7000 Series Plug-ins are compatible with the 7603N Opt 11. However, they do not meet the rigid environmental specification required by the military.

\*7 Bandwidth with equivalent time sampling and time display only.

\*8 Fully programmable mainframe. 7A16P Programmable Amplifier recommended. 7A16P provides 200 MHz, 1.8 ns in 7912AD and 80 MHz, 5.0 ns in 7612D, see page 263.

\*9 P6053B has Trace Identify

\*10 P6106 has Ground Reference



**TEK Lab Cart Model 3**

Model 3 Lab Cart accepts all 7000 Series Oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement Instruments, 5000 Series Oscilloscopes, or 400 Series Oscilloscopes.

For full details see SCOPE-MOBILE™ Cart section, page 424.

**SUMMARIZED CAMERA CHARACTERISTICS**

RECOMMENDED CAMERA	OSCILLOSCOPES	PERFORMANCE FEATURES AND BENEFITS	LENS				FILM BACKS		
			MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3.25 x 4.25 in Polaroid Film except where noted)	ORDINARILY USED	OPTIONAL AND INTERCHANGEABLE	PAGE
C-51P	7904, R7903, 7844, 7704A 7854	Fastest writing speed with 0.5 mag lens	f/1.2	0.5	3.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Pack	4 x 5 in Graflok	415
C-53P	All except 7603 7603N11S	General-purpose with 0.85 mag lens	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Pack	4 x 5 in Graflok	415
C-59AP	7603 7603N11S	General-pupose at low price	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 in	Polaroid Pack	4 x 5 in Graflok	416
C-5C	All	Low cost	f/16	0.67 or 0.85 selectable	0.02	9.76 x 12.2 cm	Polaroid Pack	None	419

\*Relative light-gathering power.  
C-50 Series Camera Adaptor, part number 016-0249-03, included with camera.  
For full details see camera section, page 415.

**Current Application Notes for 7000 Series\***

Title	Featuring	Part No	Title	Featuring	Part No
ULTRASONIC MEASUREMENTS with digital accuracy	7603/7A22/7D15/7B53A Timing measurements between non-adjacent pulses. Ultrasonic transducers	AX-3681	DIGITAL INSTRUMENTS combined within Tektronix Oscilloscope give unparalleled accuracy and capability	7000 Series digital plug-ins (counter-timers, DVM's, temperature probes, sample-hold modules) with application examples	A-3002
EASIER, FASTER, MORE ACCURATE Oscilloscope timing measurement	7B85/7B80 Delayed sweep & delta time measurements	A-3269	MEASUREMENT VARIETY An Engineering challenge featuring the 7854	7854/WAVEFORM CALCULATOR Demonstrating basic operation, application software for percent overshoot, data monitoring and histogram.	AX-4281
X-Y DISPLAYS with interval timing for measuring SOA	7D15/7A18/7A22 X-Y power dissipation measurements	AX-3957	GPIB COMMUNICATION with the 7854	7854/4052 and 7854/4924 Types of I/O transfers, transmission formats, and operational software in TEK Basic compatible with any 4050 Series computer	AX-4416
DAC MEASUREMENTS: The sampling oscilloscope approach	7S14/7D12/M2/7B92A/7904 Measuring DAC (digital analog converter settling time	AX-3632	Pulse and digital timing measurements—a better technique	7B80/7B85 General overview of the operation of the 7B85 and 7B80 Delta-Time Measurement Plug-ins	AX-3379-1
SCR GATING WAVEFORM MEASUREMENTS with high-resolution digital accuracy	7D12/M2/7A16A (four compartment mainframes) SCR measurements. Absolute and relative (two point) voltage monitoring	A-2693-1	Using storage to find troublesome logic glitches	7633 Shows how the 7633 Storage Oscilloscope can be used to capture and evaluate glitches	AX-3085
Digital delay in an oscilloscope makes your radar pulse time delay measurements quicker, easier, and more accurate	7D11 The measurement of radar pulse delay time is given as an example of 7D11 operation	AX-2659-2	Variable persistence storage applications	7613/5441 Describes various applications for variable persistence storage oscilloscopes	AX-3198
Measuring time interval between non-adjacent digital word train pulses or multiecho radar pulses	7D15 Demonstrates the ability of the 7D15 to measure the time between adjacent pulses with digital counter accuracy	AX-2680-2	Bistable storage applications	Tektronix Storage Oscilloscopes. Describes various applications for bistable storage oscilloscopes	AX-3199
Measuring memory core I/O signals with digital accuracy	7000 Series Digital Plug-ins Demonstrates how digital plug-ins can be used to make accurate pulse parameter measurements both of amplitude and pulse timing	AX-2686-1	Introduction to 7854 Oscilloscope Measurement to Programming Techniques	7854 Programming Techniques	AX-4682
Measuring disc drive time and access voltages with Tektronix 7000 Series Digital Plug-ins	7000 Series Digital Plug-ins Use a single CRT display to perform both digital and analog analysis of complex waveforms	AX-2687-1			

\*Check with your local sales office for availability.

# 7000 SERIES NONSTORAGE MAINFRAMES

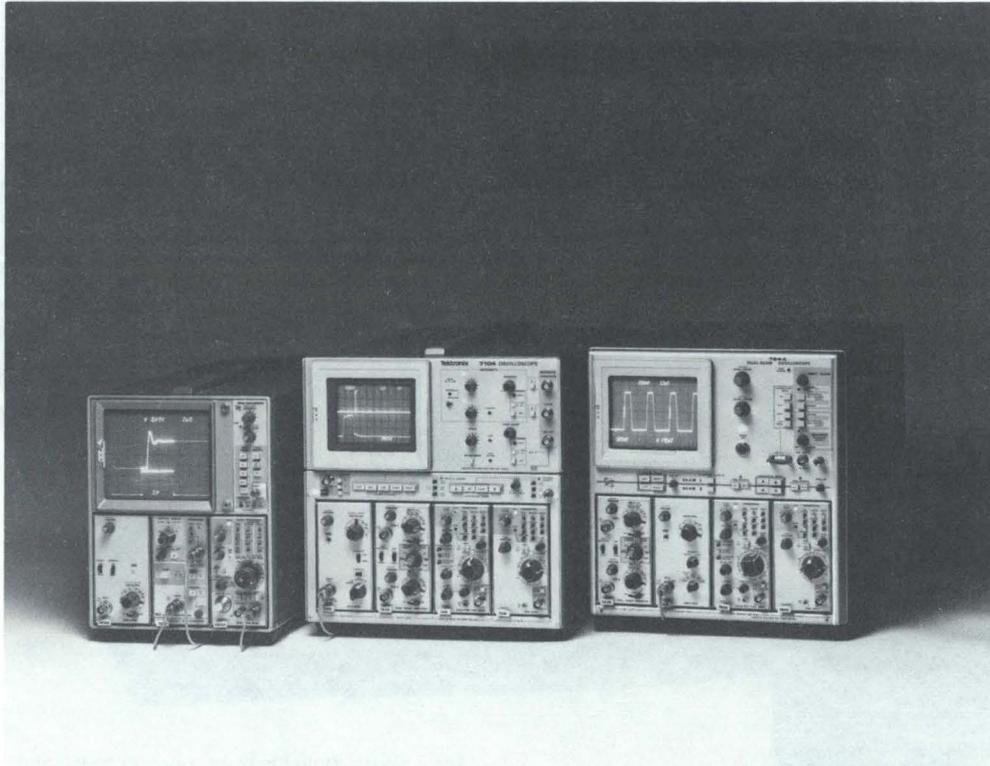
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7603N11S Ruggedized Oscilloscope System .....	248

A high performance instrument system begins with the basic oscilloscope building block — the 7000 Series Mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

The Tektronix 7104 is a 1 GHz oscilloscope featuring the fastest rise time (350 ps) and writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, dual-beam, alphanumeric displays, rackmounting, and three- or four-plug-in flexibility.



## 7104

Ultra High Writing Speed

1 GHz at 10 mV/div

0.38 ns Risetime

200 psec/div Fastest Calibrated Sweep Rate

Horizontal Bandwidth 350 MHz

Phase Compensation Option—Phase Matching to 250 MHz

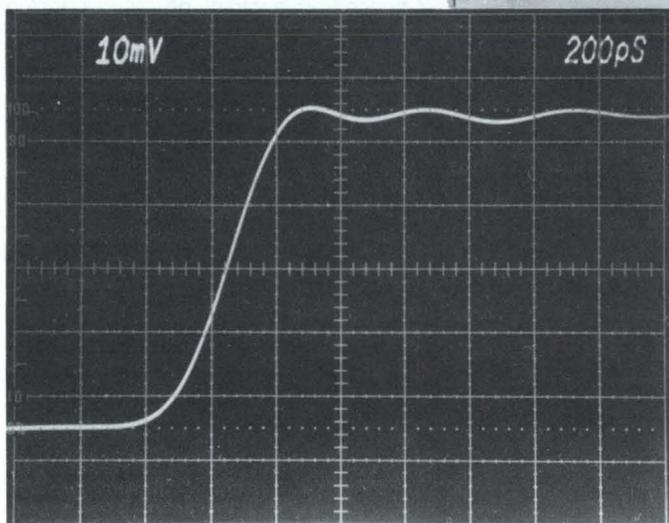
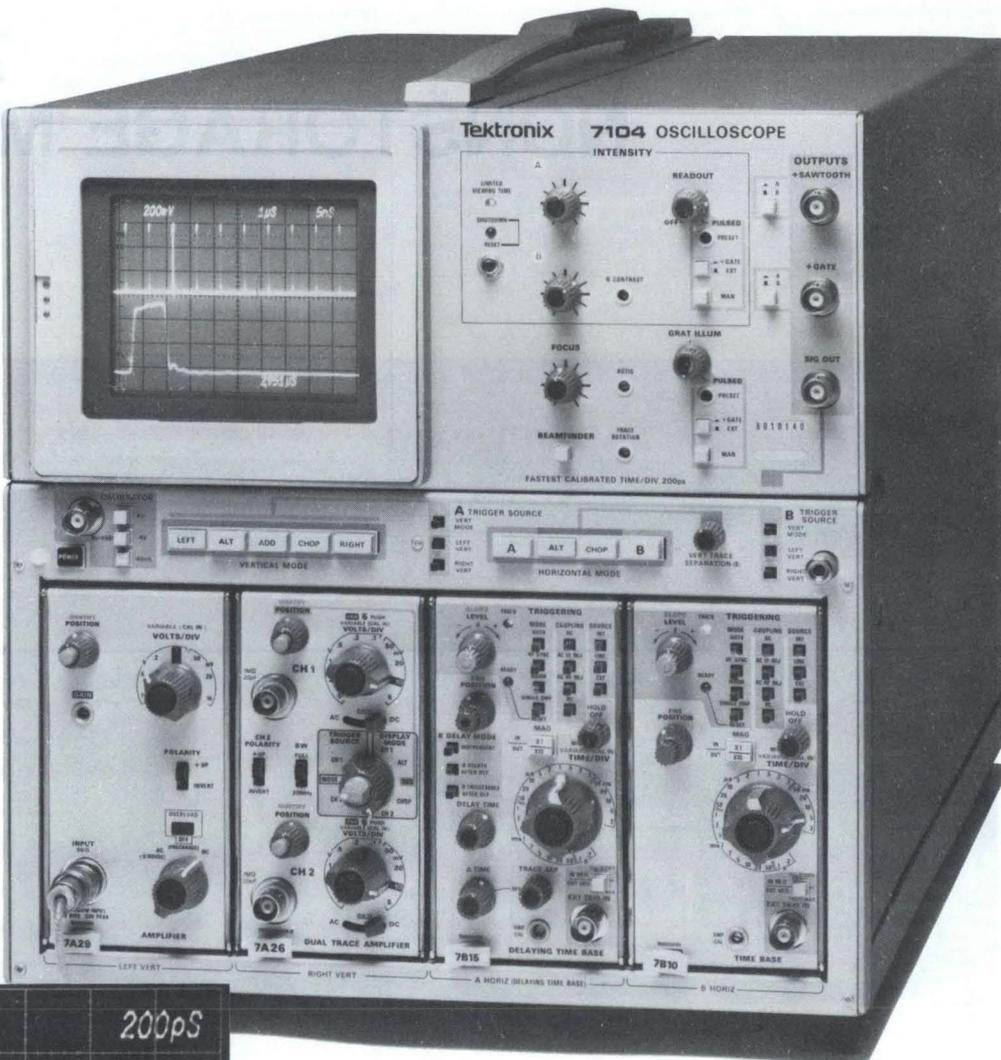
CRT Readout

### APPLICATIONS

High Speed Semiconductor Design

Laser and High Energy Research

Digital Communications



The 7104 has both the highest writing speed and highest bandwidth available in a general-purpose oscilloscope today.

The 7104 with 7A29 Amplifier plug-ins provides 1 GHz real-time vertical bandwidth at 10 mV/div. Combined with the 7B10/7B15 Time Base plug-ins, having fastest sweep speeds of 200 ps/div, very high-speed signals can now be measured with confidence.

The 7104's outstanding writing speed means unsurpassed single-shot capability, with trace brightness about **one-thousand times** that of conventional oscilloscopes. Any single-shot signal within the 7104's bandwidth can be seen directly on the CRT in average room light. Also, single-shot photography is now simple and straightforward, using standard oscillographic cameras and film without high-speed enhancement techniques.

Horizontal bandwidth of 350 MHz, with the X-Y phase compensation Option 02, gives accurate X-Y displays to 250 MHz. Designers can now directly obtain V-I curves for high-speed switching power supply evaluation or monitor performance of digital communication systems using phase constellation displays.

**CHARACTERISTICS**  
**VERTICAL SYSTEM**

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

**Vertical Display Modes** — LEFT, ALT, ADD, CHOP, RIGHT.

**Chopped Mode** — Rep rate is  $\approx 1$  MHz.

**Vertical Trace Separation** — Operative when any vertical signal is displayed with both A and B time bases. Positions B trace at least 4 div above and below A trace.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**HORIZONTAL SYSTEM**

**Channels** — Two right-hand plug-in compartments; compatible with the time bases of the 7B10 and 7B80 Series and the 7B50A and 7B92A. The 7B50 Series (except the 7B50A), the 7B70 Series and the 7B92 (non A) are not recommended. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

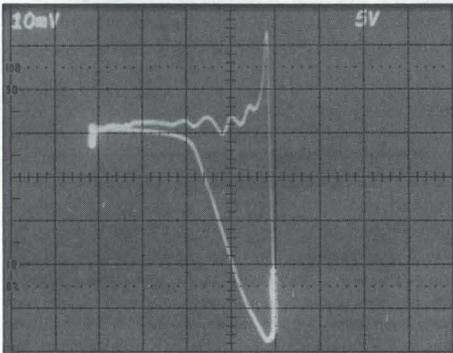
**Horizontal Display Modes** — A, ALT, CHOP, B.

**Fastest Calibrated Sweep Rate** — 200 ps/div with the 7B10 or 7B15.

**Chopped Mode** — Rep rate is  $\approx 200$  kHz.

**Bandwidth** — Dc to 350 MHz. With delay compensation (7104 Option 02 using 7A19s or 7A29s, at least one of which has the Variable Delay Option, B Horizontal compartment only), within  $2^\circ$  from dc to 50 MHz after adjusting variable delay for balance at 35 MHz. Phase balance can be obtained at any frequency up to 250 MHz. Phase shift is within  $2^\circ$  from dc to 50 kHz without delay compensation.

**Horizontal Bandwidth: 350 MHz**



The transient load line of a fast switching transistor in a power supply prototype (switching time = 10 ns) is easily measured for compliance with safe operating area. (Horizontal = V; vertical = I).

**CRT AND DISPLAY FEATURES**

**CRT** — Internal 8 x 10 div (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV with P31 Phosphor standard.

**Readout and Graticule Modes** — Each continuous or pulsed (pulse source selection by front panel controls: +Gate, external, manual). The pulsed graticule is on for  $\approx 0.5$  s.

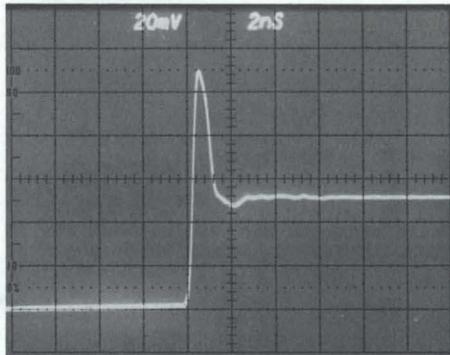
**Min Photographic Writing Speed (using Polaroid Film Type 106, 20,000 ASA w/out Film Fogging)** — 20 cm/ns (w/o blue filter). Phosphor: standard P31. Camera: Tektronix C-53, f/1.9, 1:0.85 lens.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

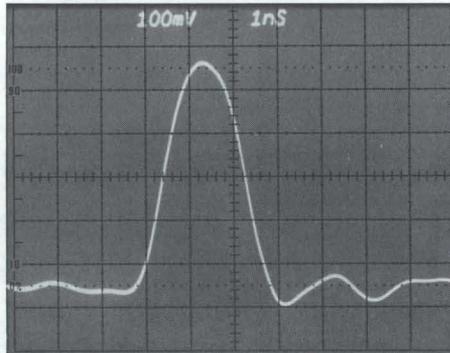
**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

**1 GHz at 10 mV/div**



Circuit faults such as high frequency pulse overshoot and ringing can easily be observed with the 7104's 1 GHz bandwidth.

**Writing Speed: 20 cm/ns**



View of a single clocking pulse 0.8 ns rise and 2 ns pulse width.

**CALIBRATOR**

**Voltage Output** — Squarewave positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 k $\Omega$ ; 4 mV, 40 mV, and 0.4 V into 50  $\Omega$ . Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450  $\Omega$ .

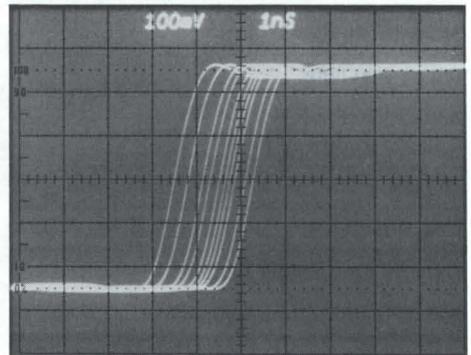
**Plug-in Compatibility**



Plug-in compatibility. The 7104 is compatible with standard 7000 Series plug-in units that provide for full 7104 System performance.

The 7D01, 7D02 Logic Analyzers and 7D20 Digitizer are not recommended for use with the 7104 Mainframe. Such use will void the 7104 warranty.

**Distinct Image Viewing**



A digital circuit that shows no jitter on a conventional oscilloscope is found to have a 2.0 ns jitter when viewed with the distinct image viewing capability of the 7104.

**OUTPUTS/INPUTS**

**+Sawtooth** — User selectable from A or B horizontal. Output voltage is 50 mV/div ( $\pm 5\%$ ) into 50  $\Omega$ , 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is  $\approx 950$   $\Omega$ .

**+Gate** — Positive-going rectangular waveform user selectable from A or B horizontal. Output voltage is 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ , 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is  $\approx 950$   $\Omega$ .

**Sig Out** — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50  $\Omega$ , 0.5 V into 1 M $\Omega$ . Bandwidth depends upon vertical plug-in. Output R is  $\approx 950$   $\Omega$ .

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series Camera.

**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes.

**Single-sweep Ready Indicators A and B** — +5 V, rear panel BNC outputs for single sweep ready indications.

**Graticule/Readout, Single-shot** — Ground closure, rear panel BNC input initiates one frame of CRT read-out and the GRAT ILLUM is illuminated for  $\approx 0.5$  s.

**External Single-sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweep.

**POWER REQUIREMENTS**

**Power Requirements** — Line voltage ranges, 90 to 132 V ac and 180 to 250 V ac. Line frequency, 48 to 440 Hz. Maximum power consumption, 215 W, 3.3 A at 90 V line, 60 Hz.

**Dimensions and Weights** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See page 234.

**7104 ORDERING INFORMATION**  
(PLUG-INS NOT INCLUDED)

7104 Oscilloscope .....	\$20,160
Option 02 — X-Y Horizontal Comp .....	+ \$300
Option 03 — EMC Modification .....	+ \$300

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC

**7A29** — Vertical amplifier to bw of mainframe; 10 mV/div to 1 V/div vertical sensitivity.

**7B10** — Delayed timebase (similar to 7B80) with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz.

**7B15** — Delaying timebase (similar to 7B85) with 200 ps/div to 0.2 s/div calibrated sweep speed; triggering up to 1 GHz; capability of  $\Delta$ time measurements in conjunction with 7B10.

## 7904/R7903

500 MHz at 10 mV/div

0.8 ns Risetime

500 ps/div Fastest  
Calibrated Sweep Rate

Greater Than 2.5 cm/ns Writing Speed

CRT Readout

Over 30 Compatible Plug-ins

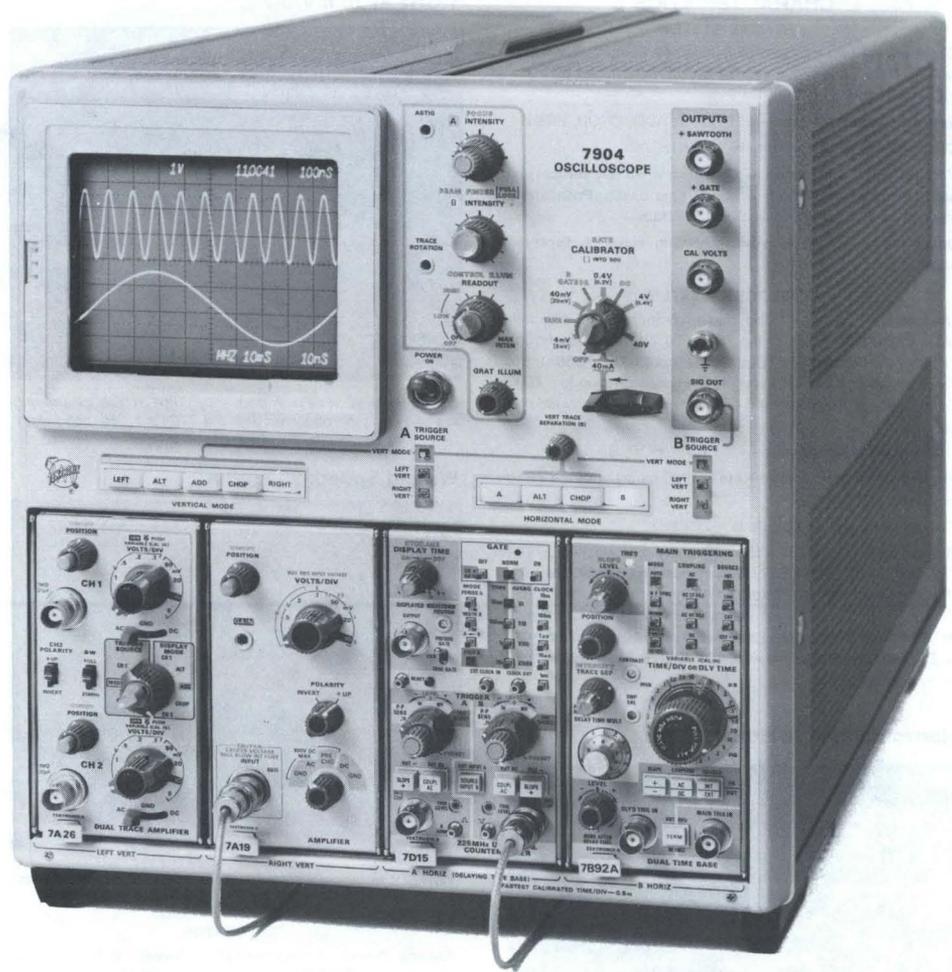
900 MHz FET Probe Available

### APPLICATIONS

Digital Design

Radar

Laser Research



The 7904 and 5.25 in rackmount R7903 are high bandwidth, general-purpose oscilloscopes. The 7A19 Amplifier/7904 Mainframe attains 500 MHz at 10 mV/div. A 7A19 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900 MHz bandwidth by itself, and in combination with the 7A19/7904, it provides a system bandwidth of 450 MHz at 10 mV.

The CRT, the major contributor to the performance of the 7904 and R7903, has good visual brightness and an 8 x 10 cm display area.

### CHARACTERISTICS

#### 7904 and 7903 — VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by mainframe and plug-in unit.

**Modes of Operation** — LEFT, ALT, ADD, CHOP, RIGHT.

**Chopped Mode** — Rep rate is  $\approx 1$  MHz.

**Trace Separation Range (Dual-sweep Modes)** — The B trace can be positioned four divisions above or below the A trace (7904 only).

**Delay Line** — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series Time Bases. 7B50 Series not recommended.

#### 7904 — HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B92A.

**Chopped Mode** — Rep rate is  $\approx 200$  kHz.

**X-Y Mode** — Phase shift is within  $2^\circ$  from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, Option 02) between vert and horiz channels. Bandwidth is dc to at least 1 MHz.

#### R7903 — HORIZONTAL SYSTEM

**Single Channel** — Right-hand plug-in compartment compatible with time bases of 7B80 and 7B90 Series. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B92A.

#### 7904 and 7903 — CRT AND DISPLAY FEATURES

**Standard** — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 Phosphor standard.

**Option 01, Without CRT Readout** — No CRT readout.

**Option 04, Max Brightness CRT With Reduced Area** — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. P11 Phosphor provides max writing rate. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

**Option 78, P11 Phosphor**

**Option 10, Pulsed Graticule (R7903 Only)** — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with CRT readout, Option 10 provides additional controls and inputs for CRT readout pulsed operation.



The R7903 requires only 5.25 in of rack height in a standard 19 in rack. It is fan-cooled and comes complete with slide-out chassis tracks.

**Typical Photographic Writing Speed  
Using The Optional P11 Phosphor and  
Polaroid Type 612 20,000 ASA Film  
without Film Fogging**

CRT	Camera	Lens	Writing Speed cm/ns
Standard 8 x 10 cm	C-51P	f/1.2 1:0.5	2.5
Option 04 4 x 5 cm			4

In typical applications, P31 Phosphor has  $\approx$  one-half the writing speed of P11 Phosphor. The writing speed can be increased by using controlled film fogging with a writing speed enhancer (camera accessory).

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

**External Z-Axis Input** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

**7904 — CALIBRATOR**

**Output Waveshape** — Rectangular positive-going from ground, 1 kHz ( $\pm 0.25\%$ ), dc or B Gate  $\div 2$ .

**Voltage Ranges** — 4 mV, 40 mV, 0.4 V, 4 V, 40 V into an open circuit; 2 mV, 20 mV, 0.2 V, 0.4 V into 50  $\Omega$  ( $\pm 1\%$ ).

**Current Output** — 40 mA dc or 1 kHz.

**R7903 — CALIBRATOR**

(Not Available with Option 10)

**Output Waveshape** — Rectangular positive-going from ground, 1 kHz ( $\pm 0.25\%$ ).

**Voltage Ranges** — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50  $\Omega$  ( $\pm 1\%$ ).

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450  $\Omega$ .

**7904 — OUTPUTS/INPUTS**

+ **Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div ( $\pm 5\%$ ) into 50  $\Omega$ , 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is  $\approx 950 \Omega$ .

+ **GATE** — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ , 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ . Rise time is 5 ns or less into 50  $\Omega$ . Output R is  $\approx 950 \Omega$ .

**Sig Out** — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50  $\Omega$ , 0.5 V/div into 1 M $\Omega$ . Bandwidth depends upon vert plug-in. See the Vertical System Specifications Chart. Output R is  $\approx 950 \Omega$ .

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series Cameras.

**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes.

**R7903 — OUTPUTS/INPUTS  
(Standard)**

+ **Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Output voltage is 50 mV/div ( $\pm 15\%$ ) into 50  $\Omega$ , 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is  $\approx 950 \Omega$ .

+ **Gate** — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5V ( $\pm 10\%$ ) into 50  $\Omega$ , 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ . Rise time is 7 ns or less into 50  $\Omega$ . Output R is  $\approx 950 \Omega$ .

**Sig Out** — Selected by TRIGGER SOURCE switches. Output voltage is 25 mV/div into 50  $\Omega$ , 0.5 V/div into 1 M $\Omega$ . Bandwidth depends on the vertical plug-in. See the Vertical System Specifications Chart. Output R is  $\approx 950 \Omega$ .

**Single-sweep Ready Indicator** — +5 V, rear panel BNC output, for single-sweep ready indication.

**External Single-sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweep.

**CRT Readout, Inhibit** — Ground closure, rear panel BNC input locks out CRT readout. Not available with Option 10.

**CRT Readout, Single-shot** — Ground closure, rear panel BNC input initiates one frame of CRT readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-50 Series Cameras.

**Probe Power** — Two front-panel connectors provide correct operating voltages for two active probes. Not available for R7903 Option 10.

**R7903 — OUTPUTS/INPUTS OPTIONS**

**Option 10, Pulsed Graticule** — No CRT readout single-shot input, CRT readout inhibit input, calibrator, and probe power. Single-shot graticule and CRT readout (ground closure) rear-panel BNC input is added. Initiates one frame of CRT readout and pulses graticule. CRT readout inputs are not functional with Option 10.

**POWER REQUIREMENTS**

**7904 Power Requirements** — Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Maximum power consumption, 190 W, 2.5 A at 115 V line, 60 Hz.

**R7903 Power Requirements** — Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Maximum power consumption, 160 W, 2 A at 115 V line, 60 Hz.

**7904 INCLUDED ACCESSORIES**

Test adaptor, (012-0092-00); two 18 in test leads, (012-0087-00); 9 pin cable-mount plug, (134-0049-00).

**R7903 INCLUDED ACCESSORIES**

Test adaptor, (012-0092-00); two 18 in test leads, (012-0087-00); rack-mounting hardware.

**Dimensions and Weights** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See page 234.

**7904 ORDERING INFORMATION  
(PLUG-INS NOT INCLUDED)**

**7904 Oscilloscope ..... \$8,510**

Option 01 — Without CRT Readout ..... - \$300

Option 02 — X-Y Horizontal Comp ..... + \$250

Option 03 — EMC Modification ..... + \$300

Option 04 — Maximum Brightness CRT with 4x5 cm Display (Specify Phosphor) ..... + \$500

Option 78 — P11 Phosphor ..... + \$35

**7904 CONVERSION KITS**

CRT Readout Order 040-0605-03 ..... \$780

X-Y Horizontal Comp Order 040-0606-00 ..... \$300

EMC Modification Order 040-0570-00 ..... \$480

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz ..... NC

Option A2 — UK 240 V/13A, 50 Hz ..... NC

Option A3 — Australian 240 V/10A, 50 Hz ..... NC

Option A4 — North American 240 V/15A, 60 Hz ..... NC

**R7903 ORDERING INFORMATION  
(PLUG-INS NOT INCLUDED)**

**R7903 Oscilloscope ..... \$8,035**

Option 01 — Without CRT Readout ..... - \$300

Option 03 — EMC Modification ..... + \$300

Option 04 — Maximum Brightness CRT with 4x5 cm Display (Specify Phosphor) ..... + \$500

Option 10 — Pulsed Graticule ..... + \$250

Option 78 — P11 Phosphor ..... + \$35

**R7903 CONVERSION KITS**

CRT Readout Order 040-0605-03 ..... \$780

EMC Modification Order 040-0647-00 ..... \$315

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz ..... NC

Option A2 — UK 240 V/13A, 50 Hz ..... NC

Option A3 — Australian 240 V/10A, 50 Hz ..... NC

Option A4 — North American 240 V/15A, 60 Hz ..... NC

Tektronix offers service training classes on the 7904 General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

## 7844/R7844

400 MHz Bandwidth

0.9 ns Risetime

Dual Beam

Full Vertical Crossover Switching

8 x 10 cm Display

CRT Readout

1 ns/div Max Calibrated Sweep

### APPLICATIONS

Radar/Lidar

Destructive Testing

SCR Switching

The 7844 and 7 inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed crt readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds.

### CHARACTERISTICS

#### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series Plug-ins. Bandwidth determined by main-frame and plug-in unit.

#### Display Logic

	Beam 1	Beam 2
Vertical Compartment	Left	Left
Controlling Beam	Left Right	Right Left
	Right	Right

**Vertical Crossover** — Permits viewing the same signal on two time bases.

**Vertical Trace Separation** — Beam 1 can be positioned  $\pm 4$  cm with respect to Beam 2.

**Delay Line** — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series Time Bases; not compatible with 7B50 Series.

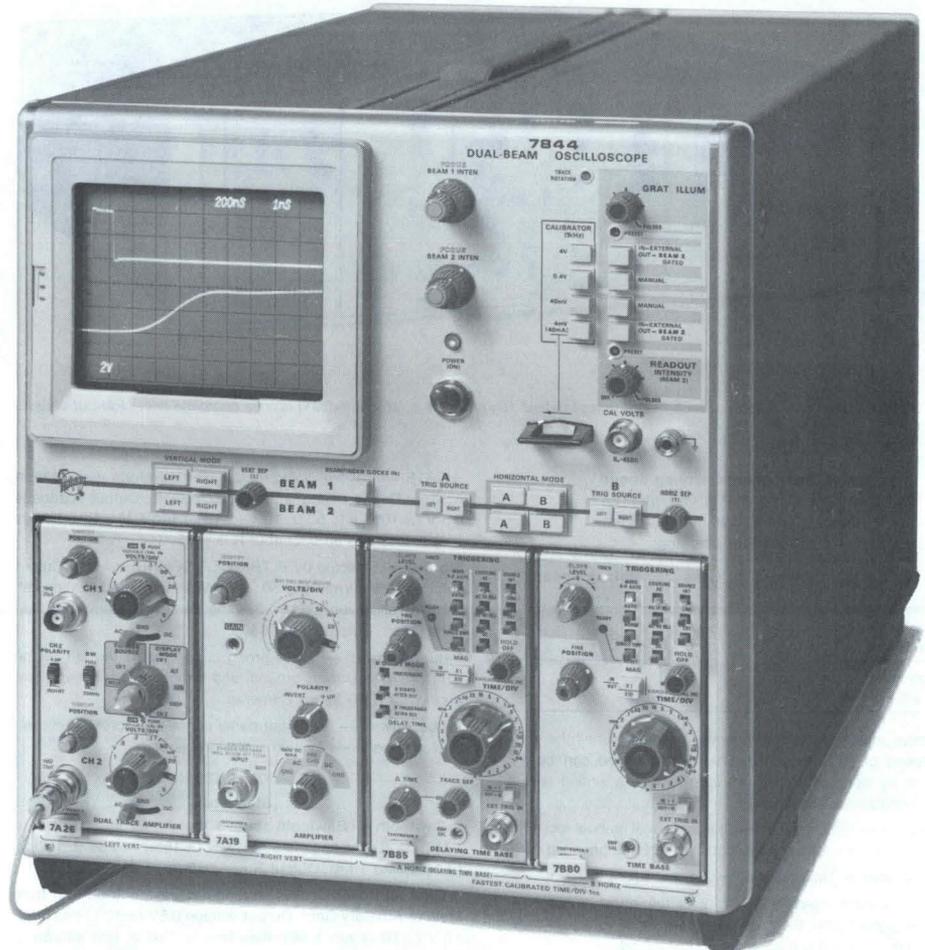
#### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000 Series Vertical Amplifiers and specialized plug-ins may also be used. 7B53AN11 requires modification for use in the 7844.

**Fastest Calibrated Sweep Rate** — 1 ns/div.

**X-Y Mode** — Phase shift is within  $2^\circ$  from dc to 50 kHz.

**Bandwidth** — Dc to at least 1 MHz.



**Horizontal Separation** — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

#### Display Logic

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

#### CRT AND DISPLAY FEATURES

**CRT** — Dual beam, full overlap. 8 x 10 cm graticule with variable illumination. CRT readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV with P31 phosphor standard.

#### Option 78, P11 Phosphor.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder (Beam 1 and Beam 2, Independent Controls)** — Limits display within graticule area and intensifies beam.

**External Z-Axis Input (Beam 1 and Beam 2)** — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

### Typical Photographic Writing Speed (Using Polaroid Type 612 20,000 ASA Film without Film Fogging)

In typical camera applications, P31 Phosphor has about one-half the writing speed of P11 Phosphor. Writing speed can be increased by using controlled film fogging with a writing speed enhancer.

The photographic writing speed enhancer, Option 22, provides a preset automatic method of film fogging for the 7844. Option 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available.



**PULSED READOUT AND GRATICULE ILLUMINATION**

Provides a means of pulsing the graticule lights or CRT readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights or CRT readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

**CALIBRATOR**

**Calibrator** — Rectangular positive-going waveform from ground, 1 kHz ( $\pm 0.25\%$ ).

**Voltage Ranges** — 4 mV, 40 mV, 0.4 V, 4 V ( $\pm 1\%$ ) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V ( $\pm 1\%$ ) into 50  $\Omega$ .

**Current Output** — 40 mA ( $\pm 1\%$ ) rectangular waveshape, front panel current loop 7844, optional current loop adaptor (012-0341-00) required for R7844.

**OUTPUTS/INPUTS**

**A and B + Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Output voltage is 50 mV/div ( $\pm 15\%$ ) into 50  $\Omega$ , 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is  $\approx 950 \Omega$ .

**A and B + Gate** — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ . 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ . Risettime is 5 ns or less into 50  $\Omega$ . Output R is  $\approx 950 \Omega$ .

**Single-sweep Ready Indicator** — +5 V, rear panel BNC output, for single-sweep ready indication.

**External Single-sweep Reset** — Ground closure, rear panel BNC, provides input to reset sweeps.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for C-5 $\frac{1}{2}$  Series Cameras.

**Probe Power** — Two connectors provide correct operating voltages for two active probes.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — Selectable 115 V nominal (90 to 132 V), 230 V nominal (180 to 264 V).

**Line Frequency** — 48 to 440 Hz.

**Maximum Power Consumption** — 235 W, 2.9 A at 60 Hz 115 V line.

**R7844 INCLUDED ACCESSORIES**

One rackmount hardware kit, one rackmount slide guide, (351-0314-01).

**Dimensions and Weights** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See pages 234.

**ORDERING INFORMATION**

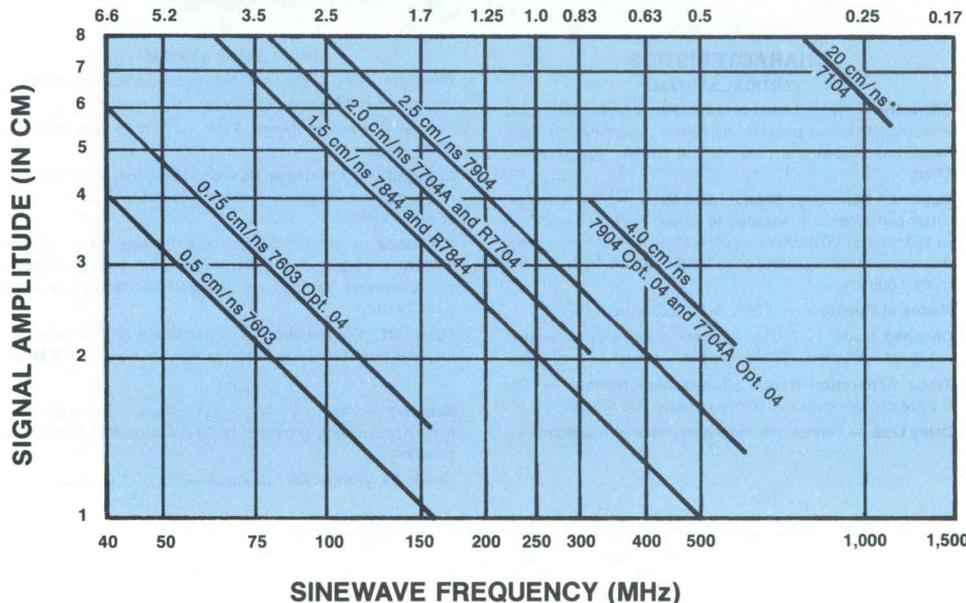
(PLUG-INS NOT INCLUDED)

7844 Oscilloscope .....	\$12,665
R7844 Oscilloscope .....	\$13,065
Option 03 — EMC Modification .....	+ \$300
Option 22 — Writing Speed Enhancer Modification .....	+ \$400
Option 78 — P11 Phosphor .....	+ \$35

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC

**STEP RISE TIME (ns)**



**SINWAVE FREQUENCY (MHz)**

Amplitude vs speed and photographic writing speed comparison of 7000 Series mainframes using optional P11 Phosphors, 20,000 ASA film and the C-51 (f/1.2, 1:0.5) Camera.

\*20 cm/ns is the specified photographic writing speed for the 7104 Mainframe. However, it is not correctly comparable to the other mainframes here because of relaxed phosphor, film and camera requirements. The microchannel plate CRT as well as

the bright photographed image allow for these relaxed requirements. Standard P31 Phosphor is used and a C-53 (f/1.9, 1:0.85 image) Camera.

**PHOTOGRAPHIC WRITING RATE**

This graph shows the relative photographic writing speed of the 7000 Series mainframes and the amplitude-speed relationship for each.

Vertical signal amplitude on the vertical scale is shown against maximum sinewave frequency (lower scale) and fastest risetime (upper scale). These speeds assume a small horizontal spot velocity compared to the maximum vertical velocity. The step ramp is assumed to be a linear ramp measured between 10% and 90% points.

To obtain these minimum photographic writing speeds, open the camera shutter before the sweep and leave open for five seconds after the sweep. Develop the film for 30 seconds at 25°C. View with front illumination. The limit of photographic writing speed will be a barely discernable trace in the center of the photographic image.

The standard P31 Phosphor has a spectral output that gives about one-half the photographic writing speed of the above optional P11 Phosphor. The visual output of the P31 Phosphor is, however, about six times greater than that of the optional P11.

## 7704A/R7704

Dc to 200 MHz with Optimum Pulse Response

1.8 ns Risetime

Dc to 250 MHz Bandwidth Option

Greater than 15 cm/ns Enhanced Writing Speed with Optional CRT and WSEN

CRT Readout

### APPLICATIONS

Communications

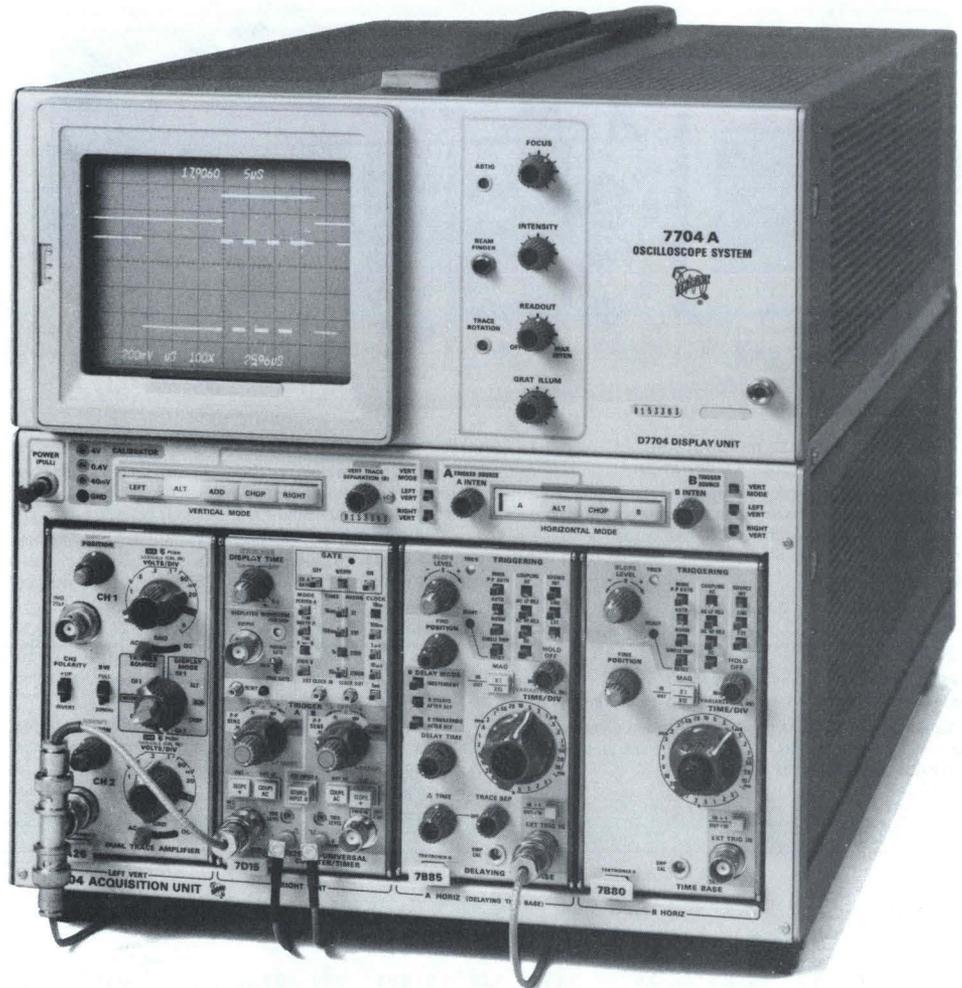
Digital Design

Component Testing

The 7704 family is a wide bandwidth general-purpose oscilloscope measurement system.

The 7704A Oscilloscope offers you the capability to optimize the oscilloscope's response for your type of work. For pulse analysis aberrations are reduced below the normal level in the optimized transient response version while still giving you a bandwidth of 200 MHz. The 250 MHz option is optimized for bandwidth performance for high-frequency applications. The R7704 offers a 175 MHz bandwidth.

Quite often the need arises to photograph the waveforms that are produced. The 7704A gives you a choice of two designs available for this purpose: the standard 8 x 10 cm CRT and an optional 4 x 5 cm reduced-scan CRT for high writing-speed applications. For additional information on the Writing Speed Enhancer (WSEN) see pages 411 and 416; for a comparison of the 7000 Series writing rate specifications see the preceding page.



### CHARACTERISTICS

#### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by main-frame and plug-in unit; see Vertical System Specifications Chart.

**Option 09 Bandwidth Change (250 MHz)** — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper -3 dB) when 7A19 is used. Provides additional performance for those working in this frequency domain.

**Modes of Operation** — LEFT, ALT, ADD, CHOP RIGHT.

**Chopped Mode** — 7704A, rep rate is internally selectable,  $\approx 100$  kHz or 1 MHz; R7704, fixed at  $\approx 1$  MHz.

**Trace Separation Range (Dual-sweep Modes)** — The B trace can be positioned above or below the A trace.

**Delay Line** — Permits viewing leading edge of waveform.

#### HORIZONTAL SYSTEM

**Channels** — Two right-hand plug-in compartments; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 2 ns/div with 7B80 or 7B90 Series.

**Chopped Mode (between Horizontal Plug-ins)** — 7704A, rep rate is internally selectable,  $\approx 20$  kHz or 200 kHz; R7704, fixed at  $\approx 200$  kHz.

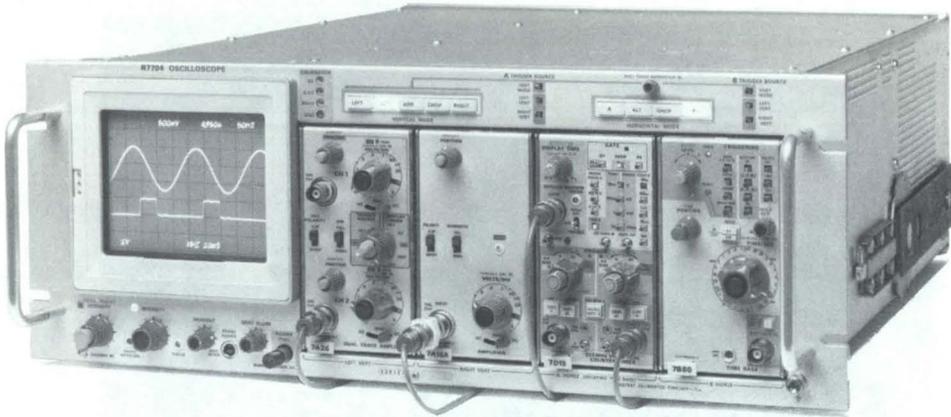
**X-Y Mode** — Phase shift is within  $2^\circ$  from dc to 50 kHz (7704A), from dc to 35 kHz (R7704) between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

**Option 02, X-Y Horizontal Compensation (R7704 only)** — Provides phase shift compensation to  $< 2^\circ$  from dc to 2 MHz.

#### CRT

**Standard** — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 Phosphor standard.

**Option 01, Without CRT Readout** — No CRT readout.



The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

**Option 04, Maximum Brightness CRT with Reduced Area (7704A Only)** — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 Phosphor standard, P11 optional. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

**Option 78, P11 Phosphor Minimum Photographic Writing Speed (Using Polaroid Film Type 612 20,000 ASA without Film Fogging)** — Can be increased by using the Tektronix Writing Speed Enhancer. In typical applications, P31 Phosphor has  $\approx$  one-half the writing speed of P11 Phosphor. See chart on page 243 for further information.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

**External Z-Axis Input (7704A only)** — 2 V p-p for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

**External Z-Axis Input (R7704 only)** — High sensitivity input: minimum pulse width to blank trace is 30 ns at 2V; 2 V peak-to-peak for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace; input R is 500 $\Omega$  within 10%. Maximum input voltage is 15V (dc + peak ac) and p-p ac.

**High Speed Input** — Minimum pulse width to blank trace is 3.5 ns at 60V; 60 V p-p for full intensity range from dc to 100 MHz. A positive signal blanks the trace; input R is 18 k $\Omega$  within 20%. Maximum input voltage is 60 V (dc + peak ac) and p-p ac.

**OUTPUTS/INPUTS**

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div ( $\pm$  15%) into 50  $\Omega$ , 1 V/div ( $\pm$  10%) into 1 M $\Omega$ . Output R is 950  $\Omega$  nominal.

**+Gate** — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V ( $\pm$  10%) into 50  $\Omega$ , 10V ( $\pm$  10%) into 1 M $\Omega$ . Rise time is 20 ns or less into 50  $\Omega$ ; output R is 950  $\Omega$  nominal.

**Sig Out** — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50  $\Omega$ , 0.5 V/div into 1 M $\Omega$ . The bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart. Output R is 950  $\Omega$  nominal.

**External Single-sweep Reset** — Ground closure, rear-panel input to reset sweep.

**Camera Power** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Probe Power** — Two rear-panel connectors provide correct operating voltages for two active probes. R7704 connectors are located on both the front and rear panels. Probe power is deleted on Option 01 of 7704A.

**CALIBRATOR**

**Voltage Output** — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 M $\Omega$ ; 20 mV, 0.2 V, 0.4 V into 50  $\Omega$ . Amplitude accuracy is within 1% ( $+15^{\circ}\text{C}$  to  $+35^{\circ}\text{C}$ ); within 2% ( $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ ). Rep rate is 1 kHz within 0.25% ( $+15^{\circ}\text{C}$  to  $+35^{\circ}\text{C}$ ); within 0.5% ( $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ ).

**Current Output** — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 90 to 132 V ac and 180 to 264 V ac.

**Line Frequency** — 48 to 440 Hz (7704A) 48 to 66 Hz (R7704).

**Option 05, Line Frequency Change (50-400 Hz)** — Converts the R7704 to 50-400 Hz operation (not required for 7704A).

**Maximum Power Consumption** — 180 W, 2.5 A at 115 V line, 60 Hz (7704A); 225 W, 2.8 A at 115 V line, 60 Hz (R7704).

**INCLUDED ACCESSORIES**

For 7704A, 20 in cable, two-pin-to-BNC, (175-1178-00); for R7704, 42 in BNC 50  $\Omega$  cable, (012-0057-01); 20 in cable, two-pin-to-BNC, (175-1178-00); rackmounting hardware.

**Weights and Dimensions** — See page 234.

**For Recommended Cameras** — see page 236.

**For Recommended Plug-ins** — See page 234.

**ORDERING INFORMATION**

(PLUG-INS NOT INCLUDED)

7704A Oscilloscope ..... \$4,260

R7704 Oscilloscope ..... \$7,090

**7704A OPTIONS**

Option 01 — Without CRT Readout and Probe Power ..... - \$300

Option 03 — EMC Modification ..... + \$300

Option 04 — Maximum Brightness CRT with 4x5 cm Display (Specify Phosphor) ..... + \$500

Option 09 — Bandwidth Change (250 MHz) ..... + \$500

Option 78 — P11 Phosphor ..... + \$35

**R7704 OPTIONS**

Option 01 — Without CRT Readout ..... - \$300

Option 02 — X-Y Horizontal Comp ..... + \$250

Option 03 — EMC Modification ..... + \$300

Option 05 — Line Frequency Change (50-400 Hz) (not required for 7704A) ..... + \$300

Option 78 — P11 Phosphor ..... + \$35

**7704A CONVERSION KITS**

**CRT Readout and Probe Power**

Order 040-0613-00 ..... \$480

**EMC Modification** Order 040-0612-00 ..... \$460

**Sig Out/In** Order 040-0619-02 ..... \$200

**R7704 CONVERSION KITS**

**CRT Readout** Order 040-0533-01 ..... \$825

**X-Y Horizontal Comp** Order 040-0529-00 ..... \$280

**EMC Modification** Order 040-0562-00 ..... \$275

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

(7704A ONLY)

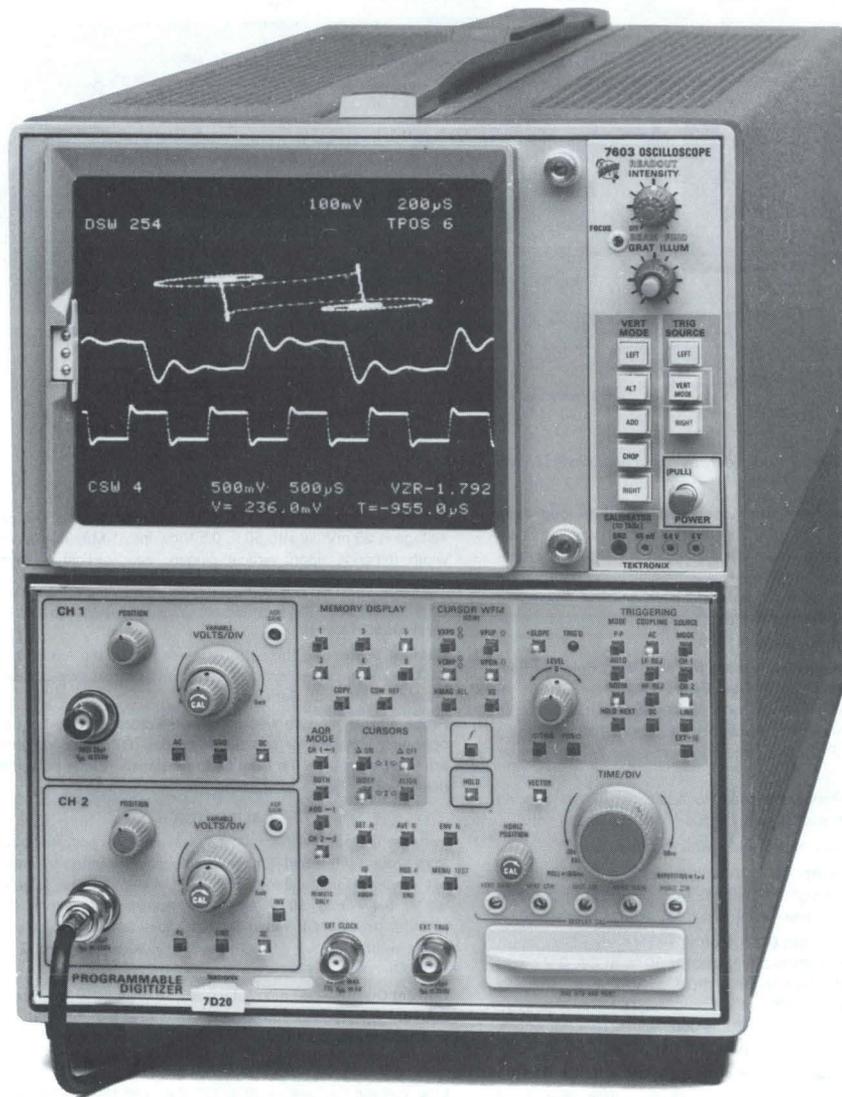
Option A1 — Universal Euro 220 V/16A, 50 Hz ..... NC

Option A2 — UK 240 V/13A, 50 Hz ..... NC

Option A3 — Australian 240 V/10A, 50 Hz ..... NC

Option A4 — North American 240 V/15A, 60 Hz ..... NC

Tektronix offers service training classes on the 7704A General Purpose Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



## 7603/R7603

Dc to 100 MHz Bandwidth

3.5 ns Risetime

6.5 inch CRT

CRT Readout

5.25 inch Rackmount

### APPLICATIONS

Digital Design and Testing

Communications

Spectrum Analysis

The Tektronix 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100 MHz plug-in oscilloscope market today.

The CRT is large, 8 x 10 div (1.22 cm/div), and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness CRT with a smaller 8 x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed.

### CHARACTERISTICS

#### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by main-frame and plug-in unit; see Vertical System Specifications Chart.

**Modes of Operation** — LEFT, ALT, ADD, CHOP, RIGHT.

**Chopped Mode** — Rep rate is  $\approx 1$  MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL SYSTEM

**Channels** — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift between vertical and horizontal channels is within  $2^\circ$  from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

#### CRT AND DISPLAY FEATURES

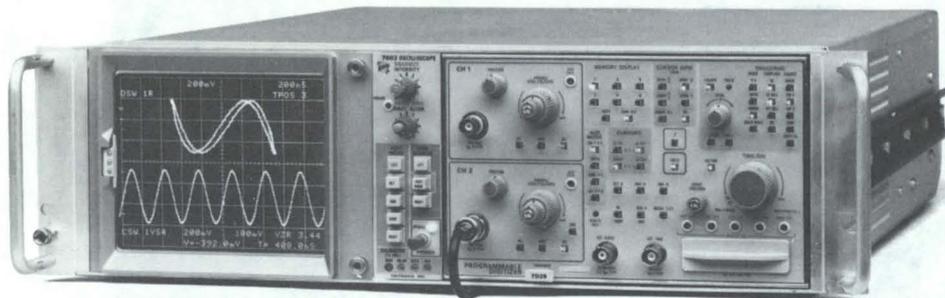
**Standard** — Internal 8 x 10 div (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV with P31 Phosphor.

**Option 01, Without CRT Readout** — No CRT readout.

**Option 04, Max Brightness CRT With Reduced Area** — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 18 kV with P31 Phosphor standard.

**Option 06, Spectrum Analyzer Graticule.**

**Optional Phosphors (Specify)** — P7, P11, or P7/SA. (Phosphor/Spectrum Analyzer graticule combination.)



The R7603 requires only 5.25 in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been adjusted.

**Beam Finder** — Limits display within graticule area.

**OUTPUTS/INPUTS**

+ **Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Output R is 950  $\Omega$ . Output voltage is 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ , 50 mV/div ( $\pm 15\%$ ) into 50  $\Omega$ .

+ **Gate** — Positive pulse of the same duration and coincident with sweep. Output R is 950  $\Omega$ . Output voltage is 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ , 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ . Rise time is 20 ns or less into 50  $\Omega$ . Source is selectable from Main, Delay, or Auxiliary Gate.

**Sig Out** — Selected by TRIGGER SOURCE switch. Output voltage is 0.5V/div into 1 M $\Omega$ , 25 mV/div into 50  $\Omega$ . Output R is 950  $\Omega$ . Bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart.

**External Single-sweep Reset** — Ground closure, rear panel BNC provides input to reset sweep.

**Single-sweep Ready Indicator** — Rear panel BNC provides 5 V for single-sweep ready condition.

**CAMERA POWER OUTPUT**

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**CALIBRATOR**

**Voltage Output** — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 M $\Omega$ ; 20 mV, 0.2 V, 0.4 V into 50  $\Omega$ . Amplitude accuracy is within 1% ( $+15^\circ\text{C}$  to  $+35^\circ\text{C}$ ); within 2% ( $0^\circ\text{C}$  to  $+50^\circ\text{C}$ ). Rep rate is  $\approx 1$  kHz.

**Current Output** — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac  $\pm 10\%$ ; internally selectable with quick-change jumpers.

**Line Frequency** — 50 Hz to 60 Hz (R7603 and 7603).

**Option 05, Line Frequency Change (50-400 Hz)** — Converts the R7603 and 7603 to 50-400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan.

**INCLUDED ACCESSORIES**

The 20 in cable, for 7603 and R7603, two-pin-to-BNC, (175-1178-00); CRT Filter (blue 337-1700-01); CRT Filter (clear 337-1700-04). The R7603 includes rackmounting hardware.

**Dimensions and Weights** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See page 234.

**ORDERING INFORMATION**  
(PLUG-INS NOT INCLUDED)

7603 Oscilloscope .....	\$2700
R7603 Oscilloscope .....	\$3100

**7603 OPTIONS**

Option 01 — Without CRT Readout .....	-\$300
Option 03 — EMC Modification .....	+\$300
Option 04 — Maximum Brightness CRT With 8 x 10 cm Display (specify phosphor) .....	+\$350
Option 05 — Line Frequency Change (50-400 Hz) .....	+\$300
Option 06 — With Internal Spectrum Analyzer Graticule .....	+\$50
Option 08 — Protective Panel Cover .....	+\$100

**R7603 OPTIONS**

Option 01 — Without CRT Readout .....	-\$300
Option 03 — EMC Modification .....	+\$300
Option 04 — Maximum Brightness CRT With 8 x 10 cm Display (specify phosphor) .....	+\$350
Option 05 — Line Frequency Change (50-400 Hz) .....	+\$300
Option 06 — With Internal Spectrum Analyzer Graticule .....	+\$50
Option 20 — IEEE Standard 488 Interface for the 7D20 only .....	+\$250

**7603 CONVERSION KITS**

CRT Readout Order 040-0654-02* .....	\$850
EMC Modification Order 040-1000-00 .....	\$230
<b>Power Supply to Light Plug-in Pushbuttons</b> Order 040-0686-01 .....	\$60
X-Y Horizontal Comp Order 040-0718-00 .....	\$410

**R7603 CONVERSION KITS**

CRT Readout Order 040-0674-02 .....	\$850
EMC Modification Order 040-0955-00 .....	\$100
<b>Power Supply to Light Plug-in Pushbuttons</b> Order 040-0686-01 .....	\$60
X-Y Horizontal Comp Order 040-0718-00 .....	\$410

**PHOSPHOR OPTIONS (7603/R7603)**

Option 76 — P7 Phosphor .....	+\$35
Option 77 — P7 Phosphor with Internal Spectrum Analyzer Graticule .....	+\$35
Option 78 — P11 Phosphor .....	+\$35

\*Not Available for 7603N11S.

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**  
(7603 and R7603)

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC

**OPTIONAL ACCESSORIES (R7603)**

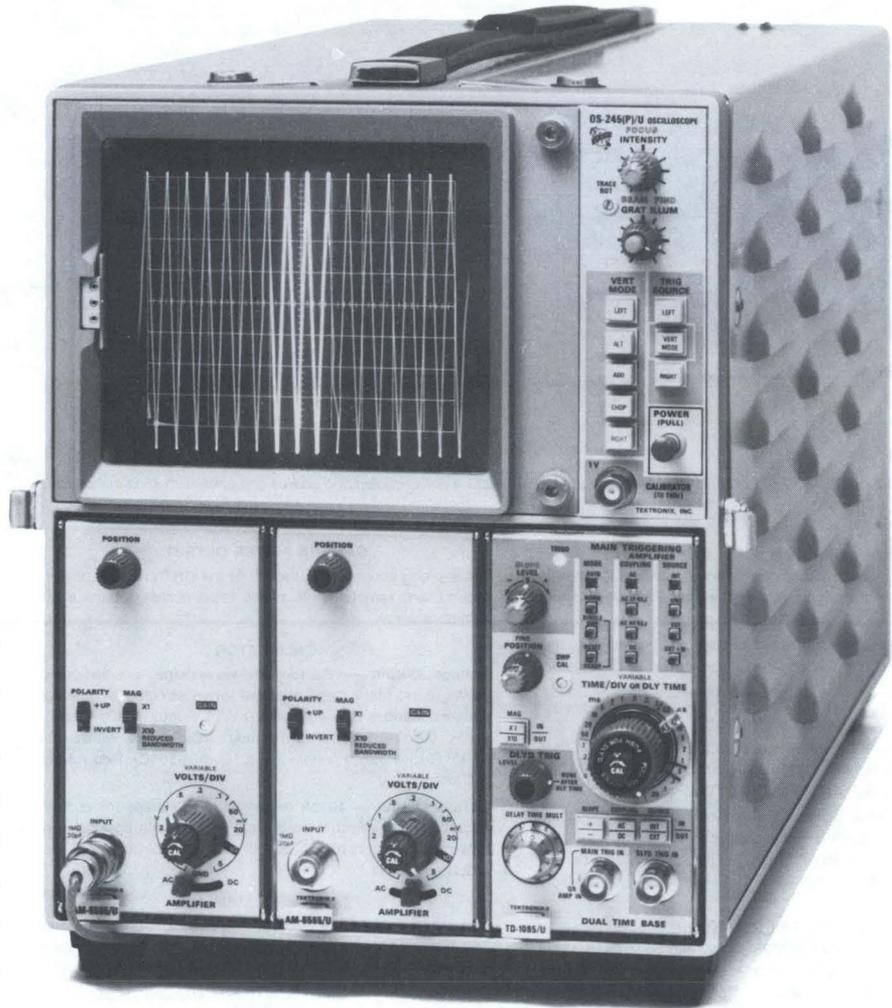
A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's IEEE Standard 488 interface to the R7603 mainframe.

\*Order 040-1093-00

Five other field installable kits are available, one for each of the international power cord and plug options, A1-A5. Contact your local Tektronix Field Office for information.

- \*A1 Universal Euro. Order 040-1094-00
- \*A2 UK. Order 040-1095-00
- \*A3 Australian. Order 040-1096-00
- \*A4 North American. Order 040-1097-00
- \*A5 Switzerland. Order 040-1098-00

\*Contact your local field office for prices.



## 7603N11S

Ruggedized for Extreme Environments

Meets or Exceeds MIL-O-24311 (EC)  
(AN/USM-218C Specifications)

Large, Bright Display - 6.5 in CRT (15 kV)

5 ns/div Delaying Sweep

0.5 mV Vertical Sensitivity

Three-plug-in Flexibility

Versatile Trigger-Source Selection

Pushbutton Switching

Illuminated No-Parallax Graticule

Color-keyed Panels

Protective Cover with Accessories

The 7603N11S Ruggedized Oscilloscope System meets the rigid environmental and electrical specifications required by MIL-O-24311 (EC) and appears on U.S. Navy QPL-24311. The system consists of a three plug-in mainframe, two single-trace amplifiers, a dual time base, and a front-panel cover with probes and accessories.

Although the military spec requires only 50 MHz performance, this system actually performs to 65 MHz. Other better-than-required specs include operating altitude, sensitivity at reduced bandwidth with 10X gain, "X" sensitivity in X-Y mode, triggering frequency range, delaying and delayed sweep speeds, and CRT size.

The mainframe and plug-ins are compatible with the Tektronix 7000 Series product line. The system does not have CRT readout, and it can't be used with the digital plug-ins.

### CHARACTERISTICS ENVIRONMENTAL

**Temperature** — Nonoperating:  $-62^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ . Operating:  $-28^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$ .

**Humidity** — 0 to 95% rh over entire temperature range, operating or nonoperating.

**Altitude** — Nonoperating: Sea level to 15 000 m (50,000 ft). Operating: Sea level to 4500 m (15,000 ft).

**Vibration (Operating)** — 5 to 15 Hz at 0.060 in  $\pm 0.012$  in p-p amplitude, 16 to 25 Hz at 0.040 in  $\pm 0.008$  in p-p amplitude, 26 to 33 Hz at 0.020 in  $\pm 0.004$  in p-p amplitude.

**Shock (Operating)** — Nine consecutive 400 pound hammer blows without failure from 1, 3, and 5 ft in vertical, horizontal, and longitudinal axis as per MIL-S-901 for Grade A, Class 1, Type A for lightweight equipment.

**Inclination (Operating)** — As per MIL-E-16400.

**Drip Proof (Nonoperating)** — As per MIL-STD-198

**Salt Spray (Nonoperating)** — As per MIL-E-16400.

**Electromagnetic Interference** — As per MIL-STD-462 performed by MIL-STD-461 for the following tests:

CE-01	30 Hz to 20 kHz	Power lead emission
CE-03	20 kHz to 50 MHz	Power lead emission
CS-01	30 Hz to 50 kHz	Power lead, radiation susceptibility
CS-02	50 kHz to 400 MHz	Power lead, radiation susceptibility
CS-06	Spike Test	Power lead, spike susceptibility
RE-01	30 Hz to 30 kHz	Instrument radiation, magnetic
RE-02	14 kHz to 10 GHz	Instrument radiation, electric
RS-01	30 Hz to 30 kHz	Instrument susceptibility, magnetic
RS-03	14 kHz to 10 GHz	Instrument susceptibility, electric

**Reliability** — Optimum performance and reliable service are provided during continuous or interrupted operation. The MIL-O-24311(EC) MTBF requirement of >600 hrs is met as tested under the following conditions: temperature +40°C ±2°C; relative humidity 70% ±5%; vibration 25 Hz at 0.040 in ±0.008 in p-p amplitude for 10 minutes of each "Power On" hour during each day of the 8 hr manned schedule; power cycled at 4 hr intervals with 10 min power off for each 4 hr period of the manned test schedule. An MTBF of >2000 hrs was achieved during testing.

**VERTICAL SYSTEM**

(Includes Two 7A15AN11 Plug-ins)

**Channels** — Two left-hand plug-in compartments, with a delay line which allows the leading edge of the displayed waveform to be viewed. All 7000 Series Plug-ins are compatible (except those which require CRT readout).

**Display Modes** — LEFT, ALT, ADD, CHOP, RIGHT. Chopped frequency is ≈1 MHz. Added mode displays signals algebraically with a CMRR of 20:1 to 25 MHz.

**Bandwidth/Sensitivity** — Dc to 65 MHz from 5 mV/div to 10 V/div, accuracy within 2%, variable extends to 25 V/div. Maximum sensitivity is 0.5 mV at 10 MHz with 10X gain. Ac-coupling lower -3 dB point is <2 Hz. Risetime is 5.4 ns with <2% aberrations.

**Input R and C** — 1 MΩ within 2%, <27 pF.

**Maximum Input Voltage** — 400 V (dc + peak ac).

**Dc Stability** — <1 div/hr drift at 25°C.

**HORIZONTAL SYSTEM**

(Includes One 7B53AN11 Plug-in)

**Channels** — One right-hand plug-in compartment. All 7000 Series Plug-ins are compatible (except those which require CRT readout).

**Internal Trigger Modes** — LEFT VERT, VERT MODE, RIGHT VERT.

**X-Y Mode** — The phase shift between vertical and horizontal channels is <2° from dc to 35 kHz. Bandwidth is at least 2 MHz. Risetime is <175 ns. Using the 7B53AN11 Time-Base external amplifier, 10mV, 100 mV, and 1 V sensitivities (±10%) are available. Input R and C for 7B53AN11 is 1 MΩ within 2%, 20 pF within 2 pF. Any vertical plug-in, such as the 7A15AN11, may be used in the horizontal compartment, providing a greater number of sensitivities for calibrated X-Y displays.

**Sweep Display Modes** — Main Sweep, Main Sweep Intensified by Delayed Sweep, Delayed Sweep.

**MAIN (DELAYING) SWEEP**

**Sweep Rate** — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div fastest calibrated sweep rate, obtained with X10 magnifier. The uncalibrated variable is continuous between steps and to 12.5 s/div.

**Sweep Accuracy** — Within 3% from 0.05 μs/div to 5 s/div, within 5% at 5 ns/div.

**Sweep Modes** — Normal, Auto, Single Sweep.

**Delay Time** — Multiplier range is 0 to 10 times the Time/Div setting. Accuracy is within 1% from 0.5 s/div to 0.5 μs/div, within 2% from 5 s/div to 1 s/div. Incremental linearity is within 0.2% of full scale. Jitter is <1 part in 20,000 of 10X time/div setting.

**Triggering (Source/Sensitivity)** — Internal 0.5 cm to 50 MHz. External, 0.25 V to 20 MHz, 0.5 V to 50 MHz. Ext ÷ 10, 2.5 V to 20 MHz, 5 V to 50 MHz. Triggering extends to 100 MHz with reduced sensitivity in both Internal and External Modes. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

**Triggering Frequency Range** — Ac, 30 Hz to 50 MHz; ac If Rej, 30 kHz to 50 MHz; ac HF Rej, 30 Hz to 50 kHz; dc, dc to 50 MHz. With external level range, slope is ±30 V.

**DELAYED SWEEP**

**Triggering (Source/Sensitivity)** — Internal 0.3 div to 10 MHz increasing to 1.5 div at 50 MHz. External, 0.1 V to 10 MHz increasing to 0.5 V at 100 MHz. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

**Triggering Frequency Range**

Ac — 30 Hz to 50 MHz.

Dc — 30 Hz to 50 MHz.

**Sweep Rate** — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). The delayed sweep runs after delay time or is triggered after delay time.

**Sweep Accuracy** — Within 3% from 50 ms/div to 0.5 μs/div, within 4% for all other sweep rates except the magnified X10 sweep rate of 5 ns/div, which is within 6%.

**CRT**

**Accelerating Potential** — 15 kV.

**Phosphor** — P31.

**Graticule** — Internal 8 x 10 cm with variable illumination. The 6.5 in CRT permits 2 cm of linear overscan in both axes, making a total viewing area of ≈10 x 12 cm.

**CRT Controls** — Located on front panel are Focus, Intensity, Graticule Illumination, Beam Finder, and Trace Rotation. Astigmatism is an internal control.

**External Z-Axis Input (BNC Connector on Rear Panel)** — 2 V p-p for full intensity range from dc to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. Maximum input voltage is 10 V (dB + peak ac).

**OUTPUTS**

**Calibrator (BNC Connector on Front Panel)** — 1 V within 1%, 1 kHz squarewave within 20%.

**Horizontal** — Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of >50 ns. All amplitudes are minimum and measured when working into at least 100 kΩ and 15 pF.

**POWER REQUIREMENTS**

**Input Voltages** — 100, 110, 120, 220, and 240 V ac ±10% internally selectable with quick-change jumpers with 47.5 to 440 Hz single phase line frequency. Maximum power consumption is 125 W.

**C281 COVER WITH ACCESSORIES**

The cover provides protection during transport and packages the included accessories.

**INCLUDED ACCESSORIES (ALL PACKAGED IN COVER)**

The P6006 Probe packages (010-0127-00); two 8 ft long 50 Ω BNC Cables (012-0366-00); two BNC Female to UHF Male Adaptors (103-0015-00); two BNC Male to UHF Female Adaptors (103-0032-00); two BNC Male to binding post adaptors (103-0033-00); two BNC T Connectors (103-0030-00). One set of technical manuals (not packaged in cover).

**Dimensions and Weights** — See page 234.

**For Recommended Cameras** — See page 236.

**ORDERING INFORMATION**

**7603N11S Oscilloscope System (AN/USM-281C) 7603NMS ..... \$7,580**

**System Includes** — One each 7603N11 Oscilloscope, two each 7A15AN11 Amplifier Plug-ins, one each 7B53AN11 Time Base, and one each C281 Cover with accessories.

**To Order Separately:**

**7603N11 Oscilloscope\* (OS-245(P)/U)**  
Order 7603N11 ..... **\$3,720**

**7A15AN11 Amplifier Plug-in (AM-6565/U)**  
Order 7A15ANM ..... **\$790**

**7B53AN11 Time Base Plug-in (TD-1085/U)**  
Order 7B53ANM ..... **\$1,905**

**C281 Cover W/Accessories**  
Order 016-0553-00 ..... **\$300**

\*CRT readout not available.

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**
- Option A2** — UK 240 V/13A, 50 Hz ..... **NC**
- Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**
- Option A4** — North American 240V/15A, 60 Hz ..... **NC**

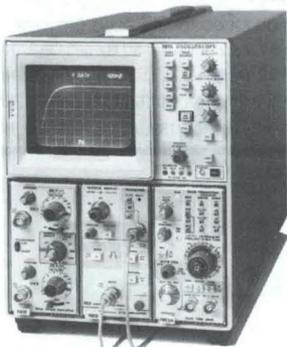
# 7000 SERIES CRT STORAGE MAINFRAMES

## CONTENTS

Nonstorage Mainframes .....	237
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Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from  $\approx 0.03 \text{ cm}/\mu\text{s}$  for mechanical, spectrum analysis, or TDR applications, to  $2500 \text{ cm}/\mu\text{s}$  for capturing fast single events such as high speed digital logic. A selection of storage modes offers the following features:

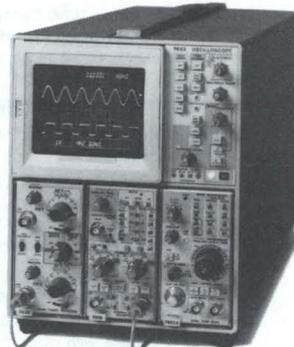
- Bistable** ..... Long View Time
- Variable Persistence** ..... High Contrast Displays
- FAST Bistable** ... Captures Fast Single or Multiple Events
- FAST Variable Persistence** ..... Provides Maximum Stored Writing Rate



7613  
Variable Persistence



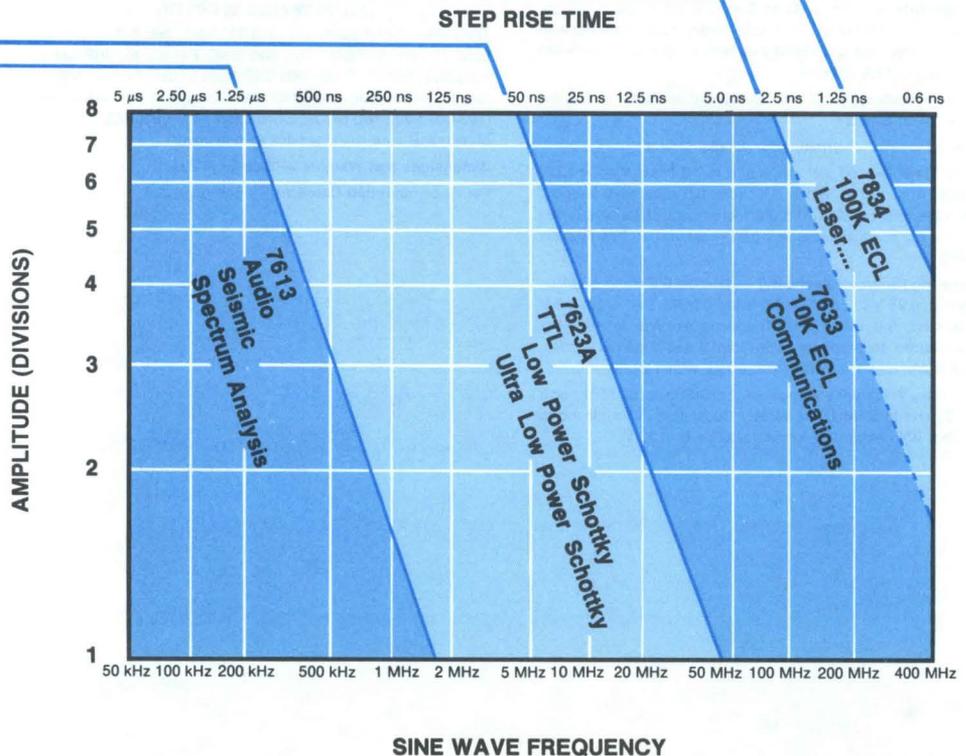
7623A  
FAST Multimode



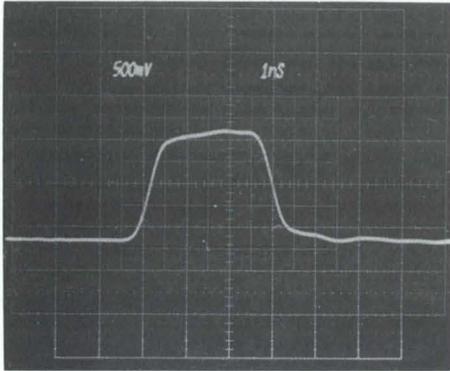
7633  
FAST Multimode



7834  
FAST Multimode



Graph shows the stored writing speed needed to display a given sinewave or step rise time at a given amplitude.



Readout is stored with the waveform on several CRT storage scopes including the 7613, 7623A, 7633 and 7834. Multimode storage is available on the 7623A, 7633, and 7834.

### 7000 Series Storage Oscilloscopes

Storage, as it applies to most instruments in the Tektronix 7000 Series, involves techniques for capturing and retaining signals within the cathode-ray tube itself, or as numeric values in digital memory.

#### Why Store?

Capturing an event for detailed analysis is perhaps the most obvious application for a storage CRT, but many other situations also call for its unique advantages. Some examples include capturing the entire display of a slowly occurring signal...observing signal changes during circuit adjustment...comparing incoming signals with a standard...increasing the brightness of a repetitive signal for viewing in normal ambient light...reducing flicker or noise...baby-sitting, or unattended monitoring for a transient event...and enhancing other recording techniques such as photography.

#### Storage Features

Since 1962, when Tektronix introduced phosphor target bistable storage in the 564, techniques for capturing and retaining waveforms have grown at an explosive rate in order to keep pace with measurement demands.

However, the language of storage—such terms as bistable, variable persistence, mesh transfer and digital storage—frequently presents as much confusion as the measurement that must be made.

Characteristics of individual 7000 Series mainframes employing storage techniques are listed on pages 250 through 266. A review, though, of storage concepts should prepare the reader to evaluate the various alternatives more knowledgeably.

#### Digital Storage

The fundamental difference between the digital storage scope and the CRT storage scope is the form of storage. Digital scopes store data representing waveforms in a digital memory; CRT storage scopes store waveforms within the CRT.

#### Bistable CRT Storage

Bistable storage, available as one storage mode on the 7834, 7633 and 7623A Mainframes, employs a mesh between the electron gun and the CRT phosphor. It features bright, long lasting displays with reduced contrast.

#### Variable Persistence CRT Storage

Variable persistence storage is available in the 7613, 7623A, 7633, and 7834 Mainframes. It features bright, high contrast displays and controlled persistence.

A front-panel persistence knob provides control of the decay (fade-away) rate of the stored image. The rate can be varied from almost instantaneous disappearance to a view time of greater than 15 s in the 7613 (30 s in the 7623A, 7633, and 7834).

#### Fast Multimode CRT Storage

Fast multimode storage, available in the 7623A, 7633, and 7834, provides four storage modes. The four modes combine the previously discussed bright bistable and variable persistence storage modes with fast bistable and fast variable persistence.

The display characteristics of fast bistable and fast variable persistence are the same as bistable and variable persistence respectively. In either fast storage mode the trace image is first written on a fast mesh, then transferred to a long retention mesh for viewing.

As the name implies, the fast storage mode provides increased storage writing speed. For example, in the reduced scan display mode, the variable persistence writing speed of 5.4 cm/ $\mu$ s is increased to 2500 cm/ $\mu$ s by selecting fast variable persistence.

## 7834

2500 cm/μs Stored Writing Speed

Stores Single-shot Risetimes as Fast as 1.4 ns

Dc to 400 MHz Bandwidth

Multimode Storage

Long View Time

### APPLICATIONS

Laser Fusion

Digital Design

Radar/Lidar

The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/μs, enabling storage of single-shot rise times to 1.45 ns, 3.6 cm high, at eight-divisions amplitude, reduced-scan mode. The 7834's mainframe bandwidth is 400 MHz (nonstore). The system bandwidth may vary from 160 MHz to 400 MHz depending on the plug-in selected.

This instrument has four storage modes—bistable and variable persistence, FAST bistable and FAST variable persistence.

**FAST VARIABLE PERSISTENCE** provides the maximum stored writing rate of 2500 cm/μs (reduced scan). View time is at least 30 s.

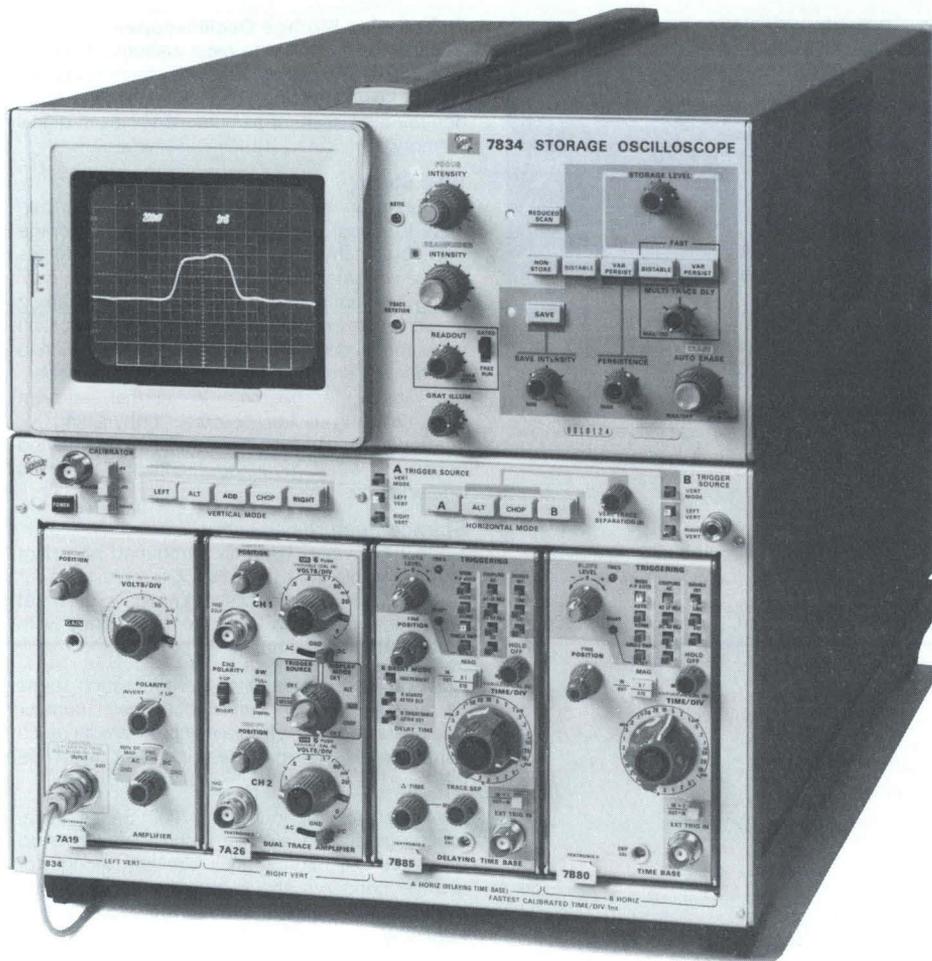
**FAST BISTABLE** increases bistable writing rates to 350 cm/μs (reduced scan).

**BISTABLE** provides stored displays with long (30 minute) view time.

**VARIABLE PERSISTENCE** gives high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, variable persistence provides continuous bright displays of new information as old information fades from the CRT.

The four-compartment flexibility means that more than one measurement can be performed at the same time without switching plug-ins. The 7834 also offers auto-erase for automatic display updating...a save control for 30 times longer viewing...gated readout which prevents the blooming that tends to occur between sweeps with nongated readout...and an adjustable multitrace delay for varying the viewing time prior to the next sweep in the FAST transfer mode.

The multimode storage unit is designed for single shot, low-rep-rate or fast pulse analysis.



### CHARACTERISTICS

#### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins.

**Modes of Operation** — LEFT, ALT, ADD, CHOP, RIGHT.

**Mainframe Bandwidth** — 400 MHz with 7A29 Amplifier plug-in.

**Mainframe Step Response** — 0.9 ns or less with 7A29 Amplifier plug-in.

**Chopped Mode** — Rep rate is ≈1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

**Trace Separation Range** — In dual-sweep modes, B trace can be positioned four divisions above or below the A trace.

#### HORIZONTAL SYSTEM

**Input** — Two right-hand plug-in compartments; compatible with all 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.

**Modes of Operation** — A, ALT, CHOP, B.

**Fastest Calibrated Sweep Rate** — 1 ns/div.

**Chopped Mode** — Rep rate is ≈200 kHz.

**X-Y Mode** — Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

#### CRT AND DISPLAY FEATURES

**Graticule** — Internal variable illuminated graticule. 8 x 10 div (0.9 cm/div) graticule in full scan and 8 x 10 div (0.45 cm/div) in reduced scan.

**Option 01, without CRT Readout and Probe Power** — Deletes CRT readout and probe power.

**Accelerating Potential** — ≈10 kV full scan mode, and 12 kV in reduced scan mode.

**Phosphor** — P31.

**CRT Display Modes** — Nonstore, Bistable, Variable Persistence, FAST Bistable and FAST Variable Persistence (full and reduced scan).

**Persistence** — (Variable Persistence mode only) controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

**Auto Erase** — Continuously variable from <1 s to >10 s.

**Multitrace Delay** — Adjusts the transfer cycle time in the FAST transfer modes. Continuously variable from <1 s to >4 s.

**Save** — Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in all modes.

**External Z-Axis Input** — 2 V peak-to-peak for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

**Auto-Focus** — Maintains CRT focus following changes in display intensity after focus control has been initially set.

**Beam Finder** — Limits display within graticule.

**STORAGE WRITING SPEED**

FULL SCAN (Center 6 x 8 div at 0.9 cm/div)				
Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	270 cm/μs 300 div/μs	45 cm/μs 50 div/μs	1.8 cm/μs 2 div/μs	0.027 cm/μs .03 div/μs
View Time	30 s*	30 min**	30 s*	30 min
≅ Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

REDUCED SCAN (Center 8 x 10 div at 0.45 cm/div)				
Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	2500 cm/μs 5,500 div/μs	350 cm/μs 776 div/μs	5.4 cm/μs 12 div/μs	0.09 cm/μs 0.2 div/μs
View Time	30 s*	30 min**	30 s*	30 min*
≅ Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

\*View times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the SAVE display mode.  
\*\*Save intensity at minimum.

**Fast Variable Persistence Writing Speed**

Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	Step Response
Reduced Scan 5,500 div/μs (0.45 cm/div)	≥ 1 ns/div	7.1 div 250 MHz	7.7 div 1.4 ns
		8 div 221 MHz	8 div 1.45 ns
Full Scan 300 div/μs (0.9 cm/div)	≥ 10 ns/div	3.2 div 30 MHz	3 div 10 ns
		6.4 div 15 MHz	5 div 16.6 ns

**OUTPUTS/INPUTS**

+ **Sawtooth** — Positive going with baseline at 0 V ± 1 V into 1 MΩ. Voltage is 1 V/div (± 10%) into 1 MΩ, 50 mV/div (± 15%) into 50 Ω. Output R is ≈ 950 Ω.

+ **Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (± 10%) into 1 MΩ, 0.5 V (± 10%) into 50 Ω. Output R is ≈ 950 Ω. Source is selectable from A Gate, B Gate or A Delayed Gate.

**Vertical Signal Out** — Selected by A TRIGGER SOURCE switch. Output voltage is 0.5 V into 1 MΩ, 25 mV into 50 Ω. Output R is ≈ 950 Ω. Bandwidth depends upon vert plug-in.

**Remote Single Sweep Reset, Remote Save and Remote Erase** — Rear panel BNC connector inputs, ground closure activated.

**Remote FAST Transfer Gate** — TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

**Camera Power Output** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Probe Power** — Two rear-panel connectors provide operating voltages for two active probes such as P6201.

**CALIBRATOR**

**Voltage Output** — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

**Current Output** — 40 mA available through CALIBRATOR output with optional BNC to current loop adaptor.

**Dimensions and Weight** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See page 234.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 90 to 132 V ac and 180 to 250 V ac.

**Line Frequency** — 48 to 440 Hz.

**Maximum Power Consumption** — 215 W.

**INCLUDED ACCESSORIES**

Gray CRT filter, installed (378-0625-02); green CRT filter (378-0625-08); power cord (161-0066-00).

**ORDERING INFORMATION  
(PLUG-INS NOT INCLUDED)**

**7834 Storage Oscilloscope ..... \$11,705**

**OPTIONS**

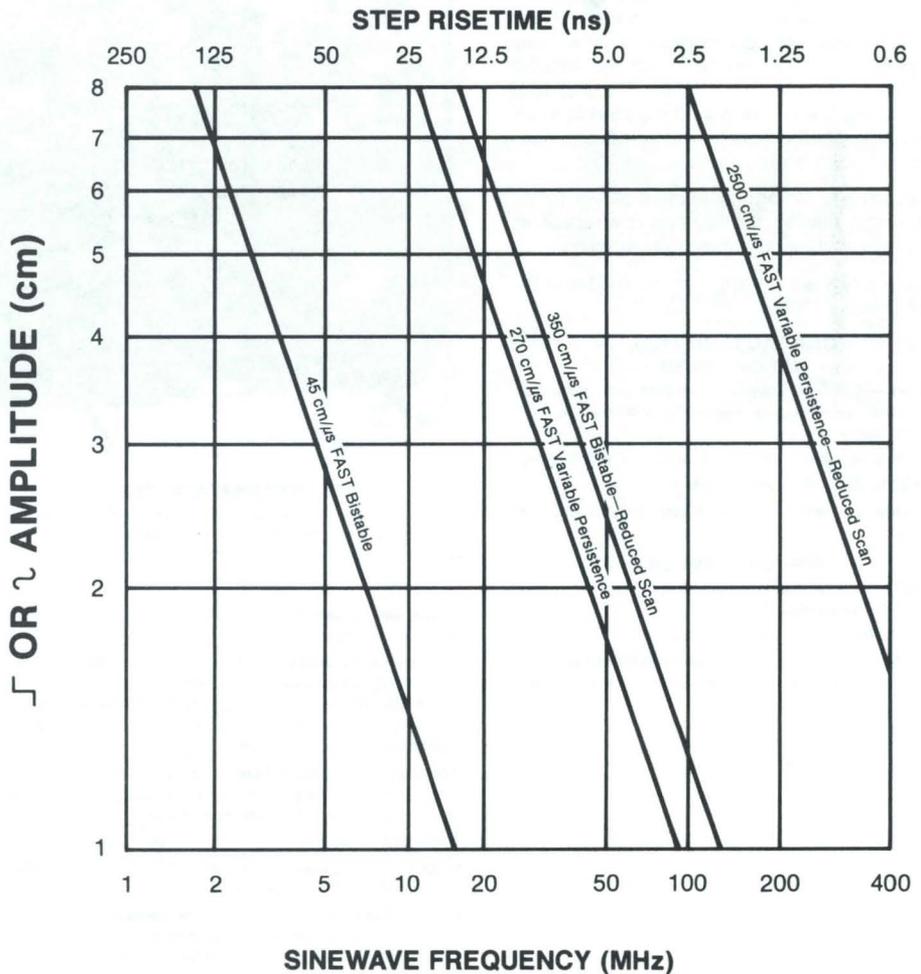
- Option 01** — Without CRT Readout and Probe Power ..... **-\$300**
- Option 02** — X-Y Mode Phase Correction ..... **+\$250**
- Option 03** — EMC Modification ..... **+\$300**
- Cradle Mount Adaptor** For Rackmounting.  
Order 040-0560-00 ..... **\$445**

**CONVERSION KITS**

- CRT Readout** Order 040-0811-02 ..... **\$480**
- EMC Modification** Order 040-0880-00 ..... **\$500**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**
- Option A2** — UK 240 V/13A, 50 Hz ..... **NC**
- Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**
- Option A4** — North American 240 V/15A, 60 Hz ..... **NC**



Graph showing the stored writing speed needed to display a given sinewave or step risetime at a given amplitude.

## 7633/R7633

1000 cm/μs Stored Writing Speed

Long View Time

Multimode Storage

Dc to 100 MHz Bandwidth

### APPLICATIONS

Digital Design

Destructive Testing

Communications

The Tektronix 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100 MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The maximum writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

This multimode storage instrument allows for retention and viewing for fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms.

Characteristics are common to the 7633 and the 7623A unless noted.

### CHARACTERISTICS

#### VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by main-frame and plug-in unit.

**Modes of Operation** — LEFT, ALT, ADD, CHOP, RIGHT.

**Chopped Mode** — Rep rate is ≈1 MHz.

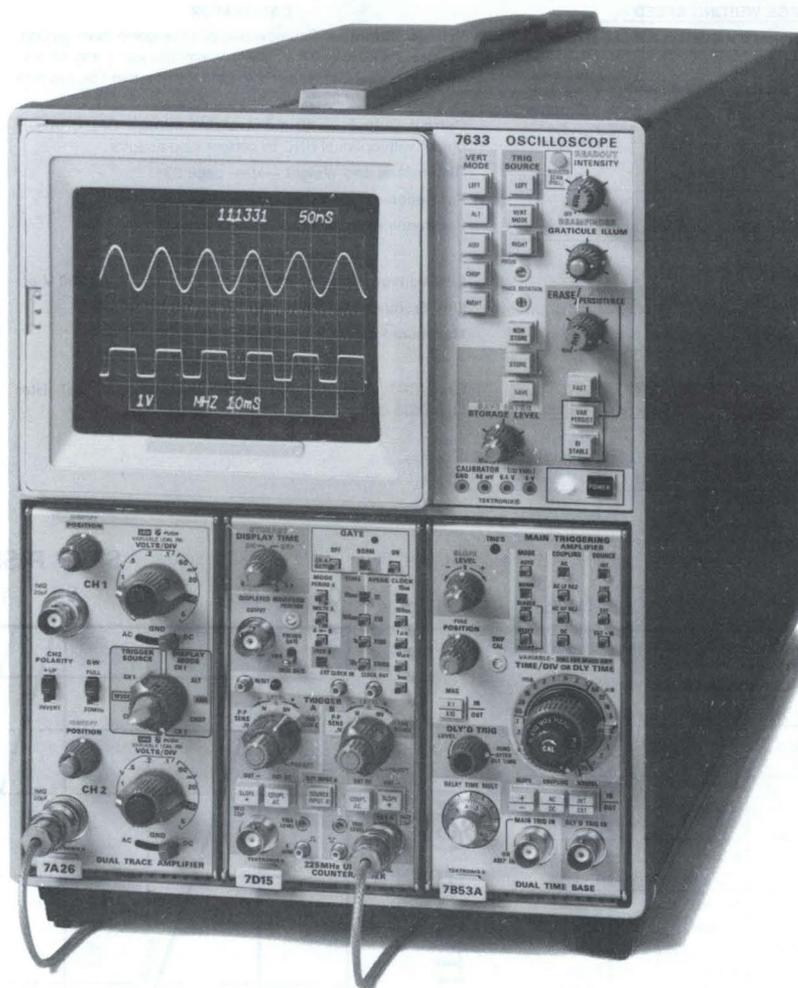
**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL SYSTEM

**Channel** — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift between vertical and horizontal channels is <2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.



#### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 div (0.9 cm/div) and 8 x 10 div (0.45 cm/div) graticule with variable illumination.

**Phosphor** — P31.

**Option 01** — No CRT readout.

**Accelerating Potential** — ≈8.5 kV in normal mode, 10 kV in reduced scan mode.

**Storage Display Modes** — Nonstore, FAST variable persistence, FAST bistable, variable persistence, bistable. Full or reduced scan may be selected on the 7633 in all display modes. Select normal scan to view the entire CRT; select reduced scan for the fastest writing rate.

**Persistence** — Variable. When set to maximum, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

**Autoerase** — Variable up to 10 s.

**Save** — Prevents erasing and storing additional displays; also extends view time in variable persistence mode.

**External Z-Axis Input** — 2 V p-p for useful intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

**Autofocus** — Reduces the need for calibrated manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

#### STORAGE WRITING SPEED

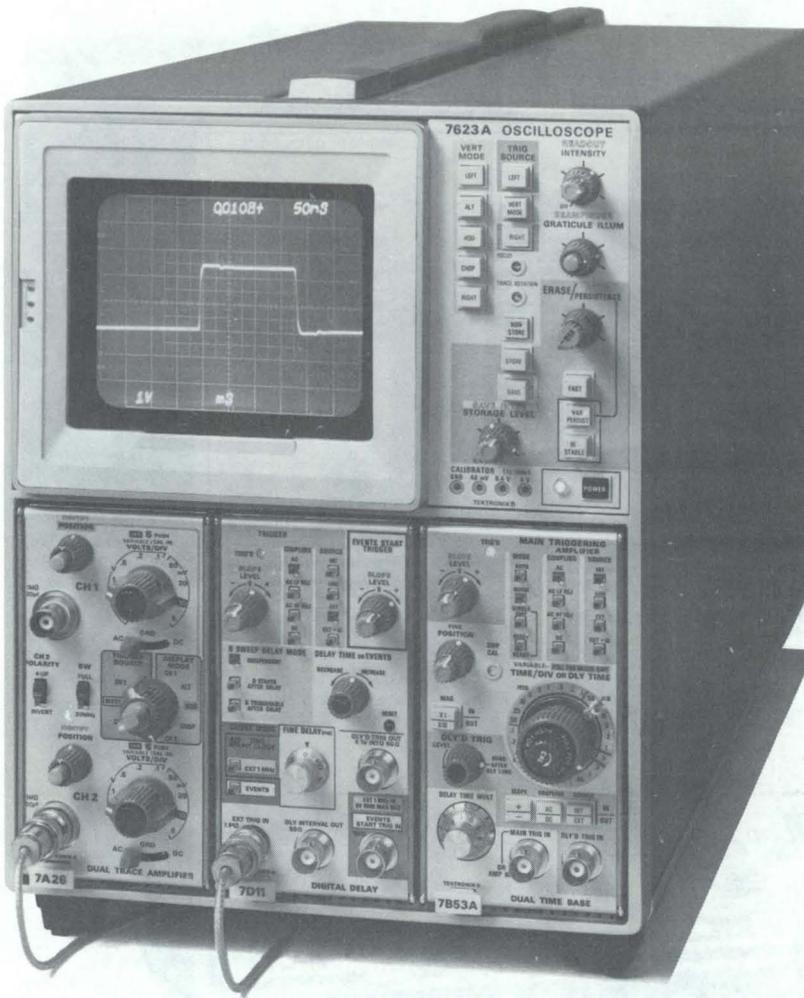
Full Scan (7633 and 7623A)

Display Mode	Fast Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/μs	45 cm/μs	0.45 cm/μs	0.027 cm/μs
View Time	30 s*	30 min minimum	30 s*	30 min minimum
≈ Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

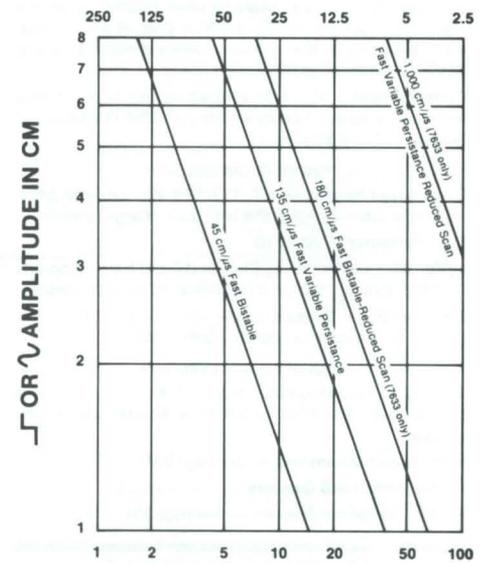
#### Reduced Scan (7633 Only)

Display Mode	Fast Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Store Writing Speed	1000 cm/μs	180 cm/μs	1.35 cm/μs	0.09 cm/μs
View Time	30 s*	30 min minimum	30 s*	30 min minimum
≈ Erase Time	1.4 s	1.4 s	0.9 s	0.9 s

\*These times are at full stored display intensity. They may be increased more than 30 times by using reduced intensity in the save display mode.



**STEP RISE TIME (ns)**



**SINEWAVE FREQUENCY (MHz)**

Graph showing the stored writing speed needed to display a given sine wave or step risetime at a given amplitude.

**OUTPUTS/ INPUTS**

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Output voltage is 50 mV/div ( $\pm 15\%$ ) into 50  $\Omega$ , 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is 950  $\Omega$  within 2%.

**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ , 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ . Rise time is 20 ns or less into 50  $\Omega$ , output R is 950  $\Omega$  within 2%. Source is selectable from main, delay, or auxiliary gate.

**Vertical Signal Out** — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50  $\Omega$ , 0.5 V/div into 1 M $\Omega$ . Bandwidth depends on vertical plug-in. Output R is 950  $\Omega$  within 2%.

**External Single-Sweep Reset** — Ground closure; rear panel BNC provides input to reset sweep.

**Remote Erase** — Ground closure; rear panel BNC provides input to erase stored trace.

**CAMERA POWER OUTPUT**

Three-prong connector to the left of the CRT provides power, ground and remote single-sweep reset access for the C-50 Series cameras.

**7623A/R7623A**

135 cm/ $\mu$ s Stored Writing Speed

Long View Time

Multimode Storage

Dc to 100 MHz Bandwidth

**APPLICATIONS**

Ultrasonics

Power Supply Design

Component Testing

**FAST VARIABLE PERSISTENCE WRITING SPEED**

Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	Step Response
Reduced Scan** 2200 div/ $\mu$ s (0.45 cm/div)	$\geq 5$ ns/div	7.1 div 100 MHz	7.7 div 3.5 ns (7633 only)
		8 div 89 MHz	8 div 3.7 ns
Full Scan 150 div/ $\mu$ s (0.9 cm/div)	$\geq 50$ ns/div	3.2 div 15 MHz	3 div 20 ns 7633 7623A
		6.4 div 7.5 MHz	5 div 33 ns

\*\*Applies to 7633 only.



The R7633 and R7623A require only 5.25 inches of rack height in a standard 19 inch rack. They are fan cooled and come complete with slide-out chassis tracks.

**CALIBRATOR**

**Voltage Output** — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 M $\Omega$ ; 20 mV, 0.2 V, 0.4 V into 50  $\Omega$ . Amplitude accuracy is within 1% (15 to 35°C); within 2% (0 to 50°C). Rep rate is  $\approx$ 1 kHz.

**Current Output** — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac  $\pm$  10%; internally selectable with quick change jumpers.

**Line Frequency** — 50-60 Hz.

**Option 05, Line Frequency Change (50-400 Hz)** — Converts the 7633, R7633, 7623A and R7623A to 50-400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

**INCLUDED ACCESSORIES**

20 in cable, two-pin-to-BNC, (175-1178-00); CRT filter, green (378-0625-08). The R7633 and R7623A include rackmounting hardware.

**Weights and Dimensions** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See page 234.

**ORDERING INFORMATION**  
(PLUG-INS NOT INCLUDED)

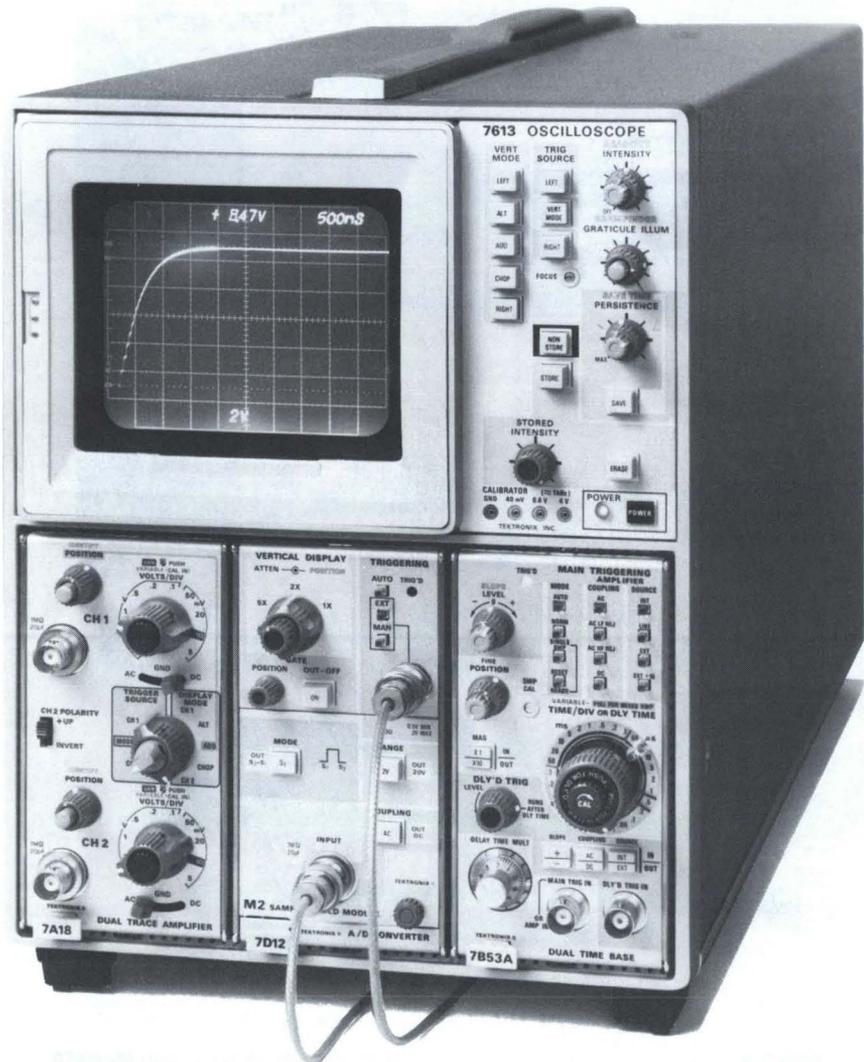
7633 Storage Oscilloscope .....	\$7,765
R7633 Storage Oscilloscope .....	\$8,165
7623A Storage Oscilloscope .....	\$5,950
R7623A Storage Oscilloscope .....	\$6,350

**OPTIONS**

Option 01 — Without CRT Readout .....	-\$300
Option 03 — EMC Modification .....	+\$300
Option 05 — Line Frequency Change (50-400 Hz) .....	+\$300

**CONVERSION KITS**

<b>CRT Readout Cabinet</b>	
Order 040-0748-01 .....	\$850
<b>Rackmount Order 040-0759-01 .....</b>	<b>\$850</b>
<b>EMC Modification Cabinet</b>	
Order 040-0663-01 .....	\$525
<b>Rackmount Order 040-0678-01 .....</b>	<b>\$285</b>
<b>Power Supply to Light Plug-in Pushbuttons.</b>	
Order 040-0686-01 .....	\$60



**7613**

Variable Persistence Storage

4.5 cm/ $\mu$ s Stored Writing Speed

Dc to 100 MHz Bandwidth

5.25 inch Rackmount Height

**APPLICATIONS**

Audio

Mechanical Transducers

Spectrum Analysis

The Tektronix 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/ $\mu$ s or nonstorage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div).

**CHARACTERISTICS**  
VERTICAL SYSTEM

**Channels** — Two left-hand plug-in compartments; compatible with all 7000 Series plug-ins. Bandwidth determined by main-frame and plug-in unit; see Vertical System Specifications Chart.

**Modes of Operation** — LEFT, ALT, ADD, CHOP, RIGHT.

**Chopped Mode** — Rep rate is  $\approx$ 1 MHz.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**HORIZONTAL SYSTEM**

**Channel** — One right-hand plug-in compartment; compatible with all 7000 Series plug-ins.

**Fastest Calibrated Sweep Rate** — 5 ns/div.

**X-Y Mode** — The phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

**CRT AND DISPLAY FEATURES**

**Variable Persistence Storage CRT** — Internal 8 x 10 div (0.9 cm/div) graticule with variable illumination.

**Phosphor** — P31.

**Option 01** — No CRT readout

**Accelerating Potential** — 8.5 kV.

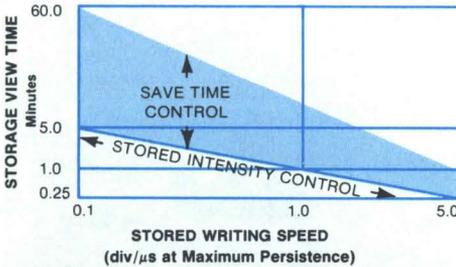
**Nonstore Mode** — For displaying waveforms in the conventional (nonstorage) mode.

**Store Mode** — For displaying waveforms using the variable persistence storage feature.

**Maximum Stored Writing Speed** — >4.5 cm/ $\mu$ s.

**View Time** — The view time is the amount of time the stored signal can be viewed before it fades away.

At the maximum writing speed the view time is 15 s or 0.25 min with the stored intensity control fully cw. Adjusting the stored intensity cw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart below).



**Erase Time** — 0.5 s or less.

**Persistence** — The persistence control also varies the view time. The persistence can be adjusted from almost instantaneous disappearance (fade away), to off, which provides the view time selected by the stored intensity control.

**Save** — Prevents erasure of the stored display and activates the save time control.

**Save Time Control** — Allows an extension of the view time (see Storage View Time Chart above).

**External Z-Axis Input** — 2 V peak-to-peak for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (dc + peak ac) and peak-to-peak ac.

**Autofocus** — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

**Beam Finder** — Limits display within graticule area.

**OUTPUTS/INPUTS**

**+Sawtooth** — Sawtooth starts 1 V or less from ground (into 1 M $\Omega$ ). Output voltage is 50 mV/div ( $\pm 15\%$ ) into 50  $\Omega$ , 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ . Output R is 950  $\Omega$  within 2%.

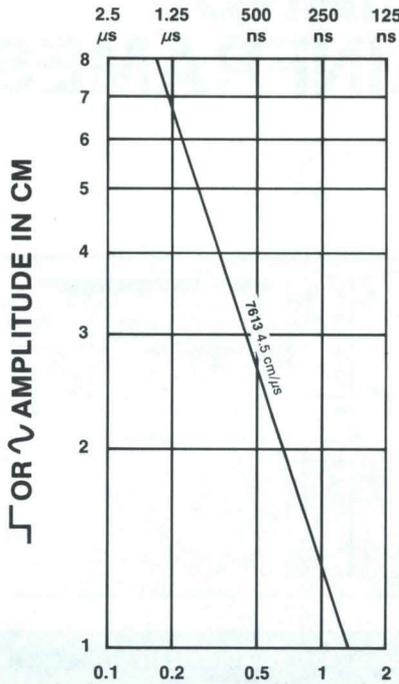
**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ , 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ . Rise time is 20 ns or less into 50  $\Omega$ ; output R is 950  $\Omega$  within 2%. Source is selectable from main, delay, or auxiliary gate.

**Sig Out** — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div into 50  $\Omega$ , 0.5 V/div into 1 M $\Omega$ . Bandwidth depends upon vertical plug-in; (see Vertical System Specifications Chart). Output R is 950  $\Omega$  within 2%.

**External Single-Sweep Reset** — Ground closure; rear panel BNC provides input to reset sweep.

**Remote Erase** — Ground closure; rear panel BNC provides input to erase stored trace.

**STEP RISE TIME (ns)**



Graph showing the stored writing speed needed for a given sinewave or step risetime at a given amplitude.

**CAMERA POWER OUTPUT**

Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**CALIBRATOR**

**Voltage Output** — Rectangular waveshape, positive-going from ground. (Dc voltage available when selected by internal jumper.) Ranges are 40 mV, 0.4 V, 4 V into 1 M $\Omega$ ; 20 mV, 0.2 V, 0.4 V into 50  $\Omega$ . Amplitude accuracy is within 1% (15 to 35 $^{\circ}$ C); within 2% (0 to 50 $^{\circ}$ C). Rep rate is  $\approx 1$  kHz.

**Current Output** — 40 mA dc or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and ground pin jacks.

**POWER REQUIREMENTS**

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac  $\pm 10\%$ ; internally selectable with quick change jumpers.

**Line Frequency** — 50-60 Hz.

**Option 05, Line Frequency Change (50-400 Hz)** — Converts the 7613 and R7613 to 50-400 Hz operation.

**Maximum Power Consumption** — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

**INCLUDED ACCESSORIES (FOR 7613 AND R7613)**

20 in cable, two-pin-to-BNC, (175-1178-00); CRT filter, (gray, 378-0625-02). The R7613 includes rackmounting hardware.

**Dimensions and Weight** — See page 234.

**For Recommended Cameras** — See page 236.

**For Recommended Plug-ins** — See page 234.

**ORDERING INFORMATION**

(PLUG-INS NOT INCLUDED)

7613 Storage Oscilloscope .....	\$5,025
R7613 Storage Oscilloscope .....	\$5,425

**7613 OPTIONS**

Option 01 — Without CRT Readout .....	-\$300
Option 03 — EMC Modification .....	+\$300
Option 05 — Line Frequency Change (50-400 Hz) .....	+\$300
Option 06 — Special Internal Graticule (Spectrum Analyzer) .....	+\$50
Option 08 — Protective Panel Cover .....	+\$100

**R7613 OPTIONS**

Option 01 — Without CRT Readout .....	-\$300
Option 03 — EMC Modification .....	+\$300
Option 05 — Line Frequency Change (50-400 Hz) .....	+\$300
Option 06 — Special Internal Graticule (Spectrum Analyzer) .....	+\$50

**7613 CONVERSION KITS**

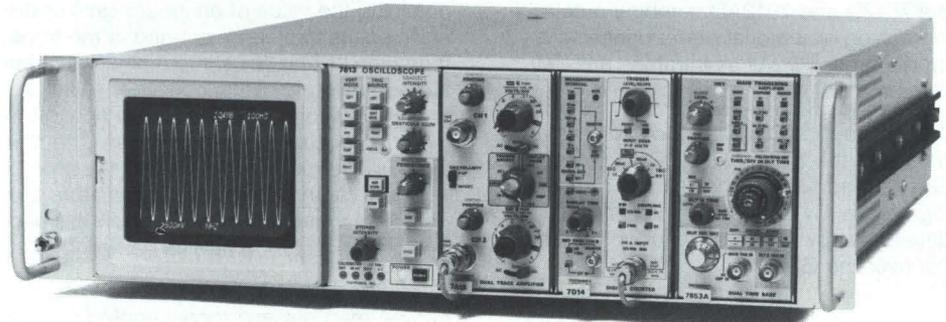
CRT Readout Order 040-0656-02 .....	\$850
EMC Modification Order 040-0663-01 .....	\$525
X-Y Horizontal Comp Order 040-0718-00 .....	\$410
Power Supply to Light Plug-in Pushbuttons Order 040-0686-01 .....	\$60

**R7613 CONVERSION KITS**

CRT Readout Order 040-0676-02 .....	\$850
EMC Modification Order 040-0678-01 .....	\$285
Power Supply to Light Plug-in Pushbuttons Order 040-0686-01 .....	\$60

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC



The R7613 requires only 5/4 in of rack height in a standard 483 mm (19 in) rack. It is fan cooled and comes complete with slide-out chassis tracks.

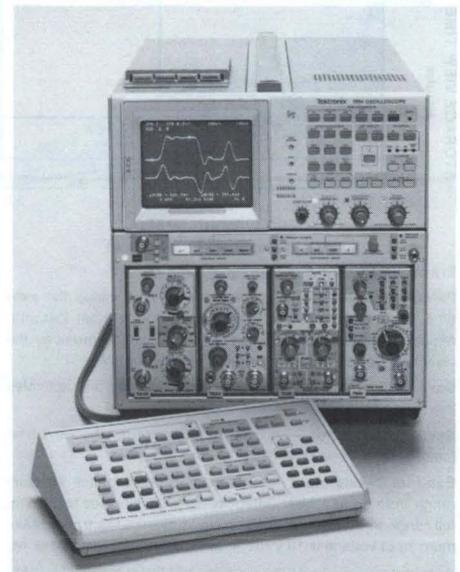
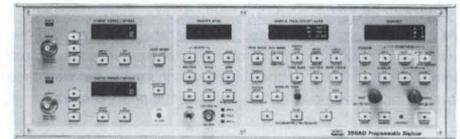
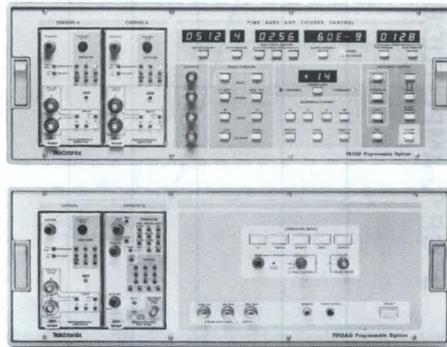
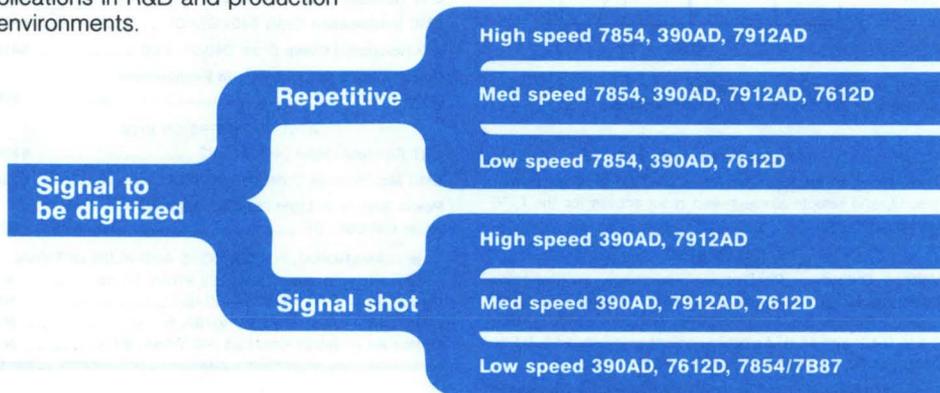
# HIGH PERFORMANCE DIGITIZING MAINFRAMES

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### IEEE STANDARD 488 COMPATIBLE

Especially designed for precise automatic waveform measurements in demanding applications in R&D and production environments.



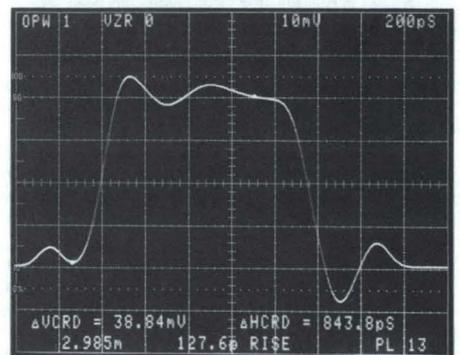
High Performance Digitizing Mainframes offer wide performance capabilities suited to today's demanding measurement needs. Depending on mainframe, capture high or low speed signals that are repetitive or single shot. Configure Mainframes to your individual needs from a choice of over 31 plug-ins. The 7854 combines outstanding analog and digital performance with microprocessor-based waveform processing whereas the 7612D and 7912AD combine outstanding analog and digital performance with full programmability. All mainframes are fully GPIB compatible.

Adjunct to the 7000 Series digitizing mainframes is the SONY/TEKTRONIX 390AD. This new addition to the Tektronix waveform digitizer family features dual-channel, dual-time-base operation and is fully programmable over the GPIB.

### Digital Storage

The fundamental difference between the digital storage scope and the CRT storage scope is the form of storage. Digital scopes store data representing waveforms in a digital memory; CRT storage scopes store waveforms within the CRT. Digital storage requires digitizing and reconstruction processes. "Digitizing" consists of "sampling" and "quantizing." Sampling is the process of obtaining the value of an input signal at discrete points in time; quantizing is the transformation of that value into a binary number by the analog-to-digital converter (ADC) in the digital scope. You determine how often digitizing occurs by the time base. The time base uses a digital clock to time the analog-to-digital (A/D) conversion and to store the data in memory. The rate at which this happens is the digitizing rate (or sampling rate).

Once the data is in the digital memory, it can be read out and reconstructed for displaying or further waveform processing.



**Store Repetitive Signals up to 400 MHz with Standard Plug-ins, and up to 14 GHz with the 7S12 Sampler**

**Digital Storage with Waveform Processing**

**Common Waveform Measurements at the Touch of a Button**

**Keystroke Programming**

**GPIB Interface**

7854



The 7854 complies with IEEE Standard 488-1978.

Waveform Parameters at the Touch of a Key

Dc to 400 MHz Bandwidth @ 10 mV/div

Calibrated Sweep Rates to 500 ps/div

Stores Repetitive Waveforms up to 400 MHz

Single Shot Events up to 50  $\mu$ s/div (with 7B87 Time Base)

Signal Averaging

Pretrigger (with 7B87 Time Base)

Resolution up to 0.01 div on Stored Data (10 bits)

Choose 128, 256, 512, 1024 Points/Waveform

Keystroke Programming (up to 2000 Key Strokes)

GPIB Interface (Standard)

APPLICATIONS

Power Supply Testing

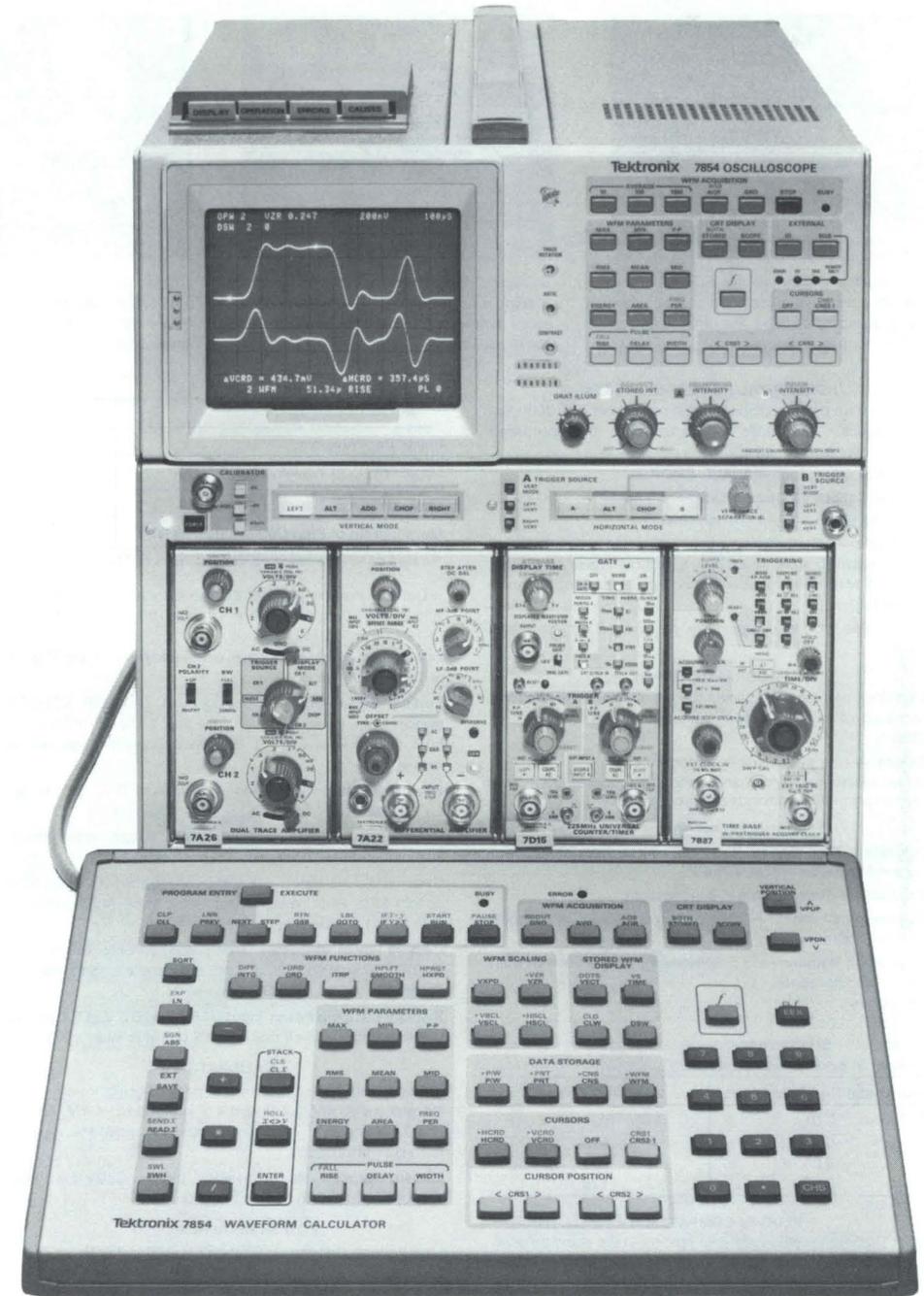
Fiber Optics

The 7854 Digital Storage/Real-time Oscilloscope represents a unique approach to today's test and measurement problems. It combines the features of a high performance real-time oscilloscope with state-of-the-art digital storage and waveform processing. When integrated with any of a wide variety of 7000 Series plug-ins, it becomes a very powerful measurement system. The 7854 offers programmable measurement routines, GPIB (IEEE Standard 488) interface for mass data and program storage plus simultaneous display of real time and stored waveforms. The 7854's on board memory can store up to 40 waveforms and 1000 lines of programming.

Mainframe and calculator keyboard functions provide cursor control and waveform parameter information at the touch of a button, e.g., maximum, minimum, peak-to-peak, rise. Additional features on the calculator keyboard enable arithmetic manipulation of waveforms such as differential, integral, log, and absolute value.

Signal averaging can recover signals buried in random noise and improve measurement accuracy. One or two cursors are selectable for voltage and time measurements. One cursor provides voltage measurements referenced to ground and time measurements referenced to time zero. Two cursors enable  $\Delta$ time and  $\Delta$ voltage measurements. Cursors may also be used to bracket an area of interest for measurement consideration.

For single-shot applications, the 7B87 Time Base plug-in allows storage of events that occur prior to a trigger (pretriggering). The amount of



pretrigger data may be varied continuously from 10 divisions of pretrigger to 10 divisions of posttrigger.

The 7854's key stroke programming, with its easy-to-use editing and debugging features, assures repeatable measurement results and lowers the skill level needed to operate the system. Measurement loops can be written to save time, log results and make pass/fail decisions. Full subroutine and conditional branching capabilities are provided.

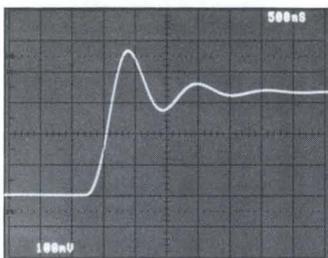
CHARACTERISTICS VERTICAL REAL TIME SYSTEM

Input — Two plug-in compartments; compatible with 7000 Series plug-ins.

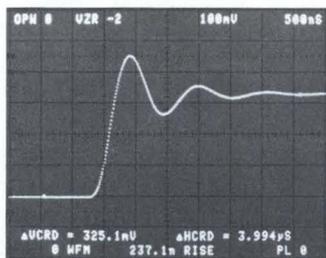
- Modes of Operation** — LEFT, ALT, ADD, CHOP, RIGHT.
- Mainframe Bandwidth** — 400 MHz with 7A29 or 7A19 Amplifier plug-in.
- Mainframe Step Response** — 0.9 ns or less with 7A29 or 7A19 Amplifier plug-in.
- Chopped Mode** — Chop rate is  $\approx$  1 MHz.
- Delay Line** — Permits viewing leading edge of displayed waveform (7B50 Series time bases not recommended for 7854 except 7B50A).
- Trace Separation Range** — In dual-sweep modes, B trace can be positioned four div above or below the A trace.

CRT AND DISPLAY FEATURES

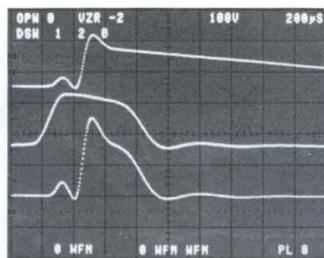
- CRT Display Modes**
- SCOPE (Conventional display.)
- STORED (Digital data display.)
- BOTH (Stored mode plus real time waveforms.)
- PROGRAM ENTRY (User program text display.)



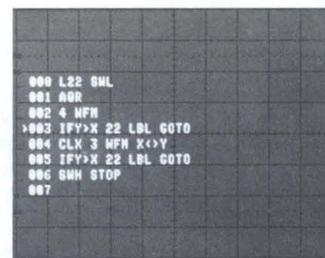
**Conventional Scope:** In the SCOPE mode, the 7854 provides a complete plug-in scope giving standard displays like other Tektronix high performance scopes.



**Storage Scope:** Risetime is calculated by pushing a single key. Time and voltage differences between cursors are shown on the line above risetime.



**Multiple Storage and Calculation:** Volts, current, and power are all shown on the display. Power ( $V = .1$ ) is calculated with two keystrokes.



**Waveform Processing:** Keystroke Programming enables the user to design measurement routines tailored to individual tests or experiments.

### HORIZONTAL REAL TIME SYSTEM

**Input** — Two plug-in compartments; compatible with 7000 Series plug-ins. 7000 Series vertical amplifiers and specialized plug-ins may also be used.\*

**Modes of Operation** — A, ALT, CHOP, B.

**Fastest Calibrated Sweep Rate** — 0.5 ns/div.

**Chopped Mode** — Rep rate is  $\approx 200$  kHz.

**X-Y Mode** — Phase shift between vertical and horizontal channels is within  $2^\circ$  from dc to 35 kHz without phase correction, (dc to 1 MHz with phase correction, B horizontal only, Option 02).

\*Note: See plug-in compatibility for exceptions for digital storage.

### PROGRAM STORAGE

Keystroke programming allows the mainframe to remember a sequence of keystrokes (with remote calculator keyboard or GPIB.)\*

**Editing** — Line by line editing capability.

\*Note: Mainframe vertical and horizontal modes and all other keys except edit commands are programmable.

### DIGITAL STORAGE

**Equivalent Time Bandwidth** — 400 MHz. See 7000 Series system bandwidth specifications.

**Accuracy** — Refer to plug-in specifications.

**Acquisition Channels** — One or two simultaneous channels (Plug-in CHOP mode not valid).

**Acquisition Window** —  $\pm 5$  divisions from center screen both vertical and horizontal.

### Resolution

Vertical — 0.01 div.

Horizontal — Selectable points/waveform on remote keyboard. Fixed at 512 points with Option 0D.

Horizontal Resolution (divs)	Points/Waveform
0.01	1024
0.02	512
0.04	256
0.08	128

### PLUG-IN COMPATIBILITY

Most 7000 Series plug-ins are compatible in the standard oscilloscope display mode. The 7L5 and 7L18 Spectrum Analyzers require factory modification for optimum use with digital storage operation. The 7D01, 7D02 and 7T11 are not compatible in STORED mode.

The 7B87 provides pretrigger for the 7854. Pretrigger allows you to view what has occurred before the trigger event in single shot applications. The amount of pre-trigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

**Single Shot Performance** — Using 7B87 with 7854 Internal clock.

Fastest Sweep (Time/Div)	Points/Waveform
50 $\mu$ s	128
100 $\mu$ s	256
200 $\mu$ s	512
500 $\mu$ s	1024

### OUTPUTS/INPUTS

**+Sawtooth** — Positive-going with baseline at 0 V  $\pm 1$  V into 1 M $\Omega$ . Voltage is 1 V/div ( $\pm 10\%$ ) into 1 M $\Omega$ , 50 mV/div ( $\pm 15\%$ ) into 50  $\Omega$ . Output R is  $\approx 950$   $\Omega$ .

### MEMORY FORMAT

	STANDARD				OPTION 2D				OPTION 0D
	128	256	512	1024	128	256	512	1024	512
Points Per Waveform*	128	256	512	1024	128	256	512	1024	512
Maximum No of Waveforms	16	8	4	2	40	20	10	5	1
Maximum No of Constant Registers	50				100				0
Maximum No of Prog Commands plus lines	920				2000				0

\*Unless otherwise selected, default value is 512 at power-up.

**+Gate** — Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V ( $\pm 10\%$ ) into 1 M $\Omega$ , 0.5 V ( $\pm 10\%$ ) into 50  $\Omega$ .

Output R is  $\approx 950$   $\Omega$ . Source is selectable from A gate, B gate, or DELAYED gate.

**Vertical Signal Out** — Selected by A TRIGGER SOURCE switch. Output voltage is 0.5 V/div into 1 M $\Omega$ , 25 mV/div into 50  $\Omega$ . Output R is  $\approx 950$   $\Omega$ . Bandwidth depends upon vertical plug-in.

**Remote Single Sweep Reset** — Rear panel BNC, ground closure activated.

**TTL Output** — Rear panel BNC, TTL output under remote keyboard control (SWH and SWL).

**External Z-Axis Input** — 2 V p-p for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

**Camera Power Output** — Three-prong connector to the left of the CRT provides power, ground, and remote single-sweep reset access for the C-50 Series cameras.

**Memory Back-Up Power Input** — 6.0 V to 6.5 V at 0.7 amp to preserve stored data if mainframe's power is interrupted.

### CALIBRATOR

**Voltage Output** — Squarewave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 k $\Omega$ ; 4 mV, 40 mV, and 0.4 V into 50  $\Omega$ . Amplitude accuracy is within 1%; rep rate is 1 kHz within 0.25%.

**Current Output** — 40 mA available through Calibrator output with optional BNC to current loop adaptor.

### POWER REQUIREMENTS

**Line Voltage Ranges** — 90 V-132 V, 180 V-250 V.

**Line Frequency** — 48-440 Hz.

**Maximum Power Consumption** — 230 W.

### INCLUDED ACCESSORIES

Power cord (161-0066-00); BNC-to-BNC cable (012-0208-00).

### PHYSICAL CHARACTERISTICS

Dimensions, Mainframe	mm	in
Width	305	12.0
Height	348	13.7
Depth	627	24.7
Waveform Calculator	mm	in
Width	277	10.9
Height	69	2.7
Depth	165	6.5
Cord Length (within 70 mm)	142	5.6
Weights	kg	lb
Net	20.4	45.0
Shipping	28.2	62.0

### IEEE STANDARD 488 INTERFACE

**Standard** — Conforms to IEEE Standard 488-1978.

**Interface Functions Subset Implemented:**

SH1	Complete Source Handshake
AH1	Complete Acceptor Handshake
T5	Talker Function
L3	Listener Function
SR1	Complete Service Request Capability
RL1	Complete Remote/Local Capability
DC1	Complete Device Clear Capability
DT1	Complete Device Trigger Capability

**I/O Records** — Waveforms constants, program text, and display text.

**End of Message Terminator (Selectable in TALK/LISTEN mode for EO1 or LF/EOI).** — Compatible with Tektronix and other popular controllers.

**Device Address** — Selectable via rear panel switch.

**Remote Operation** — All keystroke functions and vertical and horizontal modes can be remotely operated via the GPIB.

### ORDERING INFORMATION (PLUG-INS NOT INCLUDED)

**7854 Oscilloscope (including remote calculator keyboard) ..... \$13,750**

**Option 02** — X-Y Phase Correction ..... +\$150

**Option 03** — EMC Modification ..... +\$300

**Option 78** — P11 Phosphor ..... +\$35

**Option 0D** — Delete GPIB and Remote Keyboard, one waveform storage ..... -\$500

**Option 2D** — 4k Expanded Memory, 040-0941-00 ..... +\$500

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A,50 Hz ..... NC

**Option A2** — UK 240 V/13A,50 Hz ..... NC

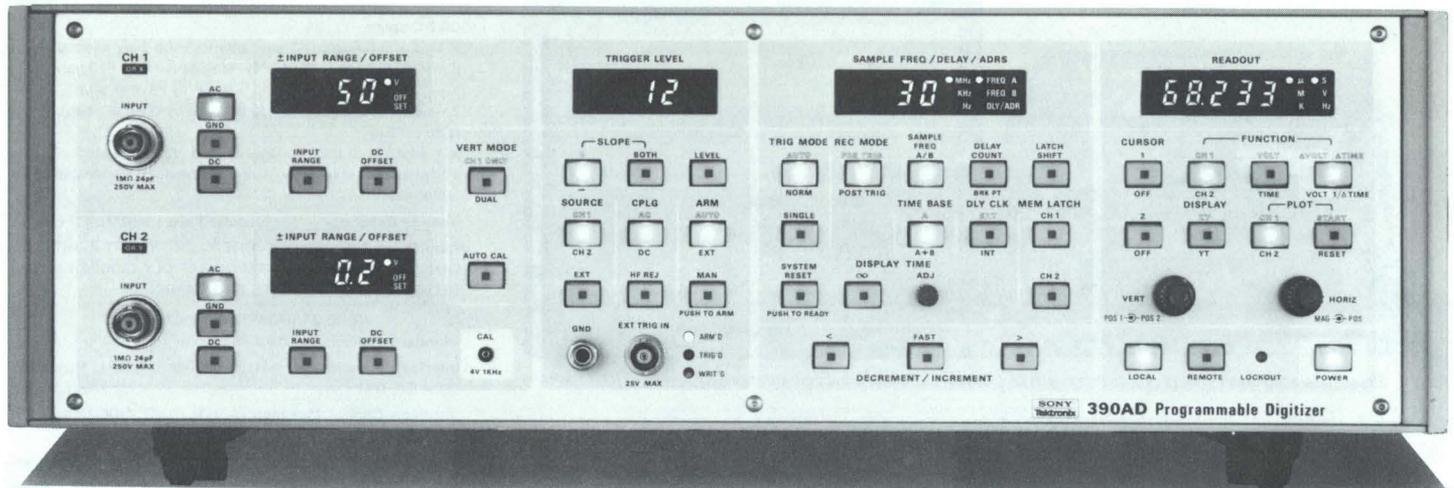
**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A4** — North American 240 V/15A, 60 Hz ..... NC

**7B87 Time Base required only for pretrigger and single shot digitizing .... \$1,575**

The 7854 is also available as a WP1310 Signal Processing System. This system is a synergistic combination of the Tektronix 7854 Oscilloscope and 4052 Graphic Computer. Together, these two instruments automate the entire waveform test and measurement process, from acquisition and calculation to storage and display formatting.

Tektronix offers service training classes on the 7854 Waveform Processing Oscilloscope. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



## NEW 390AD

**GPIB**  
IEEE-488

The 390AD complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

**True Dual Channel 30 MHz Sampling Rate (60 MHz in Single Channel Mode)**

**10-Bit Resolution**

**2048 Word Memory Per Channel (4096 Single Channel Mode)**

**Cursor-Based Measurements**

**Sample-Rate Switching**

**Direct Plotter Output Capability**

### APPLICATIONS

**Extracting Information from Signals Containing Components from dc to 15 MHz**

**Ultrasonics/Stress/Strain**

**Mechanical/Vibration**

**Audio**

**ATE**

**Laser Spectroscopy**

**Biomedical Research**

**LIDAR**

**Geo-Seismic**

Used for low-to-medium-speed signals, the 390AD Programmable Waveform Digitizer provides crystal-controlled, 30-MHz sampling on two channels. Or, a single channel of data may be digitized at up to 60 megasamples per second.

Features include 10 bit vertical resolution, dual-channel synchronized digitizing, pretriggering and posttriggering, sample-rate switching during acquisition, internal cursors for two-point time or voltage measurements and 2048 words of memory per channel. Excellent dynamic accuracy is achieved using a two-stage flash-conversion process.

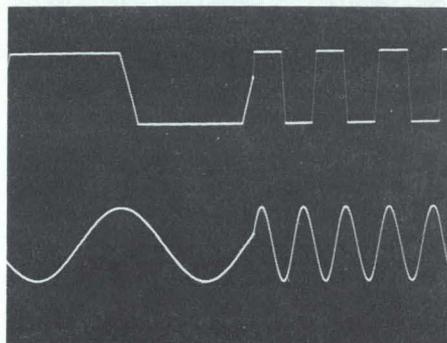


Figure 1. Photo showing sample of Rate Switching. In this example switching occurs at the 1024th sample, to extend the display window. The sample rate can be either increased or decreased at the trigger point. A minor time discontinuity may occur at the trigger point under some conditions.

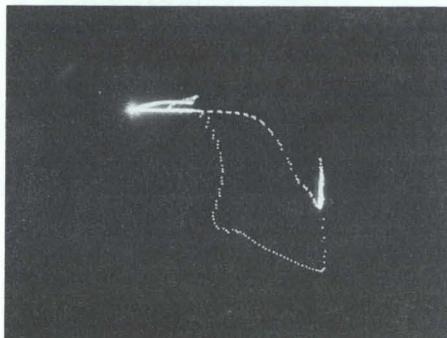


Figure 2. The 390AD display is set to X vs Y mode. Rolling channel 1 or 2 will produce a "correlation" indicative figure.

The X versus Y display mode coupled with the shift mode function provides a powerful tool for visual comparison of related phenomena.

To ensure reliable operation the 390AD includes built-in self calibration and self-test features that are automatically employed at power-on and may be activated during operation by the user.

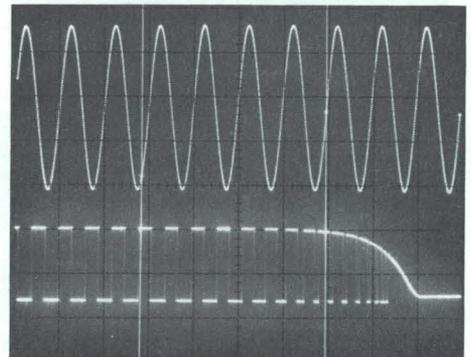


Figure 3. Two cursors may be positioned by the user or controller, at points of interest on either waveform. The voltage difference, time difference, or 1/time difference, as well as the absolute values may be directly read from the LED display, or sent to a controller. Positioning may be precisely accomplished with the aid of the "zoom" feature.

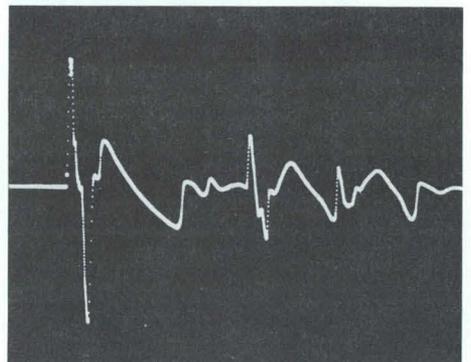


Figure 4. Complex manual set-ups may be avoided by recording the desired instrument settings for a particular measurement on a system peripheral device, then sending the English-like command string to the 390AD. (e.g., the above signal was digitized with a horizontal record of 4k samples as per the instructions of the 4052A Desktop Computer (Figure 5 following page)).



Figure 5. 390AD operating under control of a Tektronix 4052A Desktop Computer equipped with signal processing ROM Packs



390AD Rear Panel connectors and switches

## CHARACTERISTICS

### VERTICAL

**Input Channels** — Two, single ended.

**Sensitivity** —  $\pm 100$  mV to  $\pm 50$  V full scale (200 mV p-p to 100 V p-p) 9 steps, 1-2-5 sequence.

**Input R and C** —  $1\text{ M}\Omega \pm 2\%$ ;  $\approx 24$  pF.

### Maximum Input Voltage

Dc Coupled — 250 V (dc + peak ac).

Ac Coupled — 500 V (dc + peak ac).

**Bandwidth** — Dc to 15 MHz ( $-3$  dB); Lower  $-3$  dB point, Ac coupled: 10 Hz.

**Input Dc Offset Voltage** — 0 to  $\pm 99\%$  full scale, 1% step. Accuracy:  $< 0.5\%$ .

### Automatic Calibration

Gain Accuracy —  $\pm 0.4\%$

Dc Drift Accuracy —  $< \pm 0.1\%$ .

### TIME-BASE A AND B

#### Sample Rate

Internal — CH 1 Only: 5 Hz to 60 MHz, 23 steps, 1-2-5 sequence except 30 MHz and 60 MHz. DUAL: 5 Hz  $\approx$  30 MHz, 22 steps.

External — Dc to 60 MHz.

**Clock** — 60 MHz  $\pm 10$  ppm, crystal-controlled.

### TRIGGERING

**Sources** — Internal CH 1 and CH 2 or external.

**Coupling** — Ac, dc, HF REJ.

**Slope** — Positive, negative, both.

### Level Range

Internal — 0 to  $\pm 99\%$  full scale, 1% step.

External —  $\pm 4.95$  V, 0.05 V step.

### Trigger Sensitivity

Coupling	Trigger Frequency Range	Minimum Signal Required	
		Internal	External
Ac	25 Hz to 15 MHz	30 LSB	300 mV p-p
HF REJ	25 Hz to 50 kHz	30 LSB	300 mV p-p
Dc	Dc to 15 MHz	30 LSB	300 mV p-p

**Arming** — AUTO, MANual, EXternal.

### DIGITIZING

**Vertical Resolution** — 10 bits ( $1/1024$ ).

### Sample Rates

Dual Channel Mode — 30 MHz.

CH 1 Only Mode — 60 MHz.

**Aperture Jitter (Including Internal Clock)** — 150 ps, nominal.

**Dynamic Accuracy\*** (at Sampling Frequency 30 MHz)

Signal Frequency	Effective Bits
$\leq 1$ MHz	$\geq 8.5$
$\leq 10$ MHz	$\geq 7.5$

### Record Length

Dual Channel Mode — 2048 words/channel.

CH 1 Only Mode — 4096 words.

**Modes** — Auto, Norm, Single.

### Pretrigger Range

CH 1 Only Mode — 0 to 4092.

Dual Channel Mode — 0 to 2046.

### Posttrigger Range

Time Base	Vertical Mode	Range
A	Dual	0 to 9998
	CH 1 only	0 to 9998
A+B	Dual	0 to 2046
	CH 1 only	0 to 4092

**A Time Base** — Recording is taken at one rate (sample frequency A) continuously.

### A+B Time Base

Pretrigger Mode — Sample frequency A is switched to B at trigger. Recording stops at delayed trigger. The transition point (switch point) is well defined.

Posttrigger — Sample frequency A is switched to B at delayed trig and recording stops after total of 2048 (or 4096) samples.

Stored digital data are addressable by key entry while monitoring cursors on the waveform.

**Readout Display** — 5 digit LED (Reads voltage difference on the same waveform or between CH 1 and CH 2, absolute voltage, time interval, and 1/T).

### OUTPUTS

#### CRT Display

X — 1 V p-p Ramp. (Changeable to 5 V p-p by internal strap)

8 ms: Dual. 16 ms: CH 1 only. Mag gain X1 to X10 variable.

Y — 1 V p-p (Changeable to 5 V p-p by internal strap).

Z — 0 to 1 V, (changeable to 0 to 5 V by internal strap), selectable polarity.

X-Y Plot — Output Voltage: 0 to 5 V. Plot Speed: 20, 50, 100 ms/word. Auto Slow. Auto Fast Mode: (Changeable by internal strap).

**Voltage Calibrator** — Rectangular 1 kHz ( $\pm 10^{-5}$ ), 4 V ( $\pm 1\%$ ).

**Rear Panel Connectors** — CRT-X, CRT-Y, CRT-Z, INT CLK-OUT, EXT CLK-IN, EXT ARM-IN, EXT DLY CLK-IN, PLOT-X, PLOT-Y, PLOT-PEN, WRITE END, GPIB.

### IEEE STANDARD 488 INTERFACE

**Standard** — IEEE Standard 488-1978.

**Interface Functions** — SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, C0, DT1.

**Interface Control Message** — GTL, LLO, SDC-DCL, GET, SPE-SPD, IFC.

**Programmable Functions** — All instrument setting and operating modes are programmable, except power switch, vertical/horizontal position, horizontal mag, and external clock switch.

**Format** — Commands in ASCII, Waveform data in 2 byte/point high byte first.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0 to 40°C. Nonoperating:  $-25$  to  $+70$ °C.

### Altitude

Operating — Sea level to 4570 m (15,000 ft).

Nonoperating — Sea level to 15 200 m (50,000 ft).

**Line Voltage Range** — 90 to 132 V ac (115 V); 180 to 250 V ac (230 V).

**Line Frequency** — 48 to 440 Hz.

**Power Consumption** — 200 W.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	446	17.6
Height	152	6.0
Depth	540	21.3
Weights	kg	lb
Net (without accessories)	15.5	34.0

### STANDARD ACCESSORIES

Power cord (161-0066-00); GPIB cable (012-0630-03); two 4A fast-blow fuses (159-0017-00); 390AD Programming Aid (070-4467-00).

### ORDERING INFORMATION

**390AD** ..... **\$14,530**  
**Option 10** — Rackmount 390AD ..... **+\$250**

### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland 220 V/10A, 50 Hz ..... **NC**

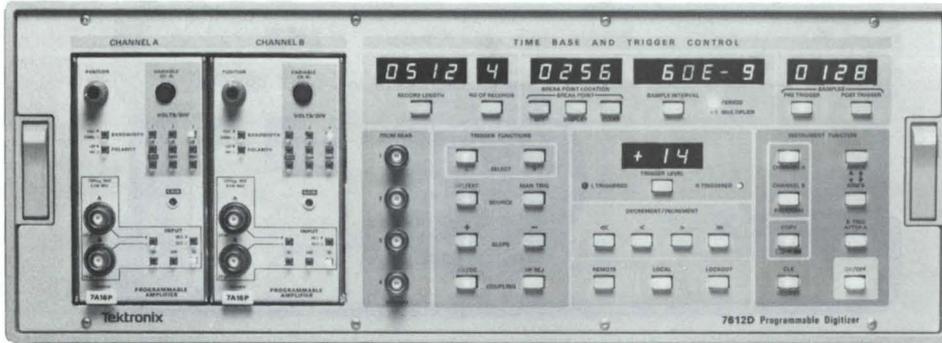
### OPTIONAL ACCESSORIES

**390AD Service Manual** Order 070-4452-00 ..... **\$25**

The 624 monitor is recommended for use with the 390AD. See Alphanumeric Index.

The SONY®/TEKTRONIX® 390AD is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 390AD is available from Tektronix, Inc., its marketing subsidiaries and distributors.

\*For further information refer to HANDSHAKE Vol 5 No 1, 33-A-4463



## 7612D



The 7612D complies with IEEE Standard 488-1975, and with Tektronix Standard *Codes and Formats*.

**200 MHz Maximum Sampling Rate**

**Two Channels, Two Time Bases**

**8 Bit Resolution**

**2048 Words of Memory per Channel**

**5 ns to 1 s Selectable Sampling Intervals with Interval Switching Allowed During Waveform Acquisition**

**Pretrigger and Posttrigger Operation**

**Fully Programmable over IEEE-488 Bus For System Oriented Operation**

### APPLICATIONS

**Automated Testing**

**EMP**

**Nondestructive Testing**

The 7612D Programmable Digitizer is a dual-channel, dual time base waveform digitizer for use under computer control. It has a maximum sampling rate of 200 MHz. Each channel has its own analog-to-digital converter, a new type designed by Tektronix for accurate, high-speed waveform digitizing. Each channel also has its own time base operating from a single 200 MHz crystal-controlled clock. The result...two fully independent channels capable of capturing one waveform each, simultaneously, with the same or different vertical sensitivities and time-base settings.

And there's still more flexibility available. The number of samples per waveform (record length) can be selected, from 256 to 2048. The sample rate can be changed during waveform digitizing, for example, using dense sampling on fast transitions and switching to sparser sampling for slow decays. Also, each channel's local memory can be partitioned into one to eight equal-length records. You have the choice, too, of looking at waveforms before the triggering event (pretrigger), immediately after the trigger, or delayed from the trigger (posttrigger). Or you can choose to operate the channels dependently by triggering one after the other.

All 7612D functions can be selected manually or operated under program control over the IEEE-488 bus. Add two 7A16P Programmable Amplifier plug-ins, one for each channel, and you have program control over every waveform acquisition function.

Extracting information from medium-speed signals is a typical application of 7612D systems.

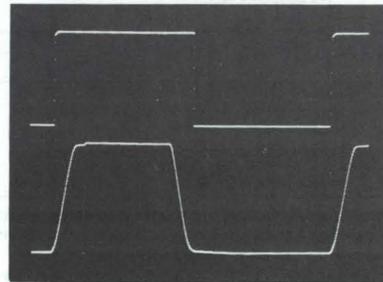


Figure 1. The complete period of a signal (top trace) is recorded at 200 ns; by changing the sample rate to 10 ns during risetimes and falltimes and 800 ns during the plateau (bottom trace), you can measure risetime, falltime, pulse width and interval accurately on a single-shot signal.

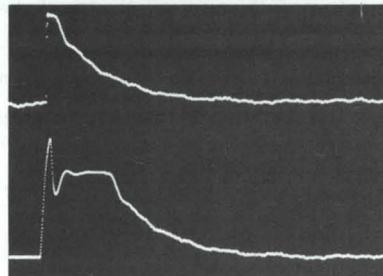


Figure 2. A decaying signal recorded at a 10 μs sampling rate (top trace); the same signal can be recorded at a 100 ns sampling rate during the initial portion and switched back to a 10 μs sampling rate (bottom trace), to capture all information on a single-shot signal.

**SYSTEMS**

The 7612D is also available in WP3000 Series Signal Processing Systems. These fully automatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the second to submicrosecond range. For more information on these systems, contact your local Tektronix Sales Engineer.

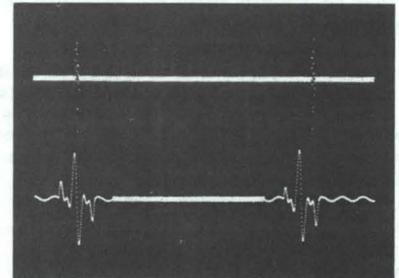


Figure 3. A signal with two echoes recorded at a uniform sampling rate (top trace), the same signal recorded at an increased sampling rate during each echo (bottom trace), to capture each echo with increased resolution.

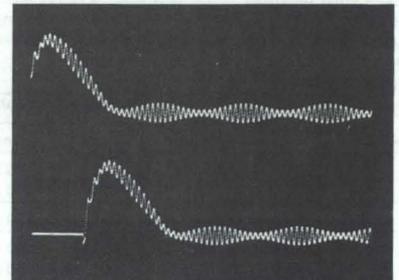


Figure 4. A transient response of a system at power-up recorded with no pretrigger (top trace); by using the pretrigger the complete response can be digitized (bottom trace).

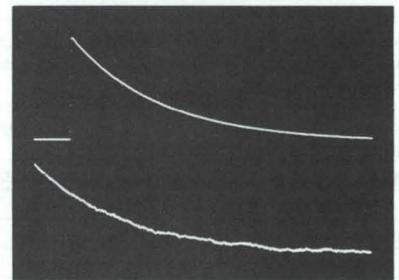


Figure 5. The initial portion of an exponential decay is recorded on Channel A (top trace); Channel B, set at a higher sensitivity and triggered to record after Channel A has finished, captures the remaining pulse tail with increased vertical resolution (bottom trace).

**7612D CHARACTERISTICS**

**VERTICAL SYSTEM**

**Channels** — Two left-hand plug-in compartments compatible with all 7000 Series amplifier plug-ins. Fully programmable when 7A16P Plug-ins are used.

**Bandwidth** — 80 MHz with 7A16P Plug-in.

**Modes of Operation** — Left channel with Time Base A and right channel with Time Base B.

**TIME BASES A AND B**

**Type** — Two built-in digital time bases with a common crystal-controlled clock.

**Clock** — Internal: 200 MHz  $\pm 0.0035\%$ ; stability: within 10 ppm/year. External: from signal source  $\leq 200$  MHz.

**Sample Interval** — With internal clock: selectable from 5 ns to 1 s in a 1, 2, 3...9 sequence (excluding 6, 7, 8 and 9 ns). With external clock: Selectable from 1 to 200 x 10<sup>6</sup> times the external clock period in a 1, 2, 4, 6...20 sequence.

**Interval Switching** — Sample interval can be changed up to 13 times per waveform record with preservation of time relationships.

**TIME MEASUREMENT ACCURACY**

Without sample interval switching: 0.0035% (stability 10 ppm/year). With sample interval switching: 0.0035% (stability 10 ppm/year) for all sample intervals slower than 5 ns.

**Modes of Operation** — Time Base A with left channel and Time Base B with right channel. Independent or B triggerable after A completes its acquisition.

**TRIGGERING A AND B**

**Source** — Left or right plug-in, external, manual by push button.

**Mode** — Single sweep.

**Coupling** — Ac, dc, ac HF REJ, dc HF REJ.

**Slope** — Positive or negative.

**Level Range** — Internal: at least  $\pm 128$  LSB in 256 steps. External: at least  $\pm 1.28$  V in 256 steps.

**Trigger Jitter (Internal)** — 0.1 ns or less, dc to 100 MHz.

**Triggering Error** —  $\pm 1$  sample ambiguity in recognizing the trigger, 1 sample maximum recognition error between channels (using same trigger channel for both time bases).

**Trigger Sensitivity**

Coupling	Triggering Frequency Range	Min Signal Required	
		Internal	External
Ac	40 Hz to 50 MHz	20 LSB	100 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Ac HF REJ	40 Hz to 50 kHz	20 LSB	100 mV
Dc	dc to 50 MHz	20 LSB	100 mV
	50 MHz to 100 MHz	44 LSB	100 mV
Dc HF REJ	dc to 50 kHz	20 LSB	100 mV

**ARMING A AND B**

Push button or computer control.

**DIGITIZING AND STORAGE**

**Method** — Continuous, sequential digitizing of the input signals with storage of samples selected by instrument settings.

**Resolution** — Eight bits.

**Dynamic Accuracy\*** — Signal to noise ratio performance at 25°C for a half scale sinewave input signal (an ideal eight bit digitizer would give a S/N ratio of 43.8 dB).

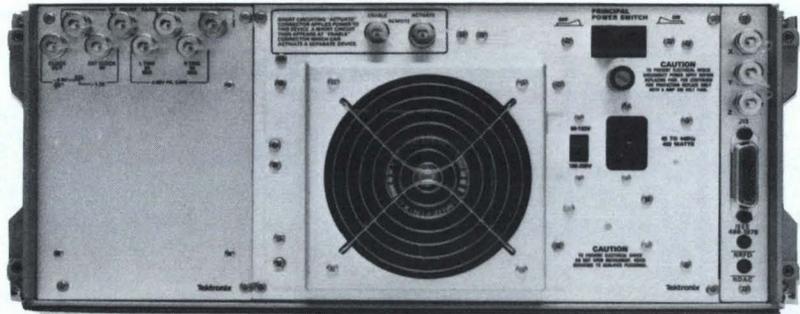
Signal Frequency	S/N Ratio	Effective Bits
300 kHz	42.0 dB	7.8
20 MHz	32.0 dB	6.0
80 MHz	20.0 dB	4.0

**Internal Memory** — Type: ECL. Size: 2048 8-bit words per channel, total of 4096 8-bit words.

**Record Length, A or B** — 256, 512, 1024, or 2048 samples. Number of stored records: Up to eight 256-word, four 512-word, two 1024-word, or one 2048-word records per channel, each requires a trigger. Trigger is automatically rearmed after each record acquisition.

**Pretrigger Delay Range** — Selectable in multiples of eight samples. Without sample interval switching: from 0 up to 16 samples less than the record length. With sample interval switching: from 0 up to 16 samples less than the position of the first sample interval change.

\*For further information refer to *HANDSHAKE VOL 5 NO 1, 33-A-4463*.



7612D rear panel: the GPIB connector and outputs for an X-Y-Z monitor (right); clock input/output, trigger inputs, and BNC connectors to feed signals to the front panel (left); remote power ON/OFF is also provided through the two central BNC connectors.

**Posttrigger Delay Range** — Selectable in multiples of eight samples from eight to the record length (requires selection of only one record).

**OUTPUTS/INPUTS**

**X, Y, Z Analog Output** — Provides for analog display of data in memory. X and Y level is 1 V peak-to-peak into 100 k $\Omega$  or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 k $\Omega$  or greater.

**Clock Out** — Provides internal clock signal at ECL level.

**External Clock In** — ECL levels.  $\leq 1$  ns risetime and falltime. 2.5 ns minimum pulse width and  $\leq 200$  MHz.

**L and R Trig In** — Provide external trigger input to the left and right trigger channels (50  $\Omega$  terminated).

**1, 2, 3, 4** — Four feed-through connections to the front panel.

**Digital Interface** — Conforms to IEEE Standard 488-1975.

**IEEE Standard 488 INTERFACE**

**Standard** — Conforms to IEEE Standard 488-1975.

**Interface Functions Subset Implemented:**

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP0	No parallel poll
DC1	Complete device clear capability
C0	No controller function
DT0	No device

**Response to Interface Control Messages** — The 7612D responds to the following interface control messages:

GTL	Go to local
LLO	Local lockout
SDC-DCL	Selected device clear and device clear
SPE-SPD	Serial poll enable and disable
IFC	Interface clear

**IEEE-488 Bus Addresses** — Mainframe and programmable plug-ins share a common primary address and are differentiated through the use of secondary addresses.

**Programmable Functions** — All instrument settings and operating modes are programmable.

**Format** — Commands in ASCII, waveform data in binary (range 0 to 377<sub>8</sub>).

**Transfer Rate** — 710k bytes/s maximum.

**Waveform Transfer Time** — To an infinitely fast controller: 8.35 ms for one 2048 points record. Actual transfer time depends on controller and software speed.

**ENVIRONMENTAL**

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: -62°C to +85°C.

**Altitude** — Operating: -76 to +4570 m (-250 to +15,000 ft). Nonoperating: -76 to +15 200 m (-250 to +50,000 ft).

**POWER REQUIREMENTS**

**Line Voltage Range** — 90 V to 132 V ac, 180 V to 250 V ac.

**Line Frequency** — 48 to 440 Hz.

**Power Consumption (including plug-ins)** — Maximum 400 W, 5 A at 115 V 60 Hz.

**Remote Control** — Power ON/OFF capability is provided.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	483	19.0
Height	178	7.0
Depth	703	27.7
Weights	kg	lb
Net	25.0	55.0

**INCLUDED ACCESSORIES**

IEEE-488 Bus Cable (012-0630-03); set of rack slides, (351-0375-01); power cord, (161-0066-00).

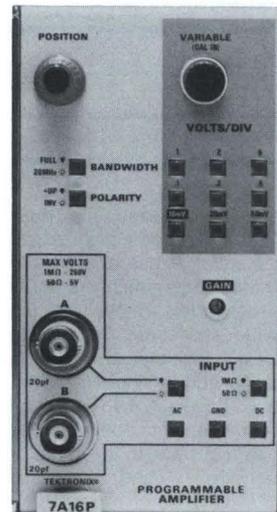
**ORDERING INFORMATION**

(PLUG-INS NOT INCLUDED)

7612D Programmable Digitizer ..... **\$26,400**

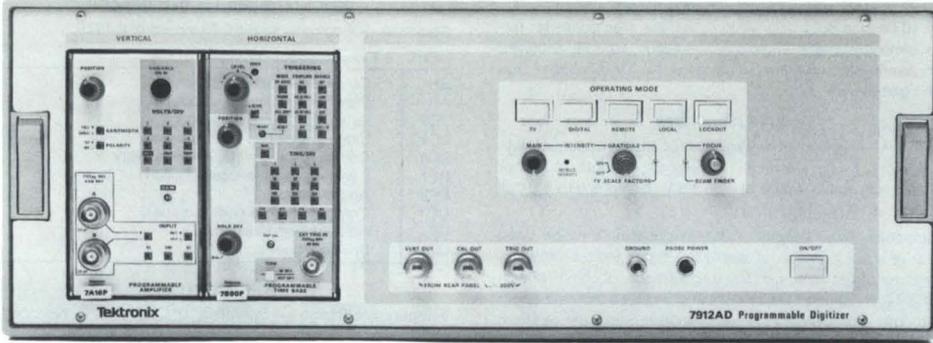
**INTERNATIONAL POWER CORDS & PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz	NC
Option A2 — UK 240 V/13A, 50 Hz	NC
Option A3 — Australian 240 V/10A, 50 Hz	NC
Option A4 — North American 240 V/15A, 60 Hz	NC
Option A5 — Switzerland 240 V/10A, 50 Hz	NC



The 7A16P is a fully programmable vertical amplifier used in the 7612D. For further information see page 271.

Tektronix offers service training classes on the 7612D Programmable Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



**SYSTEMS**

The 7912AD is also available in WP2000 Series Signal Processing Systems. These fully automatic systems are designed, assembled, tested, and documented to satisfy the demand for speed, automation, accuracy, and repeatability in characterizing devices or phenomena which give rise to waveforms in the millisecond to nanosecond range. For more information on these systems contact your local Tektronix Sales Engineer.

**7912AD**

**GPIB**  
IEEE-488

The 7912AD complies with IEEE Standard 488-1975, and with Tektronix Standard Codes and Formats.

**Digitize and Store Single-Shot or Repetitive Signals from Millisecond to Subnanosecond duration**

**500 MHz Bandwidth at 10 mV/div**

**500 ps/div Fastest Calibrated Sweep Rate**

**Waveform Digitizing to 9-Bit Vertical and 9-Bit Horizontal Resolution**

**Built-In Signal Averaging Capability**

**Fully Programmable over IEEE-488 Bus For System Oriented Operation**

**APPLICATIONS**

**Destructive Testing**

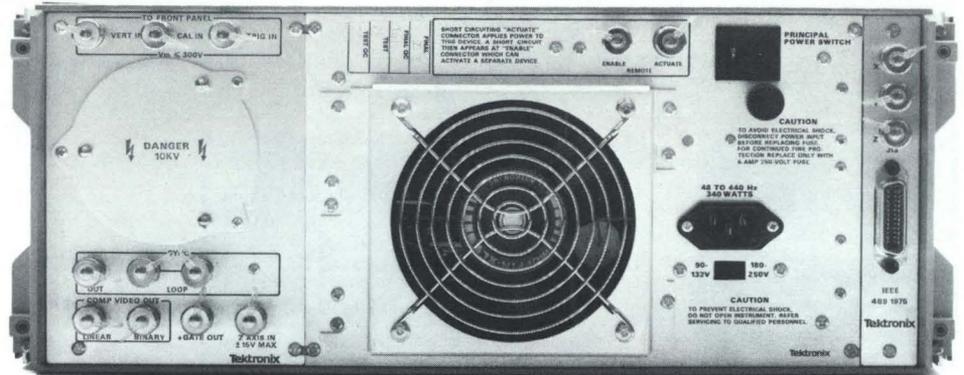
**Laser Research**

**Automated Testing**

Capturing high-speed waveforms is the 7912AD's forte. Each waveform can be sampled up to 512 times within selectable time window ranging from ten milliseconds to five nanoseconds (50 kHz to 100 GHz equivalent sampling rate).

This performance is accomplished by a Tektronix scan converter which writes the signal onto a silicon-diode target array. In TV Mode, the signal information is read from the target and converted to composite video for a bright display on a television monitor. However, in the Digital Mode the waveform data is read into an internal memory. From this memory, the digitized waveform can be transferred via the IEEE-488 bus to an external controller for processing.

The 7912AD Mainframe is programmable over the same IEEE-488 bus. When the programmable plug-ins (one 7A16P Programmable Amplifier and one 7B90P Programmable Time Base) are used, the 7912AD becomes a fully programmable digitizer with a bandwidth of 200 MHz. This is a significant step toward fully automated test and measurement in disciplines such as laser and energy-related research, component or subassembly testing, and other areas requiring information extraction from high-speed waveforms.



**CHARACTERISTICS**  
**VERTICAL SYSTEM**

**Channels** — Single plug-in compartment accepts any 7000 Series amplifier plug-in. Fully programmable when 7A16P is used.

**Bandwidth** — Determined by amplifier plug-in. 7A16P: 200 MHz. 7A19: 500 MHz.

**Delay Line** — Permits viewing of leading edge of acquired waveform.

**HORIZONTAL SYSTEM**

**Channels** — Single plug-in compartment accepts any 7000 Series time base. Fully programmable with 7B90P.

**Fastest Calibrated Sweep Rate** — 500 ps/div with the 7B90P or 7B92A Time Bases.

**Slowest Recommended Sweep Rate** — 1 ms/div in digital mode.

**DIGITIZING AND STORAGE**

**Method** — Scan conversion.

**Resolution** — Nine bits. In the Digital Mode, the target is scanned in a 512 x 512 point matrix offering at least 400 discrete horizontal elements, each with a range of at least 320 discrete vertical values. In the TV Mode, the target is scanned in a standard TV format with a resolution of at least 400 lines at 50% response.

**Writing Rate (+10°C to +40°C)** — TV Mode: writes an 8-div sinewave of at least 500 MHz in a single sweep. Digital Mode: stores a single 8-div pulse with a risetime of 1 ns or less.

**Target Defects** — No more than six points digitized other than those written by input waveform. Built-in firmware allows for defect removal by an external controller.

**Memory** — Type: semiconductor. Size: 4096 10-bit words for data from target and two 512 16-bit word areas for internally processed and reduced data. Record Length: 512 samples per waveform maximum.

**ELECTRONIC GRATICULE**

8 x 10 division dot matrix written onto the scan converter target immediately after waveform acquisition. Can be displayed simultaneously with the input signal on the TV monitor or digitized and stored.

**OUTPUTS/INPUTS**

**X, Y, Z Analog Output** — Provides for analog display of data in memory. X and Y level is 1 V peak-to-peak into 100 k $\Omega$  or greater; adjustable from 0.75 V to 1.3 V. Z level is 0 to 1 V (full white) into 100 k $\Omega$  or greater.

**Composite Video Output** — Only available in TV mode. Used to drive a TV monitor for displaying signal written on scan-converter target as an aid to setting intensity for complete digitizing. Linear Output: Replica of the signal read from the target with sync added. Binary Output: Two-level output derived from the linear composite video output. Used to indicate on the TV monitor how well a waveform will be digitized. Scale factor readout included in both linear and binary.

**Sync Output** — At least 4 V into 75  $\Omega$ . Conforms to EIA RS-170.

**Sync Loop** — Allows TV Mode to be synchronized with external EIA RS-170 sync waveform.

**+Gate Output** — Provides a positive pulse with a duration equal to and coincident with the time-base sweep.

**Z-Axis Input** —  $\pm 1$  V input modulates the writing gun intensity over its full range.

**Vert In, Cal In, Trig In** — Three internal 50  $\Omega$  coaxial cables connect signals from the rear panel to the front panel to ease system configuration in rackmounts.

**Probe Power** — Provides power for Tektronix active probes.

**IEEE STANDARD 488 INTERFACE**

**Standard** — Conforms to IEEE Standard 488-1975.

**Interface Functions Subset Implemented:**

SH1	Complete source handshake
AH1	Complete acceptor handshake
TE6	Extended talker function
LE4	Extended listener function
SR1	Complete service request capability
RL1	Complete remote/local function
PP $\emptyset$	No parallel poll.
DC1	Complete device clear capability.
C $\emptyset$	No controller function.
DT1	Device trigger complete.

**ENVIRONMENTAL**

**Temperature Range** — Operating: 0°C to +40°C. Nonoperating: -55°C to +75°C.

**Altitude** — Operating: Up to 2135 m (7000 ft). Nonoperating: Up to 15 200 m (50,000 ft).

**EMC (plug-ins inserted)** — Meets MIL-STD-461A and 462 radiated and conducted interference from 30 Hz to 1 GHz.

**POWER REQUIREMENTS**

**Line Voltage Range** — 90 V to 132 V ac and 180 V to 250 V ac.

**Line Frequency** — 48 to 440 Hz.

**Power Consumption (including plug-ins)** — 360 W maximum.

**Remote Control** — Remote power ON/OFF capabilities provided.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	483	19.0
Height	178	7.0
Length	679	26.8
<b>Weight</b>	<b>kg</b>	<b>lb</b>
Net	24.7	54.6

**INCLUDED ACCESSORIES**

Power cord (161-0066-00); set of rack slides (351-0375-01); IEEE-488 Bus Cables (012-0630-03).

**ORDERING INFORMATION**  
**(PLUG-INS NOT INCLUDED)**

It is recommended that 7912ADs not be purchased or operated without an accompanying Tektronix 634 Raster Scan Display Monitor with Option 11 (see page 120).

**7912AD Programmable Digitizer ..... \$24,800**

**Option 13 — Change TV Scan to 625 lines at 50 Hz ..... NC**

**Option 30 — Delete IEEE Bus Cable ..... - \$90**

**634 Option 11 Raster Scan**

**Display Monitor ..... \$2,940**

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

**Option A1 — Universal Euro 220 V/16A, 50 Hz ..... NC**

**Option A2 — UK 240 V/13A, 50 Hz ..... NC**

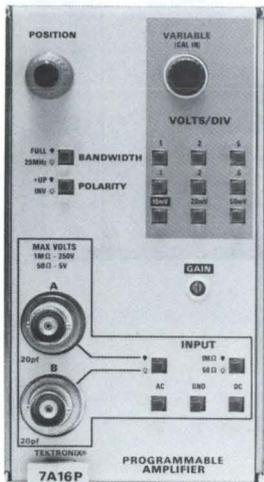
**Option A3 — Australian 240 V/10A, 50 Hz ..... NC**

**Option A4 — North American 240 V/15A, 60 Hz ..... NC**

**Option A5 — Switzerland 240 V/10A, 50 Hz ..... NC**

Tektronix offers service training classes on the 7912AD Programmable Transient Waveform Digitizer. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

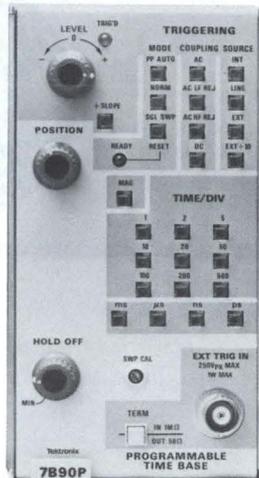
**7A16P**



**Programmable Amplifier**

The 7A16P and 7B90P are programmable plug-ins used in the 7912AD. For further information, see plug-in specifications in the 7000 Series Plug-in Section.

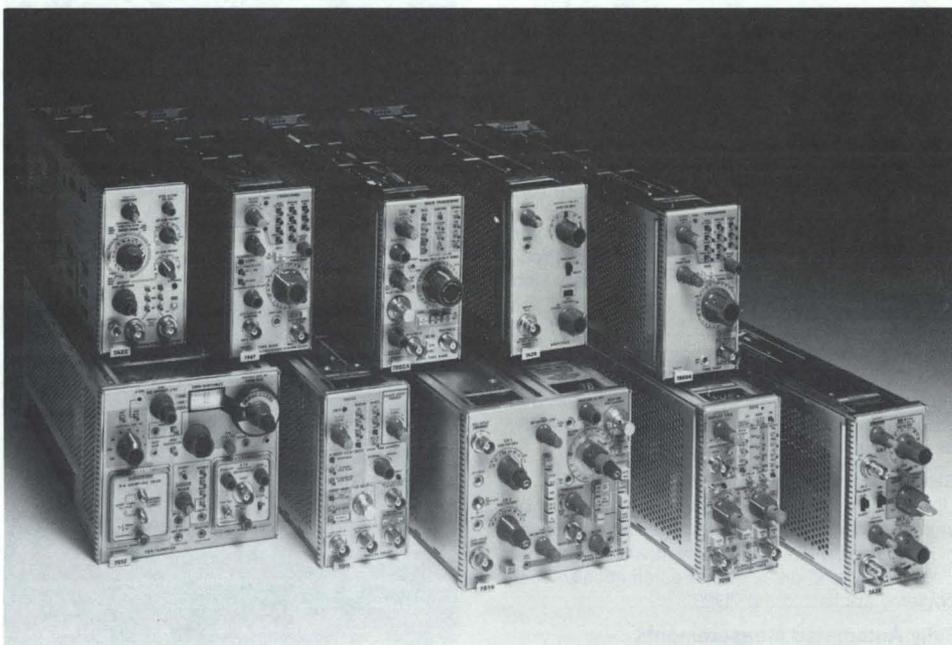
**7B90P**



**Programmable Time Base**

# 7000 SERIES PLUG-INS

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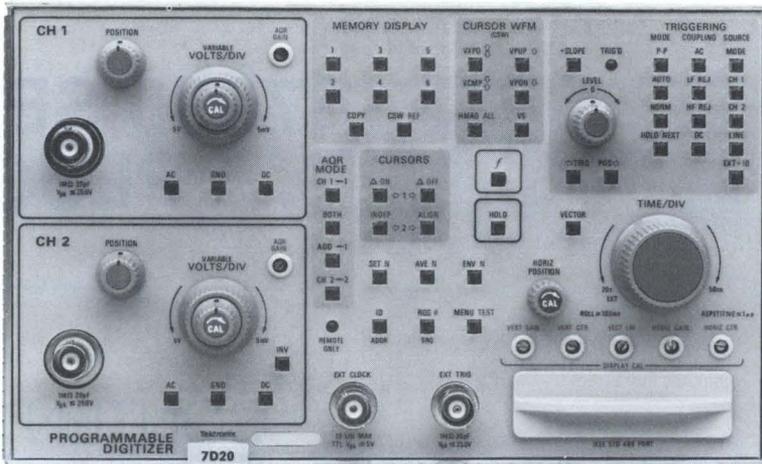


For the 7000 Series you can select from over forty different plug-ins. For example, digital multimeters, counters and A-D converters. With this plug-in selection you can solve problems in many applications including spectrum analysis, curve tracing, logic analysis, and sampling. This variety lets you tailor your instrument to meet your immediate need. And to expand its capabilities later as your needs change.

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Tektronix offers service training classes on various 7000 Series plug-ins. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

**NEW**



## 7D20

**GPIB  
 IEEE-488**

The 7D20 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

### Digital Storage for 7000 Series Mainframe

40 MHz Maximum Sampling Rate for up to 10 MHz Single-Shot Bandwidth

70 MHz Bandwidth for Repetitive Signals

Totally Programmable and Remotely Controllable

Storage of Six Independent Waveforms

Enveloping and Signal Averaging

Cursor Measurements

Pretrigger and Posttrigger

### APPLICATIONS

Ultrasonics

Digital Design

RF Modulation

Automated Production Testing

The 7D20 brings state-of-the-art digital performance to Tektronix 7000 Series mainframes and rackmounts.

The 7D20 is a GPIB programmable plug-in that is compatible with all 7000 Series mainframes (including the USM 281C) except the 7104. When combined with a 7000 Series mainframe, this plug-in creates a fully programmable, digitizing oscilloscope.

The 7D20 can accurately measure the amplitude of a 50 ns wide transient event. Dual samplers simultaneously acquire two channels as if it were a "dual-beam" scope.

Beyond basic acquisition, the 7D20 offers signal averaging to reduce uncorrelated noise, envelope displays to compare dynamic characteristics of changing signals, pretrigger for viewing prior to the trigger event, storage of six indepen-

dent waveforms plus a reference waveform, cursors for more accurate two-dot measurements, and user prompting and menu displays to improve user interface effectiveness.

### Hands Off Operation With Probe Identify Feature

Recommended for use in interactive, computer-coordinated tasks, the Tektronix P6053B Probe allows computer routines to be sequentially activated at the 7D20's probe tip. This probe's "Identify" button signals the IEEE Standard 488 Interface via an input channel coded request. This capability allows the operator to work at a short distance from the 7D20 without the need to touch front panel controls. Two such probes may be used, one for each vertical channel.

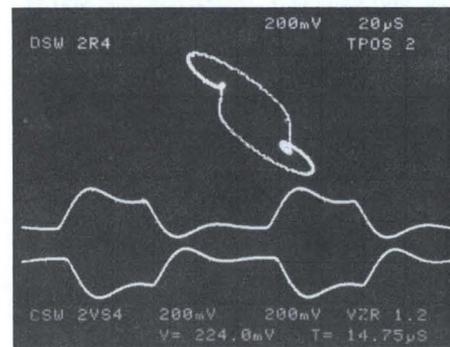
### Storage and Recall Front Panel Settings

Up to six different front panel set-ups can be stored and recalled as desired. These settings plus the last panel set-up are saved in nonvolatile memory and are restored automatically when power is applied to the 7D20.

### Fully Automated Measurements

Since the 7D20 is completely programmable, fully automated measurement and testing is possible. Tektronix programmable signal sources, multifunction interface, and RF scanner provide and control the test signals while the 7D20 acquires waveforms for the computer or controller.

### X-Y Waveform Display and Time Reference



Unique display capability allows viewing Y versus X events and Y versus time simultaneously. X-Y channels are matched at 10 MHz with less than 2° of phase shift.

### Digital Storage

A 40 MHz maximum sampling rate provides approximately 10 MHz single-shot bandwidth and up to 70 MHz bandwidth with repetitive signals.

### Cursor Measurements

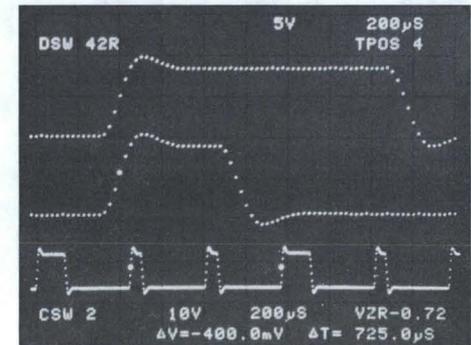
Accurate amplitude measurements (referenced to ground) and time measurements (referenced to trigger position) are made using one cursor. Point-to-point difference ( $\Delta$ ) measurements are made using two cursors.

### Master Menu



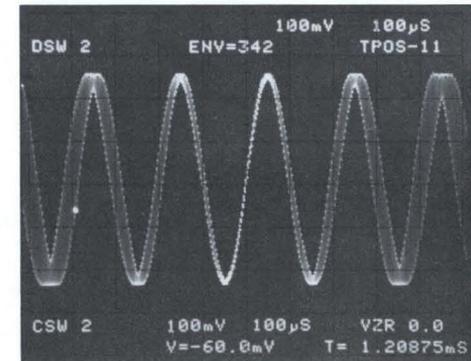
The master menu offers a convenient way to enable special functions such as the STORE and RECALL of front panel settings and also allows you to branch-out to other menus.

### Measurement Flexibility



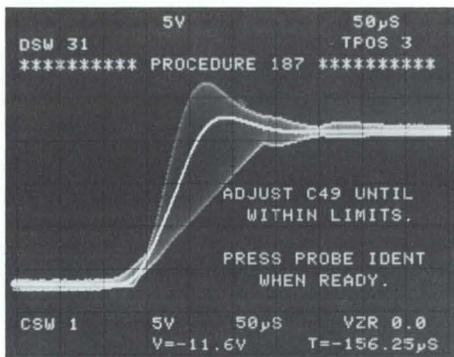
View and compare two different portions of the same waveform or of two different waveforms. All of these waveforms have been repositioned and vertically compressed. The two upper waveforms, two pulses from a single pulse train, are magnified portions of the lowest waveforms. The time ( $\Delta T$ ) between the two cursors indicates the time between the leading edges of two pulses in the pulse train.

### Enveloping



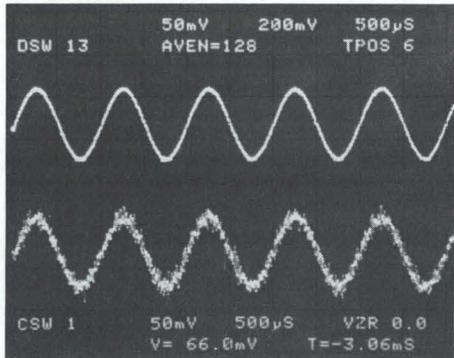
Enveloping reveals subtle variations in signals by recording maximum and minimum values of recurring sweeps while vectors "paint" in the envelope. The effects of frequency shift are dramatically displayed.

Automated Testing



For interactive test procedures, text messages, waveforms, and front panel set-ups may be transmitted and received from the 7D20 to a controller or computer. The procedure in this display informs the operator of the next task. Upper and lower tolerance limits are displayed as a single envelope. This envelope was initially constructed using the 7D20's envelope feature while a test signal was varied to its allowable limits. The waveform was then transferred and saved by the controller to serve as the test reference or overlay.

Signal Averaging



Averaging reduces uncorrelated noise to improve measurement accuracy and display quality. Continuous and self-terminating averaging are provided. The self-terminating averaging processes a fixed number (N) of waveforms and then holds the result in memory. The N value is selectable from 8 to 256 in powers of 2. The top waveform in this display is the result of averaging the bottom waveform 128 times.

CHARACTERISTICS

VERTICAL SYSTEM

- Input** — 2 channels, simultaneous sampling, BNC connectors.
- Acquire Modes** — CH 1, CH 2, ADD, BOTH (dual channel).
- Sensitivity** — 5 mV to 5 V/div; 1-2-5 sequence.
- Bandwidth** — 70 MHz maximum. (Ac Coupled Low Frequency Response: 10 Hz or less.)
- Step Response** — 5 ns or less.
- Input Impedance** — R = 1 MΩ, C ≈ 20 pF.
- Maximum Input Voltage**  
Dc Coupled: 250 V, 1 kHz or less (dc + peak ac).  
Ac Coupled: 400 V, 1 kHz or less (dc + peak ac).
- Signal Isolation** — 100:1 dc to 20 MHz.
- Vertical Resolution** — 8 bits, 256 levels, 0.04 div/level.
- Gain Ratio Accuracy** — <2%. Maximum error throughout the V/div range with acquire gain calibrated at 10 mV/div. Measurement valid with CURSORS or GPIB.
- Noise** — Mean value of 50 measurements taken at 0.02 division increments.

Volts/Div	Full Scale/RMS Noise	Percent of Full Scale
5 mV	52 dB	0.25
10 mV to 5 V	55 dB	0.18

NOTE: Full scale = 10.24 divisions.

Phase Match X-Y — <2° from dc to 10 MHz.

HORIZONTAL SYSTEM

- Time Division Range** — External Clock, 20 s/div to 50 ns/div in 1-2-5 sequence.
- Digitizing Technique Versus Time/Division**  
Real Time (Rolling Display) — External Clock, 20 s/div to 0.1 s/div.  
Real Time — 50 ms/div to 500 µs/div.  
Extended Real Time — 200 µs/div to 2 µs/div.  
Equivalent Time — 1 µs/div to 50 ns/div.
- Note: Single events can be captured as fast as 2 µs/div. For 1 µs/div to 50 ns/div, repetitive events are required to build a complete waveform.*
- Time Measurement Accuracy** — One cursor: 0.1% of reading +0, -1 sample interval ±300 ps. Two cursors: 0.1% of reading ±600 ps.

Horizontal Resolution

Time/Division	Points/Waveform	Resolution Points/Division
External, 20 s to 500 µs	1024	100
200 µs to 2 µs	820*	80*
1 µs to 50 ns	1024	100

\*Waveform interpolation to 1024 points is available for transfer over the IEEE Standard 488 Interface.

Trigger Position

- Pretrigger — 0 to 10 div in 1 div increments.
- Posttrigger (delay) — 0 to 1500 div in 1 div increments (disabled during Roll with Envelope or Average).

	Frequency Range*	Sensitivity	
		Internal	External
Normal (dc Coupling)	dc to 30 MHz	0.4 div	60 mV
	30 MHz to 70 MHz	1.0 div	150 mV
P-P and AUTO	30 Hz to 200 Hz	2.0 div	300 mV
	200 Hz to 30 MHz	0.6 div	90 mV
	30 MHz to 70 MHz	1.2 div	200 mV

\* The ac coupling low frequency limit is 30 Hz. In Time/DIV settings of 1 µs to 50 ns, when using P-P or AUTO, low-frequency limit is 300 Hz.

SIGNAL PROCESSING

- Cursors Readout** — With one cursor (ΔOFF), vertical and horizontal coordinate values are referenced to zero volts and the trigger position as zero time. With two cursors (ΔON), vertical and horizontal coordinate values are the difference between the two cursors.
- Signal Averaging**  
AVE N — A self-terminating, stable average processing "N" number of waveforms and then holds the result in memory. The "N" value may be selected using the SET N function (N = 8, 16, 32, 64, 128, 256).
- AVE — A continuous, stable averaging process. N waveforms are averaged as in AVEN, then additional waveforms are weighted at 1/N. In Roll mode a running average (smooth) is available to provide high frequency filtering.

Enveloping

- ENV N — A self-terminating recording of waveform maxima and minima. When N waveforms are processed, the result is held in memory.
- ENV — A continuous (infinite) recording of waveform maxima and minima.

Waveform Modifiers

- VPUV** ↑ (Vertical Position Up), **VPDN** ↓ (Vertical Position Down) — Provide vertical positioning control of any stored waveforms.
- VCMP** ↓ (Vertically Compress), **VXPD** ↓ (Vertically Expand) — Provide vertical display expansion or compression. Two expansions or compressions in 1,2,5 calibrated steps, from the original V/div are available.
- HMAG** (Horizontally Magnify) — Displays the cursor waveform horizontally magnified by a factor of 10.
- HMAG ALL** (Horizontally Magnify All Waveforms) — Displays all waveforms at 10 times horizontal magnification.
- VS** (Versus) — Creates a Y versus X display of any two waveforms.

IEEE STANDARD 488 INTERFACE

Interface Function

SH1	Complete Source Handshake
AH1	Complete Acceptor Handshake
T5	Complete Talker — No Secondary Address
L3	Complete Listener — No Secondary Address
SR1	Complete Service Request
RL1	Complete Remote Local
DC1	Complete Device Clear
DT1	Complete Device Trigger
PP0	No Parallel Poll
C0	No Controller
E2	Three State

**Programmable Functions** — All instrument setting and operating modes are programmable except for Variable V/DIV and Horizontal Position. However, these uncalibrated controls can be overridden and forced into the "CAL" position on command from the IEEE Standard 488 Interface. The display of MENU and ID is selectable from the front panel only.

**Format** — Device dependent commands in ASCII. Waveform data points selectable as BINARY or ASCII.

**Waveform Output Time** — 250 ms minimum for BINARY and 2.5 s minimum for ASCII. Actual transfer times depend upon the speed of the receiving device.

INPUTS

**External Trigger (Front Panel)** — Maximum Input Voltage: 250 V (dc + peak ac).

Signal Input Impedance — 1 MΩ, ≈20 pF.

**Hold Next (Mainframe Rear Panel)** — Initiates Hold Next condition; connected to Single Sweep Reset connector.

OUTPUTS

**Hold Next Ready** — High level indicates unit is in Hold Next condition; output level remains low when unit is not in Hold Next condition; connected to Single Sweep Ready connector.

**+Gate Out** — Provides high level output signal for duration of waveform/character readout.

PLUG-IN COMPATIBILITY

The 7D20 is compatible with all 7000 Series mainframes with the exception of the 7104 mainframe. Use with the 7104 will void the 7104 warranty.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	206	8.1
Height	127	5.0
Depth	371	14.6
Weight	kg	lb
Net	3.6	8.1
Shipping	8.0	17.8

ORDERING INFORMATION

**7D20 Programmable Digitizer** ..... \$7,750  
**RECOMMENDED PROBE (7D20)**

**P6053B Identify Probe** — For remote service request via probes "Identify" button. 10X attenuation; 200 MHz bandwidth; scale factor coding; 6 ft.  
Order 010-6053-13 ..... \$154

RECOMMENDED MAINFRAME

**R7603 Option 20** — The R7603 mainframe provides a six-inch diagonal CRT display and three-wide plug-in compartment in a 5.25 inch high rackmount configuration. Option 20 permits rear panel access to the 7D20's IEEE Standard 488 Interface. See pages 246 and 247 for further information. Order R7603 Option 20 Mainframe ..... +\$3,350

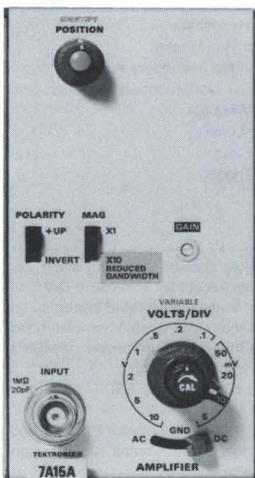
OPTIONAL ACCESSORIES (R7603)

A field installable kit adds Option 20 to the standard R7603. Intended for use with a previously purchased R7603, this kit provides parts to connect the 7D20's IEEE Standard 488 Interface to the R7603 Mainframe.  
\*Order 040-1093-00

Five other field installable kits are available, one for each of the international power cord and plug options, A1-A5. Contact your local Tektronix Field Office for information.

- \*A1 Universal Euro. Order 040-1094-00
  - \*A2 UK. Order 040-1095-00
  - \*A3 Australian. Order 040-1096-00
  - \*A4 North American. Order 040-1097-00
  - \*A5 Switzerland. Order 040-1098-00
- \*Contact your local field office for prices.

**7A15A**



**Dc to 80 MHz Amplifier**

**7A15A**

**Dc to 80 MHz Bandwidth (7900 Family)**

**5 mV/div to 10 V/div  
Calibrated Deflection Factors**

**500  $\mu$ V/div at 10 MHz (X10 Gain)**

**1 M $\Omega$  Input**

The 7A15A is an easy to use, 80 MHz amplifier that features a X10 magnifier to increase the sensitivity to 500  $\mu$ V/div with 10 MHz bandwidth. It has a constant bandwidth at all deflection factors in the X1 setting. Polarity of the display is selectable.

**CHARACTERISTICS**

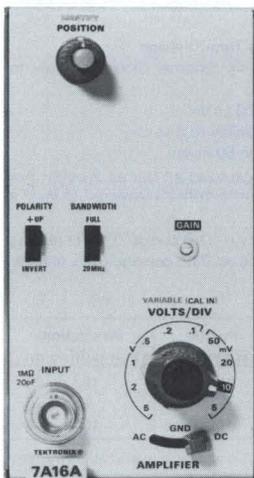
**Deflection Factor** — 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 gain accuracy is within 2% with X1 gain adjusted at 10 mV/div. X10 gain (increases sensitivity to 500  $\mu$ V) accuracy is within 10% at 10 MHz bandwidth throughout deflection factor settings. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

**Input R and C** — 1 M $\Omega$  within 2%;  $\approx$ 20 pF.

**Maximum Input Voltage** — Dc-coupled: 250 V (dc + peak ac), ac component 500 V peak-to-peak maximum 1 kHz or less. Ac-coupled: 500 V (dc + peak ac), ac component 500 V peak-to-peak maximum, 1 kHz or less.

**Order 7A15A Amplifier ..... \$600**

**7A16A**



**Dc to 225 MHz Amplifier**

**7A16A**

**Dc to 225 MHz Bandwidth (7900 Family)**

**5 mV/div to 5 V/div  
Calibrated Deflection Factors**

**1 M $\Omega$  Input**

The 7A16A is an easy to use, 225 MHz amplifier. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable; bandwidth is selectable to FULL or limited to 20 MHz for low-frequency applications.

**CHARACTERISTICS**

**Deflection Factor** — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps to a least 12.5 V/div.

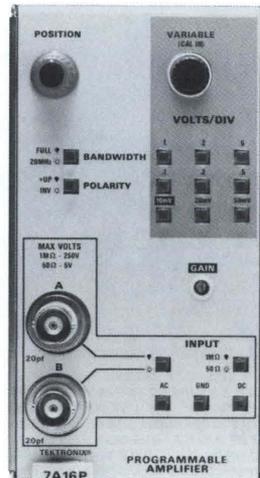
**Input R and C** — 1 M $\Omega$  within 2%;  $\approx$ 20 pF.

**Maximum Input Voltage** — Dc-coupled: 250 V (dc + peak ac), ac component 500 V peak-to-peak maximum, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V peak-to-peak maximum, 1 kHz or less.

**Dc Stability** — Drift with ambient temperature (constant line voltage) is 0.01 div/ $^{\circ}$ C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hour warm-up.

**Order 7A16A Amplifier ..... \$1,095**

**7A16P**



**Programmable—Dc to 225 MHz Amplifier**

**7A16P**

**Fully Programmable Plug-in for  
7912AD or 7612D Digitizers only**

**10 mV/div to 5 V/div Calibrated  
Deflection Factors**

**200 MHz Bandwidth (7900 Family)**

**50  $\Omega$  or 1 M $\Omega$  Input Selectable**

The 7A16P is designed for use only in Tektronix 7000 Series Programmable Digitizers. All of the normal operational features of a high-quality, wide-band 7000 Series plug-in amplifier are provided in the 7A16P. These are available at the front panel for manual selection, or they can be set under program control via a programmable mainframe and the IEEE Standard 488 bus. Whether operated manually or under program control, the front-panel push buttons light to indicate plug-in status. Plug-in status can also be read over the IEEE Standard 488 bus by an external controller for input to instrument set-up and control routines.

Two switch selected input connectors are also provided for selecting input signal source.

**CHARACTERISTICS**

**Bandwidth** — 225 MHz, plug-in only. 200 MHz in the 7912AD. Bandwidth may be limited to 20 MHz  $\pm$  3 MHz by bandwidth limit switch.

**Ac Coupled Lower Bandwidth** — 10 Hz or less.

**Step Response** — 50  $\Omega$  input plug-in only, 1.8 ns risetime.

**Deflection Factor** — 10 mV/div to 5 V/div, 9 steps in a 1-2-5 sequence. Accuracy is  $\pm$ 2% of indicated deflection factor with GAIN adjusted at 10 mV/div.

Uncalibrated VARIABLE is continuous between steps and extends selected deflection factor to at least 2.5 times the calibrated value.

**Input R and C** — Selectable: 1 M $\Omega$  within 2% and  $\approx$ 20 pF or 50  $\Omega$   $\pm$  1  $\Omega$  with VSWR  $\leq$ 1.5:1 at 200 MHz or less.

**Inputs** — Selectable A or B signal input connectors.

**Maximum Input Voltage** — 1 M $\Omega$ , dc coupled: 250 V (dc + peak ac), ac component 500 V peak-to-peak maximum, 1 kHz or less. 50  $\Omega$ , ac coupled: 500 V (dc + peak ac), ac component 500 V p-p maximum, 1 kHz or less. 50  $\Omega$ : 0.5 W maximum.

**Programmable Functions** — All functions except VARIABLE, GAIN, and IDENTIFY are programmable.

**Order 7A16P Programmable Amplifier \$2,200**

7A18A



NEW

Dc to 75 MHz Dual Trace Amplifier

7A18A

Dc to 75 MHz Bandwidth

5 mV/div to 5 V/div  
Calibrated Deflection Factors

1 MΩ Input

Optional Dc Offset

The 7A18A, the basic building block of 3- and 4-trace operation, is a dual-trace plug-in amplifier. The 7A18A features constant bandwidth for all deflection factors, five operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selectivity and color-keyed control grouping. The 7A18A has a trace identify function. Polarity of Channel 2 is selectable.

CHARACTERISTICS

**Deflection Factor** — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 10 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈20 pF.

**Maximum Input Voltage** — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

**Dc Stability** — Drift with ambient temperature (constant line voltage) is 0.01 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hr warm-up.

**Common Mode Rejection Ratio (ADD, CH 2 Invert)** — At least 10:1, dc to 50 MHz.

Order 7A18A Amplifier ..... \$1,180

DC OFFSET OPTION

Dc Offset is for the user who needs to analyze small signals that are riding on larger signals, such as power supply ripple.

**Option 06, Dc Offset** — Two separate Channel 1 and Channel 2 variable offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18A. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

**Offset Range Display** — ±200 div maximum, equivalent to ±1 V at 5 mV/div.

**Accuracy** — When in Dc OFFSET the deflection accuracy is derated by 1%.

Order Option 06 Dc Offset ..... +\$200

7A26



Dc to 200 MHz Dual Trace Amplifier

7A26

Dc to 200 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div  
Calibrated Deflection Factors

1 MΩ Input

The 7A26, a dual-trace plug-in amplifier, is a basic building block for 3- or 4-trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of Channel 2 is selectable. Bandwidth may be set at FULL or limited to 20 MHz for low-frequency applications.

CHARACTERISTICS

**Deflection Factor** — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

**Input R and C** — 1 MΩ within 2%; ≈22 pF.

**Maximum Input Voltage** — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p maximum, 1 kHz or less.

**Common Mode Rejection Ratio (ADD, Ch 1 Invert)** — At least 10:1, dc to 50 MHz.

**Dc Stability** — Drift with ambient temperature (constant line voltage) is 0.02 div/°C. Drift with time (ambient temperature and line voltage constant) is 0.02 div in any one minute after 1 hr warm-up.

Order 7A26 Amplifier ..... \$1,910

7A17



Dc to 150 MHz Bandwidth

7A17

Low Cost

Dc to 150 MHz Bandwidth (7900 Family)

50 mV/div Calibrated Deflection Factor

Easy to Customize

The 7A17 is a unique wideband, plug-in amplifier electrically and mechanically suitable for do-it-yourself design and modification.

The layout of the circuit board assembly provides a blank soldering pad matrix and ground plane surface totaling approximately 40 square inches. Circuits may be installed here. Mainframe power is identified and available on the circuit board. The front sub-panel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

CHARACTERISTICS

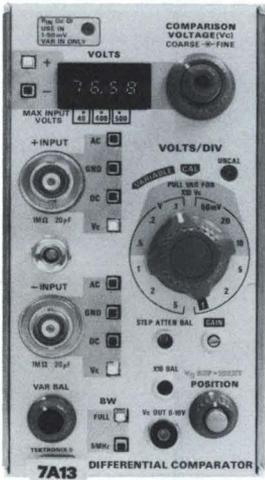
**Deflection Factor** — Adjustable to 50 mV/div. There is no step attenuation.

**Input Z** — 50 Ω.

**Maximum Input Voltage** — 5 V RMS.

Order 7A17 Amplifier ..... \$390

**7A13**



**Differential Comparator Amplifier**

**7A13**

**Dc to 105 MHz Bandwidth (7900 Family)**

**1 mV/div to 5 V/div  
Calibrated Deflection Factors**

**20,000:1 CMRR**

**10,000 cm Effective Screen Height**

**1 MΩ Input Switchable to ∞**

The 7A13 is a differential comparator amplifier. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to FULL or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and -) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 loses its differential capability, but provides an accurate (0.1%) positive or negative internal offsetting voltage covering the common-mode signal range of the unit. A signal of up to ±10 V may be applied to an input (+ or -) at a deflection factor setting of 1 mV/div and, with an opposing Vc (offset voltage), viewed in 10,000 segments of 1 mV. The offset voltage is also available as an output for external monitoring.

**High CMRR Probes for Differential Amplifiers**  
We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum common mode rejection ratio (CMRR). See page 441 for P6055 characteristics.

**CHARACTERISTICS**

**Input R and C** — 1 MΩ within 0.15%; ≈20 pF. R in ∞, is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

**Deflection Factor** — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

**Signal Range**

Deflection Factor Settings	1 mV to 50 mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
Common-mode Signal	±10 V	±100 V	±500 V
Maximum Dc-coupled Input (dc + Peak Ac at 1 kHz or less)	±40 V	±400 V	±500 V
Maximum Ac-coupled Input (dc Voltage)		±500 V	

**Maximum Input Gate Current** — 0.2 nA or less from 0 to 35°C; 2 nA or less at 85 to 55°C.

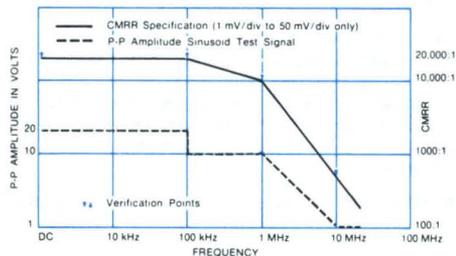
**Dc Stability** — Drift with time (constant ambient temperature and line voltage): short term, 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minute warm-up. Long term, 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hr interval after 20 minute warm-up. Drift with ambient temperature (constant line voltage), 2 mV/10°C to 0.2 div/10°C or less, whichever is greater.

**Displayed Noise (Tangentially measured)** — With X10 Vc in, 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc out, 0.4 div or less at 10 mV/div to 0.5 V/div.

**Overdrive Recovery** — 1 μs to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less at 1 mV/div only regardless of pulse duration.

**Internal Comparison Voltage** — Range, 0 V to ±10 V; accuracy, ±(0.1% of setting + 3 mV); Vc output R, ≈15 kΩ.

**Common Mode Rejection Ratio**



At least 2000:1, 10 mV/div to 50 mV (X10 Vc out) and 0.1 V/div to 5 V/div. Ac-coupled input at least 500:1 at 60 Hz.

**Order 7A13 Amplifier ..... \$2,865**

**7A22**



**Differential Amplifier**

**7A22**

**Dc to 1 MHz Bandwidth**

**10 μV/div to 10 V/div  
Calibrated Deflection Factors**

**100,000:1 CMRR**

**Selectable Upper and Lower —3 dB Points**

**Dc Offset**

**10 μV/Hour Dc Drift\***

**1 MΩ Input**

The 7A22 is a differential amplifier well suited for difficult low-amplitude, low-frequency measurements.

**High CMRR Probes for Differential Amplifiers**  
We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum common mode rejection ratio (CMRR).

See page 441 for P6055 characteristics.

\*With constant temperature. See dc stability specifications.

**CHARACTERISTICS**

**Bandwidth** — HF —3 dB point; selectable in nine steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; risetime in 1 MHz position is 350 ns  $\pm$  9%. LF —3 dB point; selectable in six steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency. The switch also contains dc and dc with OFFSET positions. Ac-coupled at input, 2 Hz or less.

**Deflection Factor** — 10  $\mu$ V/div to 10 V/div in 19 calibrated steps (1-2-5 Sequence). Accuracy is within 2% with gain adjusted to 1 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

**Input R and C** — 1 M $\Omega$  within 1%;  $\approx$ 47 pF.

**Maximum Input Gate Current** — Differentially measured, 40 pA (+25°C) and 200 pA (+50°C) at 10  $\mu$ V/div to 10 mV/div; 10 pA (+25°C) and 20 pA (+50°C) at 20 mV/div to 10 V/div.

Single ended, one-half the differential measurement. Display shift is  $\pm$ 4 div (+25°C) and  $\pm$ 20 div (+50°C) at 10  $\mu$ V/div (ac-coupled).

**Signal and Offset Range**

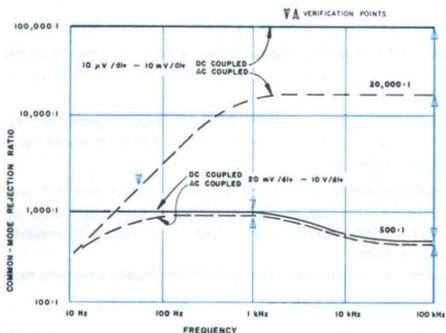
Deflection Factor Settings	10 $\mu$ V to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-mode Signal Range	$\pm$ 10 V	$\pm$ 100 V	$\pm$ 500 V	
Maximum Dc-coupled Input (dc + peak ac at 1 kHz or less)	$\pm$ 15 V	$\pm$ 200 V	$\pm$ 500 V	
Maximum Ac-coupled Input (dc voltage)	$\pm$ 500 V dc rejection, at least 4 x 10 <sup>5</sup> :1			
Dc Offset Range	+1 V to -1 V	+10 V to -10 V	+100 V to -100 V	+1000 V to -1000 V

**Dc Stability** — Drift with time (constant ambient temperature and line voltage): short term, 5  $\mu$ V (p-p) or 0.1 div, whichever is greater in any minute after one hr warm-up. Long term, 10  $\mu$ V (p-p) or 0.1 div, whichever is greater in any hr after one hr warm-up. Drift with ambient temperature (constant line voltage) is 50  $\mu$ V/°C or less.

**Displayed Noise** — 16  $\mu$ V or 0.1 div (whichever is greater) at maximum bandwidth; source resistance 25  $\Omega$  or less measured tangentially.

**Overdrive Recovery** — 10  $\mu$ s or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). Front-panel OVERDRIVE light indicates that an overdrive condition is being approached.

**Common Mode Rejection Ratio (for signals not exceeding common mode signal range)**



Order 7A22 Amplifier ..... \$1,500

**7A11**



Amplifier

**7A11**

**Built-in FET Probe**

**Dc to 250 MHz Bandwidth (7900 Family)**

**5 mV/div to 20 V/div**

**Calibrated Deflection Factors**

**Dc Offset**

**1 M $\Omega$  Input**

The 7A11 is a wideband plug-in amplifier. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 M $\Omega$ ) and low capacitance (5.8 pF at 5 mV/div), without loss of signal amplitude by probe attenuation. Two 20X attenuators, physically mounted in the probe tip, are relay-switched into the input signal path at the appropriate deflection factor. Therefore you need not concern yourself with manual plug-on attenuators and signal dynamic range.

**CHARACTERISTICS**

**Deflection Factor** — 5 mV/div to 20 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2% of gain adjustment at 0.1 V/div. Uncalibrated VARIABLE is continuous between steps to at least 50 V/div.

**Input R and C** — 1 M $\Omega$  within 1%;  $\approx$ 5.8 pF (5 mV/div to 50 mV/div),  $\approx$ 3.4 pF (0.1 V/div to 1 V/div),  $\approx$ 2 pF (2 V/div to 20 V/div).

**Signal and Offset Range**

Deflection Factor Settings	5 mV/div to 50 mV/div	0.1 V/div to 1 V/div	2 V/div to 20 V/div
Offset Range	+1 V to -1 V	+20 V to -20 V	+400 V to -400 V
Offset Range to Offset Out	1:1 within 1% +0.5 mV	20:1 within 1.5% +0.5 mV	400:1 within 2% +0.5 mV
Maximum Dc-coupled Input	200 V (dc + peak ac, ac component to 50 kHz)	200 V (dc + peak ac, ac component to 40 MHz)	200 V (dc + peak ac, ac component to 70 MHz)
Maximum Ac coupled Input (Dc Component)	$\pm$ 200 V		

**Dc Stability** — Drift with time (constant ambient temperature and line voltage): short term, 0.1 div or less per minute after 20 minute warm-up. Long term, 0.3 div or less per hr after 20 minute warm up. Drift with ambient temperature (constant line voltage), 200  $\mu$ V/°C or less.

**Displayed Noise** — 0.5 mV or 0.1 div, whichever is greater, in FULL BANDWIDTH mode, measured tangentially.

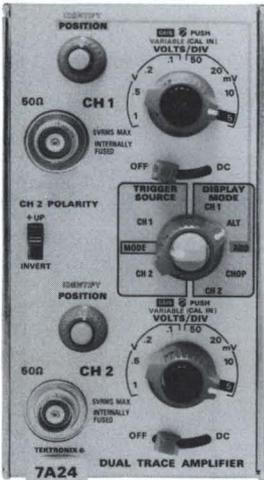
**Offset Function** — An internal dc source, continuously variable between +1 V and -1 V, may be used to offset the trace. (See chart for offset range.) An OFFSET OUT jack allows for monitoring of the offset voltage. OFFSET OUT source resistance is 500  $\Omega$  within 3%.

**INCLUDED ACCESSORIES**

Capacitor-coupler head, (011-0110-00); retractable hook tip, (013-0106-00); probe tip ground adaptor, (013-0085-00); three in ground lead (nose), (175-0849-00); three in ground lead (screw-in), (175-0848-00); 12 in ground lead (screw-in), 18 in cable (offset out), (175-1092-00); (175-0848-02); three miniature alligator clips, (344-0046-00); two insulated sleeves, probe tip to GR 50  $\Omega$  termination, (017-0088-00); (166-0404-01); probe hook tip, (206-0114-00).

Order 7A11 Amplifier ..... \$2,470

7A24



Dc to 400 MHz Dual Trace Amplifier

7A24

Dc to 400 MHz Bandwidth (with 7104)

5 mV/div to 1 V/div  
Calibrated Deflection Factors

50 Ω Input

The 7A24, a high-performance, wide band, dual-trace amplifier, is designed primarily for use with the 7700, 7800, 7900, and 7100 Series Mainframes. The 7A24 offers 350 MHz bandwidth and 5 mV/div sensitivity; this provides the basic building block for three or four trace operation. It features constant bandwidth for all deflection factors, five operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable.

CHARACTERISTICS

**Deflection Factor** — 5 mV/div to 1 V/div in eight calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 5 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 2.5 V/div.

**Input R** — 50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

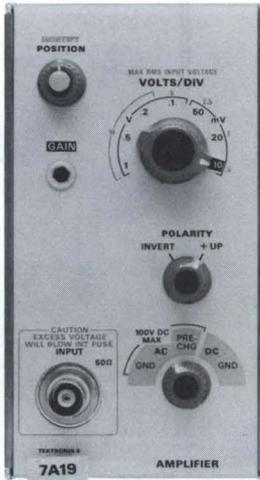
**Maximum Input** — 5 V RMS; 0.5 W maximum input power, internally protected.

**Common Mode Rejection Ratio** — At least 10:1, dc to 50 MHz.

**Dc Stability** — Drift with ambient temperature (constant line voltage) is 0.02 div/°C. Drift with time (ambient temperature and line voltage constant), 0.02 div in any one minute after one hour warm-up.

Order 7A24 Amplifier ..... \$2,225

7A19



Dc to 600 MHz Amplifier

7A19

Dc to 600 MHz Bandwidth (with 7104)

10 mV/div to 1 V/div  
Calibrated Deflection Factors

50 Ω Input

Optional ±500 ps Variable Delay Line

The 7A19 is a high-performance, wide band, single-trace, plug-in amplifier designed primarily for use with the 7100, 7700, 7800, and 7900 Family Mainframes. The polarity of the display is selectable, either normal or inverted.

CHARACTERISTICS

**Deflection Factor** — 10 mV/div to 1 V/div in seven calibrated steps (1-2-5 sequence). Accuracy is within 3%.

**Input R** — 50 Ω.

**Ac Coupling** — -3 dB at 1 kHz or less from a 50 Ω source.

**Option 04, Variable Signal Delay** — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

**Maximum Input** — 50 div peak or 10 V RMS (2 W), whichever is less, in the dc-coupled mode. 100 V dc additional in the ac-coupled mode.

ORDERING INFORMATION

7A19 Amplifier ..... \$2,225  
Option 04 — Variable Signal Delay ..... +\$350

7A29



Dc to 1 GHz Amplifier

7A29

Dc to 1 GHz Bandwidth (with 7104)

10 mV/div to 1 V/div  
Calibrated Deflection Factors

50 Ω Input

Optional ± 500 ps Variable Delay Line

The 7A29 is a high performance, wide-bandwidth, single-trace, plug-in amplifier designed primarily for use with the 7104 Mainframes. The polarity of the display is selectable, either normal or inverted. RMS sensed input protection protects the 7A29 against most common overloads.

CHARACTERISTICS

**Deflection Factor** — 10 mV/div to 1 V/div in seven calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated variable is continuous between steps to at least 2.5 V/div with some bandwidth penalty.

**Input R** — 50 Ω.

**Ac Coupling** — -3 dB at 1 kHz or less from a 50 Ω source.

**Option 04, Variable Signal Delay** — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is ±500 ps.

**Maximum Input** — 10 V RMS or 1 W-second pulses not exceeding 50 V peak in dc coupled mode. 100 V dc additional in ac coupled mode.

**Input Protection** — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

ORDERING INFORMATION

7A29 Amplifier ..... \$2,530  
Option 04 — Variable Signal Delay ..... +\$350

## 7B90P

500 ps/div to 500 ms/div  
Calibrated Time Base

Fully Programmable Plug-in  
7912AD Digitizer only

400 MHz Trigger Bandwidth

Single-Sweep Operation

The programmable 7B90P is designed for use with a Tektronix 7912AD Programmable Digitizer. Its operating functions can be manually selected at the front panel or selected under program control via the IEEE 488 bus. The only nonprogrammable functions are the Sweep Calibration adjustment and the External Trigger Input Terminator Switch.

### CHARACTERISTICS

**Sweep Rates** — 500 ms/div to 10 ns/div in 24 steps. Magnifier extends fastest calibrated sweep rate to 500 ps/div.

**Sweep Accuracy** — Measured over center 8 div, +15°C to +35°C, with any 7000 Series Programmable Mainframe. Derate accuracies by an additional 1% for 0 to +50°C.

Time/Div	Unmagnified	Magnified
500 ms/div to 100 ns/div	2%	3%
50 ns/div to 10 ns/div	3%	4%
500 ps/div	—	5%

**Trigger Holdoff** — Programmable in 62 steps between minimum and maximum.

Time/Div	Min (ccw)	Max (cw)
500 ps/div to 2 μs/div	≤3.5 μs	≥90 μs
5 μs/div to 20 μs/div	≤35 μs	≥900 μs
50 μs/div to 200 μs/div	≤350 μs	≥9 ms
500 μs/div to 2 ms/div	≤3.5 ms	≥90 ms
5 ms/div to 500 ms/div	≤35 ms	≥900 ms

**Triggering Sensitivity**

Triggering Frequency Range	Min Signal Required	
	Int	Ext
At least 50 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext*
Ac	30 Hz to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac LF REJ**	30 kHz to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac HF REJ***	30 Hz to 50 kHz	0.3 div	100 mV
Dc	Dc to 50 MHz	0.3 div	100 mV
	50 MHz to 400 MHz	1.5 div	250 mV

\*External ÷ 10 operation attenuates external trigger signal ten times.

\*\*Will not trigger on sinewaves or <8 div Internal, or 3 V External, at or below 60 Hz.

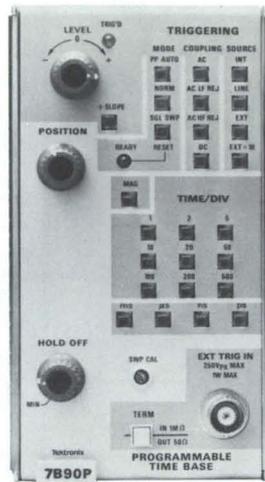
\*\*\*Will not trigger on 50 MHz sinewaves 1.5 div or less Internal, or 0.15 V or less External.

**Single-Sweep Mode** — Same as NORM mode.

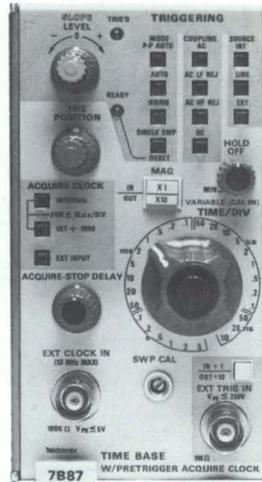
**Trigger Level** — Programmable in 0.05 div steps.

**Horizontal Position** — Programmable in 0.0125 div step unmagnified, 0.125 div step magnified.

## 7B90P



## 7B87



**Internal Trigger Jitter** — 0.1 ns or less at 400 MHz.

**External Trigger Input** — Selectable: 1 MΩ ± 5%, 20 pF ± 10% or 50 Ω ± 5% with 1.22 maximum vswr at 400 MHz. Maximum input is 250 V (dc + peak ac) for 1 MΩ or one W for 50 Ω or one W for 50 Ω. The level range (excluding peak-to-peak AUTO) for a 1 kHz sinewave input is at least ± 3 V in EXT and at least ± 30 V in EXT ÷ 10.

**Order 7B90P Programmable Time Base** ..... \$2,650

## 7B87

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Pretrigger when used with 7854

The 7B87 is a time base designed for use with the 7854 Mainframe to provide additional pretrigger capability. The pretrigger feature is only compatible with the 7854 at this time. When used in the B horizontal of the 7854, the 7B87 provides both single shot and pretrigger capability to the 7854.

The 7B87 has the same characteristics as the 7B80/7B85 Time Base Plug-ins except for single shot pretrigger capability. Pretrigger allows you to view what has occurred before the trigger even in single shot applications. The amount of pretrigger time is determined by the Acquire-Stop delay time setting. The total amount of pretrigger is 0.2 to 9.9 times the time/div setting.

The INT ÷ 1000 control reduces the stored time/div to 1000 times slower than the real time display on a 7854. This does not, however, affect the Acquire-Stop delay time. The INT ÷ 1000 control allows stored sweep speeds from 10 ms to 5000 s/div for slow speed applications.

An EXT CLOCK-IN connector is provided for clock frequencies other than what is offered by the INT clock of the 7B87.

### CHARACTERISTICS

**Sweep Rates** — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 MAGNIFIER extends fastest calibrated sweep rate to 1 ns/div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep rate.

**Sweep Accuracy** — Measured over the center 8 div, 15 to 35°C, in the 7700, 7800, or 7900 Series Mainframes. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*	Unmagnified	Magnified
5 s/div to 1 s/div	4%	unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

\*Fastest calibrated sweep rate is limited by 7700 and 7600.

**Trigger Holdoff Time**

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
0.5 μs/div to 10 ns/div	2.0 μs or less	
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster	

**Delay Time Range** — 0.2 or less to at least 9.0 times TIME/DIV setting.

**Jitter** — 0.02% of TIME/DIV setting + 0.1 ns, or less.

### TRIGGERING

**Triggering Sensitivity (Auto and Norm Modes)** — (From repetitive signals.)

Coupling	Triggering Frequency Range*	Min Signal Required	
		Int	Ext
Ac	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac LF REJ**	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
Dc***	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV

\*Triggering frequency ranges are limited to the frequency of the vertical system when operating in the internal mode.

\*\*Will not trigger on sinewaves of <8 div Internal, or 3 V External, at or below 60 Hz.

\*\*\*Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the autotrigger mode.

**Single Sweep** — Requirements are same as for repetitive inputs.

**Internal Trigger Jitter** — 0.1 ns or less at 400 MHz.

**Sensitivity** — P-P AUTO Mode (ac or dc coupling)

Triggering Frequency Range	Min Signal Required	
	Int	Ext
Low Frequency Response:		
At least 50 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

**External Trigger Input** — Maximum input voltage is 250 V (dc + peak ac). Input R and C is 1 MΩ within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ± 1.5 V in External ÷ 1, and at least ± 15 V in External ÷ 10.

**Internal Clock** - Pretrigger 0.02048 Hz to 20.45 MHz determined by the time/div, X10 magnification and ÷ 1000 switches. Accuracy of internal + Internal ÷ 1000 = 0.1%.

**External Clock** — Maximum input is 5 V peak. Input R is 100 kΩ within 5%. Threshold voltage TTL compatible. Maximum input frequency 10 MHz with BNC input. Delay 0.5 μs or less.

**Acquire Stop Delay** — Total range is 0.2 or less to at least 9.9 times Time/Div setting. Jitter from 5 s/div to 10 μs/div 0.07% of time/div setting or less. Delay accuracy (+15°C to +35°C) from 0.5 s/div to 10 μs/div is within 0.5% of measurement plus 5% of time/div setting.

**Single Shot Performance** — Using 7B87 with 7854 Internal Clock.

FASTEST Sweep (Time/Div)	Points/Waveform
50 μs	128
100 μs	256
200 μs	512
500 μs	1024

**Order 7B87 Time Base** ..... \$1,575

**7B10/7B15**

0.2 ns/div to 0.2s/div Calibrated Time Bases

Triggering to 1 GHz

Variable Trigger Holdoff

Peak-to-Peak Autotriggering

**7B15 Features:**

$\Delta$ Time Measurements with CRT Readout

Delayed Time Measurements with CRT Readout

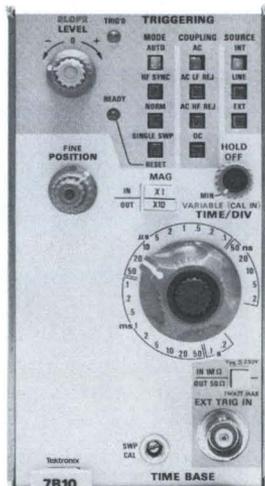
Vertical Trace Separation between Two Delayed Sweeps

The 7B10 and 7B15 are horizontal time bases designed for use with the 7104 Mainframe to provide optimum bandwidth/sweep-speed/compatibility, but may also be used with the 7700, 7800, and 7900 Series Mainframes. (Each may be used in any slower 7000 Series Mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

The 7B10 and 7B15 or the 7B80 and 7B85 provide the  $\Delta$ time measurement capability in addition to the standard delay time capability. Either time interval is digitally displayed on the CRT. A single intensified zone which you can position anywhere on the trace identifies the delay time interval (the time from the "A" or main sweep to the start of the intensified zone). Two intensified zones which you can position anywhere on a trace identify the  $\Delta$ time interval (time between intensified zones). Alternate sweep switching makes it possible to display the information between the intensified zones full screen at the "B" sweep speed. By overlapping the two expanded waveforms, you are confident of the exact positioning of the intensified zones on the "A" sweep. This results in easy-to-make, precise and repeatable timing measurements.

By rotating the TRACE SEPARATION control out of the OFF position, the  $\Delta$ time mode is activated. Two intensified zones can be independently positioned. As in the conventional delay mode, the DELAY TIME knob adjusts the time to the first intensified zone; the  $\Delta$ TIME knob adjusts the time between the two intensified zones. Now, the CRT digital readout shows the  $\Delta$ time between the two delays.

**7B10**



**Delayed Time Base**

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

**CHARACTERISTICS**

**Sweep Rates** — 0.2 s/div to 2 ns/div in 25 steps. X10 MAGNIFIER extends fastest calibrated sweep rate to 0.2 ns/div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep.

**Sweep Accuracy** — Measured over the center 8 div, +15°C to +35°C, in the 7104, 7800 or 7900 Series Mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*	Unmagnified	Magnified
0.2 s/div to 10 ns/div	2%	3%
5 ns/div and 2 ns/div	3%	4%

\*Fastest calibrated sweep rate is limited by 7900, 7800, 7700, 7600 and 7300 Series Mainframes.

**Trigger Holdoff Time**

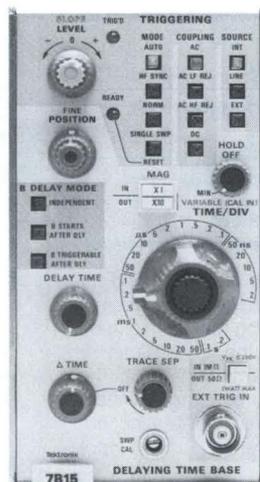
	Minimum	Maximum with VARIABLE
0.2 s/div to 50 ms/div	40 ms	400 ms
20 ms/div to 2 $\mu$ s/div	X2 the TIME/Div Setting	X20 the TIME/Div Setting
1 $\mu$ s/div to 0.5 $\mu$ s/div	2 $\mu$ s	20 $\mu$ s
0.2 $\mu$ s/div to 2 $\mu$ s/div	2 $\mu$ s	6 $\mu$ s

**$\Delta$ Time Range** — 0 to at least 9 times TIME/DIV setting.

**$\Delta$ Time Accuracy** — Within (0.5% measurement plus 3 least significant digits) 20 ms/div to 100 ns/div.

**Trace Separation Range** — Functional only in  $\Delta$ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

**7B15**



**$\Delta$ Delaying Time Base**

**Delay Time Range** — 0.2 or less to at least 9.0 times TIME/DIV setting.

**Jitter** — 0.02% of TIME/DIV setting up through 50  $\mu$ s/div. 0.03% of TIME/DIV setting plus 0.1 ns for sweep speeds of 20  $\mu$ s/div through 100 ns/div.

**TRIGGERING**

**Triggering Sensitivity**

Coupling	Triggering Frequency Range*	Minimum Triggering Signal Required	
		Int	Ext
Ac	30 Hz to 250 MHz	0.5 div	50 mV
	250 MHz to 1 GHz	1.5 div	150 mV
Ac Lf REJ**	50 kHz to 250 MHz	0.5 div	50 mV
	250 MHz to 1 GHz	1.5 div	150 mV
Ac Hf REJ	30 Hz to 40 kHz	0.5 div	50 mV
Dc***	Dc to 250 MHz	0.5 div	50 mV
	250 MHz to 1 GHz	1.5 div	150 mV

\*The triggering frequency ranges given here are limited to the -3 dB frequency of the oscilloscope vertical system when operating in the internal mode.

\*\*Will not trigger on sinewaves at or below 60 Hz when amplitudes are <8 div internal or 3 V External.

\*\*\*The Triggering Frequency Range for DC COUPLING applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

**Single Sweep** — Requirements are the same as for repetitive inputs.

**Internal Trigger Jitter** — 30 ps or less at 1 GHz.

**HF Sync Mode** — 250 MHz to 1 GHz 0.3 div internal and 0.75 mV external.

**External Trigger Input** — Maximum input voltage is 250 V (dc + peak ac) for 1 M $\Omega$  input, 1 W average for 50  $\Omega$  input. Input R and C for 1 M $\Omega$  input is 1 M $\Omega$  within 5%, 20 pF within 10%; for 50  $\Omega$  input, 50  $\Omega$  within 2%. Level range is at least  $\pm 3.5$  V in EXT  $\div$  1.

**ORDERING INFORMATION**

7B10 Time Base .....	\$2,110
7B15 Delaying Time Base .....	\$2,390

7B80/7B85

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

7B85 Features:

Δ Time Measurements with CRT Readout

Delayed Time Measurements with CRT Readout

Vertical Trace Separation Between Two Delayed Sweeps

The 7B80 and 7B85 are horizontal time bases recommended for use with 7700, 7800 and 7900 Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000 Series mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

**Sweep Rates** — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 MAGNIFIER extends fastest calibrated sweep rate to 1 ns/div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep rate.

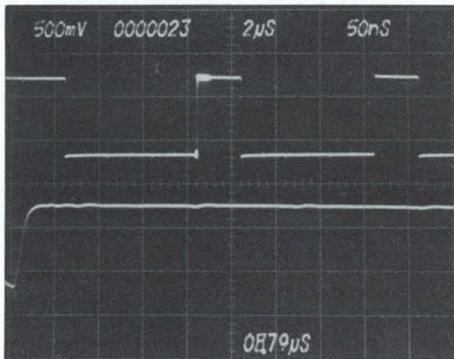
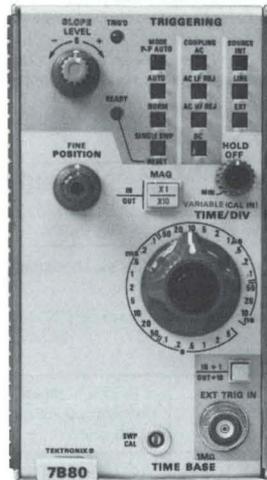


Figure 1. Delaying and delayed sweeps are shown with the mainframe selecting ALT sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the CRT.

7B80



Delayed Time Base

**Sweep Accuracy** — Measured over the center 8 div, +15°C to +35°C, in the 7700, 7800, or 7900 Series Mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div*	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

\*Fastest calibrated sweep rate is limited by 7700 and 7600.

Trigger Holdoff Time

Minimum Holdoff Setting	5 s/div to 1 µs/div	2 times TIME/DIV setting or less
	0.5 µs/div to 10 ns/div	2.0 µs or less

Variable Holdoff Range — Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster

**Δ Time Range** — 0 to at least 9 times TIME/DIV setting.

**Δ Time Accuracy** — (+15°C to +35°C)

Within (0.5% measurement 0.3% of TIME/DIV setting + 1 least significant digit) from 20 ms/div to 100 ns/div.

**Trace Separation Range** — Functional only in Δ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

**Delay Time Range** — 0.2 or less to at least 9.0 times TIME/DIV setting.

**Jitter** — 0.02% of TIME/DIV setting plus 1 ns, or less.

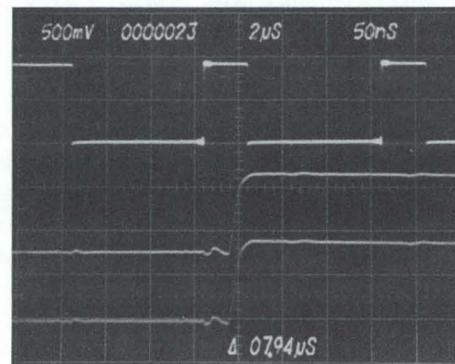
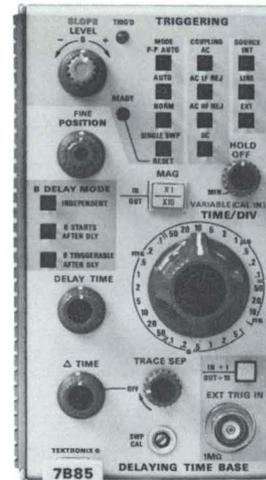


Figure 2. With the mainframe still selecting ALT sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower CRT edge shows the time between the two sweep delays. The TRACE SEPARATION knob is used to position the second delayed sweep below the first delayed sweep with up to 3 div of separation.

7B85



Δ Delaying Time Base

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes) (from repetitive signals)

Coupling	Triggering Frequency Range*1	Min Signal Required	
		Int	Ext
Ac	30 Hz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac Lf REJ*2	30 kHz to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV
Ac Hf REJ	30 Hz to 50 kHz	0.3 div	50 mV
Dc*3	Dc to 50 MHz 50 MHz to 400 MHz	0.3 div 1.5 div	50 mV 250 mV

\*1 Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.

\*2 Will not trigger on sine waves of less than 8 div Internal, or 3 V External, at or below 60 Hz.

\*3 Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.

**Single Sweep** — Requirements are same as for repetitive inputs.

**Internal Trigger Jitter** — 0.1 ns or less at 400 MHz.

**Sensitivity** — P-P AUTO Mode (ac or dc coupling)

Triggering Frequency Range	Min Signal Required	
	Int	Ext
Low Frequency Response: At least 50 Hz	2.0 div	500 mV
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV

**External Trigger Input** — Maximum input voltage is 250 V (dc + peak ac). Input R and C is 1 MΩ within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ±1.5 V in EXT ÷ 1, and at least ±15 V in EXT ÷ 10.

**7B80 Option 02 — X-Y Phase Shift** (Determined by the circuitry in mainframe) — For mainframe without X-Y horizontal compensation, the mainframe phase shift specifications are retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

ORDERING INFORMATION

7B80 Time Base .....	\$1,335
Option 02 — X-Y Horizontal Compensation .....	+\$100
7B85 Delaying Time Base .....	\$1,605

## 7B92A



### Dual Time Base

## 7B92A

0.5 ns/div to 0.2 s/div Calibrated Time Base

Triggering to 500 MHz

Alternate Display of Intensified Delaying and Delayed Sweeps

Contrast Regulation between Delaying and Delayed Sweeps

The 7B92A Dual Time Base is recommended for use only in the 7800 and 7900 Series mainframes (the 7B92A may be used in all other mainframes at slower sweep speeds).

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep (excepting alternate in R7704). When operating in the AUTO mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

## CHARACTERISTICS

### DELAYING SWEEP (MAIN SWEEP)

**Sweep Rate** — 0.2 s/div to 10 ns/div in 23 calibrated steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

**Sweep Accuracy** — Measured over the center 8 div in a 7900 Family Oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%

**Delay Time Multiplier Range** — 0 to 9.8 times the DLY TIME/DIV setting from 0.2 s/div to 10 ns/div (0 to 1.96 s).

**Differential Delay Time Measurement Accuracy** — (15°C to +35°C).

### Sweep Speed

0.2 s/div to 0.1 μs/div	Both delay time mult dial settings at 0.5 or greater	±(0.75% of measurement + 0.25% of full scale)
	One or both delay time mult dial settings at less than 0.5	±(0.75% of measurement + 0.5% of full scale + 5 ns)
50 ns/div to 10 ns/div	Both delay times equal to or greater than 25 ns	±(1% of measurement + 0.5% of full scale)
	One or both delay times less than 25 ns	±(1% of measurement + 1% of full scale + 5 ns)

Full scale is 10 times the TIME/DIV or DLY TIME setting. Accuracy applies over the center 8 Delay Time Multiplier div from +15°C to +35°C.

### Delay Time Jitter\*

0.2 s/div to 50 μs/div	1 part in 50,000 of the maximum available delay time
20 μs/div to 10 ns/div	1 part in 50,000 of the maximum available delay time + 0.5 ns

\* Not applicable for the first 2% of maximum available delay time (DELAY TIME MULT dial setting > 0.2). Maximum available delay time is 10 times the TIME/DIV or DLY TIME switch setting.

### MAIN TRIGGERING

#### Auto, Norm

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext
Ac	30 Hz to 20MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Ac LF REJ*	30 kHz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Ac HF REJ	30 Hz to 50 kHz	0.5 div	100 mV
Dc	Dc to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

EXT ÷ 10 switch attenuates external signal 10 times.

**HF Sync** — Triggering sensitivity is 0.5 div INT or 100 mV EXT, from 100 MHz to 500 MHz for any coupling except Ac HF Rej.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

**Internal Trigger Jitter** — 50 ps or less at 500 MHz.

**External Trigger Input** — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum safe input is 250 V (dc + peak ac) for 1 MΩ input and 1 W average for 50 Ω input. Range of trigger level is at least ±3.5 V in EXT, and at least ±35 V in EXT ÷ 10.

### DELAYED SWEEP

**Sweep Rate** — 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

**Sweep Accuracy** — Measured over the center 8 div in a 7900 Family Oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div to 5 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

### Delayed Triggering

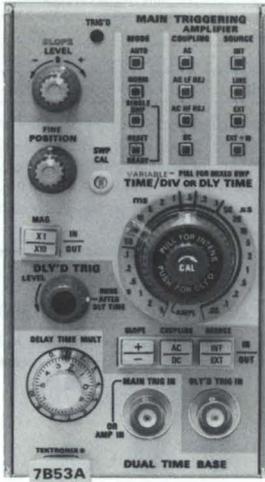
Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext
Ac	30 Hz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Dc	DC to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

**Internal Trigger Jitter** — 50 ps or less at 500 MHz.

**External Trigger Input** — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by ≈20 pF). Maximum safe input is 250 V (dc + peak ac) for 1 MΩ input, and 1W average for 50 Ω input. Range of trigger level is at least ±3.5 in EXT.

**Order 7B92A Dual Time Base ..... \$3,175**

7B53A



Dual Time Base

7B53A

5 ns/div to 5 s/div Calibrated Time Base

Calibrated Mixed Sweep

Triggering to 100 MHz

Single-Sweep Operation

Optional TV Sync-Separator Triggering

The easy-to-use 7B53A Dual Time Base is recommended for use with 7600 mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000 Series mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

The 7B53A Time Base features four kinds of sweep: normal, intensified delaying, delayed, and mixed. The pushbutton switches cannot be lit.

CHARACTERISTICS

DELAYING SWEEP

**Sweep Rate** — 0.05  $\mu$ s/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps. The variable control is internally switchable between main, delayed-sweep, and variable main-sweep holdoff.

**Sweep Accuracy** (Measured over the center 8 div.)

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 1 s/div	3%	4%	Unspecified	Unspecified
0.5 s/div to 0.05 $\mu$ s/div	3%	4%	3.5%	5%
50 ms/div to 0.5 $\mu$ s/div	2%	3%	2.5%	4%

**Delay Time Multiplier Range** — 0 to 10 times the DELAY TIME/DIV setting from 5 s/div to 1  $\mu$ s/div.

**Differential Delay Time Measurement Accuracy** — 5 s/div to 1 s/div  $\pm$ 1.4% of measurement +0.3% of full scale; 0.5 s/div to 1  $\mu$ s/div:  $\pm$ 0.7% of measurement +0.3% of full scale. Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 DTM divisions from 15 to 35°C.

**Jitter** — 0.05% or less of TIME/DIV setting.

Triggering

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext
Ac	30 Hz to 10MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV
Ac LF REJ*	30 kHz to 10 MHz	0.3 div	—
	150 kHz to 10 MHz	—	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV
Ac HF REJ	30 Hz to 50 kHz	0.3 div	100 mV
Dc	Dc to 10 MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV

\*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until reset.

**Internal Trigger Jitter** — 1 ns or less at 75 MHz.

**External Trigger Input** — Maximum input voltage is 500 V (dc + peak ac), 500 V peak-to-peak ac at 1 kHz or less. Input R and C is 1 M $\Omega$  within 2%, 20 pF within 2 pF. LEVEL range is at least 1.5 V to -1.5 V in EXT, at least 15 V to -15 V in EXT  $\div$  10.

DELAYED SWEEP

**Sweep Rate** — 0.05  $\mu$ s/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps to at least 1.25 s/div and is switchable between the main, delayed sweep, and variable main sweep holdoff.

**Sweep Accuracy** (Measured over the center 8 div.)

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
0.5 s/div to 0.1 s/div and 0.2 $\mu$ s/div to 0.05 $\mu$ s/div	4%	5%	4.5%	6%
50 ms/div to 0.5 $\mu$ s/div	3%	4%	3.5%	5%

**Delayed Sweep Gate** — Output voltage is  $\approx$  +3.5 V into at least 10 k $\Omega$  shunted by 100 pF or less, or 0.5 V into 50  $\Omega$ . Rise time is 50 ns or less; output R is 350  $\Omega$  within 10%. Gate is available at the DLY'D TRIG IN connector when the delayed sweep source switch is set to INT.

Triggering

Coupling	Triggering Frequency Range*	Min Signal Required	
		Int	Ext
Ac	30 Hz to 10MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV
Dc	Dc to 10 MHz	0.3 div	100 mV
	10 MHz to 100 MHz	1.5 div	500 mV

**Internal Trigger Jitter** — 1 ns or less at 75 MHz.

**External Trigger Input** — Maximum input voltage is 500 V (dc + peak ac), 500 V peak-to-peak ac at 1 kHz or less. Input R and C is 1 M $\Omega$  within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to -1.5 V in EXT.

MIXED SWEEP

**Sweep Accuracy** — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: first 0.5 div after start of main sweep display and 0.2 div or 0.1  $\mu$ s (whichever is greater) after transition of main to delayed sweep.

EXT HORIZONTAL INPUT

**Deflection Factor** — 10 mV/div within 10% when in EXT, MAG X10; 100 mV/div within 10% when in EXT; 1 V/div within 10% when in EXT  $\div$  10.

Bandwidth

Coupling	Lower -3 dB	Upper -3 dB
Ac	40 Hz	2 MHz
Ac LF REJ	16 kHz	2 MHz
Ac HF REJ	40 Hz	100 kHz
Dc	Dc	2 MHz

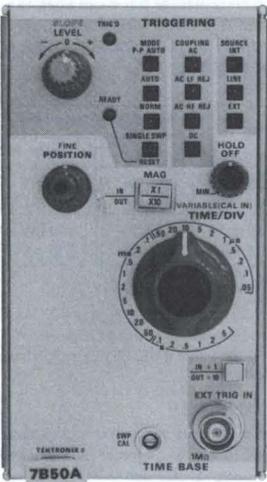
TV SYNC

**Option 05, TV Sync Separator Triggering** — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed circuit tv systems, domestic or international, with up to 1201-line, 60 Hz field rates. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system. Option 05 deletes ac line trigger and External  $\div$  10 from trigger source.

ORDERING INFORMATION

7B53A Dual Time Base ..... \$1,430  
 Option 05 — TV Triggering ..... +\$150

7B50A



Time Base

7B50A

5 ns/div to 5 s/div Calibrated Time Base

Triggering to 150 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

Single-Sweep Operation

The easy-to-use 7B50A Time Base is recommended for use with 7600 Series mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000 Series mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

This time base features expanded capability in maximum triggering frequency — now 150 MHz — and variable trigger holdoff — for stability on lengthy asynchronous data trains.

Pushbutton positions select triggering mode, coupling method, and source. For routine applications, hands-off triggering is accomplished by actuating three switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE. The P-P AUTO MODE provides a base line trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of + or - SLOPE this mode is automatic. The other triggering positions are useful for specific applications.

Ac LF REJ attenuates undesirable trigger components below 30 kHz. Ac HF REJ attenuates components above 50 kHz, which can cause triggering problems during low-frequency applications. Single-sweep functions with lighted READY indicator and manual reset are associated with the trigger mode controls.

X-Y displays are available with Option 02 installed. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B50A. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

**Sweep Rates** — 0.05  $\mu$ s/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE allows continuous sweep rate selection between steps.

**Sweep Accuracy** — Measured over center 8 div, 15 to 35°C, with any 7000 Series mainframe. Derate accuracies by an additional 1% each for 0 to 50°C.

Time/Div	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 0.5 $\mu$ s/div	2%	3%
0.2 $\mu$ s/div to 0.05 $\mu$ s/div	3%	4%

Trigger Holdoff Time

Minimum Holdoff Setting	5 s/div to 1 $\mu$ s/div	2 times TIME/DIV setting or less
	0.5 $\mu$ s/div to 50 ns/div	2.0 $\mu$ s or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster	

Triggering Sensitivity (AUTO and NORM modes)

Coupling	Triggering Frequency Range*	Min Signal Required	
		Int	Ext
Ac	30 Hz to 50MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
Ac LF REJ**	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
Ac HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
Dc***	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV

\*Triggering frequency ranges are limited to the frequency of the vertical system when operating in the internal mode.

\*\*Will not trigger on sinewaves of less than 8 div internal, or 3 V External, at or below 60 Hz.

\*\*\*Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.

Sensitivity (P-P AUTO MODE) (Ac or Dc Coupling)

Triggering Frequency Range	Min Signal Required	
	Int	Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 150 MHz	1.5 div	375 mV

**Option 02 X-Y Phase Shift** (Determined by the circuitry in mainframe) — For mainframes without X-Y horiz compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horiz compensation, the extra delay adds to the phase shift error above 50 kHz.

ORDERING INFORMATION

7B50A Time Base ..... \$890  
 Option 02 — X-Y Horizontal Compensation ..... +100

7D11



Digital Delay Unit

7D11

Delay by Time or Events

Digital Delay Readout to 7 1/2 Digits

100 ns to 1 s Delay Time

1 ns Resolution

2.2 ns Delay Time Jitter

0.5 ppm (±2 ns) Accuracy

Delay Interval CRT Display

The 7D11 Digital Delay Plug-in gives stable delayed triggers for measurements requiring low jitter. The 7D11 also provides precision time delays. The 7D11 may be used in any compartment of a 7000 Series mainframe equipped with CRT readout. It provides a variety of outputs.

The delay-by events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

In the delay-by events, the 7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see Figure 2).

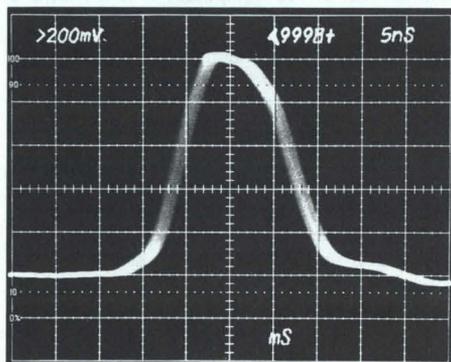


Figure 1. Delay-by-time. A 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

An accurate and jitter-free delay-by-time is very useful when working with digital logic, pcm telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

When the 7D11 is installed in a vertical compartment, the CRT can display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D11 triggers on. From a vertical compartment, the 7D11 can trigger a time base such as 7B80, 7B53A, or another 7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates a display similar to the "A intensified by B" mode of conventional delayed sweep (see Figure 2). When used in the A horizontal compartment, the 7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1 MHz timing standard through the EXT 1 MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc, the CRT readout would display the "one-way-trip" time.

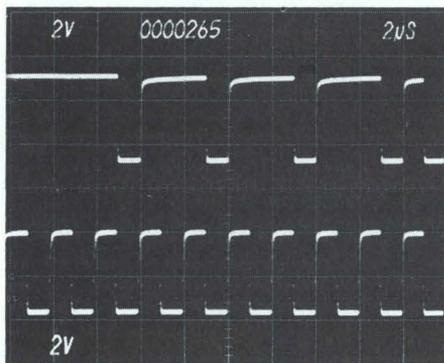


Figure 2. Delay-by events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.

CHARACTERISTICS

EVENTS DELAY

- Events Delay Range — One to 10<sup>7</sup> events.
- Delay Increment — One event.
- Insertion Delay — 35 ns ± 5 ns.
- Recycle Time — <500 ns.
- Max Event Frequency — At least 50 MHz.

TRIGGERING

External Trigger				
Source	Int, Line, Ext, Ext ÷ 10			
Coupling	Dc, Ac, Ac LF Rej, Ac HF Rej			
Max Input Voltage	250 V DC + peak Ac			
Level Range	± 1.75 V in Ext ± 17.5 V in Ext ÷ 10			
Input R and C	1 MΩ ± 5%, 20 pF ± 2 pF			
Sensitivity	Coupling	Frequency Range	Min Signal Required	
			Int	Ext
Sensitivity	Ac	30 kHz to 10 MHz 10 MHz to 50 MHz	0.3 div 1.0 div	150 mV 750 mV
	Ac LF REJ*	30 kHz to 10 MHz 150 kHz to 10 MHz	0.3 div —	— 150 mV
	Ac HF REJ	30 Hz to 50 kHz	0.3 div	150 mV
	Dc	Dc to 10 MHz 10 MHz to 50 MHz	0.3 div 1.0 div	150 mV 750 mV

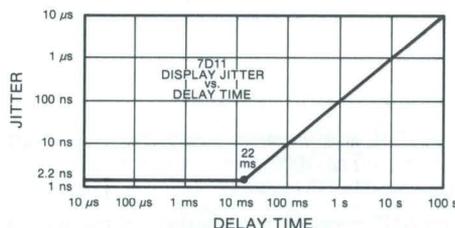
\*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

Events Start Trigger

Source	External Only		
Coupling	Dc Only		
Max Input Voltage	150 V dc + peak ac		
Level Range	± 3 V		
Input R and C	1 MΩ within 5%, 20 pF ± 2 pF		
Sensitivity	100 mV min, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.		

TIME DELAY

- Digital Delay Range — Normal mode: 100 ns to 1 s in 100 ns increments. Echo mode: 200 ns to 2 s in 200 ns increments.
- Analog Delay — Continuously variable from 0 to at least 100 ns, accuracy within 2 ns of indicated delay.
- Jitter with Internal Clock — 2.2 ns or delay time x 10<sup>-7</sup>, whichever is greater.



- Insertion Delay — Zero within 2 ns.
- Recycle Time — Less than 575 ns.
- Time Base — 500 MHz oscillator phase-locked to internal or external clock.
- Internal Clock — 5 MHz crystal oscillator. Accuracy is 0.5 ppm.
- External Clock — 1 MHz within 1%, ac coupled, 50 Ω.

OUTPUTS

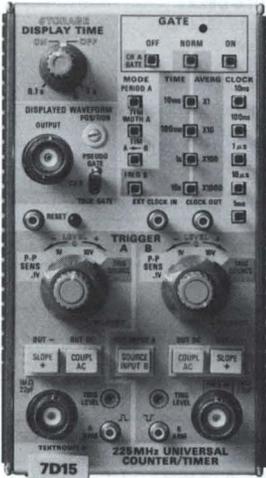
- Delayed Trigger Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risettime into 50 Ω load: 2 ns or less. Fall time into 50 Ω load: 5 ns or less. Pulse width: 200 to 250 ns.
- Delay Interval Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risettime into falltime: 5 ns or less. Accuracy: equal to delay interval less 20 to 30 ns.

READOUT

- Display — 7 1/2 digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the FINE DELAY (ns) setting.

Order 7D11 Digital Delay Unit ..... \$2,915

## 7D15



225 MHz Counter/Timer

## 7D15

Oscilloscope-controlled Time and Frequency Measurements

10 ns "Single-shot" Time Interval Measurement Resolution

Time Interval Averaging

CRT Display of Counting Interval

10 ps Period-Averaging Resolution

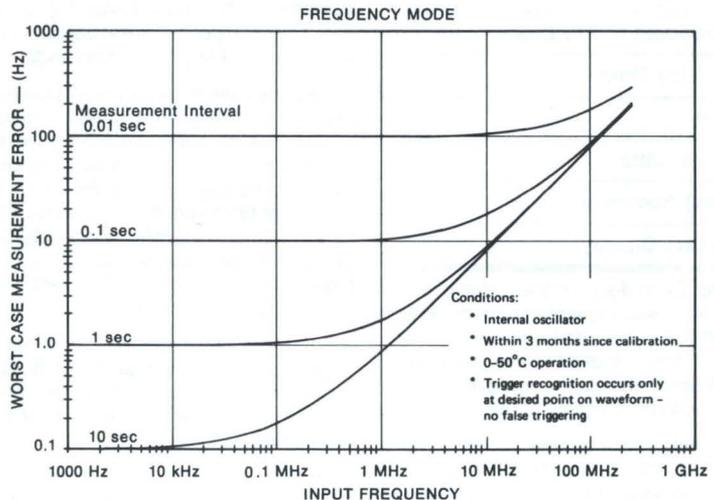
Frequency Measurements Directly to 225 MHz

Signal Conditioning via Mainframe Trigger Source

### Modes of Operation

Frequency Mode	Range	Dc to 225 MHz Resolution 0.1 Hz maximum
	Accuracy	$\epsilon_{\text{freq(Hz)}} = \pm TB \cdot f_{\text{in}} \pm \frac{1}{T}$
Period and Multi-Period Mode	Range	10 ns to 10 <sup>5</sup> seconds with averaging times of X1 to X1000 in decade steps. Resolution: 10 picoseconds maximum
	Accuracy	$\epsilon_{\text{period(s)}} = \pm TB \cdot P_{\text{in}} \pm \frac{10^{-9}}{M} \pm \frac{2E_{\text{npk}}}{\frac{dv}{dt} \cdot M} \pm \frac{P_{\text{ck}}}{M}$
Time Interval T1 and (T1 Average) Mode	Range	6 ns to 10 <sup>5</sup> seconds with averaging times of X1 to X1000. 0.1 ns resolution (usable)
	Accuracy Worst Case (Nominal)	$\epsilon_{\text{T1(s)}} = \pm TB \cdot P_{\text{in}} \pm \frac{P_{\text{ck}}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{\text{npk}}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	Range	10 <sup>-7</sup> to 10 <sup>4</sup>
Manual Stop Watch	Range	0 to 10 <sup>5</sup> seconds
Totalize, Ch B	Range	0 to 10 <sup>8</sup> counts

NOTE: Formulas given where  $\epsilon$  is the error; TB (expressed as a decimal) is the time base accuracy;  $P_{\text{in}}$  is the period or time interval of unknown signal;  $M$  is the number of averages given;  $P_{\text{ck}}$  is the measurement clock period;  $T$  is the gate time;  $f_{\text{in}}$  is the frequency of the unknown signal;  $E_{\text{npk}}$  equals peak noise pulse amplitude as presented to Schmitt trigger circuit;  $dv/dt$  equals signal slope at input to Schmitt trigger (volts per second). These formulas were used to develop the associated charts.



The 7D15 is a universal counter/timer designed for use in all 7000 Series Oscilloscope Mainframes with CRT readout.

The 7D15 offers all the measurement capabilities of the counter/timer, such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

Three displays, the pseudo gate, CH B Schmitt trigger output, and true gate, are selected by a 7D15 front panel switch and are also available at a front panel connector.

The 7D15 can also be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, visually selective measurements can be made at any point on the CRT display.

Two identical high-speed trigger circuits provide complete signal processing. Identical trigger circuits also allow single-shot time interval measurements to be made with 10 ns resolution. With repetitive signals, time interval averaging will increase the accuracy of a measurement by a factor of ten or more.

The 7D15 has high resolution because of a 10 ns clock, one of five clock positions obtainable from the front panel. A front panel Clock Out connector makes the selected clock signal available at a front-panel connector. This provides a time mark function that is TTL compatible and will drive a 50  $\Omega$  load.

The Ext Clock in connector allows an external 1 MHz timing standard to be used for measurements requiring a higher degree of accuracy than that provided by the internal time base.

The 7D15 may be used in vertical or horizontal compartments of 7000 Series mainframes. It provides a full eight digit CRT display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

**ACCURACY**

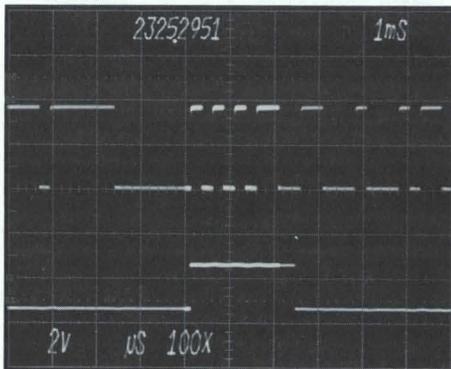
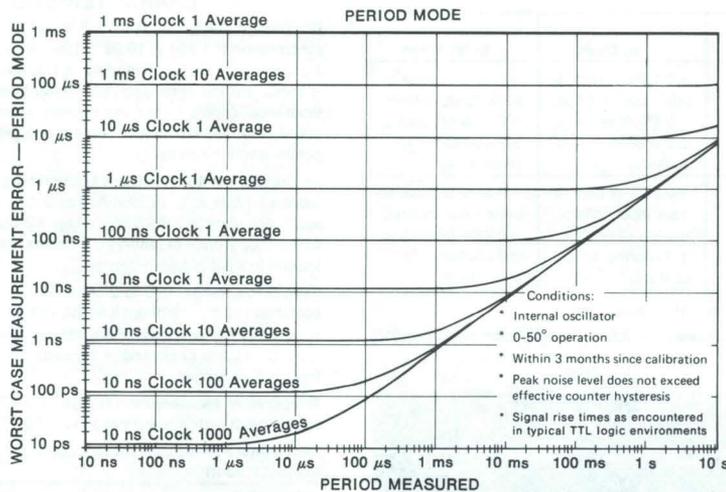
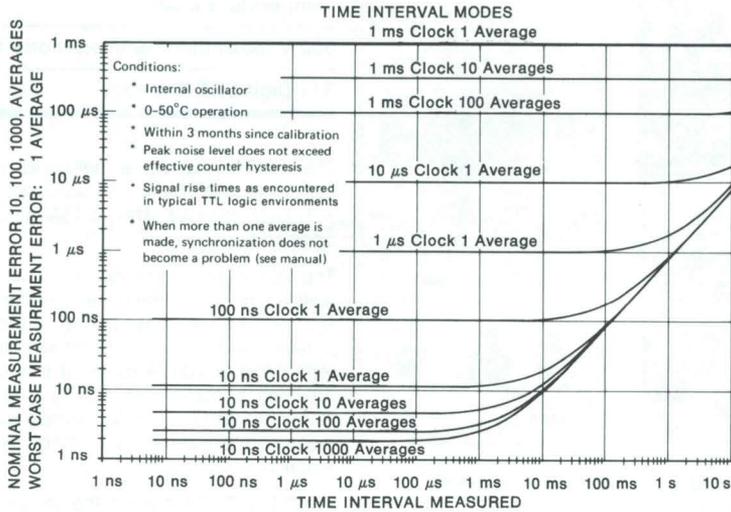


Figure 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time interval measurement from third to seventh pulse on CRT display. Counter CH A is "armed" with leading edge of B gate while CH B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. CRT readout displays the result of 2325.295 μs.

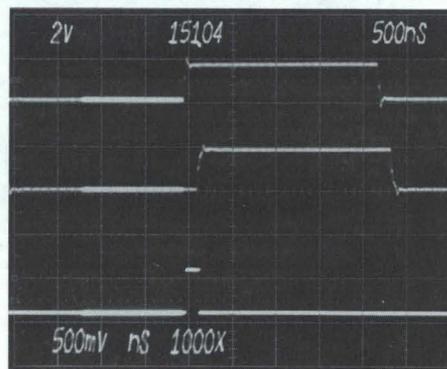


Figure 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. CRT readout displays the result of 151.0 ns.

**CHARACTERISTICS**

**INTERNAL TIME BASE**

**Crystal Oscillator** — Accuracy: within 0.5 ppm (0 to +50°C ambient). Long-term drift: 1 part or less in 10<sup>7</sup> per month. Oscillator is temperature compensated; no warm up is required.

**OUTPUT SIGNALS**

**Clock Out** — Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤ 0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

**A and B Trigger Level** — Z<sub>out</sub> ≈ 1 kΩ, V<sub>out</sub> = ±0.5 V into 1 MΩ.

**Displayed Waveform (Internally Connected)** — Front-panel switch selects true gate, pseudo gate, or Channel B signal out. Position controlled by front-panel screwdriver control.

**External Display** — Same as internal except position control has no effect.

**Display Mode Switch** — 0.1 to 5 s; also a preset position for infinite display time. Allows selection of readout "follow or store."

**Readout** — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a greater than symbol.

**INPUT SIGNAL CH A & B**

**Frequency Range (CH B only)** — Dc-coupled: dc to 225 MHz. Ac-coupled: 5 Hz to 225 MHz.

**Sensitivity (CH A and B Inputs)** — 100 mV peak-to-peak. Trigger source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

**Input R and C** — 1 MΩ and 22 pF.

**Triggering (Preset Position)** — Automatically triggers at 0 V.

**Level Control Range (CH A and B Inputs)** — 100 mV range: ±500 mV. 1-V range: ±5 V. 10-V range: ±50 V.

**Arming Inputs** — Input R and C: 10 kΩ and 20 pF. Sensitivity arm A: logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity arm B: logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

**External Clock-In** — 20 Hz to 5 MHz.

**Reset Front Panel** — Reset readies the instrument. All counters are affected, including averaging circuits.

**INCLUDED ACCESSORIES**

Two cables RF 44 in (012-0403-00, Sealectro to BNC connector).

**Order 7D15 Universal**

Counter/Timer ..... \$3,020

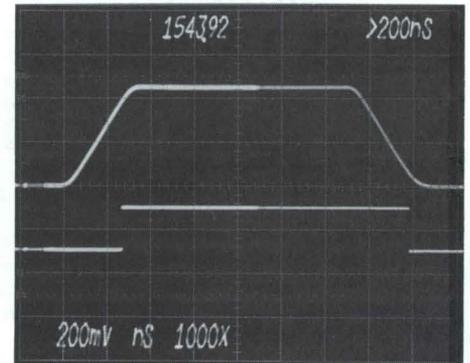


Figure 3. Independent slope and level control allows the user to visually select precise points on the waveform where the counter starts and stops. CRT readout displays the result of 1543.9 ns.

**7D12/M2**

**Oscilloscope-controlled Sampling DVM**

10 ns Aperture Uncertainty

Input Signal and Sample Points  
Displayed on CRT

1 mV Resolution

25 MHz Bandwidth

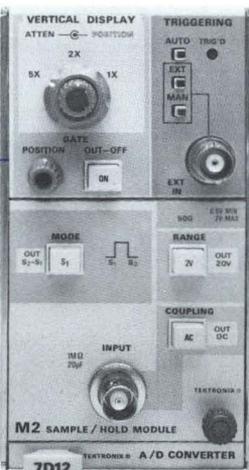
0-to-2 V and 0-to-20 V Input Range, 200 V  
with P6055 Probe

Automatic, Manual, or External Triggering

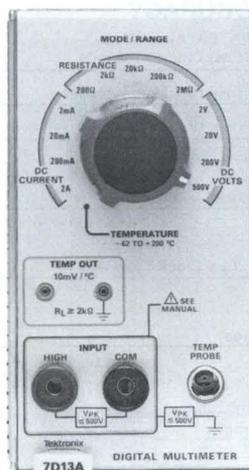
Automatic Polarity and Overrange  
Indicators

3 1/2 Digit CRT Readout

7D12/M2



7D13A



**7D13A**

**Temperature Mode**

500 V Maximum Common-mode Voltage

3 1/2 Digit CRT Readout

The 7D13A is a digital multimeter designed for use in all 7000 Series Oscilloscope mainframes with CRT readout. The 7D13A functions in any compartment.

The 7D13A measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6601 temperature probe. The temperature probe functions regardless of 7D13A mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 V). Temperature may be measured simultaneously along with any other function.

When the 7D13A is used, the character generator traces out a 3 1/2 digit display on the CRT and a legend for units like kΩ, mA, °C.

**CHARACTERISTICS**

**Dc Voltage Range** — 0 to 500 V in four ranges. 3 1/2 digit presentation of 1.999 V, 19.99 V, 199.9 V, and 500 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +35°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Maximum safe input is 500 V peak between either contact and ground, 500 V peak between voltage contacts.

**Dc Current Range** — 0 to 2 A in four ranges. 3 1/2 digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +35°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum input is fuse protected.

**Resistance Range** — 0 to 2 MΩ in five ranges. 3 1/2 digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +35°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

**Temperature Measurement Range** — -62°C to +200°C in one range. 3 1/2 digit presentation to +200°C.

**Temperature Measurement Accuracy (Probe calibrated to the instrument)**

7D13A Operating Conditions	Temperature Value Measured	Measurement Accuracy
+18°C to +28°C	-62°C to +150°C	±2°C
(room temperature)	+150°C to +200°C	0°C, -6°C
0°C to +18°C	-62°C to +200°C	Add 1.5°C to above tolerance in each direction
+28°C to +50°C	-62°C to +200°C	

**Settling Time** — 1 s or less (voltage, current, and resistance modes).

**Polarity** — Automatic indication.

**Maximum Common-Mode Voltage** — 500 V peak between two terminals and ground.

**Normal-mode Rejection Ratio** — At least 30 dB at 60 Hz.

**Common-mode Rejection Ratio** — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

**Over Range Indication** — When over range occurs, the readout blinks and the most significant digit displays a 3.

**Temperature Out** — 10 mV/°C into a load of at least 2 kΩ.

**INCLUDED ACCESSORIES**

P6601 Temperature Probe package (010-6601-01); pair of test leads (003-0120-00).

**Order 7D13A Digital Multimeter ..... \$1,105**

The 7D12 is designed for use with all 7000 Series oscilloscope mainframes with CRT readout.

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together, providing a visual indication of where the sample(s) is taken. In the S<sub>1</sub> mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken, and the voltage amplitude, from the 0 V level, is digitally displayed on the CRT readout. In the S<sub>2</sub>-S<sub>1</sub> mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the CRT readout.

**CHARACTERISTICS**

**Sample-gate Display Amplitude** — 2 div, risetime and falltime 5 ns or less.

**Analog-signal Display** — Bandwidth is dc to 25 MHz (dc-coupling), 3.4 Hz to 25 MHz (ac-coupling). Vertical sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

**Input R and C** — 1 MΩ and 20 pF.

**Maximum Input Voltage** — 100 V peak.

**Measurement Readout** — 0 to 20 V in two ranges. 3 1/2 digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 Probe.

**Overrange Indication** — When overrange occurs, a > symbol appears to the left of the reading.

**Aperture Uncertainty** — 10 ns or less.

**Pulse-Width Sample Time (S<sub>2</sub>-S<sub>1</sub> mode)** — 30 ns to 5 ms with repetitive signal. 150 μs to 5 ms with single-shot signal.

**Measurement Rate** — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

**A/D Converter and Sample/Hold Module Digital Multimeter**

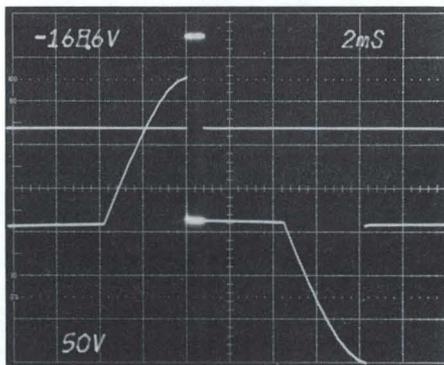
**Settling Time** — 40 ns.

**Accuracy without Probe (40 ns after Input Signal Step Function)**

Temperature Range	S <sub>1</sub> Mode	S <sub>2</sub> -S <sub>1</sub> Mode
+20°C to +30°C	±0.15% of peak-to-peak input voltage, ±0.1% of reading, ±2 counts, ±% of ac decay*	±0.25% of peak-to-peak input voltage, ±0.15% of reading, ±2 counts, ±% of ac decay*
+15°C to +40°C	±0.25% of peak-to-peak input voltage, ±0.2% of reading, ±3 counts, ±% of ac decay*	±0.35% of peak-to-peak input voltage, ±0.25% of reading, ±3 counts, ±% of ac decay*

\*Applicable when M2 is ac-coupled.

**Included Accessory** — 3.5 ft P6055 Probe package (010-6055-01).



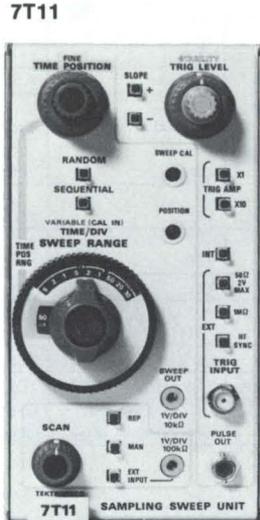
Sample and Hold DVM measures difference voltage (-168.6 V) between two points on complex waveform. Gate waveform indicates two points: leading and trailing edges where voltage difference is made.

**ORDERING INFORMATION**

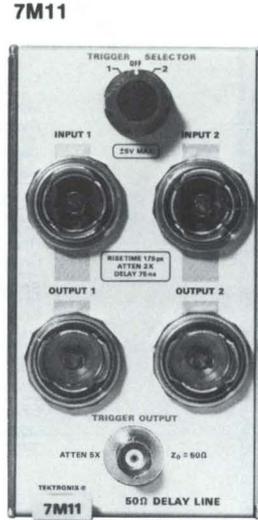
7D12A/D Converter (Module not included) .....	\$1,500
M2 Sample/Hold Module .....	\$1,315
Option 02 without P6055 .....	-\$120



7S11 Sampling Unit



7T11 Sampling Sweep Unit



7M11 Delay Line

## 7S11

- 2mV/div to 200 mV/div Calibrated Deflection Factors
- Plug-in Sampling Heads

The 7S11 is a single-channel sampling unit. The input configuration employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used in a variety of combinations. Single-channel sampling uses one 7S11 with a 7T11 Time Base. Two 7S11s and one 7T11 provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

### CHARACTERISTICS

**Deflection Factor** — 2 units/div to 200 units/div in 7 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous (extends deflection factor from 1 unit/div or less to at least 400 units/div). Deflection factor is determined by the plug-in sampling head.

**Bandwidth** — Determined by the sampling head.

**Input Impedance** — Determined by the sampling head.

**Dc Offset** — Range, +1 V to -1 V or more. Offset out is 10X the offset voltage within 2%. Source R is 10 kΩ within 1%.

**Delay Range** — At least 10 ns for comparing two signals in a dual-trace application.

**Memory Slash** — 0.1 div or less at 20 Hz.

**Vertical Signal Out** — 200 mV per displayed div within 3%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

**Order 7S11 Sampling Unit without Sampling Head ..... \$1,780**

## 7T11

- 10 ps/div to 5 ms/div Calibrated Time Base
- Random or Sequential Sampling
- Equivalent or Real Time Sampling
- No Pretrigger Required

The 7T11 Sampling Time Base provides equivalent-time and real-time horizontal deflection for single- or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from approximately 10 Hz (sequential mode) to above 12.4 GHz.

### CHARACTERISTICS

**Time/Div Range** — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated VARIABLE is continuous between steps to at least 4 ps/div.

**Time Position Range** — Equivalent time is 50 ns to 50 μs in four steps; real time is 0.5 ms to 50 ms in three steps.

**Time/Div Accuracy** — Within 3% for all time/div settings over center 8 cm.

### TRIGGERING

**Ext 50 Ω Input** — Frequency range is dc to 1 GHz in 1X TRIG AMP mode. Sensitivity range is 12.5 mV to 2 V peak-to-peak (dc to 1 GHz) in X1 TRIG AMP, 1.25 mV to 2 V peak-to-peak (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 50 Ω within 10%. Maximum input voltage is 2 V (dc + peak ac).

**Ext 1 MΩ Input** — Frequency range is dc to 100 MHz in X1 TRIG AMP mode. Sensitivity range is 12.5 mV to 2 V peak-to-peak (dc to 100 MHz) in X1 TRIG AMP, 1.25 mV to 2 V peak-to-peak (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 1 MΩ within 5%. Maximum input voltage is 100 V peak-to-peak to 1 kHz (derating 6 dB per octave to a minimum 5 V peak-to-peak).

**Ext HF Sync** — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV peak-to-peak. Input R is 1 MΩ. Maximum input voltage is 2 V peak-to-peak.

**Int Trigger Source (Sinewave Triggering)\*** — Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP; 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is 125 mV to 1 V peak-to-peak (referred to the vertical input) in X1 TRIG AMP; 12.5 mV to 1 V peak-to-peak (referred to the vertical input) in the X10 TRIG AMP.

\*Trigger circuits will operate to dc with pulse triggering, except for HF Sync.

**Random Mode Trigger Rate** — 100 Hz minimum.  
**Display Jitter** — Measured under optimum trigger conditions with TIME/DIV switch clockwise.

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

**Pulse Out** — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns risetime or less.

**Trigger Kickout** — 2 mV or less into 50 Ω (except HF SYNC).

**Display Scan Rate** — Continuously selectable from at least 40 sweeps/s to <2 sweeps/s.

**External Scan** — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ within 10%. Maximum input voltage is 100 V (dc + peak ac).

**Sweep Out** — 1 V/div within 2%. Source R is 10 kΩ within 1%.

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

### INCLUDED ACCESSORIES

42 in BNC 50 Ω cable (012-0057-01); SMA (3 mm) male to BNC adaptor (015-1018-00); 10X 50 Ω attenuator (011-0059-02); SMA (3 mm) male to GR874 adaptor (015-1007-00).

**Order 7T11 Sampling Sweep Unit ..... \$4,460**

## 7M11

- 75 ns Time Delay
- Selectable Trigger Out
- 175 ps Risetime

The 7M11 is a passive dual delay line for use with the 7000 Series Sampling System. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per-div settings.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50 Ω, 75 ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175 ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

### CHARACTERISTICS DELAY LINE

**Time Delay** — 75 ns within 1 ns.

**Delay Difference** — 30 ps or less between channels.

**Risetime** — 175 ps or less.

**Attenuation** — 2X within 2% into 50 Ω.

**Input Impedance** — 50 Ω within 2%.

**Maximum Input** — ±5 V (dc + peak ac).

### TRIGGER OUTPUT

**Risetime** — 600 ps or less.

**Attenuation** — 5X within 10% into 50 Ω (referred to INPUT).

**Output Impedance** — 50 Ω within 10%

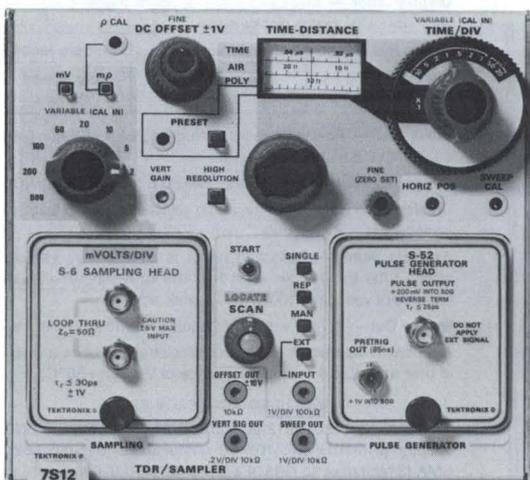
**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

### INCLUDED ACCESSORIES

Ten inch, BNC Cable (012-0208-00); two 2 ns GR cables (017-0505-00).

**Order 7M11 Delay Line ..... \$1,335**

## 7S12



### TDR/Sampler

## 7S12

45 ps TDR or a General-purpose Sampler

6 Plug-in Sampling Heads Available

2 Plug-in Pulse Sources Available

1 Trigger Recognizer Head Available

1 Trigger Countdown Head Available

The 7S12 is a combined vertical-horizontal, double-width plug-in for high resolution TDR or general purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination) and distance range to 290 feet in any cable. Its vertical scale is calibrated in reflection coefficient ( $\rho$ ) from 2 m $\rho$ /div to 500 m $\rho$ /div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line TDR using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 ft (air line) and discontinuities to twice this distance may be viewed. System risetime with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

### CHARACTERISTICS

#### SYSTEM PERFORMANCE WITH S-6 AND S-52

**System Risetime** — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

**Time and Distance Ranges** — Direct-reading tape dial gives calibrated one-way distance to at least 400 ft (air line). Time range is at least 0.9  $\mu$ s round trip. Both ranges are limited by the duration of the pulse from the S-52.

**Pulse Amplitude** — At least +200 mV into 50  $\Omega$ .

**Input Characteristics** — Nominal 50  $\Omega$ , feed-through signal channel (termination supplied). SMA (3 mm) connectors.

**Jitter** — <10 ps (without signal averaging).

**Abserrations** — +7%, -7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, -2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

#### TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

**System Rise Time** — 1.5 ns or less for the displayed reflection from a short-circuited test line.

**Time and Distance Ranges** — Direct-reading tape dial gives calibrated one-way distances to 4900 ft air line, 3240 ft solid polyethylene. Time range is 20  $\mu$ s round trip.

**Pulse Amplitude** — At least +400 mV into 50  $\Omega$ .

**Input Characteristics** — Nominal 50  $\Omega$  test line connection (cable and T supplied). BNC connectors.

**Jitter** — <20 ps (without signal averaging).

**Abserrations** — +4%, -6%, total of 10% p-p within first 17 ns of step; +1.5%, -1.5%, total of 3% thereafter.

#### OTHER 7S12 CHARACTERISTICS

**Vertical Scale** — Calibrated in m $\rho$  (reflection coefficient 10<sup>-3</sup>) and mV from 2 to 500 units/div in 8 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous between steps.

**Resolution** — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

**Dc Offset Range** — +1 V to -1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X 10 dc offset through 10 k $\Omega$ .

**Time/Distance** — Tape dial is calibrated in time and distance: full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10  $\mu$ s, 1  $\mu$ s, 0.1  $\mu$ s (time). Accurate within 1%. Distance calibration may be preset for dielectric having propagation factors from 0.6 to 1.

**Time/Div** — 20 ps/div to 1  $\mu$ s/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

**Locate Button** — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

### COMPARISON OF SAMPLING FEATURES

	7S11/7T11	7S12	7S14
Maximum Bandwidth	14 GHz	14 GHz	1 GHz
Fastest Risetime	≤25 ps	≤25 ps	≤350 ps
Vertical Sensitivity Range	2 to 200 mV/div	2 to 500 mV/div	2 to 500 mV/div
Sequential Equiv Sampling	YES	YES	YES
Random Equiv Sampling	YES	NO	NO
Real Time Sampling	YES	NO	NO
Smoothing	YES	YES	YES
Channels	1 (2 with an additional 7S11)	1 (2 with an additional 7S11)	2
TDR	NO (but can be done)	YES	NO (but can be done)
Changeable Heads	YES (vertical only)	YES (horizontal and vertical)	NO
Input Impedance	50 $\Omega$ or 1 M $\Omega$ (depending on head)	50 $\Omega$ or 1 M $\Omega$ (depending on head)	50 $\Omega$

**Display Modes** — Repetitive or single sweep, manual or external scan.

**Signal Outputs** — Pin jacks provide both vertical signal and sweep outputs.

#### INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR slide rule (003-0700-00).

#### ORDERING INFORMATION

7S12 TDR/Sampler (tape dial in feet) without Sampling Heads .....	\$3,390
Option 03 Tape Dial Change (Meters) .....	+\$25

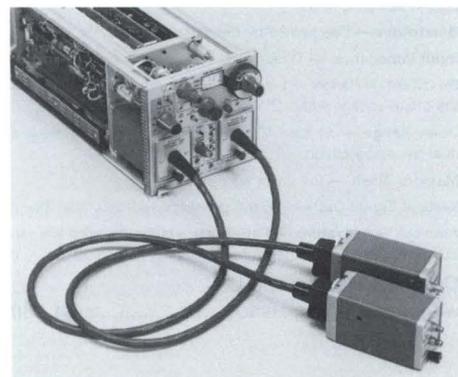
#### OPTIONAL ACCESSORIES

**Patch Cords** — Available for the OFFSET OUT, EXT SWEEP INPUT, VERT SIG OUT, and SWEEP OUT jacks of the 7S12. Pin-jack to pin-jack, 0.08 in dia. pin.

Red, 8 in Order 012-0179-00 .....	\$3.75
Red, 18 in Order 012-0180-00 .....	\$3.75
Black, 8 in Order 012-0181-00 .....	\$3.75
Black, 18 in Order 012-0182-00 .....	\$3.75

**Tape Dial (Calibrated in ft)**  
Order 331-0273-00 .....

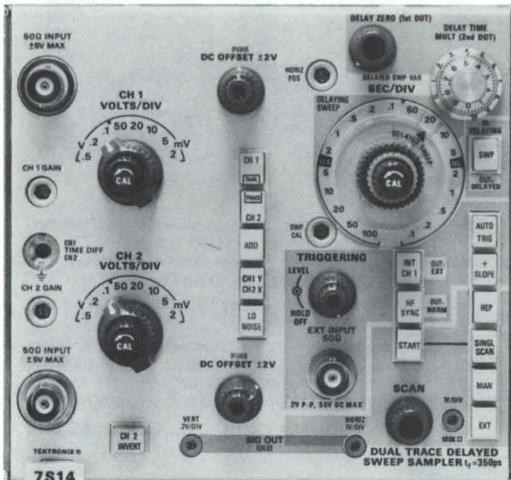
**Tape Dial (Calibrated in Meters)**  
Order 331-0276-00 .....



3 ft Sampling-Head Extender Order 012-0124-00 ..... \$375  
6 ft Sampling-Head Extender Order 012-0125-00 ..... \$445

NOTE: See 1502 and 1503 Portable TDR Cable Testers on pages 140-141.

7S14



Dual Trace Delayed Sweep Sampler

7S14

Calibrated Delayed Sweep

Two-dot Measurements

Dc to 1 GHz Bandwidth

Dual Trace, 2 mV Sensitivity

CRT Readout

Simplified Triggering

Operational Ease of a Conventional Oscilloscope

The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in. Two identical vertical channels provide dual-trace sampling, a two-ramp time base and calibrated delayed sweep. Front-panel controls are grouped by color, and the control nomenclature is similar to conventional oscilloscope nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation.

CHARACTERISTICS

VERTICAL CHANNEL

**Modes** — CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 INVERT); CH 1 Vertical (Y), CH 2 Horizontal (X).

**Input Impedance** — Nominally 50  $\Omega$ .

**Bandwidth** — Equivalent to dc to 1 GHz.

**Rise Time** — 350 ps or less.

**Step Aberrations** — +2%, -4%, total of 6% peak-to-peak within first 5 ns,  $\pm 1\%$  thereafter, tested with a 284 Pulse Generator.

**Deflection Factor** — 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

**Accuracy** — Within  $\pm 3\%$ .

**Maximum Input Voltage** —  $\pm 5$  V.

**Input Signal Range** — 2 V peak-to-peak maximum within a +2 V to -2 V window at any sensitivity.

**Dc Offset Range** — At least +2 V to -2 V.

**Displayed Noise** — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

**Vertical Signal Output** — 0.2 V/div of vertical deflection; 10 k $\Omega$  source resistance.

**Channel Delay Difference** — Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE

**Scan Modes** — Repetitive, single, manual, or external.

**Delaying Sweep** — May be used as the CRT time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

**Delayed Sweep** — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

**Horizontal Signal Output** — 1.0 V/div of horizontal deflection; 10 k $\Omega$  source resistance.

DELAYING SWEEP

**Range** — 10 ns/div to 100  $\mu$ s/div in 13 steps (1-2-5 sequence).

**Accuracy** — Within  $\pm 3\%$ , excluding first one-half division of displayed sweep.

**Delayed Zero (1st Dot)** — Adjustable to correspond to any instant within the time interval represented by the first 9 division of the delaying sweep selected.

**Delay Time (2nd Dot)** — Adjustable to any position of the time interval represented by 10 div of the delaying sweep selected.

**Delay Accuracy** — Within  $\pm 1\%$  of 10 division when measurement is made within the last 9.5 division.

DELAYED SWEEP

**Range** — 100 ps/div to 100  $\mu$ s/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

**Accuracy** — Within  $\pm 3\%$  excluding first one-half division of displayed sweep.

**Start Delay** — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by 10 divisions of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

**Delay Jitter** —  $< 0.05\%$  of the time represented by 1 division of the delaying sweep selected.

TRIGGERING AND SYNC

**Signal Sources** — Internal from CH 1 vertical input or external through front-panel connector.

**External Triggering** — Nominal 50  $\Omega$  input, ac coupled, 2 V peak-to-peak 50 V dc maximum. Trigger pulse amplitude 10 mV peak-to-peak or more with risetime of 1  $\mu$ s or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV peak-to-peak or more from 150 kHz to 100 MHz.

**Internal Triggering** — Pulse amplitude 50 mV peak-to-peak or more with risetime of 1  $\mu$ s or less. Sinewave amplitude 50 mV peak-to-peak or more from 150 kHz to 100 MHz.

**Triggered Mode** — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and -0.5 V on either a + slope or a - slope of the triggering signal.

**Autotrigger Mode** — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the peak-to-peak voltage of the signal.

**Holdoff** — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

**HF SYNC Mode** — For sinewaves from 100 MHz to 1 GHz, 10 mV peak-to-peak or more from external source, 50 mV peak-to-peak or more from internal pickoff.

**Order 7S14 Dual-Trace Delayed Sweep Sampler ..... \$5,235**



284

70 ps or Less Rise Time

Sinewave and Squarewave Outputs

CHARACTERISTICS

**Pulse Output** — 70 ps or less risetime with a pulse width of more than 1  $\mu$ s and a repetition rate of  $\approx 50$  kHz. Aberrations immediately following positive-going transitions are  $< \pm 3\%$ , 3% total peak-to-peak; after 2 ns  $< \pm 2\%$ , 2% total peak-to-peak. Pulse amplitude is more than +200 mV into 50  $\Omega$ . Source resistance is 50  $\Omega$ .

**Squarewave Output** — Periods of 10  $\mu$ s, 1  $\mu$ s, or 100 ns. Amplitude is 10 mV, 100 mV, or 1 V into 50  $\Omega$ .

**Sinewave Output** — Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50  $\Omega$ .

**Trigger Output** — Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When PULSE OUTPUT is selected, the trigger can be switched to arrive 5 ns  $\pm 5$  ns, or 75 ns  $\pm 5$  ns ahead of the main pulse. Rise time is 3 ns or less; pulse width is 10 ns or greater.

Output	Period	Timing Accuracy	Amplitude Accuracy		
			1 V	100 mV	10 mV
Pulse	20 $\mu$ s	$\pm 10\%$			
	10 $\mu$ s	$\pm 0.5\%$	$\pm 0.5\%$	$\pm 1\%$	$\pm 1.5\%$
	1 $\mu$ s	$\pm 0.05\%*$	$\pm 2\%†$	$\pm 2.5\%†$	$\pm 3\%†$
Sinewave	10 ns				
	1 ns	$\pm 1\%$			$\pm 20\%$

\*crystal controlled † 20 ns after transition

**Order 284 Pulse Generator ..... \$2,000**

ACCESSORY PROBES FOR 50  $\Omega$  SAMPLERS

Passive						
Type	At-tenu-ation	Len-gth*	Load-ing	Rise-time in ns	Band-width	Package Number**
P6056	10X	6.0	500 $\Omega$ 1 pF	$< 0.1$	Dc to 3.5 GHz	010-6056-03
P6057	100X	6.0	5k $\Omega$ 1 pF	$< 0.25$	Dc to 1.4 GHz	010-6057-03

Active — FET***						
Type	At-tenu-ation	Len-gth*	Load-ing	Rise-time in ns	Band-width	Package Number**
P6201	1X	6.0	100 k $\Omega$ 3 pF	$< 0.4$	Dc to 900 MHz	010-6201-01 (includes attenuators)
	10X	6.0	1 M $\Omega$ 1.5 pF	$< 0.4$	Dc to 900 MHz	
	100X	6.0	1 M $\Omega$ 1.5 pF	$< 0.4$	Dc to 900 MHz	
P6202	10X	2M	10 M $\Omega$ 2 pF	$< 0.7$	Dc to 500 MHz	010-6202-03 plus 010-0384-00 to provide 500 MHz 100X
	100X	2M	10 M $\Omega$ 2 pF	$< 0.7$	Dc to 500 MHz	

\*Length in feet except where specified.

\*\*Refer to probe section for additional information.

\*\*\*Requires power source: Most four compartment mainframes provide probe power. For other oscilloscopes, use 1101 Accessory Power Supply.

**S-1**

**Dc to 1 GHz Bandwidth**

**Clean Transient Response**

The S-1 Sampling Head is a low noise, 350 ps risetime unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

**Risetime** — 350 ps or less.

**Bandwidth** — Equivalent to dc to 1 GHz at 3 dB down.

**Transient Response** — Aberrations as observed with the 284 Pulse Generator are +0.5%, -3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; -0.5% or less, total of 1% or less p-p after 5 ns.

**Displayed Noise** — 2 mV or less, unsmoothed; 1 mV, smoothed.

**Signal Range** — Variable dc offset allows signals between +1 V and -1 V limits to be displayed at 2 mV/div. Signals between +2 V and -2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <500 mV p-p.

**Input Characteristics** — Normally 50 Ω. Safe overload in ±5 V. GR874 input connectors.

**Included Accessories** — 5 ns, 50 Ω RG58 A/U Cable (017-0512-00); 10X, 50 Ω GR Attenuator (017-0078-00).

**Order S-1 Sampling Head ..... \$1,160**

**S-2**

**Dc to 4.6 GHz Bandwidth**

**Displayed Noise <6 mV (Unsmoothed)**

The S-2 Sampling Head is a 75 ps risetime unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

**Risetime** — 75 ps or less.

**Bandwidth** — Equivalent to dc to 4.6 GHz at 3 dB down.

**Transient Response** — Aberrations as observed with the 284 Pulse Generator are +5%, -5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, -2% or less total of 4% or less p-p after 2.5 ns.

**Displayed Noise** — 6 mV or less, unsmoothed; 3 mV, smoothed.

**Signal Range** — Variable dc offset allows signals between +1 V and -1 V limits to be displayed at 2 mV/div. Signals between +2 V and -2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be <200 mV p-p.

**Input Characteristics** — Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

**Included Accessories** — 5 ns, 50 Ω RG213/U Cable (017-0502-00); 10X, 50 Ω GR Attenuator (017-0078-00).

**Order S-2 Sampling Head ..... \$1,365**

**OPTIONAL ACCESSORIES**

- P6040/CT-1 Current Probe**  
Order (Std) 015-0041-00 ..... \$143
- P6056 10X Passive Probe**  
Order (Std) 010-6056-03 ..... \$154
- P6057 100X Probe**  
Order (Std) 010-6057-03 ..... \$159
- Coupling Capacitor, GR874-K**  
Order 017-0028-00 ..... \$90
- Power Divider GR874-TPD**  
Order 017-0082-00 ..... \$260
- GR to BNC Adaptor**  
Order 017-0063-00 ..... \$43



**S-3A**

**Compact, 4.5 ft, 100 kΩ, 2.3 pF Probe**

**Dc to 1 GHz Bandwidth**

**Displayed Noise <3 mV (Unsmoothed)**

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

**Risetime** — 350 ps or less.

**Bandwidth (Probe Only)** — Equivalent to dc to 1 GHz at 3 dB down.

**Transient Response (Probe Only)** — Aberrations in the first 2 ns following a step are +8%, -2% or less, total of 10% or less p-p, +1%, -1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

**Displayed Noise (Probe Only)** — 3 mV or less referred to probe tip (includes 90% of dots).

**Signal Range** — Variable dc offset allows signals between +1 V, 1X range, or +2 V and -2 V, 2X range, to be displayed at 2 mV/div. The signal range may be increased 10X or 100X with the probe attenuators.

**Included Accessories** — 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); two test-point jacks (131-0258-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tipground adaptor (013-0085-00); 5/16 in ground lead (175-1017-00); 1/2 in ground lead (175-1018-00); 3 in cable assembly (175-0249-00); end cap (200-0834-00); three ground clips (344-0046-00); two end caps (200-0835-00); probe holder (352-0090-00); carrying case (016-0121-01); 6 in elec lead (175-0849-00) 3 in elec lead (175-0849-00) retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01).

**Order S-3A Sampling Head ..... \$1,780**

**S-4**

**25 ps Sampling Head**

**Dc to 14 GHz Equivalent Bandwidth**

**Displayed Noise <5 mV (Unsmoothed)**

The S-4 Sampling Head is a 25 ps risetime unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

**Risetime** — 25 ps or less.

**Bandwidth** — Equivalent to dc to 14 GHz at 3 dB down.

**Transient Response** — Aberrations in the first 400 ps following a step from an S-52 Pulse Generator Head are -10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, -0%, +10% or less, total of 10% or less, p-p with 284 pulse displayed; after 25 ns, -2%, +2% or less, total of 4% or less p-p.

**Displayed Noise** — 5 mV or less, un-smoothed; 2.5 mV, smoothed (includes 90% of dots).

**Signal Range** — Variable dc offset allows signals between +1 V and -1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

**Input Characteristics** — Nominally 50 Ω. Safe overload ±5 V. SMA (3 mm) input connector.

**Included Accessories** — 2 ns cable with SMA Connectors (015-1005-00); 10X 50 Ω SMA Attenuator (015-1003-00); GR874 to SMA Male Adaptor (015-1007-00); SMA Male-to-Male Adaptor (015-1011-00); 5/16 in wrench (003-0247-00).

**Order S-4 Sampling Head ..... \$2,665**

**S-5**

**1 MΩ, 15 pF Input Impedance**

**Passive Probe**

**Internal Trigger Pickoff**

The S-5 Sampling Head is a low-noise, 1 ns risetime sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 Passive Probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns risetime at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

**Risetime** — S-5 only, 1 ns or less; with 3.5 ft P6010, 1 ns or less.

**Bandwidth** — Equivalent to dc to 350 MHz at 3 dB down at input connector or probe tip.

**Transient Response** — S-5 only (driven with a 50 Ω source terminated in 50 Ω): aberrations +2.5%, -5% or less, total of 7.5% or less p-p within 17 ns after step; +1%, -1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft probe, properly compensated): aberrations +5%, -5% or less total of 10% or less p-p within 25 ns after step; +1%, -1% or less total of 2% or less p-p thereafter.

**Displayed Noise** — S-5 only, 500 μV or less (includes 90% of dots). S5/P6010, 5 mV or less (includes 90% of dots).

**Signal Range** — S-5 only: dc coupled, 1 V p-p from +1 V to -1 V; ac coupled, 1 V p-p. S5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.

**Input Characteristics** — S-5 only, 1 MΩ within 1% paralleled by 15 pF. S-5/P6010, 10 MΩ paralleled by ≈10 pF.

**Attenuator Accuracy** — Probe attenuation is 10X within 3%.

**Included Accessories** — 50 Ω termination (011-0049-01); P6010 Probe package (010-0188-00).

**Order S-5 Sampling Head ..... \$1,250**

**OPTIONAL ACCESSORIES**

- Probe Tip-to-BNC Adaptor**  
Order 013-0084-01 ..... \$8.00
- Probe Tip-to-GR Adaptor**  
Order 017-0076-00 ..... \$42.00
- Probe Tip-to-GR Terminated Adaptor**  
Order 017-0088-00 ..... \$50.00

**SAMPLING HEAD CHARACTERISTICS**

	S-1	S-2	S-3A	S-4	S-5	S-6
<b>Bandwidth</b>	Dc to 1 GHz	Dc to 4.6 GHz	Dc to 1GHz	Dc to 14 GHz	Dc to 350 MHz	Dc to 11.5 GHz
<b>Risetime</b>	≤350 ps	≤75 ps	≤350 ps	≤25 ps	≤1 ns	≤30 ps
<b>Input Impedance</b>	50 Ω	50 Ω	100 kΩ	50 Ω	1 MΩ	50 Ω feed thru
<b>Noise: Smoothed</b>	≤1 mV	≤3 mV	—	≤2.5mV	≤500 μV	—
<b>Unsmoothed</b>	≤2 mV	≤6 mV	≤3 mV at probe tip	≤5 mV	≤5 mV	≤5 mV
<b>Connector</b>	GR	GR	Probe	SMA (3 mm)	BNC	SMA (3 mm)

**TIMING HEAD CHARACTERISTICS**

	S51	S52	S53	S54
<b>Bandwidth</b>	1 to 18 GHz trigger countdown	—	Dc to 1 GHz trigger recognizer	—
<b>Risetime</b>	—	≤25 ps	—	≤1 n
<b>Application</b>	Extremely High Speed Sampling	High Resolution TDR	General Purpose Sampling	Medium Resolution TDR



**S-6**  
**30 ps Rise Time**  
**Displayed Noise <5 mV (Unsmoothed)**  
**Loop-Through Input**

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

**Risetime** — 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

**Bandwidth** — Equivalent to dc to 11.5 GHz at 3 dB down.

**Transient Response** — Pulse aberrations following the steps are +7%, -7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, -2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

**Displayed Noise** — 5 mV or less, measured tangentially.

**Signal Range** — +1 V to -1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

**Input Characteristics** — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Maximum safe overload is ±5 V.

**Included Accessories** — 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) Female-to-Female Adaptor (015-1012-00); combination wrench (003-0247-00); SMA Male-to-GR874 Adaptor (015-1007-00).

**Order S-6 Sampling Head ..... \$2,295**

OPTIONAL ACCESSORIES FOR SAMPLING HEADS WITH SMA (3 mm) CONNECTORS

2X 50 Ω Attenuator Order 015-1001-00 .....	\$120
5X 50 Ω Attenuator Order 015-1002-00 .....	\$120
10X 50 Ω Attenuator Order 015-1003-00 .....	\$120
50 Ω Termination Order 015-1004-00 .....	\$60
2 ns 50 Ω Signal Cable Order 015-1005-00 .....	\$80
5 ns 50 Ω Signal Cable Order 015-1006-00 .....	\$130
Female-to-GR874 Adaptor Order 015-1007-00 .....	\$90
Male-to-GR874 Adaptor Order 015-1008-00 .....	\$90
Male-to-N Female Adaptor Order 015-1009-00 .....	\$50
Male-to-7 mm Adaptor Order 015-1010-00 .....	\$175
Male-to-Male Adaptor Order 015-1011-00 .....	\$20
Female-to-Female Adaptor Order 015-1012-00 .....	\$16
Coupling Capacitor Order 015-1013-00 .....	\$170
50 Ω Power Divider T Order 015-1014-00 .....	\$200
500 ps 50 Ω Semirigid Cable Order 015-1015-00 .....	\$40
SMA T Adaptor Order 015-1016-00 .....	\$30
SMA Male-to-BNC Female Adaptor Order 015-1018-00 .....	\$8.00
1 ns 50 Ω Cable Order 015-1019-00 .....	\$105
SMA Male Short-Circuit Termination Order 015-1020-00 .....	\$17.50
SMA Female Short-Circuit Termination Order 015-1021-00 .....	\$24
SMA Male 50 Ω Termination Order 015-1022-00 .....	\$32

With BNC Connectors

50 Ω Feed-through Termination Order 011-0049-01 .....	\$25
50 Ω Feed-through (5 W) Order 011-0099-00 .....	\$40
50 Ω 2X Attenuator Order 011-0069-02 .....	\$35
50 Ω 2.5X Attenuator Order 011-0076-02 .....	\$35
50 Ω 5X Attenuator Order 011-0060-02 .....	\$35
50 Ω 10X Attenuator Order 011-0059-02 .....	\$35
50 Ω 18 in, Coaxial Cable Order 012-0076-00 .....	\$17
50 Ω 42 in, Coaxial Cable Order 012-0057-01 .....	\$17

**S-51**  
**18 GHz Countdown**  
**10 ps or Less Trigger Jitter**

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

**Input Signal** — Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p maximum.

**Input Characteristics** — 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

**Trigger Output** — Front-panel trigger output is at least 200 mV into 50 Ω, BSM type connector. Internal trigger output is at least 100 mV into 500 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less; kickout occurs between successive samples.

**Order S-51**  
Trigger Countdown Head ..... **\$1,300**

**S-52**  
**25 ps Rise Time**  
**200 mV into 50 Ω**  
**50 Ω Source**  
**Pretrigger Output**

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution Time Domain Reflectometer.

For TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 32 ft in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

**Pulse Output** — Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 800 ns, pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, -7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, -2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

**Pretrigger Output** — Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

**Output Connectors** — Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

**Included Accessory** — 1 ns, 50Ω semirigid coax delay line (015-1023-00).

**Order S-52 Pulse Generator Head ..... \$1,655**

**S-53**  
**Dc-to-1 GHz Operation**  
**10 mV Sensitivity**

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12.

**Input Characteristics** — Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

**Output Characteristics** — Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

**Connectors** — Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

**Included Accessories** — 42 in, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02).

**Order S-53**  
Trigger Recognizer Head ..... **\$1,190**

**S-54**  
**1 ns Rise Time**  
**Low Aberrations**  
**400 mV into 50 Ω**  
**50 Ω Source**  
**Variable Pretrigger Lead Time**

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line Time Domain Reflectometer unit.

Intended for TDR applications, the S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

**Pulse Output** — Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, -1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Base line level is 0 V within 20 mV, terminated in 50 Ω.

**Pretrigger Output** — Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

**Output Connectors** — Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

**Included Accessories** — BNC T connector (103-0030-00); 8 in 50 Ω cable (012-0118-00).

**Order S-54 Pulse Generator Head ..... \$1,075**

	SAMPLING HEAD ≈ WEIGHTS									
	S-1		S-2		S-3A		S-4		S-5	
	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Net	0.5	1.0	0.5	1.0	1.4	3.0	0.5	1.0	0.3	0.6
Shipping	1.4	3.0	1.4	3.0	2.3	5.0	0.9	2.0	0.9	2.0
	S-6		S-52		S-53		S-54		S-51	
	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Net	0.5	1.0	0.3	0.8	0.3	0.8	0.3	0.8	0.5	1.0
Shipping	0.9	2.0	0.5	1.0	0.5	1.0	0.5	1.0	2.3	5.0

**7CT1N**



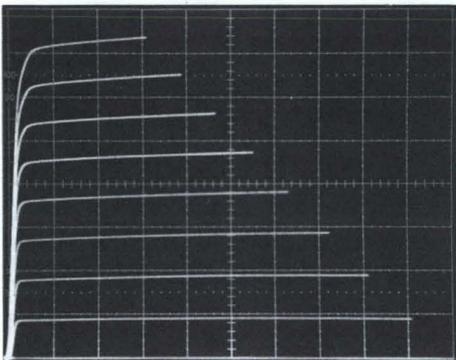
**Curve Tracer**

**7CT1N**

**10 nA/div to 20 mA/div  
Vertical Deflection Factors**

**0.5 V/div to 20 V/div  
Horizontal Deflection Factors**

The 7CT1N Curve Tracer Plug-in displays characteristic curves of small-signal semiconductor devices to power levels up to 0.5 W. The 7CT1N operates in horizontal or vertical compartments of 7000 Series Oscilloscopes.



2N3904 transistor characteristic generated by the 7CT1N. Control settings are indicated on front panel of 7CT1N.  
Vertical — 2 mA/div  
Horizontal — 0.5 V/div  
Base Current — 10  $\mu$ A/step

**CHARACTERISTICS**

**COLLECTOR/DRAIN SUPPLY**

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 to 7.5 V	0 to 30 V	0 to 75 V	0 to 300 V
Max Current	240 mA	60 mA	24 mA	6 mA

**Maximum Open Circuit Voltage** — Within  $\pm 20\%$ . Maximum short-circuit current, within 30%.

**Series Resistance** — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less, depending upon control settings.

**High Voltage Warning** — When the horizontal V/div switch is in the X10 position, a flashing warning light, indicating that dangerous voltages may exist at the test terminals, appears on the front panel.

**STEP GENERATOR**

**Transistor Mode** — Step amplitude range is 1  $\mu$ A/step to 1 mA/step, 1-2-5 sequence. Maximum current (steps plus aiding offset) is 15X amplitude setting. Maximum voltage (steps plus aiding offset) is at least 13 V. Maximum opposing offset current is at least 5X amplitude setting.

**FET Mode** — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is 15X amplitude setting, 13 V maximum. Source impedance is 1 k $\Omega$   $\pm$  1%.

**Accuracy** — Incremental: within 3% between steps. Absolute: within  $\pm(3\% + 0.3X$  amplitude setting).

**Step Polarity** — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

**Number of Steps** — Selectable in 1 step increments between 0 and 10.

**Offset** — Selectable to 5 steps. Polarity aids or opposes the step polarity.

**Vertical Deflection Factors** — 10 nA/div to 20  $\mu$ A/div with the  $\pm 1000$  control activated. 10  $\mu$ A/div to 20 mA/div in the 1X mode.

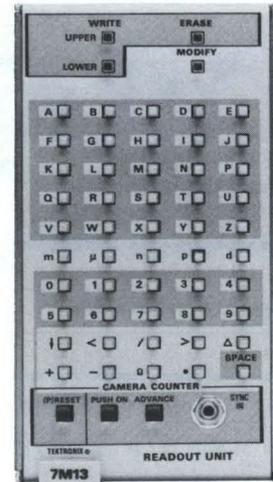
**Vertical Display Accuracy** — Within 5% in the 1X mode. Within 5%  $\pm 0.2$  nA per displayed horizontal volt in the  $\pm 1000$  mode.

**Horizontal Deflection Factors** — Selectable: 0.5 V, 2 V, 5 V, or 20 V.

**Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in is a vertical or horizontal amplifier with a 100 mV/div deflection factor and an input R of at least 50 k $\Omega$  when it is used in the horizontal compartment.

**Order 7CT1N Curve Tracer ..... \$1,385**

**7M13**



**Readout Unit**

**7M13**

**Easy and Convenient Identification of Photographed Displays**

**Automatic Sequence Advance with Each Camera Exposure**

The 7M13 Readout Unit provides front-panel keyboard operation for convenient access to the CRT readout characters. Up to ten alphanumeric characters can be displayed at the top and/or at the bottom of the CRT. The 7M13 is designed for use in all 7000 Series mainframes with CRT readout. A remote-advance cable is supplied with the 7M13 to connect it to the shutter X-sync connector of the C-50 Series Cameras. An optional cable is available for cameras using an ASA connector for X-sync.

**INCLUDED ACCESSORIES**

Remote-advance cable (012-0339-01).

**Order 7M13 Readout Unit ..... \$950**

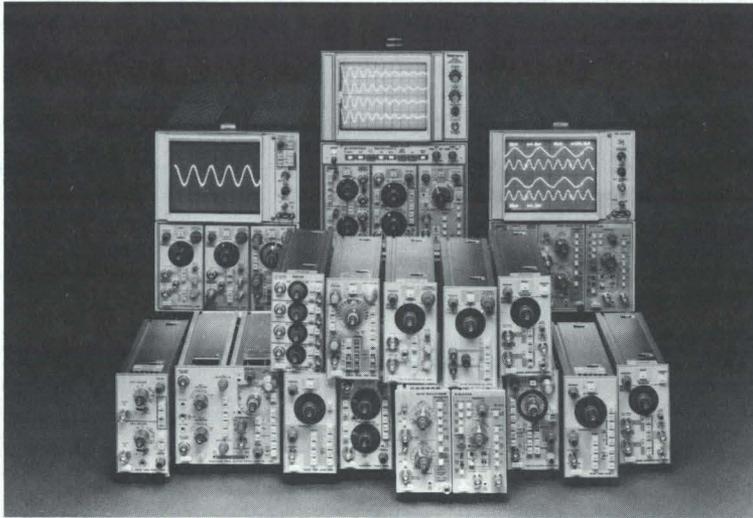


The photograph above was identified as TEST 14 by using the 7M13 in 7834 Oscilloscope.

**Optional Accessory** — Remote-advance cable with ASA connector for camera X-sync.

Order 012-0364-01 ..... \$21

# 5000 SERIES INSTRUMENTS



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### Digital Storage Capability

The 5223 Digitizing Oscilloscope provides digital storage at the touch of a button, intensified pretrigger viewing, equivalent time sampling, and X-Y displays. This 5000 Series scope, with optional IEEE Standard 488 interface, is ideal for physical, mechanical and biomedical applications.

### Performance Value

Designed for the cost-conscious user as an alternative to the monolithic scope the 5400 Series gives you 50 MHz bandwidth in both nonstore and variable persistence storage mainframes with CRT readout.

### Maximum Flexibility

The 5100 Series is ideal for low frequency applications such as medical and mechanical measurements requiring up to 2 MHz bandwidth. It gives you unparalleled choices in measurement flexibility such as dual-beam, split-screen, bistable storage displays, differential inputs and spectrum analysis.

### Expandability

With the 5000 Series plug-in oscilloscope, you are making a cost-effective investment in current technology—and ensuring yourself a share in the future.

#### MAINFRAMES

Mainframe/ Display Unit	Page	Beams	Storage	Display Size
5110	301	Single		8 x 10 div (1.27 cm/div)
5111A	300	Single	Bistable	8 x 10 div (1.27 cm/div)
5113	301	Dual	Bistable	8 x 10 div (1.27 cm/div)
5223	294	Single	Digital	8 x 10 div (1.22 cm/div)
5440	296	Single		8 x 10 div (1.22 cm/div)
5441	297	Single	Variable Persistence	8 x 10 div (0.9 cm/div)

#### AMPLIFIERS

Product	Page	Type	Minimum Deflection Factor	Band- width —3 dB	CMRR
5A13N	305	Single	1 mV/div	2 MHz	10,000:1
5A14N	304	Four	1 mV/div	1 MHz	
5A15N	304	Single	1 mV/div	2 MHz	
5A18N	304	Dual	1 mV/div	2 MHz	
5A19N	305	Single	1 mV/div	2 MHz	1000:1
5A21N	305	Single (voltage and current)	50 $\mu$ V/div 0.5 mA/div	1 MHz	100,000:1
5A22N	306	Single	10 $\mu$ V	1 MHz	100,000:1
5A26	306	Dual	50 $\mu$ V/div	1 MHz	100,000:1
5A38	298	Dual	10 mV/div	35 MHz	
5A48	298	Dual	1 mV/div*	50 MHz	

\*Bandwidth is dc to 25 MHz at 1 mV/div and 2 mV/div.

#### TIME-BASE PLUG-INS

Product	Page	Type	Sweep Range	Mag	Single Sweep	Volts/ Div Ext Mode
5B10N	307		1 $\mu$ s to 5 s	X10	Yes	50 mV and 500 mV
5B12N	307	Dual Delaying	A 1 $\mu$ s to 5 s B 2 $\mu$ s to 0.5 s	X10	Yes	50 mV and 500 mV
5B40	298		0.1 $\mu$ s to 5 s	X10	Yes	50 mV
5B42	299	Delaying	A 0.1 $\mu$ s to 5 s B 0.1 $\mu$ s to 0.5 s	X10	Yes	50 mV
5B25N	299	Digitizer	0.2 $\mu$ s to 5 s	X10	Yes	50 mV

#### SPECIAL-PURPOSE PLUG-INS

Product	Page	Description
5CT1N	308	Semiconductor Curve Tracer
5L4N	308	Low-Cost Spectrum Analyzer
5S14N	308	Dual-Trace Delayed Sweep Sampler
5D10	302	Waveform Digitizer

**Low Cost**

**2 MHz, 10 MHz or 50 MHz Bandwidth**

**Sampling to 1 GHz**

**0 to 100 kHz Spectrum Analysis**

**6 Oscilloscope Models**

**21 Plug-ins Available**

**Digital, Dual-Beam and Storage Displays**

**CRT Readout (5400 Series only)**

**Large 6.5 inch CRT (8 x 10 div)**

**10  $\mu$ V/div High Gain Differential Amplifier**

**1 to 8 Trace Capability**

**Delayed-Sweep Time Bases**

**Y-T or X-Y Operation**

**Bench-to-Rack Convertibility**

The 5000 Series oscilloscopes are designed to provide optimum versatility and performance at the lowest possible price.

**5100 SERIES OSCILLOSCOPES**

Three 5100 Series oscilloscopes are available. They include single-beam, dual-beam, and storage displays. The storage display units feature bistable, split-screen storage with large 6.5 inch CRTs. The dual beam units, have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drives both beams.

The 5100 Series also features 2 MHz mainframes with large 6.5 inch single-beam CRTs that accommodate two vertical deflection plug-ins and one horizontal deflection plug-in. They can be easily converted from bench to rackmount configuration.

To date, 15 plug-ins are available for use with the 5100 Series. Among these are the low-cost 5L4N Spectrum Analyzer for the 0 to 100 kHz frequency range the 5S14N, a general purpose 1 GHz dual-trace sampling plug-in and the 5D10 Waveform Digitizer.

**5223 DIGITIZING OSCILLOSCOPE**

You can get the benefits of digital storage, along with the time-tested advantages of a conventional analog scope, in the 10 MHz 5223 Digitizing Oscilloscope. Combined in one powerful, convenient oscilloscope are pushbutton ease, high quality waveform display, pretrigger signal manipulation, and optional GPIB interface, plus real-time analog display capability.

Use the 5223 in the digital storage mode to capture repetitive events at speeds of up to 10 MHz or single-shot events at speeds of up to 100 kHz. The 5223's maximum sample rate is 1 MHz; storage capacity is 1024 bits per vertical compartment.

The digitized display will never fade or bloom, so you get more accurate measurements, more conveniently. High 10-bit vertical resolution gives you an accurate representation of your signals.

**5400 SERIES OSCILLOSCOPES**

Two 5400 Series display units are presently available: a single-beam, nonstorage display and a variable persistence storage display. Both feature CRT readout of plug-in scale factors, three plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series offers 50 MHz bandwidth and is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the CRT (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The CRT readout can also be externally accessed.

**PLUG-IN VERSATILITY**

Twenty-one plug-ins are now available in the 5000 Series family. All these plug-ins are compatible with the 5400 Series, and all but six are compatible with 5100 Series mainframes.

The amplifier plug-ins include single, dual, and four trace units, various differential amplifiers (including one with a current probe input), and a differential comparator amplifier. The time-base plug-ins include single, dual, delayed sweep units, and a digital time base.

Four special-purpose plug-ins are also available. The 5L4N is a spectrum analyzer for the 0 to 100 kHz frequency range. It has 10 Hz bandwidth resolution. The 5CT1N is a semiconductor curvetracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the CRT. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of the 5100, the 5400 Series, and the 5223 to 1 GHz at 2 mV sensitivity.

The 5D10 is a dual channel waveform digitizer with cursors, CRT scale factor readout, roll mode and plotter output.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and the recommended 1X and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the CRT when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.

- CARTS**  
**SCOPE-MOBILE® Carts** — For cabinet models, order TEK Lab Cart, Model 3.
- CAMERAS**  
**All 5100 Series** — C-5C, suitable for repetitive or stored traces.  
**5100 Storage Instruments, 5440 (with P back), 5441 (with G back)** — C-59, general purpose.  
 For full details see camera section.
- ACCESSORIES**  
**Blank Plug-in Kit** Order 040-0818-03 ..... \$105  
**Blank Panel** Order 016-0195-02 ..... \$18  
**Viewing Hoods** Order 016-0154-00 ..... \$28  
 or Order 016-0452-00 folding ..... \$18  
**Protective Cover** Order 016-0544-00 ..... \$25  
 For full details see accessories section.

**5000 SERIES INSTRUMENTS—PHYSICAL CHARACTERISTICS**

	5223				5100 and 5400 Series				Plug-ins			
	Cabinet		Rackmount		Cabinet		Rackmount		Single Width		Double Width	
Dimensions	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
Width	214	8.4	483	9.0	213	8.4	483	19.0	66	2.6	132	5.2
Height	328	12.9	178	7.0	302	11.9	133	5.25	127	5.0	127	5.0
Depth	572	22.5	569	22.4	518	20.4	483	19.0	305	12.0	305	12.0
Weight $\approx$	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Net	16.9	37.3	19.1	42.0	10.4	23.0	10.9	24.0	1.3	2.8	2.6	5.8
Shipping	20.5	45.0	23.6	52.0	10.5	32.0	19.5	43.0	4.5	10.0	4.9	10.8

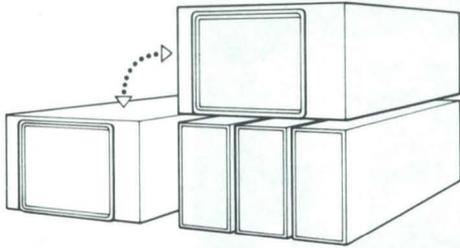
**RECOMMENDED PROBES FOR 5000 SERIES AMPLIFIER PLUG-INS**

The following probes are recommended for general use with the listed amplifier plug-ins. These probes automatically program the knob-skid readout and the CRT readout (available only in the 5400 Series) to indicate correct deflection factor. Probe packages include various tips, ground leads and accessories.

Probes are also available in different lengths, attenuation ratios, input loading and bandwidths. Special purpose probes, such as high voltage, FET and current probes are available for use with 5000 Series Amplifier Plug-ins. See Probe section for complete information.

Amplifier Plug-ins	Voltage Probe	Attenuation	Standard Length	Features	Package Number
5A14N 5A15N 5A18N	P6060	10X	6 ft	Full bw, low cost (not compatible with CRT readout).	010-6060-03
	P6062B	1X/10X	6 ft	Full bw, switchable attenuation, ground reference button.	010-6062-13
5A13N 5A21N* 5A22N 5A26	P6062B	1X/10X	6 ft	Full bw, switchable attenuation, ground reference button.	010-6062-13
	P6101	1X	2 m	Full bw, miniature. Modular construction simplifies repair.	010-6101-03
	P6055	Adjustable to 10X	3.5 ft	Adjustable attenuation. Will give up to 20,000; 1 CMRR when used in pairs. (5A21N, 5A22N and 5A26).	010-6055-01
5A38 5A48	P6105	10X	2 m	Full bw, miniature. Modular construction simplifies repair.	010-6105-03
	P6062B	1X/10X	6 ft	Switchable attenuation (full bandwidth in the 10X position) ground reference button.	010-6062-13
	P6101	1X	2 m	Miniature, modular (reduced bandwidth).	010-6101-03

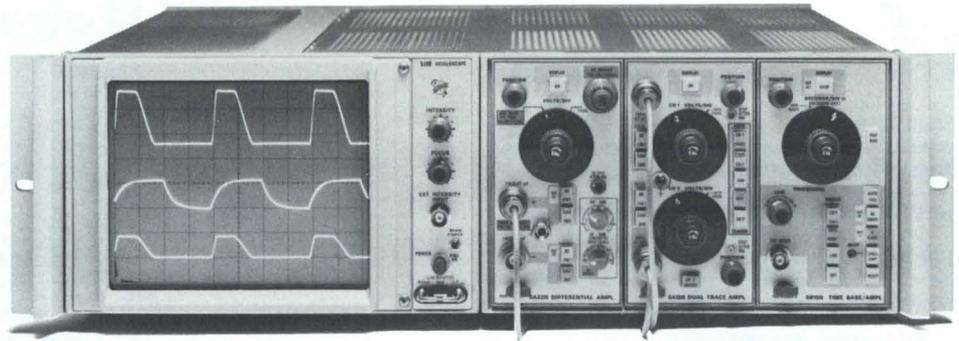
\*The 5A21N also provides direct access to current probe P6021. Order 5A21N, Option 01 for 5A21N Amplifier and Current Probe package. See pages 305-306 for complete information.



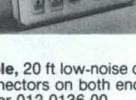
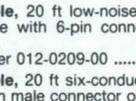
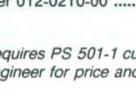
All 5000 Series Rackmount Oscilloscopes and cabinet-to-rackmount kits include complete slide out tracks and mounting hardware to interface with standard 19 inch racks.

**CONVERSION KITS**

- Cabinet-to-Rackmount Order 040-0583-03 ..... \$95
- Rackmount-to-Cabinet Order 040-0584-03 ..... \$150



**MECHANICAL MEASUREMENT TRANSDUCERS**

TRANSDUCER PACKAGE	DESCRIPTION	PERFORMANCE	RECOMMENDED ACCESSORIES
	<b>PRESSURE</b> 015-0161-00* RANGE: 3000 psig TYPE: Bonded Strain Gage 4 arm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitation: ≈10 Vdc Scale Factor: 3 mV/V f.s. f <sub>s</sub> ≈65 kHz	012-0209-00 20 ft multi-conductor cable
	<b>PRESSURE</b> 015-0162-00* RANGE: 300 psig TYPE: Bonded Strain Gage 4 arm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitation: ≈10 Vdc Scale Factor: 3 mV/V f.s. f <sub>s</sub> ≈24 kHz	012-0209-00 20 ft multi-conductor cable
	<b>PRESSURE (EAS)</b> 015-0117-00 RANGE: 3000 psig (dynamic only) TYPE: Piezoelectric	Accuracy: <5% Sensitivity: 200 pc/psi Max Overpressure: 300% Temp: -40°C to +150°C max	015-0118-00 cooling adapter
	<b>ACCELERATION</b> 015-0165-00 RANGE: 0.001 to 1000 g's TYPE: Piezoelectric compression High capacitance (≈ 10,000 pF) NBS traceability	Accuracy: 5% Linearity: 2% Sensitivity: ≈12 mV/g f <sub>s</sub> ≈30 kHz	012-0211-00 microdot to BNC 20 ft cable
	<b>VIBRATION (EAS)</b> 015-0116-00 RANGE: 0.01 to 100 g's (100 to 10,000 RPM) TYPE: Piezoelectric magnetically mounted	Sensitivity: 6 mV/g (o.c.) Ct ≈3500 pF Temp: -40°C to +150°C f <sub>s</sub> ≈11 kHz	012-0137-00 BNC-BNC cable 50 ft
	<b>VERTICAL VIBRATION</b> 015-0168-00 TYPE: Selsmic (geophone) Self generating SIGNALS: Velocity Displacement (integrated velocity) <b>HORIZONTAL VIBRATION</b> 015-0167-00 RANGE: 0.050 inch peak to peak	Accuracy: <5% Scale Factor: ≈ 600 mV/in/s Velocity ≈ 10 mV/0.002 in Freq Range: 10 Hz to 2 kHz f <sub>s</sub> ≈ 8 Hz Temp: -40°C to +71°C	012-0136-00 BNC-BNC cable 20 ft long
	<b>FORCE (Displacement)</b> 015-0164-00* RANGE: 50 grams 50 lbs (with load cell) 0.120 mm Unbonded 350 Ω Strain Gage 4 arm bridge	Accuracy: 0.5% Excitation: ≈5 Vdc Full Scale Output: 60 to 80 mV Temp: -50°C to +85°C	Included with unit is 50 lb (22-5 kg) load cell connected power cable attachment bracket and tools
	<b>DISPLACEMENT</b> 015-0168-00 RANGE: ±4.0 mm (Calibrated and usable to ±0.2 inch) TYPE: Dc to dc LVDT	Accuracy: 2% linearity <1% Excitation: 3 to 11 Vdc Scale Factor: 1 V/mm at 8.5 Vdc 20 mV/0.001 inch at 7.5 Vdc Temp: -54°C to +60°C	012-0209-00 20 ft cable
	<b>STRAIN</b> 015-0171-00 RANGE: 30,000 μ Strain TYPE: Foil Strain Gages 0.125 inch long. Attached leads. Package of five	Resistance: 120 Ω Gage Factor (Nominal) 2.1 Accuracy: 1% Excitation: (bridge), 5 V max	Strain Gage Adaptor, 015-0169-00 Cement Kit 015-0172-00
	<b>STRAIN GAGE ADAPTOR</b> 015-0169-00* Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type PS 501-1 Mod 730E Transducer Power Supply. Has variable shunt resistor for gage factor calibration. The adaptor has four binding post terminals and a six-foot cable with 6-pin connector.	Accuracy: Governed by initial calibration and strain gages used. Strain Gage Resistance Range: 30 Ω to 5000 Ω for 4 arm bridges. 120 Ω for 1, 2 or 4 arm bridges. Bridge Volts: Typically 5 V for 120 Ω gages. Gage Factor Correction Range: 1.7 to 2.3	Strain Gage Package, 015-0171-00 Cement Kit, 015-0172-00
	<b>CEMENT KIT</b> 015-0172-00 Provides means for mounting and connecting foil strain gages. Includes Room Temperature Curing Epoxy cement, RTV Clear Silicon Rubber coating, Neoprene pads and metal plates, cementable Wiring terminals, and clear Mylar film.		Strain Gage Package, 015-0171-00

**Cable**, 20 ft low-noise cable with BNC connectors on both ends.  
Order 012-0136-00 ..... \$70

**Cable**, 20 ft low-noise six-conductor cable with 6-pin connector on each end.  
Order 012-0209-00 ..... \$315

**Cable**, 20 ft six-conductor cable with 6-pin male connector on one end.  
Order 012-0210-00 ..... \$115

**Cable**, 20 ft low-noise coaxial cable with miniature coaxial connector on one end and BNC connector on the other.  
Order 012-0211-00 ..... \$40

**Connector**, Mates Type PS501-1 Transducer Power Supply INPUT 6-pin connector.  
Order 131-0618-00 ..... \$35

**TRANSDUCER PACKAGE PRICE LIST**

015-0161-00 .... \$785	015-0167-00 ..... \$500
015-0162-00 .... \$660	015-0164-00 ..... \$870
015-0117-00 ... \$1,625	015-0168-00 ..... \$615
015-0165-00 .... \$450	015-0171-00 ..... \$40
015-0116-00 ... \$1,000	015-0169-00 ..... \$425
015-0166-00 .... \$250	015-0172-00 ..... \$110

**APPLICATION NOTES**

Following is a list of currently available Application Notes for 5000 Series oscilloscopes.

Title	Featuring	Request Number
<b>STRUCTURAL TESTING</b>		
The Digitizing Approach		AX-4461
	5223/5B25N/5A18N Single-shot techniques. Multitrace using transducers.	
<b>BIOPHYSICAL DATA RETRIEVAL</b>		
The Digitizing Approach		AX-4462
	5223/5B25N/5A18N Roll mode, chart recorder output.	
<b>RECORDING ELECTRO-PHYSIOLOGICAL NERVE ACTIVITY</b>		
Using a plug-in oscilloscope		AX-3746
	5113/5A26/5A22N Low level measurements and storage.	
<b>INTERPRETING MECHANICAL MEASUREMENTS WITH THE PLUG-IN OSCILLOSCOPE</b>		
		AX-3533-1
	5111/5A22N/5A18N Transducer measurements and storage.	
<b>SIMULTANEOUS DISPLAY OF TWO INDEPENDENT X-Y SIGNAL PAIRS</b>		
		AX-4114
	5111/5A15/5A15N/5A18N. Dual X-Y techniques, engine analysis.	
<b>SIMULTANEOUS X-Y, Y-T DISPLAYS</b>		
		AX-4113
	5111/5A15N/5A15N/5B12N. X-Y, Y-T techniques. Bio-medical application.	
<b>CUSTOM PLUG-IN IDEAS FOR 5000 SERIES SCOPES</b>		
		AX-3758
	Recommended starter note for customers considering custom plug-in project.	
<b>A HIGH RESOLUTION 60 Hz NOTCH FILTER</b>		
		AX-4031
	Construction project using a commercial module in our plug-in kit. Preconditions signals by removing 60 Hz hum.	
<b>A TRUE RMS CONVERTER</b>		
		AX-4112
	Construction project using thermal true RMS converter module in our blank plug-in kit. Measures true RMS up to 200 V RMS.	

\* Requires PS 501-1 custom modified Transducer Power Supply mounted in a TM 500 Series mainframe. Consult a Tektronix Sales Engineer for price and installation information on power supply and adaptor.

## 5223

**GPIB**   
IEEE-488

The 5223 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Digital Storage (with 5B25N)**

**10 MHz Bandwidth Repetitive Store**

**100 kHz Bandwidth Single Shot Store**

**Pretrigger**

**10 Bit Vertical Resolution**

**Stored X versus Y Display**

**Roll Mode**

**X-Y Plotter Output with Penlift**

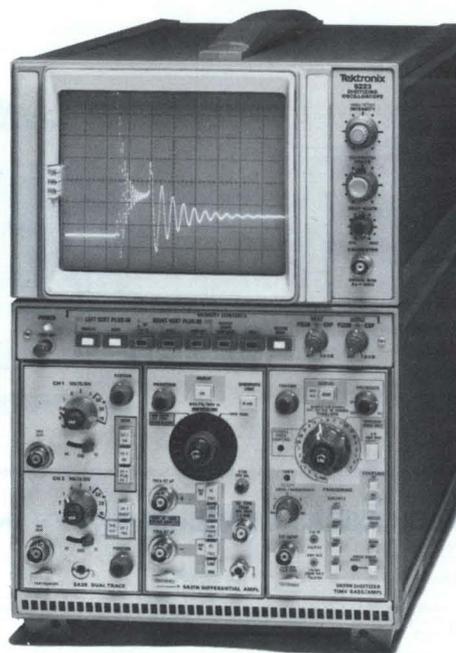
### APPLICATIONS

**Mechanical Transducers**

**Biophysical**

**GPIB**

The Tektronix 5223 Digitizing Oscilloscope is a digital storage instrument with a real-time bandwidth of 10 MHz. The 5223 is capable of displaying real-time and stored waveforms simultaneously (four real-time waveforms and four stored waveforms, if dual channel amplifier units are used); the real-time waveforms need not be related to the stored waveforms. Stored waveforms can be expanded vertically and horizontally up to a factor of 10, using front-panel controls. The left and right stored vertical signals can be displayed against each other in the X-Y mode, using the L vs R front-panel display function. The roll mode is useful when viewing low-frequency signals. Rear-panel connectors provide access to the internal analog and control signals to record stored waveforms using associated equipment (e.g., X-Y plotter). The 5223 accepts most 5000 Series Plug-in units; the flexibility of the plug-in feature, and variety of plug-in units available, allows the system to be used for many measurement applications.



*The digital storage functions can only be accessed or enabled by using the 5B25N Time Base*

### Display and Save Functions

The Display buttons allow the 5223 to digitize the signals originating from the corresponding vertical compartments (left and right). The digitized display is continuously updated as long as a triggered sweep occurs, or until the Save button is pushed. The Save buttons freeze the memory contents. Up to four channels may be displayed and saved simultaneously.

### L vs R Display

This function will display the memory contents of the left compartment versus the right compartment. The left defines the vertical axis and the right compartment defines the horizontal axis. Since the X-Y display is from memory, the real-time sweep is still in the standard Y-time format and may be displayed simultaneously.

### Roll Mode Display

For continuous data stream monitoring of biomedical or low frequency events, Roll Mode digitizes the signal and displays the latest

acquired point at the right of the CRT while the previous data moves from right to left. The display appears much like a strip chart recorder. ROM mode is available on the sweep range of 5 s/div to 0.1 s/div.

### Vector Display

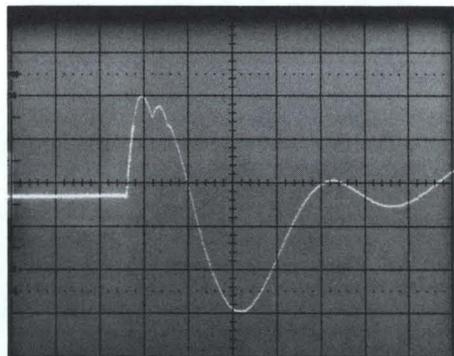
When Vector Display is selected, a continuous trace connects the discrete data points into a clear and comprehensive display. This eliminates perception problems of scattered data and reduces interpretation errors.

### Output Saved Displays

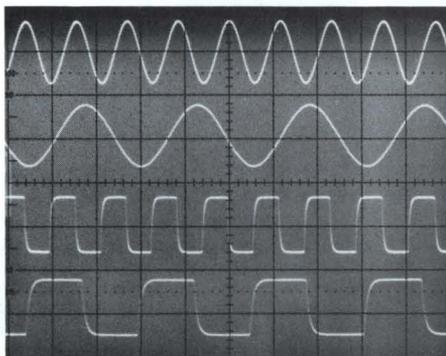
When pressed, an analog output of the displayed/ saved waveforms is activated for driving conventional X-Y analog plotters. Pen lift is also provided and is activated before and after each waveform is output. Up to four waveforms may be output.

### Display Out Speed Control (rear panel)

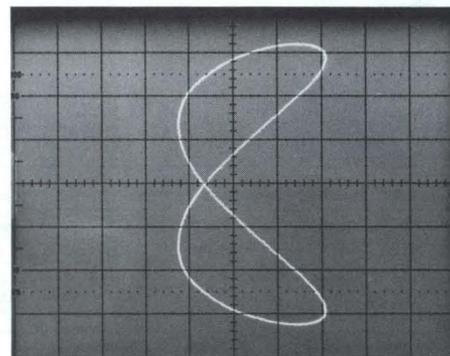
The Display Out Speed control adjusts the X-Y plotter output speed to compensate for differences in plotter speeds and response.



*Single-shot data can be captured and stored automatically without the operator's presence. Pretrigger signal portion has an intensified trace for easy reference.*



*Up to four channels may be stored at a time either Single Shot or Repetitive.*



*By pressing the L vs R button, the memory contents of one vertical compartment are displayed against that of the other.*

**CHARACTERISTICS**

**VERTICAL REAL TIME SYSTEM**

**Channels** — Two plug-in compartments; compatible with 5000 Series plug-ins.

**Mainframe Bandwidth** — 10 MHz with 5A38, 5A45 or 5A48.

**Mainframe Step Response** — 35 ns.

**Chop Mode** — 100 chopped segments/division unexpanded with 5B25N Time Base.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**HORIZONTAL REAL TIME SYSTEM**

**Channel** — Single compartment compatible with 5000 Series time bases and amplifiers. 5B25N must be used in storage modes.

**Fastest Calibrated Sweep Rate** — 20 ns/div.

**X-Y Mode** — <2° phase shift, dc to 20 kHz between either vertical compartment and horizontal compartment.

**DIGITAL STORAGE (with 5B25N)**

**Vertical Resolution** — 10 bits (100 pts/div unexpanded).

**Display Memory Size** — 1k points per vertical compartment, shared by multiple trace plug-ins.

**Sample Rate** — Maximum of 1  $\mu$ s/pt (1 MS/s). Actual sample rate depends on time base setting.

**Fastest Single Shot Sweep Speed** — 100  $\mu$ s/div.

**External Clock In** — Maximum of 1 MS/s (1  $\mu$ s/pt). TTL compatible.

**Equivalent Time Bandwidth** — 10 MHz.

**Acquisition Window** —  $\pm 4$  divisions vertically and  $\pm 5$  divisions horizontally from center screen.

**Accuracy** — Determined by plug-ins. Refer to plug-in specifications.

**X-Y** — (Left vs right single channel mode only excluding 100  $\mu$ s/division sweep range). Maximum of 5° phase shift between vertical compartments up to 10 MHz using two identical 5400 Series vertical plug-ins.

**MEMORY CONTROLS**

**Display and Save** — Controls for each vertical compartment. X-Y (left vs right), Data Out, Roll, Vector Mode, Horizontal and Vertical positioning, and expansion ( $\geq 10:1$ ).

**Data Out** — Analog voltage of stored signal. 200 mV/div  $\pm 5\%$ . Output rate variable with rear panel control. Pen lift available on rear panel (normally open).

**OUTPUT/INPUTS**

**Plug-in Signal Outputs**

**Left Vertical, Right Vertical, Horizontal Compartments** — 50 mV/division  $\pm 5\%$  from 50  $\Omega$ .

**Left, Right Vertical Compartments** — Dc  $\geq 10$  MHz; horizontal compartment - dc  $\geq 7$  MHz.

**Time Base Gate** — TTL compatible, positive going.

**Remote Single Sweep Reset** — Rear panel BNC closure to ground resets sweep.

**External Z-Axis Input** — Usable, dc  $\geq 5$  MHz voltage swing of 5 V will fully modulate beam dc  $\geq 1$  MHz. Negative voltage will blank trace. Maximum input voltage is 40 V (dc + peak ac).

**Calibrator:**

**Voltage Output** — Squarewave, positive going from ground. Amplitude is 300 mV  $\pm 1\%$ .

**Current Output** — 3 mA  $\pm 1\%$  available through calibrator output with optional BNC to current loop adaptor.

**CRT AND DISPLAY FEATURES**

**CRT** — 8 x 10 divisions with 1.22 cm/div. Internal illuminated graticule.

**Phosphor** — P31.

**Acceleration Potential** — 15 kV.

**Camera Power** — Compatible with Tektronix C-59 Camera.

**POWER REQUIREMENTS**

**Line Voltage Range** — 90 to 117 V, 102 to 132 V, 191 to 249 V, 204 to 250 V maximum.

**Line Frequency** — 48 to 62 Hz (48-440 Hz, Option 05).

**Maximum Power Consumption** — 145 W at 120 V, 60 Hz.

**OPTIONS**

**Option 05 Line Frequency Change (48-440 Hz)** — Converts the R5223 to 48 to 440 Hz operation.

**Option 10 GPIB Interface** — For I/O of stored waveforms and control of 5223 digital storage functions (except vertical and horizontal expansion and position controls). Waveform output format is selectable through the interface for either BINARY or ASCII.

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 26 for additional information.

**I/O Records** — Waveforms.

**Device Address** — Selectable via rear panel switch.

**Talk/Listen** — Full bi-direction transfer of waveforms plus remote manipulation of storage controls.

**Talk Only** — Continuous output of digitized waveform to maximum sweep of 20 ms/div (dependent on other instruments on bus).

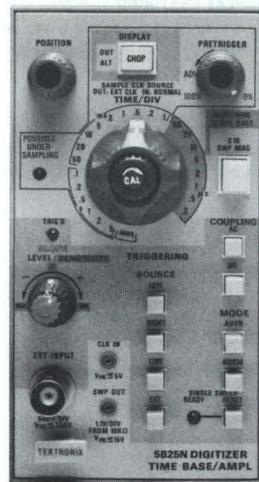
**Implemented Interface Functions**

SH1	Complete Source Handshake
AH1	Complete Acceptor Handshake
T5	Talker Function
L4	Listener Function
SR1	Complete Service Request Capability
RL2	Remote/Local Capability
DC1	Complete Device Clear Capability

**PLUG-IN COMPATIBILITY**

All 5000 Series plug-ins are compatible in the standard oscilloscope display mode. The 5L4N, 5A18N, 5A26, 5A48 plug-ins may require modification for optimum use with digital storage operation. The 5A14N is not recommended for use in storage mode.

**5B25N**



**5B25N Digital Time Base**

The 5B25N is required with the 5223 to enable the digital functions and waveform acquisition. The 5B25N combines the performance of a standard 5B40 Time Base for real time displays and a crystal controlled clock to drive the digitizer. Additional features of the 5B25N aid in the triggering and acquisition signals to be stored.

**Pretrigger**

To view events that occur prior to the trigger, a Pretrigger control is continuously variable from 0 to 100% of full screen. An intensified zone is generated that corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s/div to 0.1 ms/div.

**Possible Undersampling Indicator**

To aid in eliminating aliasing, an LED indicator illuminates when the ratio of sampling frequency to trigger frequency is less than eight.

**Bi-Slope Triggering**

Besides the standard positive and negative slope and level control, the 5B25N has Bi-Slope triggering. When selected, Bi-Slope will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope to select, for example, in collision and destructive testing where a wrong guess could be costly.

**Sampling Rate**

For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div.

**Repetitive Store**

For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50  $\mu$ s/div to 0.2  $\mu$ s/div.

**External Clock Input**

Clock-in pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

**DIGITIZER-RELATED FUNCTIONS (5223 MAINFRAME ONLY)**

Overall Speed Accuracy Of Digitized Signal— (Center 8 Div). Excluded portions first 200 ns or 0.2 div of each waveform	Digitized Waveform	Digitized Waveform Relative To Realtime	
		CAL	UNCAL
2 and 5 s/div	3%	4%	6%
1 s to 0.1 ms/div	3%	3%	5%
50 $\mu$ s to 0.2 $\mu$ s/div	3%	3%	3%

See page 299 for details.

**ORDERING INFORMATION**

5223 Digitizing Oscilloscope .....	\$4,930
R5223 Rackmount .....	\$5,080
Option 05 — Line Freq Change (R5223 only) .....	+\$200
Option 10 — GPIB Interface .....	+\$750
5B25N Time Base .....	\$795
4932 GPIB Extender .....	\$1,195

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

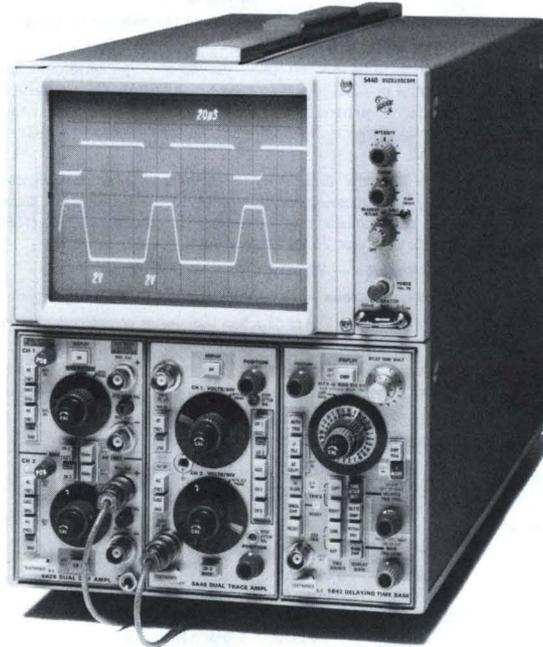
Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC

**5440/R5440**

- Low Cost
- Dc to 50 MHz
- Sampling to 1 GHz
- CRT Readout
- 3 Plug-in Flexibility
- Choice of 20 Plug-ins
- Bench to Rack Convertibility

**APPLICATIONS**

- Electrical Engineering
- Component Testing
- Ultrasonics



The 5440 combines versatility and low cost in a 50 MHz general-purpose, plug-in oscilloscope. It features CRT readout of plug-in scale factors, a three plug-in mainframe, a choice of 20 plug-ins\* and bench to rack convertibility.

CRT readout displays plug-in scale factors on the CRT, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. It can also be accessed externally. This unique ability can be used to read out dates, picture numbers, digital clock times, etc (with Option 03 User Addressable CRT Readout).

All the plug-ins in the 5000 Series are compatible with the 5440.\*\*

The wide variety of plug-ins available lets you configure your oscilloscope to meet your needs today as well as tomorrow: from a single-trace, single time-base configuration for production monitoring, to 4-trace, delayed sweep for logic work, to 4-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

If you're looking for a general-purpose oscilloscope, the 5440 gives you the most versatility and performance at the lowest price.

\*Plug-ins with a suffix N (5B12N, etc.) do not provide CRT readout.

\*\*The 5B10N and 5B12N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.

**CHARACTERISTICS**

**VERTICAL SYSTEM**

**Channels** — Left and center plug-in compartments are compatible with all 5000 Series plug-ins. CRT readout is not available with plug-ins having a suffix N (5B10N, etc.).

**Deflection Factor** — Determined by plug-in unit.

**Bandwidth** — 50 MHz, determined by plug-in unit.

**Chopped Mode** — The 5440 will chop between channels at  $\approx 25$  to 100 kHz, depending on plug-ins and operating modes.

**Alternate Mode** — Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5440 switches to the second amplifier.

**HORIZONTAL SYSTEM**

**Channel** — Right-hand plug-in compartment compatible with all 5000 Series plug-ins. CRT readout is not available for plug-ins with a Suffix N.

**Internal Trigger Mode** — Left vertical, center vertical.

**Fastest Calibrated Sweep Rate** — 10 ns/div, determined by plug-in.

**X-Y Mode** — Phase shift within  $2^\circ$  from dc to 20 kHz.

**CRT AND DISPLAY FEATURES**

**CRT** — Internal parallax-free 8 x 10 div (1.22 cm/div) graticule with edge-lit illumination.

**Phosphor** — P31 Standard, P7 or P11 optional.

**Accelerating Potential** — 15 kV.

**External Intensity Input** — +5 V turns beam on from off condition. -5 V turns beam off from on condition. Frequency range dc to 2 MHz. Input R and C is  $\approx 10$  k $\Omega$  paralleled by  $\approx 40$  pF. Maximum input is  $\pm 50$  V (dc + peak ac).

**OTHER CHARACTERISTICS**

**Calibrator** — Voltage amplitude is 400 mV within 1%. Current is 4 mA within 1%. Frequency is two times the line frequency.

**Minimum Photographic Writing Speed** — Using Polaroid film 20,000 ASA without film fogging. Writing speed can be increased with the Tektronix Writing Speed Enhancer (see camera section for more information).

Writing Speed cm/ $\mu$ s				Camera	Lens
P31 Phosphor	P11 Phosphor				
20,000 ASA	3000 ASA	20,000 ASA	3000 ASA	C-59P	f/2.8 0.67 mag
180	90	245	125		
330	160	450	230	C-50P	f/1.9 0.7 mag

\*Slight cropping of the graticule corners.

\*\*Requires optional battery pack (016-0270-02) for operation with the 5440.

**Beam Finder** — Intensifies trace and brings it into graticule areas.

**Ambient Temperature** — Performance characteristics valid from 0°C to +50°C unless otherwise specified.

**Line Voltage Range** — 100, 110, 120, 200, 220, and 240 V ac  $\pm 10\%$ ; (Except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

**Maximum Power Consumption** — 100 W at 120 V ac, 60 Hz.

**OPTIONS**

**Option 01 Without CRT Readout** — The 5440 may be ordered without CRT readout. This feature can easily be added later with a conversion kit.

**Option 03 User Addressable CRT Readout** — An additional CRT readout access is available for the operator to program two 10-digit characters such as time, operator name, or test number. The additional display is useful for photographic records and is programmed by external resistors and switches.

**Option 04 Protective Panel Cover (Cabinet Model Only)** — The 5440 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

**For Recommended Cameras** — Refer to camera section in Functional Index.

**ORDERING INFORMATION**

(PLUG-INS NOT INCLUDED)

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 5.25 in rackmount oscilloscope with slide-out assembly.

- 5440 Oscilloscope ..... **\$2,615**
- R5440 Oscilloscope (Rackmount) ..... **\$2,665**
- Option 01 — Without CRT Readout ..... **-\$300**
- Option 03 — User Addressable CRT Readout ..... **+\$75**
- Option 04 — Protective Panel Cover (Cabinet Model Only) ..... **+\$25**
- Option 76 — P7 Phosphor ..... **+\$35**
- Option 78 — P11 Phosphor ..... **+\$35**

**CONVERSION KITS**

- Cabinet-to-Rackmount Order 040-0583-03 ..... **\$95**
- Rackmount-to-Cabinet Order 040-0584-04 ..... **\$150**
- CRT Readout Order 040-0691-02 ..... **\$755**

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

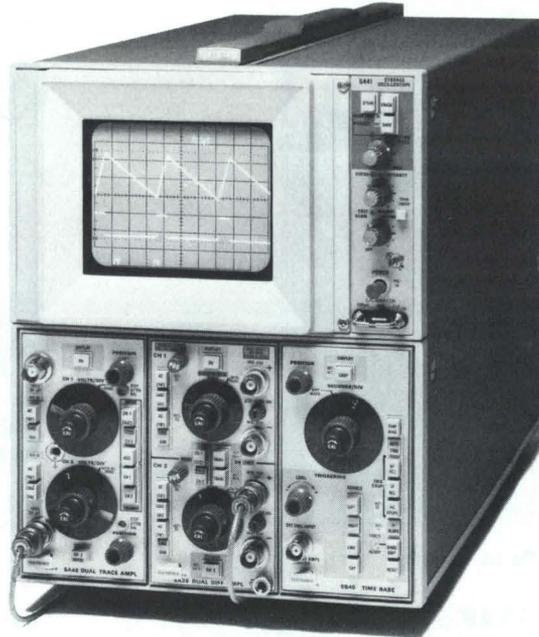
- Option A1 — Universal Euro 220 V/16A, 50 Hz ..... **NC**
- Option A2 — UK 240 V/13A, 50 Hz ..... **NC**
- Option A3 — Australian 240 V/10A, 50 Hz ..... **NC**
- Option A4 — North American 240 V/15A, 60 Hz ..... **NC**

5441/R5441

- Low Cost
- Variable Persistence Storage
- CRT Readout
- Dc to 50 MHz
- 3 Plug-in Flexibility
- 20 Versatile Plug-ins
- Bench to Rack Convertibility
- 5 div/μs Stored Writing Speed

APPLICATIONS

- Ultrasonics
- Low Power Laser
- Fiber Optics



With the 5441 Variable Persistence Storage Oscilloscope, view time at normal intensity can be varied from a fraction of a second to more than five minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

High-speed events that occur only once or at very low repetition rates are easily observed. You can make low frequency measurements more easily and accurately by eliminating flicker or transforming a slowly moving dot into a stable display. Repetitions of the same signal can be compared simultaneously to detect changes in amplitude or phase. The integrating effect of variable persistence can be used to suppress the random noise that obscures low signal-to-noise ratio waveforms.

The 5441 enhances the capabilities of the 5000 Series sampler and spectrum analyzer plug-ins. In sampling applications, discrete dot traces are converted into a continuous waveform by holding repeated sweeps on the CRT.

In spectrum analysis, slow scan rates are used to maximize resolution. With the 5441, it is easy to display a full-scan pattern simultaneously even when the scan rate yields full-scale periods of more than a second.

Like other 5400 Series oscilloscopes, the 5441 offers CRT readout of deflection factors for convenient, error-free measurements and optional user-programmable CRT readout of test information for ready identification and easy photographic recording. With the flexibility of a 3 plug-in mainframe and a choice of 20 plug-ins, you can make virtually any measurement from dc to 50 MHz.

CHARACTERISTICS  
VERTICAL SYSTEM

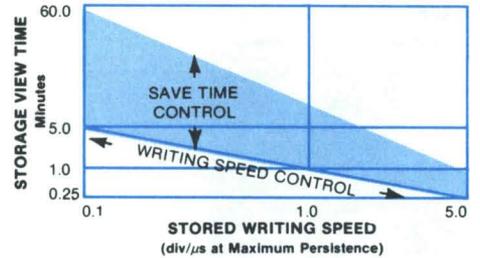
- Channels** — Left and center plug-in compartments compatible with all 5000 Series plug-ins. CRT readout not available for plug-ins with suffix N.
- Deflection Factor** — Determined by plug-in.
- Bandwidth** — 50 MHz, determined by plug-in.
- Chopped Mode** — The 5441 will chop between channels at ≈25 kHz to 100 kHz, depending on plug-ins and operating modes.
- Alternate Mode** — Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5441 switches to the second amplifier.

HORIZONTAL SYSTEM

- Channel** — Right-hand plug-in compartment compatible with all 5000 Series plug-ins. CRT readout not available for plug-ins with suffix N.
- Internal Trigger Mode** — Left vertical, right vertical.
- Fastest Calibrated Sweep Rate** — 10 ns/div, determined by plug-in.
- X-Y Mode** — Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

- CRT** — Internal, parallax-free, 8 x 10 div (0.9 cm/div) graticule with edge-lit illumination.
- Persistence** — Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.
- Phosphor** — P31.
- Accelerating Potential** — 8.5 kV.
- Maximum Stored Writing Speed** — Writing speed >5 div/μs for a view time of 15 s.
- Storage View Time** — The view time is the amount of time the stored signal can be viewed before it fades away. At the maximum writing speed the view time is 15 s or 0.25 minutes with the writing speed control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart next column).
- Save Mode** — Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.
- Erase Time** — 0.5 s ±10%.



**External Intensity Input** — +5 V turns beam on from off condition. -5 V turns beam off from on condition. Dc to 2 MHz usable frequency range. Input R and C ≈10 kΩ paralleled by ≈40 pF. Maximum input 50 V (dc + peak ac).

OTHER CHARACTERISTICS

- Beam Finder** — Intensifies trace and brings it into graticule area.
- Auto Focus** — Reduces the need for manual focusing with changes in intensity after the front-panel FOCUS control has been set.
- Calibrator** — Voltage amplitude 400 mV ±1%. Current amplitude 4 mA ±1%. Frequency is 2 times line frequency.
- Ambient Temperature** — Performance characteristics valid from 0°C to 50°C unless otherwise specified.
- Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac ±10%; (except that maximum input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.
- Maximum Power Consumption** — 100 W at 120 V ac, 60 Hz.

OPTIONS

- Option 01 Without CRT Readout** — The 5441 may be ordered without CRT readout. This feature can easily be added later with a conversion kit.
- Option 03 User Addressable CRT Readout** — CRT readout access allows the operator to program up to two 10-digit words.
- Option 04 Protective Panel Cover (Cabinet Model Only)** — The 5441 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.
- For Recommended Cameras** — Refer to camera section in Functional Index.

ORDERING INFORMATION  
(PLUG-INS NOT INCLUDED)

5441 Oscilloscope .....	\$4,425
R5441 Oscilloscope (Rackmount) .....	\$4,475
Option 01 — Without CRT Readout .....	-\$300
Option 03 — User Addressable CRT Readout .....	+\$75
Option 04 — Protective Panel Cover (Cabinet Model Only) .....	+\$25

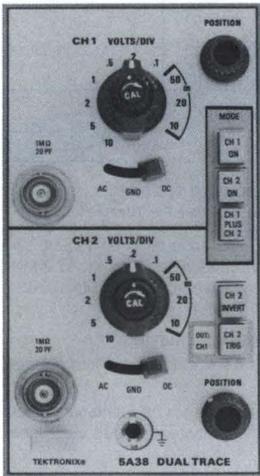
CONVERSION KITS

Cabinet-to-Rackmount Order 040-0583-03 .....	\$95
Rackmount-to-Cabinet Order 040-0584-04 .....	\$150
CRT Readout Order 040-0691-02 .....	\$755

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC

5A38



Dc to 35 MHz

5A38 Dual-trace Amplifier

Low Cost

Dc to 35 MHz Bandwidth

10 mV/div to 10 V/div Calibrated  
Deflection Factors

The 5A38 is a dual-trace, 35 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. It features 10 mV/div sensitivity and CRT readout of deflection factor.\*

CHARACTERISTICS

**Bandwidth** — Dc coupled, to  $\geq 35$  MHz. Lower end response, ac coupled,  $\leq 10$  Hz.

**Display Modes** — Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from Channel 1 or Channel 2.

**Risetime** —  $\leq 10$  ns.

**Deflection Factors** — Calibrated deflection factors from 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy  $\leq 3\%$  from 15°C to 35°C, 4% from 0°C to 50°C. A continuously variable control provides  $\geq 2.5X$  additional attenuation on each range.

**Common-Mode Rejection Ratio** —  $\geq 50:1$  up to 1 MHz.

**Channel Isolation** —  $\geq 50:1$  to 35 MHz with both traces displayed.

**Input R and C** — 1 M $\Omega$  shunted by  $\approx 20$  pF.

**Maximum Input Voltage** — Dc coupled, 250 V (dc + peak ac); ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p maximum at 1 kHz or less.

**Stability** —  $\leq 0.3$  mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant.  $\leq 0.2$  mV/°C vertical shift with line voltage held constant.

\*CRT readout not functional in 5223.

5A48



Dc to 50 MHz

5A48 Dual-trace Amplifier

Dc to 50 MHz Bandwidth

1 mV/div to 10 V/div Calibrated  
Deflection Factors

The 5A48 is a dual-trace 50 MHz plug-in amplifier for use only in the 5223 and the 5400 Series mainframes. The 5A48 features five operating modes, selectable trigger source, and CRT readout of deflection factor.\*

CHARACTERISTICS

**Bandwidth** — Dc coupled, dc to at least 50 MHz at 5 mV/div to 10 V/div, decreasing to dc to 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac coupled, 10 Hz or less (1.0 Hz with a 10X probe) at all deflection factors (3 dB down).

**Display Modes** — Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, Added, Alternated, Chopped (determined by time-base plug-in horizontal compartment). Internal trigger source is selectable from Channel 1 or Channel 2.

**Risetime** — 7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

**Deflection Factors** — Calibrated deflection factors from 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy  $\leq 5\%$  at 1 mV/div and 2 mV/div;  $\leq 3\%$  from 5 mV/div to 10 V/div from 15°C to 35°C;  $\leq 4\%$  from 5 mV/div to 10 V/div from 0°C to 50°C. A continuously variable control provides  $\geq 2.5X$  additional attenuation on each range.

**Common-Mode Rejection Ratio** —  $\geq 50:1$  from 5 mV/div to 10 V/div, up to 1 MHz.  $\geq 20:1$  from 1 mV/div to 2 mV/div, up to 1 MHz.

**Input R & C** — 1 M $\Omega$  within 1%,  $\approx 24$  pF.

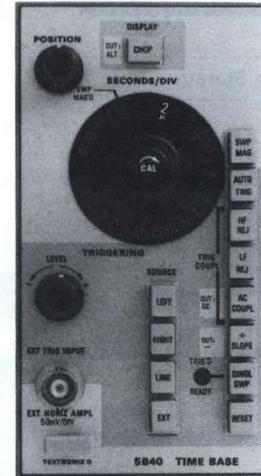
**Maximum Input Voltage** — Dc coupled, 250 V (dc + peak ac); ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p maximum, 1 kHz or less.

**Stability** —  $\leq 0.3$  mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant.  $\leq 0.2$  mV/°C vertical shift with line voltage held constant.

\*CRT readout not functional in 5223.

For recommended probes — refer to page 292.

5B40



Time Base

5B40 Time Base

Low Cost

10 ns/div to 5 s/div  
Calibrated Time Base

Triggering to 50 MHz

The 5B40 Time Base is designed for use only in 5400 Series mainframes. It features sweep rates from 10 ns/div to 5 s/div and CRT readout of the sweep rate selected.

CHARACTERISTICS

**Sweep Rate** — 0.1  $\mu$ s/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

**Sweep Accuracy** — Measured in 5400 Series oscilloscope over center 8 gradate divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 $\mu$ s/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 $\mu$ s/div and 0.1 $\mu$ s/div	4%	5%	5%	6.5%

TRIGGERING

Coupling	Frequency Range	Minimum Signal Required	
		Internal	External
Dc	Dc to 10 MHz 10 MHz to 60 MHz	0.4 div 1.0 div	60 mV 150 mV
Ac	Trigger requirements increase below 50 Hz		
LF REJ	Trigger requirements increase below 7.5 kHz		
HF REJ	Trigger requirements increase above 50 kHz		

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

**External Trigger Input** — Maximum input voltage is 350 V dc + peak ac, 350 V p-p ac at  $\leq 1$  kHz. Input R and C is 1 M $\Omega$  paralleled by  $\approx 24$  pF. Trigger level range is  $\geq \pm 1.5$  V.

**External Horizontal Input** — Deflection factor is 50 mV/div  $\pm 3\%$ . Input R and C is 1 M $\Omega$  paralleled by  $\approx 24$  pF. Dc coupled bandwidth is dc to  $\leq 2$  MHz. The ac coupled lower response is  $\leq 50$  Hz. Maximum input voltage is 350 V (dc + peak ac) or 350 V p-p ac at  $\leq 1$  kHz.

## 5B42 Delaying Time Base

10 ns/div to 5 s/div Calibrated Time Base

Single-Sweep Operation

Triggering to 50 MHz

The 5B42 Delaying Time Base is designed for use in 5400 Series Mainframes. The 5B42 is designed so that the user may easily operate the time base in the many applications where delayed sweep and sweep rates up to 10 ns/div are required.

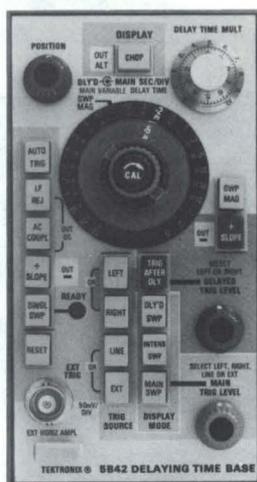
The 5B42 also features CRT readout and an edge-lighted seconds/div selector switch.

### CHARACTERISTICS

**Sweep Rate** — 0.1  $\mu$ s/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

**Sweep Accuracy** — Measured over the center 8 div. Same as 5B40. See chart on previous page.

## 5B42



Delaying Time Base

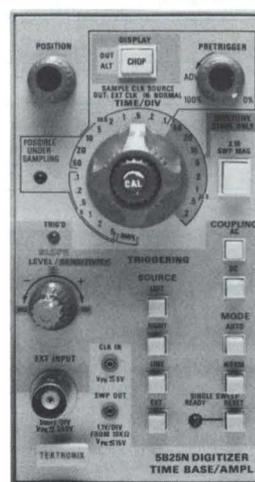
## 5B25N Digital Time Base

Bi-Slope Triggering

20 ns/div to 5 s/div Calibrated Time Base

Triggering to 15 MHz

## 5B25N



Digitizer Time Base/Amplifier

TRIGGERING			
Coupling	Frequency Range	Minimum Signal Required	
		Internal	External
Dc 5400 ampl 5400 ampl 5100 ampl	Dc to 10 MHz	0.4 div	100 mV
	10 MHz to 60 MHz	1.0 div	400 mV
	Dc to 2 MHz	0.4 div	100 mV
Ac	Requirements increase below 50 Hz		
Ac LF REJ	Requirements increase below 7.5 kHz		

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

**External Trigger Input** — Maximum input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 M $\Omega$  within 2%,  $\approx$ 20 pF. Trigger level range is at least  $\pm$ 2.5 V.

### DELAYING SWEEP

**Delay Time Multiplier Range** — 0.2 to 10 times the TIME/DIV setting.

**Differential Time Measurement Accuracy** — Within 1% plus 0.2% of full scale from 1  $\mu$ s to 0.5 s delay time. Within 2% plus 0.2% of full scale of 1 s to 5 s delay time.

**Jitter** — <0.05% of the time represented by one div of delay-ing sweep selected.

### DELAYED SWEEP

**Sweep Rate** — 0.1  $\mu$ s/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.

**Sweep Accuracy** — Measured over the center 8 div. Same as undelayed sweep. See chart on previous page.

TRIGGERING		
Coupling	Frequency Range	Minimum Signal Required
		Internal
Dc 5400 ampl 5400 ampl 5100	Dc to 10 MHz	0.4 div
	10 MHz to 60 MHz	1.0 div
	Dc to 2 MHz	0.4 div

### EXTERNAL HORIZONTAL INPUT

**Deflection Factor** — 50 mV/div within 3%.

**Bandwidth** — Dc coupled, dc to at least 2 MHz, Ac coupled, 50 Hz or less to at least 2 MHz.

The 5B25N is designed specifically for use in the 5223 Digital Storage Oscilloscope. Pretrigger is only available with the 5223 (see page 294). However, the standard analog sweep features including Bi-Slope Triggering and X10 Mag are compatible with 5400 Series Mainframes.

### CHARACTERISTICS

#### BI-SLOPE TRIGGERING

Besides the standard positive and negative slope and level control, the 5B25N has Bi-Slope triggering. When selected, Bi-Slope will trigger on either a positive or negative slope and the threshold or sensitivity is controlled by the trigger level knob. This eliminates the uncertainty of which slope is select, for example, in collision and destructive testing where a wrong guess could be costly.

**Modes** — Auto, Normal, Single Sweep.

**Single Sweep** — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

**External Trigger Input** — Maximum input voltage is 350 V-peak. Input R and C is 1 M $\Omega$  paralleled by  $\approx$ 24 pF.

**External Horizontal Input** — Deflection factor is 50 mV/div  $\pm$ 3%. Dc coupled bandwidth is dc to 2 MHz.

**Sweep Rate** — 0.2  $\mu$ s/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

**Sweep Accuracy** — Measured in 5400 Series Oscilloscope over center 8 graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.2 $\mu$ s/div	3%	4%	4%	5%
5 s/div and 2 s/div	4%	5%	5%	6%

TRIGGERING			
Slope	Frequency Range	Minimum Signal Required	
		Internal	External
+ or -	Dc to 1 MHz	0.4 div	50 mV
	1 MHz to 15 MHz	0.6 div	200 mV
$\pm$ (Bi-Slope)	Dc* to 1 MHz	$\pm$ 0.5 div	$\pm$ 50 mV

\*30 Hz when ac coupled.

### 5B25N CHARACTERISTICS WHEN USED WITH THE 5223 MAINFRAME

#### PRETRIGGER

For viewing events that occur prior to the trigger, a Pretrigger control is continuously variable from 0% to 100% of full screen. An intensified zone is generated which corresponds to the amount of pretrigger selected. This intensified zone remains with the saved waveform. Pretrigger is available from 5 s/div to 0.1 ms/div.

#### SAMPLING RATE

For single shot acquisition, the 5B25N has a maximum sample rate of 1 MHz at 0.1 ms/div (only when used with 5223).

#### REPETITIVE STORE

For repetitive signals, the 5B25N controls the equivalent time sampling feature of the 5223 to allow digitizing from 50  $\mu$ s/div to 0.2  $\mu$ s/div.

#### EXTERNAL CLOCK INPUT

Clock-In pin jack allows the user to introduce an external sampling clock. Maximum input frequency of 1 MHz, with TTL threshold, and 5 V peak input voltage.

#### Digitizer-Related Function (5223 Mainframe Only)

Overall Speed Accuracy Of Digitized Signal — (Center 8 Div). Excluded Portions: First 200 ns or 0.2 Div of Each Waveform	Digitized Waveform	Digitized Waveform Relative To Real-Time Waveform	
		CAL	UNCAL
2 and 5 s/div	3%	4%	6%
1 s to 0.1 ms/div	3%	3%	5%
50 $\mu$ s to 0.2 $\mu$ s/div	3%	3%	3%

### ORDERING INFORMATION

5B25N Digital Time .....	\$795
5B42 Delaying Time Base .....	\$1,215
5A38 Dual-Trace Amplifier .....	\$640
5B40 Time Base .....	\$660
5A48 Dual-Trace Amplifier .....	\$940

## 5100 Series Oscilloscopes

Low Cost

Dc to 2 MHz

Sampling to 1 GHz

Choice of 15 Plug-ins

Rear Panel Signal Outputs Optional

### COMMON CHARACTERISTICS FOR 5110, 5111A, 5113 UNLESS OTHERWISE SPECIFIED

#### VERTICAL SYSTEM

**Channels** — Left and center plug-in compartments compatible with all 5100 Series Plug-ins.

**Deflection Factor** — Determined by plug-in.

**Bandwidth** — 2 MHz, determined by plug-in.

**Chopped Mode** — (5110, 5111A) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is  $\approx 5 \mu\text{s}$ , consisting of  $\approx 4 \mu\text{s}$  displayed,  $\approx 1 \mu\text{s}$  blanked. Chop or alternate mode is selected at the time base unit.

**Chopped Mode** — (5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is  $\approx 5 \mu\text{s}$ , consisting of  $4 \mu\text{s}$  displayed,  $\approx 1 \mu\text{s}$  blanked. Chop or alternate mode is selected at the time base unit.

**Alternate Mode** — (5110, 5111A) Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before switching to the second amplifier.

**Alternate Mode** — (5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

#### HORIZONTAL SYSTEM

**Channel** — Right-hand plug-in compartment compatible with all 5100 Series Plug-ins.

**Fastest Calibrated Sweep Rate** —  $0.1 \mu\text{s}/\text{div}$  (X10 mag) with 5B10N or 5B12N.

**X-Y Mode** — Phase shift within  $1^\circ$  from dc to 100 kHz.

#### OTHER CHARACTERISTICS

**Ambient Temperature** — Performance characteristics valid from  $0^\circ\text{C} + 50^\circ\text{C}$ .

**Line Voltage Ranges** — 100, 110, 120, 200, 220, and 240 V ac  $\pm 10\%$  (except that maximum input should not exceed 250 V ac). Internally selected with quick change jumpers.

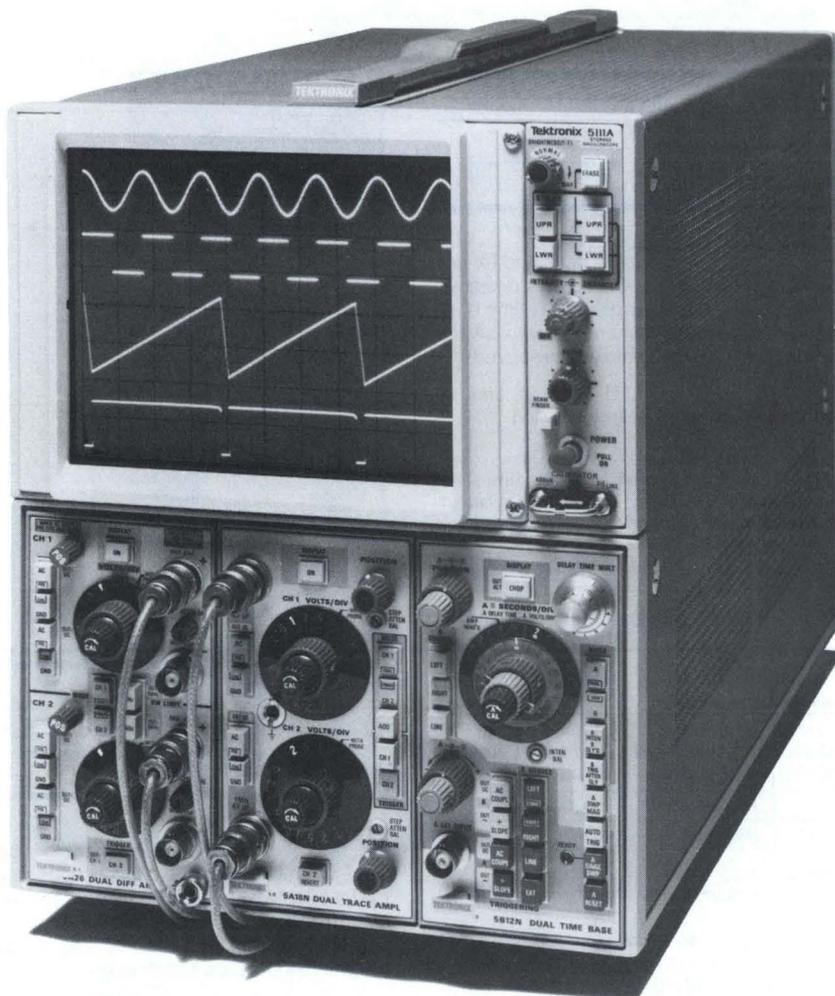
**Line Frequency Range** — 48 to 440 Hz.

**Maximum Power Consumption** — 5110, 5111A, 5113: 110 W.

**External Intensity Input** — +5 V turns beam on from off condition. -5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is  $\approx 10 \text{ k}\Omega$  paralleled by  $\approx 40 \text{ pF}$ . Maximum input  $\pm 50 \text{ V}$  (dc + peak ac.)

**Calibrator** — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

**Beam Finder** — Positions beam on screen regardless of vertical and horizontal position control settings.



## NEW

### 5111A

Single-Beam Storage Oscilloscope

Bistable, Split-Screen Display

Stored Writing Speed

20 divs/ms in Normal Mode  
50 divs/ms in Enhanced Mode  
or

200 divs/ms in Normal Mode  
800 divs/ms in Enhanced Mode with  
Option 03

The 5111A incorporates the time proven features of the 5111 plus improvements that further extend the usefulness of this popular instrument.

In addition to the normal storage function, the 5111A incorporates an Enhanced Mode which extends the stored writing speed to 50 div/ms.

For those applications where even greater stored writing speed is needed, we offer Option 03, Fast Writing Speed CRT. Option 03 provides ten times the standard stored writing speed at lower stored brightness.

Other new features for the 5111A include a detachable power cord and international power cord and plug options.

The 5111A is a single-beam, split-screen, bistable oscilloscope with a large-screen,  $6\frac{1}{2}$  in diagonal (1.27 cm/div) display.

The 5111A extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography. It is particularly useful for recording low and medium speed displays like those found in audio spectrum analysis, semi-conductor curve tracing, sampling, vibration analysis, and the biophysical sciences.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

### CHARACTERISTICS

#### CRT AND DISPLAY FEATURES

**CRT** — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.\*\*

**Accelerating Potential** — 3.5 kV.

**Phosphor** — Equivalent to P1.

**Maximum Stored Writing Speed** — At least 20 div/ms in the Normal-Mode and 50 div/ms in the Enhanced Mode.

**With Option 03, Fast Writing Speed CRT** — At least 200 div/ms (center 6 x 8 div) in the Normal-Mode and 800 div/ms (center 6 x 8 div) in the Enhanced Mode.\*\*

**Storage View Time** — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

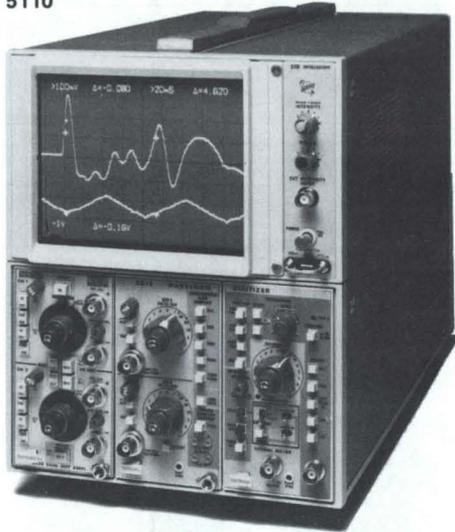
**Erase Time** —  $\approx 250 \text{ ms}$ .

\*\*Illuminated graticule available at extra cost.

#### INCLUDED ACCESSORIES

Power cord (161-0066-00).

5110



Single Beam

5110

Lowest Cost Single-Beam Nonstorage Oscilloscope with Plug-in Configurability

8 Channels at 1 mV/div, 4 Channels at 50  $\mu$ V/div, 2 Channels at 10  $\mu$ V/div, with Appropriate Amplifiers

The 5110 is a single-beam nonstorage oscilloscope featuring a large diagonal 6.5 in (1.27 cm/div) CRT.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10  $\mu$ V/div), four channel differential at 50  $\mu$ V/div, eight-channel displays at 1 mV/div. Or choose from our extra low cost basic amplifier and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.\*

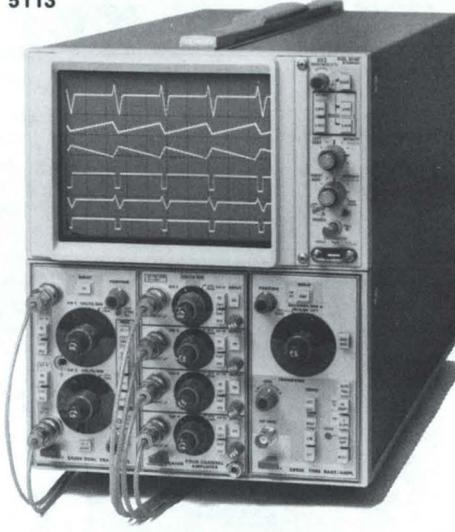
Accelerating Potential — 3.5 kV.

Phosphor — P31 standard, P7 or P11 optional.

\*Illuminated graticule available at extra cost.

CRT Readout as shown above, is generated via the new 5D10 Waveform Digitizer, described on page 302.

5113



Dual-beam Bistable Storage

5113

Dual-beam Bistable Storage Oscilloscope

Two Independent Vertical Systems

Can Display Two Single-Shot Signals Without Timesharing, or up to Eight Signals in the Chop Mode

Split-screen Storage. Stored Writing Speed  $\geq$  20 div/ms.

The 5113 is a dual-beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms. View time is at least one hour at normal intensity and can be increased to ten hours at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. Both beams are driven by one set of horizontal deflection plates.

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be observed and recorded.

CRT AND DISPLAY FEATURES

CRT — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.\*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

Maximum Stored Writing Speed — At least 20 div/ms.

Storage View Time — At least one hour at normal intensity; up to ten hours at reduced intensity, after which time it may be increased to original level.

Erase Time —  $\approx$  250 ms.

\*Illuminated graticule available at extra cost.

OPTION 07: 5100 SERIES

REAR PANEL SIGNAL OUTPUTS

**Left and Center Compartments** — Two BNC connectors provide access to the CRT related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/CRT division. Output impedance: 1 k $\Omega$ .

**Right Compartment (Sweep)** — One BNC connector provides access to the CRT-related sweep waveform. Sensitivity: 0.5 V/CRT division; positive-going sawtooth,  $\geq$  5 V. Output impedance: 1 k $\Omega$ .

**Right Compartment (Gate)** — One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

**X-Y Mode** — CRT-related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/CRT division.

ORDERING INFORMATION  
(PLUG-INS NOT INCLUDED)

Cabinet Models

5110 Oscilloscope .....	\$1,425
5111A Oscilloscop .....	\$2,300
5113 Oscilloscope .....	\$3,350

Rackmount Models

R5110 Oscilloscope .....	\$1,475
R5111A Oscilloscope .....	\$2,350
R5113 Oscilloscope .....	\$3,400

**Option 02** — Protective Panel Cover (Cabinet Models Only) — The cover protects the front panel and knobs during transportation and storage ..... +\$25

**Option 03** — Fast Write CRT (5111A/R5111A Only) . . . +\$130

**Option 03** — Fast Write CRT (5113/R5113 Only) ..... +\$150

**Option 07** — Add Rear Panel Signals Out (All Models) ..... +\$75

**Option 76** — P7 Phosphor (5110, R5110 Only) ..... +\$35

**Option 78** — P11 Phosphor (5110, R5110 Only) ..... +\$35

CONVERSION KITS

**Cabinet-to-Rackmount Conversion Kit**  
Order 040-0583-03 ..... \$95

**Rackmount-to-Cabinet Conversion Kit**  
Order 040-0584-04 ..... \$150

**Protective Panel Cover Kit**  
Order 040-0620-00 ..... \$40

**Rear Panel Signal Outputs Conversion Kit (Option 07)**  
Order 040-0915-01 ..... \$180

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC

**Option A2** — UK 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A4** — North American 240 V/15A, 60 Hz ..... NC

**Option A5** — Swiss 220 V/10A, 50 Hz ..... NC

**For Recommended Cameras** — Refer to camera section in Functional Index.

**5D10**

Compatible with all 5000 Series Mainframes

Digital Storage

CRT Readout for Complete Operational Status at a Glance

Powerful Triggering Capability

1% Accuracy

Dual Channel

1 MHz Sample Frequency

Save Reference Waveforms

X-Y Recorder Output

Signal Conditioning Via Left Vertical Plug-In

The 5D10 enhances all Tektronix 5000 Series mainframes by providing storage for transient events with frequency components up to 100 kHz for a single channel acquisition and up to 50 kHz for dual channel acquisition, all in a compact two-wide plug-in.

The Digital Storage characteristics of the high performance 5D10 duplicate most of what CRT storage can do and in addition provides the following important features:

**Digital Storage**

Provides clear, crisp and bright displays with indefinite viewing time.

**Cursors**

To permit convenient single point or point-to-point measurements of time and amplitude for fast, accurate and reliable answers.

**CRT Readout**

Displays all pertinent instrument settings, cursors, and waveform levels. Lets you read out complete operational status at a glance.

**Pretrigger**

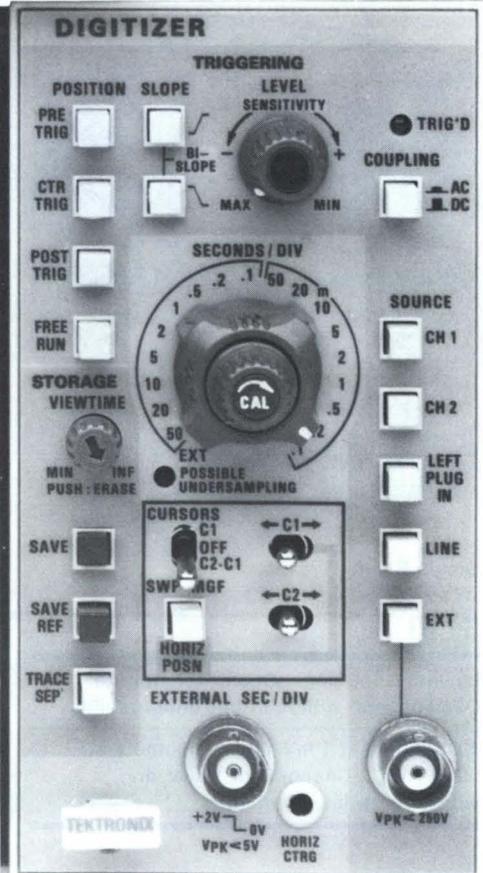
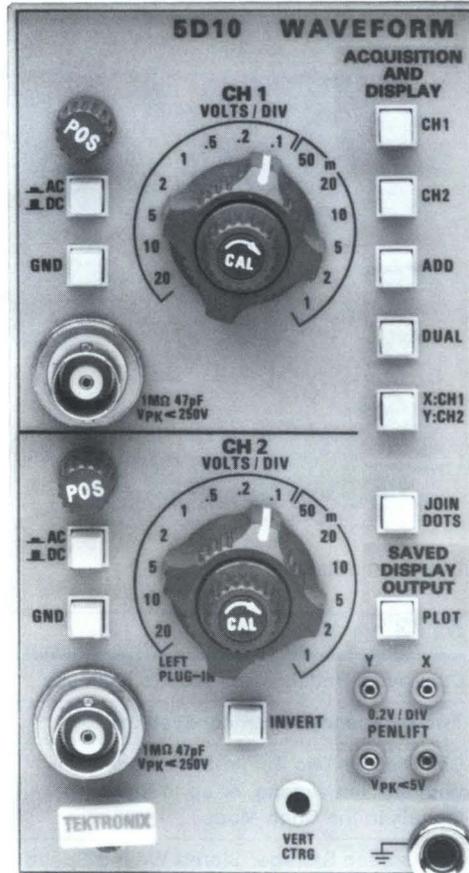
Allows viewing information prior to the trigger event so you can see all your data. Center and posttrigger selection is also provided.

**Free Run**

Optimizes the data presentation for low speed phenomena, much like a stripchart recorder.

**1% Accuracy**

Improves measurement quality in both vertical and horizontal modes.



**Dual Samplers**

Ensures time coincidence between the two input channels.

**Bi-Slope Triggering**

Ensures triggering when you are unsure of the slope of a transient event.

**1 MHz Sample Frequency**

Stores single-shot events to approximately 100 kHz in bandwidth with 8-bit vertical resolution.

**Save Reference**

Permits comparisons of signals stored at different times.

**X-Y Displays**

Provides less than 1° phase shift up to 100 kHz of parametric related signals.

**X-Y Recorder Output**

Provides inexpensive, archivable hard copies complete with readout, graticule and displayed waveforms.

**Left Vertical Plug-in**

May be used to precondition up to two signals for Channel 2 of the 5D10 (when used in 5100 Series mainframes only).

For example, plug-ins such as the 5A21N, 5A22N and 5A26 can provide differential performance with sensitivities ranging to 10  $\mu$ V/div (5A22N). The 5D10 can acquire a total of three signal channels when using the **Channel 2 left plug-in** acquisition feature.

**CHARACTERISTICS**

**VERTICAL**

**Vertical Modes** — CH 1, CH 2, ADD, Dual, X-CH 1, and Y-CH 2.

**Channel 2 Modes** — V/div, Left plug in.

**Deflection Factor** — 1 mV/div to 20 V/div in 14 calibrated steps (1-2-5 sequence).

**Accuracy**

Input to Readout Numbers: 5 mV/div to 1 V/div  $\pm 1\%$ ; 1 mV/div to 2 mV/div  $\pm 2\%$ ; 2 V/div to 20 V/div  $\pm 2\%$ ; Input to CRT graticule  $\pm 2\%$ .

From Left Vertical Plug-in: Add  $\pm 1\%$  to above specifications.

Add Mode: Add  $\pm 1\%$  to above specifications.

**Input R and C** — 1 M $\Omega$   $\pm 0.5\%$  at  $\approx 47$  pF.

**Maximum Input** — 250 V (dc + peak ac); 250 V p-p ac at 1 kHz or less.

**Bandwidth**

Single Channel: Suitable from dc to 100 kHz.

Dual Channel: Suitable from dc to 50 kHz.

Ac Coupling: 3 dB point—10 Hz or less (1 Hz with 10x probe).

**Common Mode Rejection** — At least 50:1, dc to 100 kHz.

**Resolution**

Vertical: X-Y or Y-T; 0.04 div (8-bit digitizer).

Horizontal: Y-T; 0.01 div (1024 memory locations shared among all traces displayed).

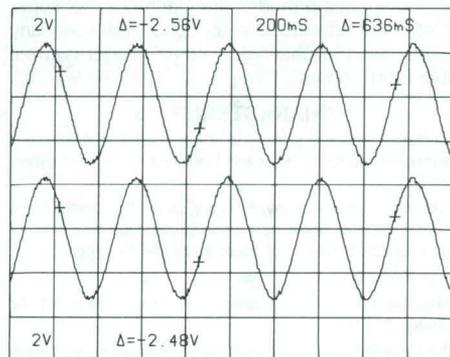
**Phase Shift** —  $\leq 1.0^\circ$  phase shift between CH 1 and CH 2, dc to 100 kHz.

**Display Output (to X-Y Recorder)**

Amplitude: 0.2 V/div  $\pm 2\%$ .

Speed: Compatible with X-Y recorders with 20 in/s slew rate, or faster.

Pen Lift: Isolated switch contacts, SPST (floating); normally open or normally closed selected by internal jumper.



Example of plotter waveforms with graticule scaling information

**TIME BASE**

**Sweep Rates** — 0.1 ms to 50 s/div in 18 calibrated steps 1-2-5 sequence.

**Accuracy** — Within  $\pm 1\%$  of readout numbers.

**External Input** — Allows external pulse generator to determine acquisition rate. Accepts TTL levels up to 1 MHz rate.

**Possible Under-Sampling Indicator** — Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossing of triggering signals.

**TRIGGERING**

**Sources** — CH 1, CH 2, left plug-in (via mainframe), line, external.

**Coupling** — Dc, ac.

**Sensitivity**

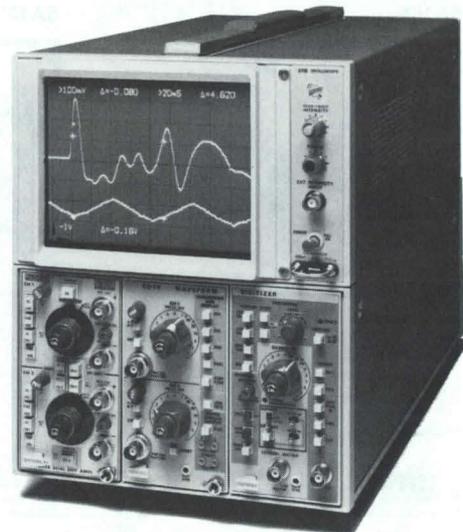
External: 100 mV; dc to 50 kHz or pulsewidth  $> 5 \mu\text{s}$ ; 250 mV 50 kHz to 250 kHz or pulsewidth  $> 1 \mu\text{s}$ .

CH 1, CH 2, Left Plug-in: 0.4 div, dc to 50 kHz or pulsewidth  $> 5 \mu\text{s}$ ; 1.0 div, 50 kHz to 250 kHz or pulsewidth  $> 1 \mu\text{s}$ .

**Bi-Slope Trigger** — Amplitude, frequency, and pulsewidth specifications apply to absolute value of signal (rectified).

**External Trigger Input**

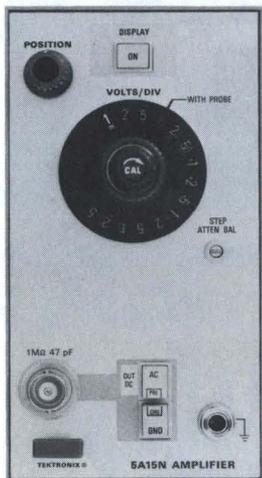
Input R and C: 1 M $\Omega$   $\pm 2\%$  at  $\approx 47$  pF. Maximum input 250 V (dc + peak ac). 250 V p-p ac at 1 kHz or less.



5D10 Installed in 5110 mainframe

Order 5D10 Waveform Digitizer ..... \$2,850

5A15N



Single Trace Dc to 2 MHz

### 5A15N Amplifier

1 mV/div to 5 V/div

The 5A15N Single Trace Amplifier features easy to use front-panel controls and can be used in many 5000 Series mainframe.

Two 5A15Ns (one must be located in the right-hand compartment) provide versatile X-Y operation when used in a 5100 Series Mainframe.

#### CHARACTERISTICS

**Bandwidth** — Dc coupled: dc to at least 1 MHz at all deflection factors. Ac coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor** — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

**Input R and C** — 1 MΩ within 1% at ≈47 pF.

**Maximum Input** — Dc coupled: 350 V (dc + peak ac). Ac coupled: 350 V dc.

### 5A18N Amplifier

1 mV/div to 5 V/div

The 5A18N Dual Trace Amplifier features easy to use front-panel controls and can be used in any 5000 Series mainframe.

5A18N operating modes include Channel 1 or 2 only, Channels 1 and 2 added, Channel 2 inverted and Channel 1 alternated or chopped with Channel 2. Internal trigger source is selectable from Channel 1 and Channel 2.

#### CHARACTERISTICS

**Bandwidth** — Dc coupled: dc to at least 2 MHz at all deflection factors. Ac coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

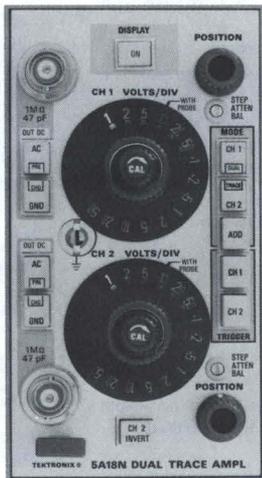
**Deflection Factor** — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

**Input R and C** — 1 MΩ within 1% at ≈47 pF.

**Maximum Input** — Dc coupled: 350 V (dc + peak ac). Ac coupled: 350 V dc.

**Chopping Rate** — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A18N



Dual Trace Dc to 2 MHz

### 5A24N Amplifier

50 mV/div to 1 V/div Deflection Factors

Easy to Customize

The 5A24N is a low cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5000 Series mainframes. It contains mode switching, CRT beam positioning, trigger pickoff for basic measurements, and a built-in 3% x 2 3/4 inch soldering pad matrix for use by the customers who wish to build their own input circuits for special applications. Customer-built circuits are powered through the circuit board which provides access to all mainframe power supplies.

#### CHARACTERISTICS

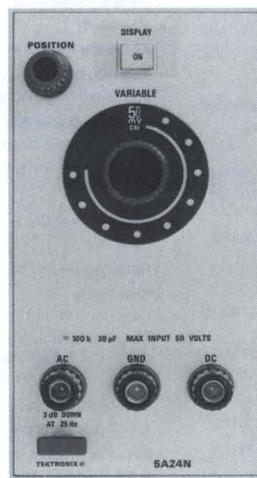
**Bandwidth** — Dc coupled: dc to at least 2 MHz at 50 mV/div, decreasing to dc to 200 kHz at mid-attenuator range. Ac coupled: 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

**Deflection Factor** — 50 mV/div, accurate within 3%. Continuously variable, uncalibrated from 50 mV/div to at least 1 V/div.

**Input R and C** — ≈100 kΩ at ≈30 pF.

**Maximum Input** — 50 V (dc + peak ac).

5A24N



Single Trace Dc to 2 MHz

### 5A14N Amplifier

1 mV/div to 5 V/div

The 5A14N Four Trace Amplifier features simplified front-panel controls and can be used in any 5000 Series mainframe.

5A14N operating modes are: each channel separately, and alternated or chopped between any combination of channels. Internal trigger is available from Channel 1 only.

#### CHARACTERISTICS

**Bandwidth** — Dc coupled: dc to at least 1 MHz at all deflection factors. Ac coupled: 2 Hz or less to at least 1 MHz at all deflection factors.

**Deflection Factor** — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and 12.5 V/div.

**Input R and C** — 1 MΩ within 1% at ≈47 pF.

**Maximum Input** — Dc coupled: 350 V (dc + peak ac). Ac coupled: 350 V dc.

**Chopping Rate** — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

#### ORDERING INFORMATION

5A14N Four Trace Amplifier .....	\$1,390
5A15N Single Trace Amplifier .....	\$330
5A18N Dual Trace Amplifier .....	\$690
5A24N Single Trace Amplifier .....	\$180

5A13N

Dc to 2 MHz Bandwidth

1 mV/div to 5 V/div

10,000:1 CMRR

10,000 Div Effective Screen Height

The 5A13N is a differential comparator plug-in amplifier for the 5000 Series. It incorporates a number of performance features that make it particularly versatile.

Conventional Mode

The 5A13N has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at 2 MHz or 10 kHz for best displayed noise conditions during low-frequency applications. The plus or minus inputs allow normal or inverted displays.

Differential Mode

The 5A13N maintains its conventional features and provides a balanced input for applications requiring rejection of a common-mode signal. The CMRR is 10,000:1 from dc to 20 kHz, decreasing to 100:1 at 2 MHz. The unit rejects up to 15 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 350 V rejection capability above 100 mV/div.

Comparator Mode

The 5A13N provides an accurate positive or negative internal offsetting voltage. A signal of up to ±10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 div by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for applications requiring maximum resolution. The offset voltage may be externally monitored through a front-panel output.

CHARACTERISTICS

**Bandwidth** — Dc to 2 MHz. Bandwidth limit mode, dc to 10 kHz. Ac coupled: 2 Hz or less at the lower -3 dB point.

**Deflection Factor** — 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

**Input R and C** — 1 MΩ at ≈51 pF.

Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Max Ac Coupled Input (Dc Voltage)		±350 V

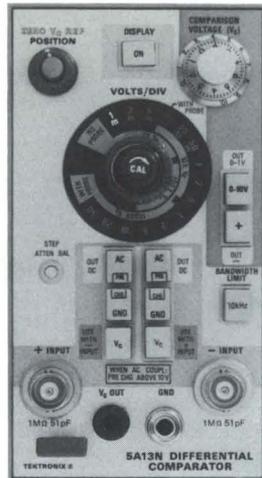
**Maximum Input Gate Current** — 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

**Overdrive Recovery** — 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after removal of an overdrive signal between +10 V and -10 V, regardless of overdrive signal duration.

**Internal Comparison Voltage** — Ranges, 0 V to ±10 V and 0 V to ±1 V. Accuracy, within 0.2% of dial setting plus 5 mV from ±1 V to ±10 V; within 0.2% of dial setting plus 1 mV from ±25 mV to ±1 V on the 0 V to ±1 V range. From 0 V to ±25 mV, use the on-screen display for greater resolution. Vc output R<sub>i</sub> ≈ 15 kΩ.

**Common-Mode Rejection Ratio** — At least 10,000:1, dc to 10 kHz at 1 mV/div to 50 mV/div dc coupled, with up to 20 V p-p sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 V/div to 5 V/div dc coupled, with up to 100 V p-p sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, CMRR is the same as stated for dc coupled. Below 5 kHz ac coupled, CMRR decreases to 400:1 at 10 MHz. CMRR with two P6060 Probes is at least 400:1 at any deflection factor.

5A13N



Differential Comparator

5A21N

Dc to 1 MHz Bandwidth

10 kHz Bandwidth Limiter

50 μV/div to 5 V/div

100,000:1 CMRR

Voltage and Current Probe Inputs

The 5A21N is a 50 μV/div, dc coupled differential amplifier for the 5000 Series and has a current probe input.

**High CMRR Probes for Differential Amplifiers** We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum common-mode rejection ratio (CMRR).

See page 441 for P6055 characteristics.

CHARACTERISTICS

**Bandwidth** — Dc coupled: dc to at least 1 MHz. Ac coupled: 2 Hz less at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor** — 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

**Input R and C** — Voltage mode, 1 MΩ within 0.15% at ≈47 pF.

Maximum Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap pre-charged), 10 V peak ac
10 mV/div to 5 V/div		350 V (dc + peak ac)

**Input Gate Current** — 100 pA or less (equivalent to 100 μV or less, depending on external loading), at 25°C.

**Displayed Noise** — 30 μV or less, tangentially measured.

**Common-Mode Rejection Ratio** — Ac coupled, 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1 dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sine wave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sine wave. CMRR with two P6060 Probes is at least 400:1 at any deflection factor.

PROBE INPUT (with P6021 CURRENT PROBE)

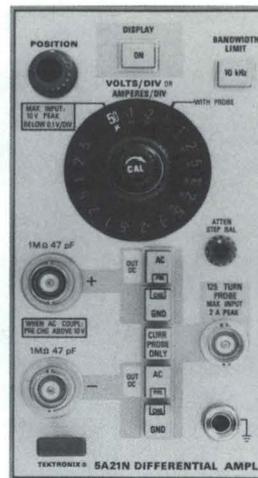
**Bandwidth** — 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor** — 0.5 mA/div to 0.5 A/div in 10 calibrated steps (1-2-5 sequence). Accurate within 3%. Uncalibrated, continuously variable between steps and to 1.25 A/div.

**Maximum Input Current** — 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

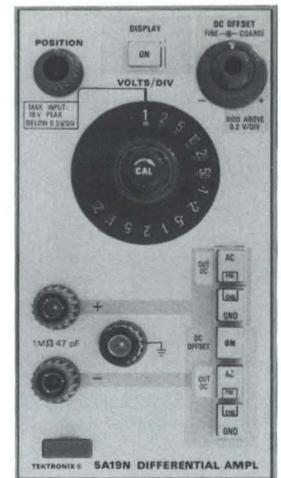
**Displayed Noise** — 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.

5A21N



Differential

5A19N



Differential

5A19N

Dc to 2 MHz Bandwidth

1 mV/div to 20 V/div

Dc Offset

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000 Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

CHARACTERISTICS

**Bandwidth** — Dc coupled: dc to at least 2 MHz at all deflection factors. Ac coupled: 2 Hz or less to at least 2 MHz at all deflection factors.

**Deflection Factor** — 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 50 V/div.

**Input R and C** — 1 MΩ within 0.3% at ≈47 pF.

Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Maximum Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Maximum Ac Coupled Input (Ac Voltage)	±350 V	
Dc Off Set Range	+15 V to -15 V	+350 V to -350 V

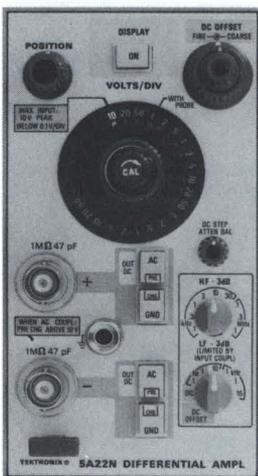
**Common-Mode Rejection Ratio** — Dc coupled, 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

ORDERING INFORMATION

5A13N Differential Comparator Amplifier .....	\$1,245
5A19N Differential Amplifier .....	\$410
5A21N Differential Amplifier .....	\$510
Option 01 — (includes P6021, 5 ft current probe) .....	+\$280

The 5A21N and 5A22N Differential Amplifiers are available with CRT readout at additional cost (CRT readout functional in 5400 Series mainframes only). Contact your local Tektronix Sales Engineer for details.

5A22N



Differential

5A22N

Dc to 1 MHz Bandwidth

10  $\mu$ V/div to 5 V/div

100,000:1 CMRR

Selectable Upper and Lower -3 dB Points

Dc Offset

The 5A22N is the most versatile of the 5000 Series Differential Amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

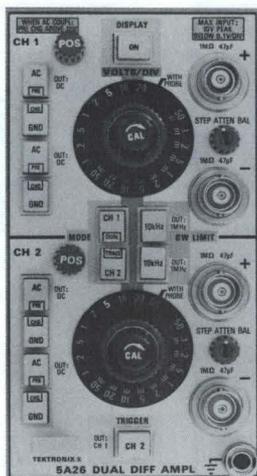
CHARACTERISTICS

**Bandwidth** — HF -3 dB point: selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accurate to within 20% of selected frequency; at 1 MHz, bandwidth is down 3 dB or less. LF -3 dB point: selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accurate to within 20% of selected frequency. Ac coupled, 2 Hz or less.

**Deflection Factor** — 10  $\mu$ V/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

**Common-Mode Rejection Ratio** — Ac coupled, 10  $\mu$ V/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz from 10  $\mu$ V/div to 100  $\mu$ V/div with up to 20 V p-p sinewave, decreasing by <20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V p-p sinewave. CMRR with two P6060 Probes is at least 400:1 at any deflection factor.

5A26



Dual Differential

Signal and Offset Range

Deflection Factor Settings	10 $\mu$ V to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	$\pm$ 10 V	-350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	$\pm$ 12 V	$\pm$ 350 V
Max Ac Coupled Input (Dc Voltage)	$\pm$ 350 V Dc rejection, at least $4 \times 10^5:1$	
Dc Offset Range	+0.5 V to -0.5 V	+50 V to -50 V

**Input R and C** — 1 M $\Omega$  within 0.15% at  $\approx$ 47 pF.

**Overdrive Recovery** — 10  $\mu$ s or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

**Maximum Input Gate Current** — 200 pA or less.

**Displayed Noise** — 20  $\mu$ V at maximum bandwidth, source resistance 25  $\Omega$  or less, measured tangentially.

**Drift with Temperature** — 100  $\mu$ V/ $^\circ$ C or less.

5A26

Two Differential Amplifiers in One Plug-In

50  $\mu$ V/div Sensitivity at 1 MHz

100,000:1 CMRR

CRT Readout

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000 Series Laboratory Oscilloscopes. It may be used in any 5000 Series mainframe.

The 5A26 provides 50  $\mu$ V/div sensitivity at 1 MHz, high common-mode rejection ratio, CRT readout in any standard 5400 Series mainframe, trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time in the chop or alternate mode.

For recommended probes—refer to page 292.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

**High CMRR Probes for Differential Amplifiers**  
We recommend the P6055 high CMRR adjustable 10X probes for use with Tektronix differential amplifiers.

When used in pairs, these probes allow adjustment for maximum common-mode rejection ratio (CMRR).

See page 441 for P6055 characteristics.

CHARACTERISTICS

**Number of Differential Channels** — Two.

**Bandwidth** — Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

**Deflection Factor** — 50  $\mu$ V/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

**CRT Readout** — CRT readout of deflection factors. Functional in CRT readout-equipped 5400 Series oscilloscopes, nonfunctional in 5100 Series oscilloscopes.

**Input R and C** — 1 M $\Omega$  within 0.15% paralleled by  $\approx$ 47 pF.

MAXIMUM INPUT VOLTAGE

	Dc Coupled	Ac Coupled
50 $\mu$ V/div to 50 mV/div	10 V (dc + peak ac)	10 V ac, 350 V (coupling cap precharged)
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

**Input Gate Current** — 100 pA or less (equivalent to 100  $\mu$ V or less, depending on external loading) at 25 $^\circ$ C.

**Displayed Noise** — 30  $\mu$ V or less, tangentially measured.

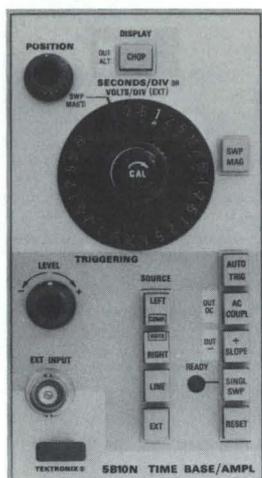
COMMON-MODE REJECTION RATIO

Dc Coupled	
50 $\mu$ V/div to 50 mV/div	At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sinewave
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sinewave
Ac Coupled	
50 $\mu$ V/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz
With 2 P6062A Probes	400:1 at 10x probe attenuation

ORDERING INFORMATION

5A22N Differential Amplifier ..... \$1,025  
5A26 Dual Differential Amplifier ..... \$1,105

5B10N



Single Sweep Time Base

5B10N

100 ns/div to 5 s/div Calibrated Time Base

Single Sweep

X10 Magnifier

Provides Alternate and Chopped Displays

50 mV/div and 500 mV/div External Input

The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5000 Series oscilloscopes. An external input allows use of the 5B10N as a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

Multiple triggering modes may be pushbutton selected with the 5B10N. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

CHARACTERISTICS

**Sweep Rates** — 1  $\mu$ s/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

**Sweep Accuracy** — Unmagnified, within 3% from 1  $\mu$ s/div to 1 s/div and within 4% of 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy.

TRIGGERING

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

**Auto Trig** — Same as above except signal rate requirements are 15 Hz and above.

**Single Sweep** — Same as for ac and dc coupled.

**External Trigger Input** — Maximum input is 350 V (dc + peak ac). Input R and C is 1 M $\Omega$  within 2% paralleled by  $\approx$ 70 pF. Trigger level voltage range is +5 V to -5 V.

EXTERNAL HORIZONTAL MODE

**Deflection Factor** — 50 mV/div and 500 mV/div, accurate within 3%. X10 variable extends range to at least 5 V/div.

**Bandwidth** — Dc coupled: dc to at least 1 MHz. Ac coupled: 50 Hz or less to at least 1 MHz.

**Input R and C** — 1 M $\Omega$  within 2%,  $\approx$ 70 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

5B12N



Dual Sweep Time Base

5B12N

100 ns/div to 5 s/div Calibrated Time Base

Dual and Delayed Sweep

X10 Magnifier

The 5B12N is a time base for generating single, dual, or delayed sweeps in 5000 Series oscilloscopes. The 5B12N is normally used in the right plug-in compartment but is compatible with the vertical deflection compartments as well.

The display modes are A sweep, B sweep, A intensified -B delayed, and dual sweep. Each mode is selectable by pushbutton switches. Triggering sources for A and B sweep include left and right plug-in, line, and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep is triggerable after the delay time.

When operated in the dual-sweep mode in a dual-beam oscilloscope with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers; four traces will be displayed. Both sweeps are displayed simultaneously in chop mode.

When operated in the dual-sweep mode in a single-beam oscilloscope with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode pushbutton selects chop or alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

CHARACTERISTICS

**A Sweep Rates** — 1  $\mu$ s/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

**A Sweep Accuracy** — Unmagnified, within 3% from 1  $\mu$ s/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Magnified, displays accurate to within 1% in addition to specified time-base sweep accuracy.

**B Sweep Rates** — 0.2  $\mu$ s/div to 0.5 s/div in 20 calibrated steps.

**B Sweep Accuracy** — Within 3% from 1  $\mu$ s/div to 0.1 s/div. Within 4% at 0.2  $\mu$ s/div, and 0.5 s/div, 0.2 s/div, and 0.5 s/div.

TRIGGERING

The following applies to the A and B trigger except as noted.

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

\*A Trigger only.

B sweep operates in triggered or free-run mode after delay time.

**Auto Trig** — Same as above on signal rates of 15 Hz and above.

The following characteristics apply to the A trigger only.

**Single Sweep** — Same as for ac and dc coupled.

**External Trigger Input** — Maximum input voltage is 350 V (dc + peak ac). Input R and C is 1 M $\Omega$  within 2% paralleled by  $\approx$ 70 pF. Trigger level voltage range is +5 V to -5 V.

DELAYING SWEEP

**Delay Time Accuracy** — 1  $\mu$ s/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%.

**Delay Time Multiplier Range** — 0.2 to 10.2 times the time/div setting.

**Delay Time Multiplier Incremental Linearity** — Within 0.2%.

**Differential Time Measurement Accuracy** — Within 1% plus 2 minor dial div for 1  $\mu$ s to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

**Jitter** — <0.05% of the time represented by one div of the delaying sweep selected.

EXTERNAL HORIZONTAL MODE

**Deflection Factor** — 50 mV/div and 500 mV/div accurate to within 3%. X10 variable extends range to at least 5 V/div.

**Bandwidth** — Dc coupled: dc to at least 1 MHz. Ac coupled: 50 Hz or less to at least 1 MHz.

**Input R and C** — 1 M $\Omega$  within 2%,  $\approx$ 70 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

ORDERING INFORMATION

5B10N Time Base/Amplifier .....	\$500
5B12N Dual Time Base .....	\$1,060

5CT1N

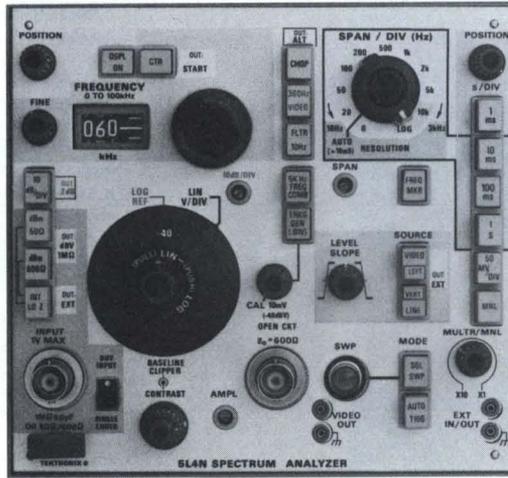


Curve Tracer

**5CT1N Curve Tracer**

- Test Semiconductor Devices to 0.5 W • 10 nA/div to 20 mA/div Vertical Deflection Factors • 0.5 V/div to 20 V/div Horizontal Deflection Factors • For a complete description see page 404.

5L4N

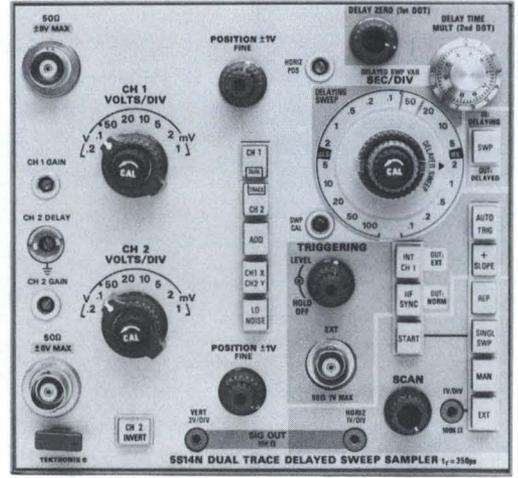


Spectrum Analyzer

**5L4N Spectrum Analyzer**

- Low Cost • 0-100 kHz Frequency Range • Resolution Bandwidth 10 Hz to 3 kHz • Log and Linear-Span Modes • Auto Resolution • For a complete description see page 211.

5S14N



Dual Trace Delayed Sweep Sampler

**5S14N Sampler**

- Dc to 1 GHz Bandwidth
- Dual Trace, 2 mV/div Sensitivity
- Calibrated Delayed Sweep
- Simplified Triggering
- Operational Ease of Conventional Oscilloscope
- Two-Dot Time Measurements

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-width plug-in unit designed to operate in all 5000 Series mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide new economy and ease of operation.

Two identical amplifier channels provide dual-trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned

by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time Multiplier Dial by the selected time per division.

**CHARACTERISTICS**  
**AMPLIFIER**

**Modes** — CH 1 only; CH 2 only; Dual Trace; CH 1 added to CH 2; CH 2 subtracted from CH 1 (CH 2 INVERT); CH 1 vertical (Y), CH 2 horizontal (X).

**Input Impedance** — Nominally 50 Ω.

**Bandwidth** — Dc to 1 GHz.

**Risetime** — 350 ps or less.

**Step Aberrations** — +2%, -3%, total of 5% p-p within first 5 ns, ±1% thereafter, tested with 284 Pulse Generator.

**Deflection Factor** — 2 mV/div to 0.5 V/div in 8 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

**Accuracy** — Within ±3%.

**Maximum Input Voltage** — ±5 V.

**Input Signal Range** — 2 V p-p maximum within a +2 V to -2 V window at any sensitivity.

**Dc Offset Range** — At least +2 V to -2 V.

**Displayed Noise** — 2 mV or less unsmoothed (tangentially measured). Low noise pushbutton reduces random noise by factor of 4 to 1 or more.

**Vertical Signal Output** — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

**Channel Delay Difference** — Adjustable to zero or for any time difference up to at least 1 ns.

**TIME BASE**

**Scan Modes** — Repetitive, Single, Manual, or External.

**Delaying Sweep** — May be used as CRT time base or as a delay generator for the Delayed Sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the Delaying Sweep mode is selected for the time base, two bright dots in the trace are generated which may be positioned anywhere on the displayed waveform. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

**Delayed Sweep** — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The Delayed Sweep may be started with zero delay time with respect to the start of the Delaying Sweep. Or the start may be delayed by any time interval up to that represented by 10 div of the Delaying Sweep selected.

**Horizontal Signal Output** — 1.0 V/div of horizontal deflection; 10 kΩ source resistance.

**DELAYING SWEEP**  
**Range** — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).  
**Accuracy** — Within ±3% excluding first 1/2 div of displayed sweep.

**Delay Zero (1st Dot)** — Adjustable to correspond to any instant within the time interval represented by the first 9 div of the Delaying Sweep selected.

**Delay Time (2nd Dot)** — Adjustable to any portion of the time interval represented by 10 div of the Delaying Sweep selected.

**Delay Accuracy** — Within ±1% of 10 div when measurement is made within the last 9.5 div.

**DELAYED SWEEP**

**Range** — 100 ps/div to 100 μs/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

**Accuracy** — Within ±3% excluding first 1/2 div of displayed sweep.

**Start Delay** — Depends on the Delaying Sweep time selected and the setting of the Delay Time Mult dial. Adjustable from Zero to any time interval up to that represented by 10 div of the Delaying Sweep selected. The Delaying Sweep start point corresponds to the second bright dot position.

**Delay Jitter** — <0.05% of the time represented by 1 div of the Delaying Sweep selected.

**TRIGGERING AND SYNC**

**Signal Source** — Interval from CH 1 vertical input or external through front-panel connector.

**External Triggering** — Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

**Internal Triggering** — Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

**Triggered Mode** — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and -0.5 V at instants when either a + slope or a - slope of the triggering signal crosses that level.

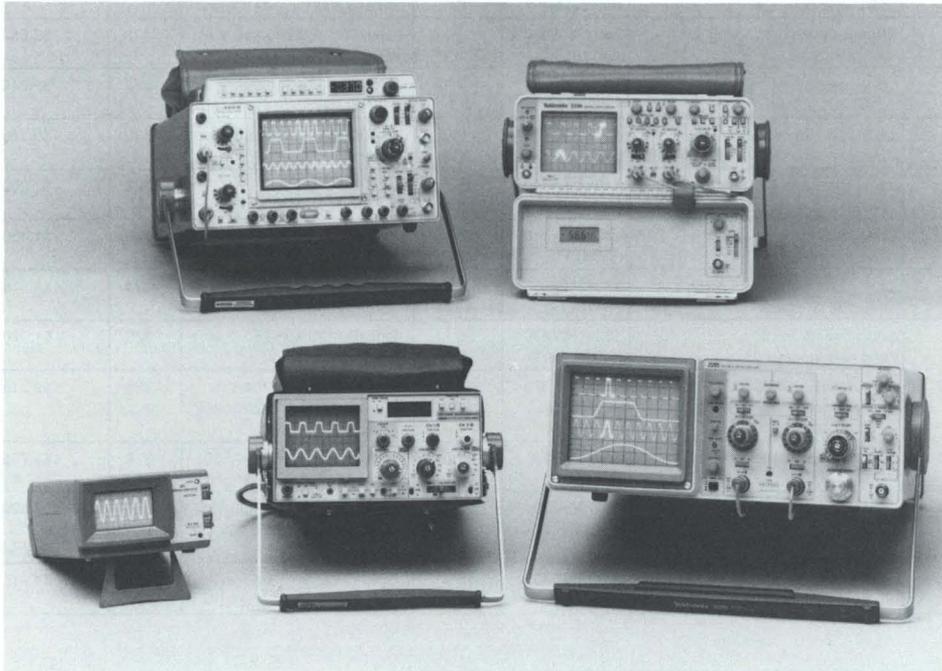
**Auto Triggered Mode** — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so a trace may always be generated and displayed. The trigger level range automatically adjusts to approximate the p-p voltage of the signal.

**Holdoff** — Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

**HF SYNC Mode** — For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

**Order 5S14N Sampler ..... \$5,310**

# PORTABLE OSCILLOSCOPES



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**PORTABLE REALTIME OSCILLOSCOPES COMPARISON CHART**

PRODUCT	BANDWIDTH (MHz)	SENSITIVITY (mV/div)	DUAL TRACE	DELAYED SWEEP	FASTEST SWEEP (ns/div)	FEATURES	SIZE mm (in) HxWxD	WEIGHT kg (lb)	POWER REQUIREMENTS	PAGE	PRICE
485	350 *1	5	yes	yes	1	Widest BW in a portable instrument	170x310x470 (7x12x19)	9.5 (21)	Line (90-136/180-272 V ac, 48-440 Hz)	312	\$7,690
475A	250	5	yes	yes	1	High performance 250 MHz portable	160x330x460 (7x12x21)	10.3 (23)	Line (99-132/198-264 V ac, 48-440 Hz) or battery pack	314	\$4,630
475	200	2	yes	yes	1	Highest gain/BW in a portable scope	160x330x460 (7x12x21)	10.3 (23)	Line (99-132/198-264 V ac, 48-440 Hz) or battery pack	314	\$4,300
465B	100	5	yes	yes	2	Cost effective, full-featured 100 MHz portable	160x330x460 (7x12x21)	10.3 (23)	Line (99-132/198-264 V ac, 48-440 Hz) or battery pack	316	\$3,140
465M	100	5	yes	yes	5	Tri-service standard 100 MHz portable	180x330x550 (7x13x24)	10.9 (24)	Line (100-132/200-264 V ac, 48-440 Hz)	318	\$3,860
2335	100	5	yes	yes	5	Rugged, compact lightweight	140x270x430 (5x11x17)	7.7 (17)	Line (100-132/200-250 V ac, 48-440 Hz)	320	\$2,550
2336	100	5	yes	yes	5	B trigger, Δtime	140x270x430 (5x11x17)	7.7 (17)	Line (100-132/200-250 V ac, 48-440 Hz)	320	\$2,845
2337	100	5	yes	yes	5	B trigger, Δtime, DMM	140x270x430 (5x11x17)	7.7 (17)	Line (100-132/100-250 V ac, 48-440 Hz)	320	\$3,145
2213	60 *2	2	yes	yes	5	Low cost delayed sweep	140x240x440 (5x14x17)	6.1 (13.5)	Line (90-250 V ac, 48-440 Hz)	322	\$1,200
2215	60 *2	2	yes	yes	5	Dual time base delayed sweep	140x240x440 (5x14x17)	6.1 (13.5)	Line (90-250 V ac, 48-440 Hz)	322	\$1,450
335	35	10	yes	yes	20	1 mV sensitivity at 25 MHz, external dc power	110x240x350 (4.4x9x14)	4.7 (10.3)	Line (90-132/180-264 V ac, 48-440 Hz) or external dc	324	\$3,015
T922R	15	2	yes	no	20	Rackmount, front and rear inputs	130x480x430 (5.25x19x17)	9.1 (20)	Line (90-132/198-250 V ac, 50-60 Hz)	329	\$1,970
305	5	5	yes	no	100	Autoranging DMM battery power	110x240x370 (4.4x9x15)	4.8 (10.6)	Line (90-132/180-264 V ac, 48-440 Hz) built-in battery, or external dc	325	\$2,315
221	5	5	no	no	100	5 MHz hand-held	80x130x230 (3x5x9)	1.6 (3.5)	Built-in battery, line (90-250 V ac, 48-62 Hz)	326	\$1,765
213	1	20	no	no	400	DMM/scope at <4 lbs	70x130x230 (3x5x9)	1.7 (3.7)	Built-in battery, line (90-136/180-250 V ac, 48-62 Hz), or external dc	327	\$2,320
212	0.5 (500 kHz)	10	yes	no	1000 (1 μs/div)	Integral 1 MΩ probe	80x130x240 (3x5x10)	1.6 (3.5)	Built-in, battery, line (104-126 V ac 58-62 Hz)	328	\$1,710

**PORTABLE STORAGE OSCILLOSCOPES COMPARISON CHART**

468	100	5	yes	yes	2	GPIB Interface option 10 MHz Stored Writing Speed*3	160x330x550 (6x13x22)	12.7 (28)	Line (90-132/198-250 V ac 48-440 Hz)	330	\$6,500
466	100	5	yes	yes	5	Two storage modes and reduced scan 3000 div/μs Stored Writing Speed	160x330x550 (6x13x22)	11.8 (26)	Line (99-132/198-264 V ac, 48-440 Hz) or battery pack	332	\$6,700
464	100	5	yes	yes	5	Two storage modes 110 div/μs Stored Writing Speed	160x330x550 (6x13x22)	11.8 (26)	Line (99-132/198-264 V ac 48-440 Hz) or battery pack	332	\$5,695
434	25	10	yes	no	20	Split screen storage 5000 div/μs Stored Writing Speed	140x330x480 (6x13x19)	9.4 (20.7)	Line (99-136/180-272 V ac, 48-440 Hz) or external dc	334	\$4,840
314	10	1	yes	no	100	Stored Viewing Time to 4 hr 400 div/ms Stored Writing Speed	110x240x350 (4.4x9x14)	4.7 (10.3)	Line (90-132/180/264 V ac, 48-440 Hz) or external dc	335	\$3,655
T912	10	2	yes	no	50	Low cost bistable storage 250 div/ms Stored Writing Speed	250x180x480 (10x7x19)	8.2 (18)	Line (90-132/198-250 V ac 50-60 Hz)	337	\$2,170
214	0.5 (500 kHz)	10	yes	no	1000 (1 μs/div)	Fully self-contained 500 div/ms Stored Writing Speed	80x130x240 (3x5x10)	1.6 (3.5)	Built-in battery or line (104-126 V ac, 58-62 Hz)	336	\$2,320

\*1 Bandwidth specifications for the 485 are dc to 350 MHz with 50 Ω inputs and dc to 250 MHz with 1 MΩ inputs.

\*2 The 2213 and 2215 are specified at 60 MHz for sensitivities from 10 V/div (10X probe) to 20 mV/div (1X probe) and 50 MHz from 10 mV/div to 2 mV/div.

\*3 Useful Storage Bandwidth

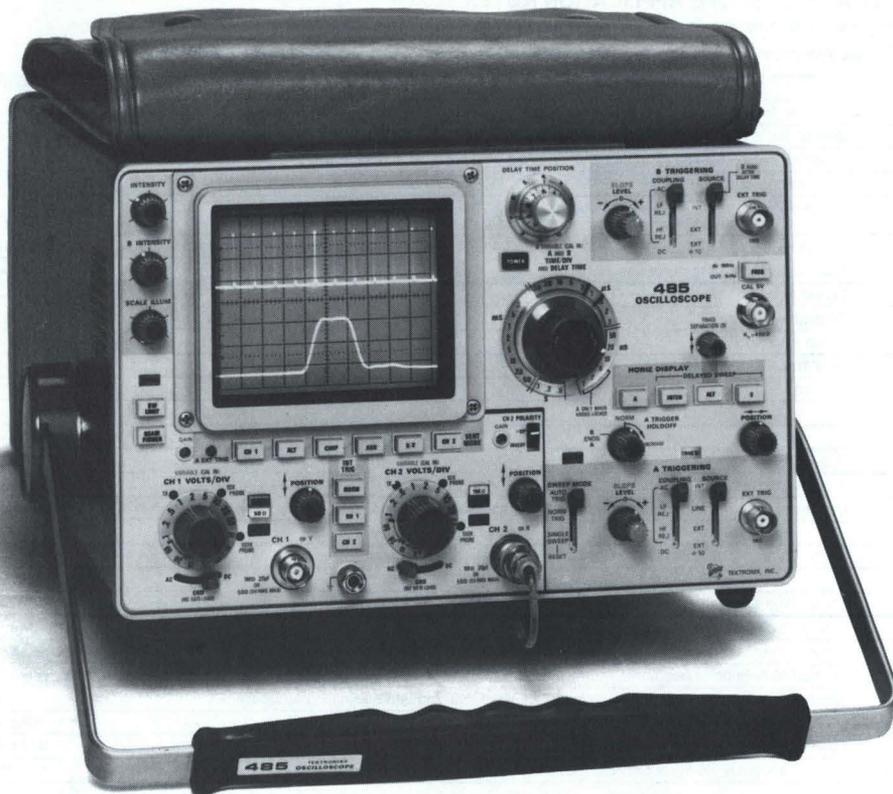
**PORTABLE SCOPE APPLICATION NOTES**

Tektronix product literature is readily available from your local Tektronix Sales office. Addresses and phone numbers are listed on pages 10 through 12 of this catalog. For data sheets and product brochures, just ask for literature on the specific instrument. Additional related publications also available are listed below.

TITLE	FEATURING	PART NO
How To Select Your Portable Oscilloscope	(Also ask for 2200 and 2300 Series literature.)	40AX-4232
Miniature, Battery-Powered Scopes	Built to Tek's High-Performance Standards	40A-5000
300 Series Portable Oscilloscopes	Brochure for the full line of SONY-TEKTRONIX mini-portable scopes	40AX-3792-2
400 Series Portable CRT Storage Scopes	Descriptions of the 466, 464, and 434 portable storage scopes	40A-3793-2
T900 Series Data Sheet	Includes the popular T922R rackmount scope and the T912 low cost storage scope. Ask for 2200 Series literature to supplement this data sheet	41X-3933
DM 44 Differential Time/DMM Option	Describes the DM 44 option available for the 464, 465, 466, 475, and 475A portable scopes	40X-3877-1
XYZs Of Using a Scope	A basic primer that features the 2213	41AX-4758
Basic Oscilloscope Measurements:	Period And Frequency	41AX-3839-1
Basic Oscilloscope Measurements:	Amplitude	41AX-3840
Basic Oscilloscope Measurements:	Setup And Analysis	41AX-3841-1
Basic Oscilloscope Measurements:	Dual-Trace And X-Y Phase	41AX-3928
Basic Oscilloscope Measurements:	Risetime	41AX-3929
Using Delayed Sweep In Measuring Digital Word Trains		41AX-3349
VITS Analysis for TV Servicing		41AX-4047-1
Troubleshooting Color TV Power Supplies		41AX-4048-1
The Digital Storage Oscilloscope	A primer that describes digital storage concepts and the 468	40AX-4319-1
Select The Right Kind of Storage For Your Application	Describes bistable, variable persistence, FAST transfer, and digital storage for portable and plug-in scopes	42AX-4280-1
Variable Persistence Storage Applications		42AX-3198
Bistable Storage Applications		42AX-3199
Fast And Multimode Storage Applications		42AX-3200
Spotlight Hidden Pulses With High Speed Storage	Three-page application note that features the 466	40AX-3225
468 <i>ELECTRONICS</i> Reprint	Describes digital storage scopes and concepts	40AX-4444-1
468 <i>BROADCAST ENGINEERING</i> Reprint	Making broadcast timing measurements with the 468	40AX-4483
External Storage For The 468 Digital Storage Oscilloscope	Application note describes transferring waveforms captured with the 468 to external data storage devices.	40AX-4614
Using The 468 in Envelope Mode	Application note on the 468 envelope mode for glitch-catching and babysitting applications.	40AX-4615
468 <i>COMPUTER DESIGN</i> Reprint	Dual sampling rates in the 468 envelope mode	40AX-4838
468 <i>EDN</i> Reprint	Catching glitches on slow sweeps with the 468	41AX-4765
Your Direct Line To The World's Best Instruments And Technical Expertise	Find out about the Tektronix National Marketing Center and Tek's service offices	60A-4873

**PORTABLE SCOPE ACCESSORIES CHART**

400 SERIES	PROBES			CAMERAS			CART	MISCELLANEOUS ACCESSORIES
	Passive	Active	Current	Single Shot or Low Rep Rate	Stored/Stable or Repetition	Low Cost		
485	P6101 P6063B P6106 P6015 P6056 P6009 P6057 P6048 P6130	P6201 P6202	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B with 016-0306-01 adaptor	C-30B with 016-0306-01 adaptor	NA	200C	Folding Viewing Hood-016-0274-00 & 016-0082-00; 1105 Battery Power Supply Rain Cover-016-0554-00; Rack adaptor 016-0558-00.
475 475A	P6101 P6015 P6106 P6009 P6063B P6048 P6130	P6201 P6202	P6102 P6022 A6302/AM 503 A6303/AM 503	C-31B with 016-0269-03 adaptor	C-30B with 016-0269-03 adaptor	C-5C with 016-0359-01 adaptor	200C	Folding Polarized Viewing Hood-016-0269-03. Collapsible viewing hood (binocular)-016-0566-00 Protective Cover 016-0554-00; Mesh Filter 378-0726-01. 1105 or 1106 Battery Power Supply; Rack Adaptor 016-0556-00
465B 468	P6101 P6015 P6105 P6009 P6062B P6048 P6130	P6201 P6202	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B with 016-0269-03 adaptor	C-30B Opt 01 with 016-0269-03 adaptor	C-5C with 016-0359-01 adaptor	200C	Viewing hood (Binocular)-016-0566-00; Folding Polarized Viewing hood-016-0180-00. 1105 or 1106 Battery Power Supply Mesh Filter-378-0726-01 Rack Adaptor (468) 016-0675-00.
465M 6021	P6101 P6015 P6104 P6009 P6130	P6201 P6202	P6022 P6021 A6302/AM 503 A6303/AM 503	C-31B with 016-0269-03 adaptor	C-30B Opt 01 with 016-0269-03 adaptor	C-5C with 016-0359-01 adaptor	200C	Folding Polarized Viewing Hood-016-0180-00. Mesh Filter-378-0726-01; 1105 Battery Power Supply; Rack Adaptor-040-0825-01
466 464	P6101 P6015 P6105 P6009 P6062B P6130	P6202 P6201	P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B with 016-0269-03 adaptor	C-30B Opt 01 with 016-0269-03 adaptor	C-5C with 016-0359-01 adaptor	200C	Folding Polarized Viewing Hood-016-0180-00. Collapsible Viewing Hood (Binocular)-016-0566-00 Protective Cover-016-0365-00; Mesh Filter-378-0726-01 1105 Battery Power Supply; Rack Adaptor-016-0675-00.
434	P6101 P6015 P6108 P6120 P6009		P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B with 016-0269-03 adaptor	C-30B Opt 01 with 016-0269-03 adaptor	C-5C Opt 02 with 016-0359-01 adaptor (handheld)	200C	Folding Polarized Viewing Hood-016-0180-00; Mesh Filter-378-0682-00. 1105 Battery Power Supply Rack Adaptor-016-0272-00
<b>2300 SERIES</b>								
2335 2336 2337	P6063B P6130	P6202A	P6021 P6022 A6302/AM 503 A6303/AM 503	NA	NA	C-5C with 016-0357-01 adaptor	NA	2335 Rack Adaptor Kit 016-0468-00
<b>2200 SERIES</b>								
2213 2215	P6120 P6101		P6021 P6022 A6302/AM 503 A6303/AM 503			C-5C with 016-0359-01 adaptor (with flash)	200C	Clear CRT Light Filter Custom Mod-337-2775-01 CRT TV Graticule Custom Mod-035-0175-00 Accessories Pouch-016-0677-00, Front Cover 200-2520-00 RM Kit 016-0466-00
<b>300 SERIES</b>								
314 305 335	P6101 P6149A		P6021 P6022 A6302/AM 503 A6303/AM 503	C-31B with 016-0327-01 adaptor	C-30B with 016-0327-01 adaptor		NA	Viewing Hood-016-0297-00; Mesh Filter-378-0063-00 1105 Battery Power Supply Rain Cover (314, 335) 016-0612-00
<b>T900 SERIES</b>								
T912	P6101 P6015 P6108 P6120 P6062B P6007		P6021 P6022 A6302/AM 503 AM6303/AM 503			C-5C Opt 03 with 016-0358-01 adaptor	NA	Protective Cover-016-0340-00; Dust/Rain Jacket-016-0361-00
T922R	P6101 P6015 P6108 P6120 P6062B P6007		P6021 P6022 A6302/AM 503 A6303/AM 503			C-5C with 016-0357-01 adaptor	NA	Viewing Hood-016-0377-00



## 485

350 MHz at 5 mV/div

1 ns/div Sweep Rate

2.0 div/ns Writing Speed

1 MΩ and 50 Ω Input Impedances

Input Protection 50 Ω Internal

Automatic Deflection Factor Readout

Pushbutton Ext Trigger View

Battery Operation (Optional)

Weighs ≈9.5 kg (21 lb)

At just 21 pounds, the 1 ns/div dual-trace 485 is the only true portable, 350 MHz oscilloscope on the market. This wide bandwidth is one reason why the 485 is highly compatible with today's increasing technology.

Many features contribute to the 485's extraordinary overall performance. Fast 2.0 div/ns writing speed is one, making it especially attractive for use in field research environments.

The 485 features a wide bandwidth at its full 5 mV/div vertical sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ). Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes.

Internal detection circuitry protects the 50 Ω input by automatically disconnecting when the signal exceeds approximately 5 V RMS.

You no longer have to mentally compensate for attenuating probes. Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen V/div when the recommended 10X or 100X probes are used.

You always know exactly where you are in a pulse train when making a delayed sweep measurement. An alternate sweep mode allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, you can view the intensified zone and the delayed display simultaneously.

The external trigger signal can be easily viewed on the 485. A front-panel pushbutton automatically routes the external signal used to trigger time base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

On the 485, focus is always correct for single-shot photography. An autofocus circuit eliminates the need to readjust the focus each time the intensity is changed.

When commercial power is not available, use the 1105 Battery Power Supply. It weighs only 19.5 pounds, and lets you take the high-performance 485 virtually anywhere.

Often chosen as a general-purpose scope for computer and electronic servicing environments because of its fast writing speed and wide bandwidth, the 485 can also be found in specialized and unusual applications. For example, to maintain a groundbased laser/radar acquisition system, the 485's alternate sweep switching capability can be very useful.

## CHARACTERISTICS

### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth\* and Risetime** — (At all deflection factors from 50 Ω terminated source).

	-15°C to +35°C	+35°C to +55°C
50 Ω	Dc to 350 MHz, 1 ns	Dc to 300 MHz, 1.2 ns
1 MΩ	Dc to 250 MHz, 1.4 ns	Dc to 200 MHz, 1.8 ns

\*Measured at -3 dB. Bandwidth may be limited to ≈20 MHz by bandwidth limit switch.

Lower -3 dB point, ac coupling 1X probe: 1 kHz or less for 50 Ω, and 10 Hz or less for 1 MΩ. 10X probe: 100 Hz or less for 50 Ω, and 1 Hz or less for 1 MΩ.

**Deflection Factor** — 5 mV/div to 5 V/div (1-2-5 sequence), accurate +2%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

**Display Modes** — CH 1, CH 2 (normal and inverted), alternate, chopped (≈1 MHz rate), X-Y (CH 1-Y and CH 2-X), ADD (CH 1 ± CH 2).

**CMRR** — Common mode rejection ratio at least 20 dB at 50 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X, 10X, and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

**Selectable Input Impedance** — 50 Ω and 1 MΩ impedances are available at a single BNC connector by pushbutton selection.

50 Ω ± 0.5%; VSWR 1.15:1 or less from 20 mV/div to 5 V/div, 1.25:1 or less at 5 mV/div and 10 mV/div to 350 MHz.

**Input R and C** — 1 MΩ ± 1% paralleled by ≈20 pF.

**50 Ω Protection** — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

### Maximum Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approx: 5 V RMS continuous 0.1 W-second for instantaneous voltages of 5 V to 50 V	
	Signals in excess of 150 V will damage the instrument	
1 MΩ	Dc coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz
	Ac coupled	500 V (dc + peak ac) 500 V p-p to 1 kHz

**Selectable Input Coupling** — Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Probe Power** — Connectors provide correct voltages for two optional P6201 FET Probes.

### HORIZONTAL DEFLECTION

**Time Base A and B** — Calibrated sweep range; 1 ns/div to 0.5 s/div (1-2-5 sequence).

**Variable Time Control** — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

### Time Base A and B Accuracy, Center 8 Division

Sweep Rate	+15°C to +35°C	-15°C to +55°C
1 ns/div to 20 ns/div	±3%	±5%
50 ns/div to 0.1 s/div	±2%	±4%
0.2 s/div and 0.5 s/div	±3%	±5%

**Horizontal Display Modes** — A, intensified, alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2, and 5 ns/div B ends A for increased intensity in the delayed mode.

**Alternate Display Modes** — Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed sweep ≈4 div from the A sweep).

**CALIBRATED SWEEP DELAY**

**Delay Time Range** — 0 to 10X delay time/div setting of 10 ns/div to 0.5 s/div.

**Differential Delay Time Measurement Accuracy**

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	±(1% of measurement + 0.2% of full scale)*
50 ns/div to 1 ms/div	±(0.5% of measurement + 0.1% of full scale)*
2 ms/div to 0.5 s/div	±(1% of measurement + 0.1% of full scale)*

\*Full scale is 10 times the delay time/div setting.

**Jitter** — 1 part or less in 20,000 of 10X the time/div setting.

**TRIGGERING A and B**

**A Trigger Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights Indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for faster than 0.2 s/div.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

**Time Base A and B Trigger Sensitivity and Coupling**

Coupling	To 50 MHz	To 350 MHz
Dc Internal	0.3 div deflection	1.5 div deflection
Dc External	20 mV	100 mV
Ac	Signals below 16 Hz are attenuated	
Ac LF Reject	Signals below 16 kHz are attenuated	
Ac HF Reject	Signals below 16 Hz and above 50 kHz are attenuated	

**Jitter** — 0.1 ns or less at 350 MHz at 1 ns/div.

**A Trigger View** — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is ≈ 50 mV/div (0.5 V/div with external ÷ 10 source).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for Ext ÷ 10.

**A Sources** — Internal, line, external, external ÷ 10.

**B Sources** — B runs after delay time, internal, external, external ÷ 10.

**External Inputs** — R and C ≈ 1 MΩ paralleled by ≈ 20 pF. Maximum input voltage; 500 V (dc + peak ac), 500 V p-p to 1 kHz.

**X-Y OPERATION**

**Full Sensitivity X-Y (CH 1 Vertical, CH 2 Horizontal)** — 5 mV/div to 5 V/div, accurate ±2%. Y-axis bandwidth identical to CH 1. X-axis bandwidth is dc to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

**DISPLAY**

**CRT** — 8 x 10 division display, each division is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2 division increments. P31 Phosphor standard; P11 optional. 21 kV accelerating potential.

**Photographic Writing Speed** — At least 1. div/ns with standard P31 Phosphor and at least 2 div/ns with optional P11 Phosphor using the Tektronix C-31B Camera and 3000 speed type 107 film.

**Auto Focus** — Automatically maintains beam focus for all intensity settings.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

**Z-Axis Input** — Risetime ≈ 15 ns. Input R ≈ 500 Ω. +0.2 V (dc to 20 MHz) decreases intensity. +2 V (dc to 2 MHz) blanks maximum intensity trace.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: −15°C to +55°C. Nonoperating: −35°C to +75°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: to 4500 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: to 15 200 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes. 0.06 cm (0.025 in) p-p displacement (four g's at 55 Hz) 10 to 55 to 10 Hz in one minute cycles.

**Humidity** — Operating and nonoperating: five cycles (120 hrs) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class four).

**Shock** — Operating and nonoperating — 30 g's, 1/2 sine, 11 ms duration, two shocks per axis in each direction for a total of 12 shocks.

**OTHER CHARACTERISTICS**

**Two-Frequency, Fast-Rise Calibrator** — Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%. Amplitude is 5 V ± 0.5% into 1 MΩ and 0.5 V ± 1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA ± 1%. Selectable repetition rates are 1 kHz and 1 MHz ± 0.25%. Specifications apply over +15°C to +35°C range.

**A Sweep Output** — Open circuit, ≈ 10 V positive-going sawtooth; into 50 Ω, ≈ 0.5 V.

**A and B Gate Outputs** — Open circuit, ≈ 4 V positive-going rectangular pulse; into 50 Ω ≈ 0.5 V.

**Power Requirements** — Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 W maximum power consumption at 115 V. Line frequency 48 to 440 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width	305	12.0	483	19.0
Height	168	6.6	177	7.0
Depth			457	18.0
(handle extended)	523	20.6		
(handle not extended)	470	18.5		
<b>Weights</b> ≈	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net (with accessories)	10.9	24.0		
Net (without accessories)	9.5	21.0	11.9	26.2
Shipping	15.0	33.0	24.5	54.0

**INCLUDED ACCESSORIES**

50 Ω, 18 inch BNC cable (012-0076-00); two BNC jack posts (012-0092-00); two 50 Ω terminators (011-0049-01); clear filter (386-0118-00); four 3 amp fuses (159-0015-00); accessory pouch (016-0535-00); or (016-0537-00). Rack models also include mounting hardware and slide out assemblies.

**ORDERING INFORMATION**

**485 Oscilloscope** ..... \$7,690

**R485 Rackmount Oscilloscope** ..... \$7,910

**INSTRUMENT OPTIONS**

**Option 04** — EMC Modification for 485 ..... +\$140

**Option 04** — EMC Modification for R485 ..... +\$140

**Option 78** — P11 Phosphor ..... +\$35

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC

**Option A2** — UK 224 V/13A, 50 Hz ..... NC

**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A4** — North American 240 V/15A, 60 Hz ..... NC

For more information on instrument options, see your Tektronix Sales Engineer, Distributor, or Representative.

**OPTIONAL ACCESSORIES**

Input Terminal	Probe Type	Attenuation	Input Impedance	Bandwidth* with 485
50 Ω Input	P6056 6 ft	10X	500 Ω 1 pF	350 MHz
	P6057 6 ft	100X	5000 Ω 1 pF	350 MHz
	P6201 FET 2 m	1X 10X Head 100X Head	100 kΩ 3 pF 1 MΩ 1.5 pF 1 MΩ 1.5 pF	330 MHz
50 Ω or 1 MΩ	P6202 2 m	10X 100X Head (optional)	10 MΩ 2 pF	285 MHz
	P6106 2 m	10X	10 MΩ 13 pF	250 MHz
1 MΩ Input	P6063B 6 ft	1X Switchable 10X	1 MΩ 12 pF 10 MΩ 14 pF	6 MHz 200 MHz
Current Probe	Probe Type	Calibration	Insertion Impedance	Bandwidth* with 485
	P6022 5 ft	1 mA/mV 10 mA/mV (selectable)	0.03 Ω @ 1 MHz increasing to 0.2 Ω @ 120 MHz	130 MHz

\*Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

**Current Loop Adaptor** — The adaptor provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is ≈ 25 ns.

Order 012-0341-00 ..... \$45

**50 Ω 5X Pad** — Provides reverse termination for the calibrator. Order 011-0060-02 ..... \$35

**Folding Viewing Hoods**

Folds to 1.2 x 11.5 x 19.1 cm (7/16 x 7 1/2 x 7 1/2 in).

Order 016-0274-00 ..... \$15

Folds to 1.4 x 17.2 x 34.9 cm (9/16 x 6 3/4 x 13 3/4 in).

Order 016-0082-00 ..... \$15

**SCOPE-MOBILE® Cart** — Occupies <18 in aisle space, has storage area in base.

Order 200C ..... \$295

**Battery Power Supply**

Order 1105 Battery Power Supply ..... \$1,375

**Rack Adaptor** — Order 016-0558-00 ..... \$320

**RECOMMENDED CAMERAS**

**C-30BP General Purpose Camera** — Includes 016-0306-01 mounting adaptor.

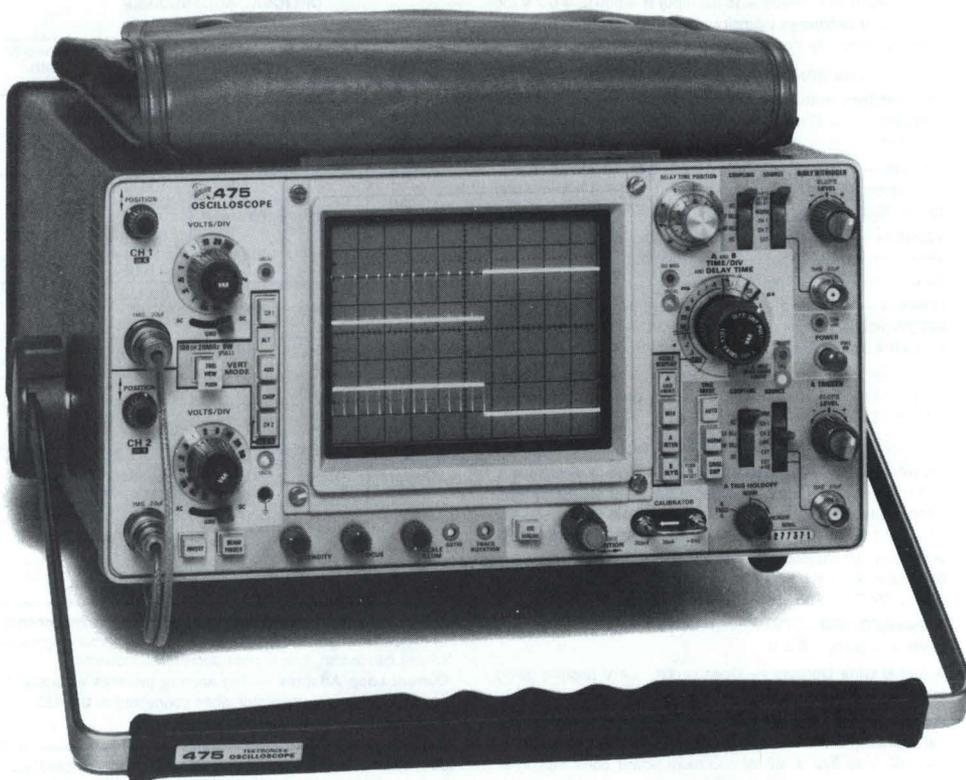
Order C-30BP ..... \$1,360

**C-31BP High Speed Camera** — Includes 016-0306-01 mounting adaptor.

Order C-31BP ..... \$1,570

For further information see camera section.

Tektronix offers service training classes on the 400 Series Oscilloscopes. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



## 475/475A

**1 ns/div Sweep Rate (475) (475A) with X10 Sweep Magnifier**

**Trigger View**

**Versatile Trigger Selection**

**Battery Operation (Optional)**

**Weighs  $\approx$  10.3 kg (22.75 lb)**

Both of these Tektronix portable oscilloscopes feature high performance and light weight for making complex measurements in the field.

The 475A provides a 250 MHz bandwidth at 5 mV/div. It features wider bandwidth than the 475, plus a more concise spot size and trace for particular applications.

With 200 MHz at 2 mV/div, the 475 features better sensitivity than the 475A. This bandwidth/sensitivity combination is useful in a wide variety of measurements.

Both the 475 and 475A offer 2% (1 ns/div) or 1% (10 ns/div) timing accuracy, which can be critical in servicing computers.

Both oscilloscopes are light, compact, and rugged for portability and durability, yet each contains a large, bright 8 x 10 cm CRT. Operation has been simplified by single-function pushbuttons, control knob design, layout, and color-coordinated front panels.

Determining deflection factors used to be error-prone and costly. Now, it's a problem of the past...readout lights behind knob skirts automatically indicate the proper probe tip deflection factors for recommended 1X and 10X probes.

Measuring with respect to ground is important in many applications. This is controlled at the probe when dc-coupled by simply pressing the small ground reference button on recommended probes.

You can choose from the 1105 or 1106 Battery Packs. Both are small and light weight, and provide a ready solution for making accurate measurements in difficult environments such as conducted EMC, ground loops, power line fluctuations or where line power is nonexistent.

Applications for these instruments are widespread. The 475 performs tests and measurements aboard flight test aircraft, in both stationary and portable modes.

### CHARACTERISTICS

All characteristics are common to the 475 and 475A except where indicated.

#### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth\* and Rise time** — (At all deflection factors from 50  $\Omega$  terminated source).

	-15°C to +40°C	+40°C to +55°C
475	Dc to 200 MHz, 1.8 ns	175 MHz, 2.0 ns
475A	Dc to 250 MHz, 1.4 ns	250 MHz, 1.4 ns

\*Measured at -3 dB, bandwidth may be limited to  $\approx$  20 MHz or 100 MHz by bandwidth limit switch.

Lower -3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

### Deflection Factor at BW

475 — 2 mV/div to 5 V/div

475A — 5 mV/div to 10 V/div

1-2-5 sequence, accurate  $\pm$  3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div (475) to at least 25 V/div (475A). In cascade mode sensitivity is  $\approx$  400  $\mu$ V/div (475); and  $\approx$  2.5 mV/div (475A). Cascaded bandwidth is at least 50 MHz (475/475A) when signal out is terminated in 50  $\Omega$ .

**Display Modes** — CH 1; CH 2 (normal and inverted), alternate, chopped ( $\approx$  1 MHz rate), added; X-Y (CH 1-X, CH 2-Y).

**CMRR** — Common-mode rejection ratio at least 20 dB at 1 kHz for common-mode signals of 8 division or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 M $\Omega$   $\pm$  2%, paralleled by  $\approx$  20 pF.

#### Maximum Input Voltage

Dc coupled	250 V (dc + peak ac)
	500 V (p-p ac at 1 kHz or less)
Ac coupled	500 V (dc + peak ac)
	500 V (p-p ac at 1 kHz or less)

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Probe Power** — Connectors provide correct voltages for two optional P6201 FET Probes.

#### HORIZONTAL DEFLECTION

**Time Base A and B** — 0.01  $\mu$ s/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 1 ns/div.

**Variable Time Control** — Time Base provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

#### Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C	-15°C to +55°C
Unmagnified	$\pm$ 1%	$\pm$ 2%
Magnified	$\pm$ 2%	$\pm$ 3%

**Horizontal Display Modes** — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

**Calibrated Mixed Sweep** — Displays A sweep for period determined by delay-time position control, then displays B sweep for remainder of horizontal sweep.

#### CALIBRATED SWEEP DELAY

**Delay Time Range** — 0 to X10 delay time/div settings of 50 ns to 0.5 s (minimum delay time is 50 ns).

#### Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
Over one or more major dial divisions	$\pm$ 1%
Less than one major dial division	$\pm$ 0.01 major dial division

**Jitter** — One part or less in 50,000 (0.002%) of X10 the A sweep time/div setting. One part in 20,000 when operating from 50 Hz line.

#### TRIGGER

**A Trigger Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

**Time Base A and B Trigger Sensitivity and Coupling**

		475		475A	
Coupling		To 40 MHz	At 200 MHz	to 40 MHz	At 250 MHz
Dc	Internal	0.3 div deflection	1.5 div deflection	0.3 div deflection	2.0 div deflection
	External ÷ 10	50 mV 500 mV	250 mV 2.5 V	50 mV 500 mV	250 mV 2.5 V
Ac		Requirements increase below 60 Hz			
Ac LF Reject		Requirements increase below 50 kHz			
Ac HF Reject		Requirements increase below 60 Hz and above 50 kHz			

**475 Jitter** — 0.2 ns or less at 200 MHz and 1 ns/div.

**475A Jitter** — 0.2 ns or less at 250 MHz and 1 ns/div.

**A Trigger View** — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is ≈50 mV/div (0.5 V/div with external ÷ 10 source).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷ 10.

**A Sources** — Normal, CH 1, CH 2, line, external, and external ÷ 10.

**B Sources** — Starts after delay, normal, CH 1, CH 2, and external.

**External Inputs** — R and C ≈1 MΩ paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

**X-Y OPERATION**

**Full-Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 2 mV/div to 5 V/div (475), 5 mV to 10 V/div (475A) accurate ±3%. Bandwidth is dc to at least 3 MHz. Phase difference between amplifiers is 1° or less from dc to 1 MHz.

**DISPLAY**

**CRT** — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 Phosphor standard; P11 optional. 18 kV accelerating potential.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: -15°C to +55°C. Nonoperating: -55°C to +75°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: to 4500 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 15 200 m (50,000 ft).

**Vibration** — Operating — 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

**Humidity** — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9 5.1, class four).

**Shock** — Operating and nonoperating: 30 g's 1/2 sine, 11 ms duration, two shocks per axis in each direction for a total of 12 shocks.

**OTHER CHARACTERISTICS**

**Amplitude Calibrator**

Output Voltage	0.3 V	1% +0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	≈ 1 kHz	

**Vertical Signal Output** — CH 2 vertical signal is dc to at least 50 MHz (-3 dB), and ≈10 mV/div terminated into 50 Ω, and ≈20 mV/div terminated in 1 MΩ.

**Gate Outputs** — Positive gates from both time bases (≈5 V).

**Power Requirements** — Quick-change line voltage selector provides six ranges; 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, or 100 W maximum at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width (with handle)	328	13.1	483	19.0
Height (w/o pouch)	157	6.2	177	7.0
Depth (with panel cover)	460	18.1	457	18.0
Depth (handle extended)	516	20.3		
<b>Weights ≈</b>	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net (without panel cover)	10.3	22.8	13.3	29.4
Net (with panel cover and accessories)	11.5	25.3		
Shipping	16.7	37.0	26.3	58.0

**INCLUDED ACCESSORIES**

Two P6106 10X probes (010-6106-03); blue accessory pouch for DMM version only (016-0594-00); blue accessory pouch for standard cabinet versions only (016-0535-02); blue CRT light filter, (337-1674-00); clear CRT light filter, (337-1674-01); clear pouch (016-0537-00); two 1 1/2-amp fuses, (159-0016-00); one 3/4-amp fuse (159-0042-00); BNC male to ground wire, (134-0016-01). Rack models also include mounting hardware and slide out assemblies, do not include accessory pouches.

**ORDERING INFORMATION**

475 Oscilloscope .....	\$4,300
475A Oscilloscope .....	\$4,630
R475 Rackmount Oscilloscope .....	\$4,520
R475A Rackmount Oscilloscope .....	\$4,850
475 DM 44 DM 44 info on page 317 ..	\$4,820
475A DM 44 (order 475A 44) .....	\$5,150

**INSTRUMENT OPTIONS**

Option 01 — Delete Temperature Probe on DM 44 .....	-\$90
Option 04 — EMC Modification .....	+\$160
Option 07 — Ext Dc Operation (Cannot be ordered with DM 44.) .....	+\$245
Option 78 — P11 Phosphor .....	+\$35

Modification kits for field conversion of existing 475s or 475As to Option 04, Option 07, or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15A, 60 Hz .....	NC

**OPTIONAL ACCESSORIES**

**Probes**

Probe Type	Attenuation	Input Impedance	Bandwidth* with	
			475	475A
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz	6 MHz
	Switchable			
	10X	10 MΩ 14pF	145 MHz	160 MHz
P6202 FET Probe 2 m	10X	10 MΩ 2 pF	185 MHz	220 MHz
	100X Head	10 MΩ 2 pF	185 MHz	220 MHz
	Ac Head	10 MΩ 4 pF	185 MHz	220 MHz
Current Probe	Calibration	Insertion Impedance	Bandwidth with	
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	125 MHz	160 MHz

\*Bandwidths are measured at the upper -3 dB and apply only to the cable length shown. Generally shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

<b>Folding Polarized Viewing Hood</b> Order 016-0180-00 .....	\$40
<b>Collapsible Viewing Hood Binocular.</b> Order 016-0566-00 .....	\$15
<b>Protective Cover Waterproof, blue vinyl.</b> Order 016-0554-00 .....	\$17
<b>Mesh Filter Improves contrast and EMC filtering.</b> Order 378-0726-01 .....	\$55
<b>SCOPE-MOBILE® Cart Occupies &lt;18 in aisle space, has storage area in base. Order 200C .....</b>	\$295
<b>Order 1105 Battery Power Supply .....</b>	\$1,375
<b>Rack Adaptor (Not for use with DM 44). Order 016-0556-00 .....</b>	\$300

**RECOMMENDED CAMERA**

**C-30BP Option 01** — General Purpose Compact Camera Includes 016-0301-01 mounting adaptor/corrector lens.  
Order C-30BP Option 01 .....

**\$1,360**

For further information see camera section.



**1106 BATTERY PACK**

The 1106 is a convenient, snap-on battery power supply for Tektronix 455, 464, 465B, 466, 475 or 475A Oscilloscopes when the scope is ordered with Option 07.

**Output Power** — 22 to 26 V dc; 100 W-hours from full charge.  
**Charging Power Source** — 90 to 132 V ac, 50 to 400 Hz; or 180 to 264 V ac, 50 to 400 Hz.  
**Charging Time** — 14 to 16 hours.  
**Weight** — 7.2 kg (16 lb).

**Order 1106 Battery Pack .....**

**\$1,000**



465B44 Oscilloscope/DMM shown above includes DM 44 Digital Multimeter.

## 465B/DM 44

100 MHz at 5 mV/div

2 ns/div Sweep Rate with X10 Sweep Magnified

Trigger View

Versatile Trigger Selection

Alternate Sweep

The 465B continues the tradition of the 465 as the industry standard 100 MHz oscilloscope.

It is the scope most preferred for servicing mainframes and minicomputers as well as meeting the most demanding service needs in the telecommunications, medical instrumentation, and aerospace industries.

465B trace selection versatility allows you to choose channel 1 and/or channel 2, sum or difference, and A trigger view in any combination.

In addition, the 465B has all the features of the original 465: 5 mV/div vertical trace, delayed sweep, the differential time/DMM option, and a sharp, bright 8 x 10 cm CRT.

### CHARACTERISTICS VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth\* and Risettime** — (at all deflection factors from 50  $\Omega$  terminated source)

-15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, 3.5 ns	85 MHz, 4.1 ns

\*Measured at -3 dB. Bandwidth may be limited to  $\approx$ 20 MHz by bandwidth limit switch.

Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50  $\Omega$ .

Lower -3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe - 1 Hz or less.

**Deflection Factor at BW** — 5 mV/div to 5 V/div. 1-2-5 sequence, accurate  $\pm$ 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. LED warning light indicates uncalibrated setting. In cascade mode sensitivity is  $\approx$ 1 mV/div.

**Display Modes** — CH 1; CH 2 ADD (normal and inverted), alternate, chopped— $\approx$ 500 kHz rate, in any combination electronically switched.

**CMRR** — Common-mode rejection ratio at least 20 dB at 20 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are indicated by two readout lights behind knob skirts. LEDs are off when channel not displayed. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 M $\Omega$   $\pm$ 2%, paralleled by  $\approx$ 20 pF.

#### Maximum Input Voltage

Dc coupled	250 V (dc + peak ac)
	500 V (p-p ac at 1 kHz or less)
Ac coupled	250 V (dc + peak ac)
	500 V (p-p at 1 kHz or less)

**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL DEFLECTION

**Time Base A** — 0.02  $\mu$ s/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 2 ns/div. LED indicates X10 magnified.

**Time Base B** — 0.02  $\mu$ s/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 2 ns/div. LED indicates X10 magnified.

**Variable Time Control** — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. LED warning light indicates uncalibrated setting.

#### Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C	-15°C to +55°C
Unmagnified	$\pm$ 2%	$\pm$ 3%
Magnified	$\pm$ 3%	$\pm$ 4%

**Horizontal Display Modes** — A, A intensified, alternate (A intensified and B delayed), B delayed. B ends A for increased intensity in the delayed mode. Electronic switching between intensified and delayed sweep. A sweep and B sweep may be viewed simultaneously.

#### CALIBRATED SWEEP DELAY

**Delay Time Range** — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s.

#### Differential Time Measurement Accuracy

<b>Delay Time Setting</b>	+15°C to +35°C
Over one or more major dial divs	$\pm$ 1%
Less than one major dial div	$\pm$ 0.01 major dial divs

**Jitter** — one part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. One part in 20,000 when operating from 50 Hz line.

#### TRIGGER

**A Trigger Modes** — Normal (sweep runs when triggered), automatic (sweep runs in the absence of a triggering signal and for signals below 30 Hz), Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). LED lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

#### Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
Dc		
Internal	0.3 div deflection	1.5 div deflection
External	50 mV	150 mV
External $\div$ 10	500 mV	1.5 V
Ac	Requirements increase below 60 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase below 60 Hz and above 50 kHz	

**Jitter** — 0.5 ns or less at 100 MHz and 2 ns/div.

**Zero Delay A Trigger View** — Electronically switched trigger view displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal which can be displayed simultaneously. The deflection factor is  $\approx$ 100 mV/div (1 V/div with external  $\div$  10).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least  $\pm$ 2 V in external, through at least  $\pm$ 20 V in external  $\div$  10.

**A Sources** — Normal, CH 1, CH 2, line, external, and external  $\div$  10.

**B Sources** — Starts after delay, normal, CH 1, CH 2, and external.

**External Inputs** — R and C  $\approx$ 1 M $\Omega$  paralleled by  $\approx$ 20 pF. 250 V (dc + peak ac) maximum input.

#### X-Y OPERATION

**Full-sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div, accurate  $\pm$ 4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

#### DISPLAY

**CRT** — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 phosphor standard; P11 optional. 18 kV accelerating potential.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in locating an offscreen signal. A preset intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

#### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: -15°C to +55°C. Nonoperating: -62°C to +85°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: to 4500 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: to 15 200 m (50,000 ft).

**Vibration** — Operating: 15 minute along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10-55 to 10 Hz in 1 minute cycles.

**Humidity** — Operating and nonoperating: 5 cycles (120 hours) to 95%-97% relative humidity as specified in MIL-T-28800B (par 3.9.2.2).

**Shock** — Operating and nonoperating: 30 g's  $\frac{1}{2}$  sine, 11 ms duration, three shocks per axis in each direction for a total of 18 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	≈ 1 kHz	

**Vertical Signal Output** — CH 1 vertical signal is dc to at least 50 MHz (−3 dB), and ≈25 mV/div terminated into 50 Ω, and ≈50 mV/div terminated into 1 MΩ.

**Gate Outputs** — Positive gates from both time bases (≈5 V).

**Power Requirements** — Quick-change line voltage selector provides six ranges; 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, 85 W maximum at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

PHYSICAL CHARACTERISTICS

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width (with handle)	328	13.1	483	19.0
Height	157	6.2	177	7.0
Depth (with panel cover)	460	18.1	457	18.0
Depth (handle extended)	516	20.3		
<b>Weights</b> ≈	<b>kg</b>	<b>lb</b>	<b>kg</b>	<b>lb</b>
Net (w/o panel cover)	10.3	22.8	13.3	29.4
Net (with panel cover and accessories)	11.5	25.3		
Shipping	16.7	37.0	26.3	58.0

INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03); blue accessory pouch for standard cabinet version only (016-0535-02); blue accessory pouch for DMM version only (016-0594-00); clear pouch (016-0537-00); blue CRT light filter (337-1674-00); clear CRT light filter (337-1674-01); ground wire (134-0016-01); two 1½-amp fuses (159-0016-00); one ¼-amp fuse (159-0042-00). Rack models also include mounting hardware and slide out assemblies, but not pouches.

ORDERING INFORMATION

465B Oscilloscope .....	\$3,140
R465B Rackmount Oscilloscope .....	\$3,360
465B44 Oscilloscope/DMM .....	\$3,660

INSTRUMENT OPTIONS

**Option 01** — Delete Temperature Probe on 465B44 ..... **−\$90**  
**Option 04** — EMC Modification ..... **+\$160**  
**Option 05** — TV Sync Separator (Provides triggering on TV field and TV line) ..... **+\$300**  
**Option 07** — Ext Dc Operation (not for 465B44) ..... **+\$245**  
**Option 78** — P11 Phosphor ..... **+\$35**  
 Modification kits for field conversion of existing 465Bs, to Option 04, Option 07, or 465B44 scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

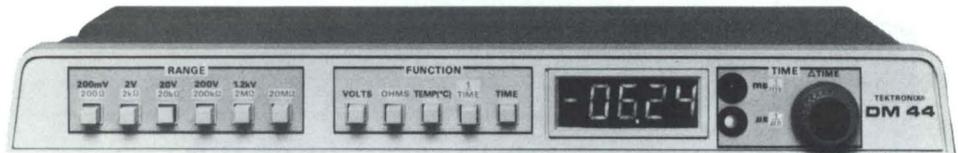
INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**

OPTIONAL ACCESSORIES

Probe Type	Attenuation	Input Impedance	Bandwidth*
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz
	Switchable 10X	10 MΩ 14 pF	90 MHz
P6202 FET Probe 2 m	10X	10 MΩ 2 pF	100 MHz
	100X Head	10 MΩ 2 pF	100 MHz
	Ac Head	10 MΩ 4 pF	100 MHz
Current Probe	Calibration	Insertion Impedance	
P6022 5 ft	1 mA/mV	0.03 Ω @ 1 MHz	85 MHz
	10 mA/mV (Selectable)	0.2 Ω @ 120 MHz	

\*Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth.



DM 44 DIFFERENTIAL-TIME/DMM OPTION

1% timing measurements were never this easy! With the DM 44 Option, available on five Tektronix 400 Series Portables, time intervals can be read directly from the 3½ digit LED Screen. Simply use the Delay Time control and the Δtime dial to position intensified spots at the beginning and end of the interval you wish to measure. Next, switch to delayed sweep and use the Δtime dial to superimpose the end of the interval on the beginning. Then read its differential time or frequency from the 3½ digit LED panel. It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the CRT may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44-equipped 400 Series Oscilloscope. The DM 44 measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to 150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

The DM 44 is available as a factory installed option on the 464, 465B, 466, 475 and 475A Portables. It adds Delta Delayed Sweep and independent DMM capabilities to these 400 Series Scopes. First, consider your bandwidth, sensitivity, storage, and price requirements. Then specify the DM 44 Option for simple and accurate digital measurements.

DM 44 CHARACTERISTICS

Timing Measurements

Differential Time Delay Accuracy		
+15°C to +35°C	−15°C to +55°C	
Used with 464, 465B, 466, 475, and 475A	used with 464, 465B, and 466	used with 475 and 475A
Within 1% of reading ±1 count	within 2.5% of reading ±1 count	within 1.5% of reading ±1 count
1/Time Accuracy		
+15°C to +35°C	−15°C to +55°C	
Used with 464, 465B, 466, 475, and 475A	used with 464, 465B, and 466	used with 475 and 475A
Within 2% of reading ±1 count	within 3.5% of reading ±1 count	within 3% of reading ±1 count

DC Voltage

**Ranges** — 0-200 mV, 0-2 V, 0-20 V, 0-200 V, 0-1.2 kV.  
**Resolution** — 100 μV.  
**Accuracy** — Within 0.1% of reading ±1 count.  
**Input Resistance** — 10 MΩ for all ranges. Removal of an internal strap increases resistance to ≈1000 MΩ on 200 mV and 2 V ranges.  
**Normal-Mode Rejection Ratio** — At least 60 dB at 50 Hz and 60 Hz.  
**Common Mode Rejection Ratio** — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.  
**Recycle Rate** — ≈3.3 measurements/s.  
**Response Time** — Within 0.5 s.

**Maximum Safe Input Voltage** — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

Resistance

**Ranges** — 0-200 Ω, 0-2 kΩ, 0-20 kΩ, 0-200 kΩ, 0-2 MΩ and 0-20 MΩ.  
**Resolution** — 0.1 Ω.  
**Accuracy**

Range	Accuracy
200 Ω	within 0.25% ±1 count + probe resistance
2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ	within 0.25% ±1 count
20 MΩ	within 0.3% ±1 count

**Recycle Rate** — ≈3.3 measurements/s.

Response Time

200 Ω through 200 kΩ ranges	within 1 s
2 MΩ ranges 20 MΩ ranges	within 5 s

**Maximum Safe Input Voltage** — 120 V RMS between + and common inputs.

Temperature Using P6430 Probe

**Range** — −55°C to +150°C.

DM 44 Temperature	P6430 Tip Temperature	Accuracy (Probe Calibrated to DM 44)
+15°C to +35°C	−55°C to +150°C	±2°C
−15°C to +55°C	−55°C to +125°C	±3°C
	+125°C to +150°C	±4°C

INCLUDED ACCESSORIES

One pair, Test Leads (003-0120-00); one P6430 Temperature Probe (010-6430-00).

ORDERING INFORMATION

465B DM 44 (Order 465B 44) .....	\$3,660
475 DM 44 Oscilloscope/DMM .....	\$4,820
475A DM 44 (Order 475A 44) .....	\$5,150
466 DM 44 Oscilloscope/DMM .....	\$7,220
464 DM 44 Oscilloscope/DMM .....	\$6,215

INSTRUMENT OPTIONS

**Option 01** — Delete Temperature Probe ..... **−\$90**  
 Modification kits for field conversion of existing 464s, 465s, 466s, 475s, and 475As to DM 44-equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**

For information on hoods, covers, filters, carts, battery packs, rack adapter, and cameras, see previous page.



## 465M (AN/USM)425 (v) 1

Fully Provisioned through the Federal Supply System

Meets MIL-T-28800, Type II, Class 4, Style C for the Environmental Conditions Listed

100 MHz at 5 mV/div, Dual Trace, Delayed Sweep

Accepted and Specified by All Branches of the Military and by Several Civil Agencies

If you're a contractor involved in designing and specifying systems for the government, here's a 100 MHz oscilloscope that should top your recommended support equipment list—the Tektronix 465M Portable Oscilloscope.

The Tektronix 465M is the AN/USM-425 (v) 1 tri-service standard 100 MHz portable oscilloscope. The instrument is accepted, fully provisioned, and supported throughout the Federal Supply System. Because the MIL manuals and support documentation are already complete, your required paper work is greatly reduced and it's much simpler for the government to accept your recommendations.

You can now order the 465M directly from your Tektronix Sales Engineer with the AN/USM 425 (v) 1 nomenclature by simply specifying option 49. This assures the fastest possible delivery of your AN/USM 425 (v) 1.

## CHARACTERISTICS

### VERTICAL SYSTEM

**Bandwidth and Rise Time** — Dc to at least 100 MHz (–3 dB) and rise time 3.5 ns or less for dc coupling and –15°C to +55°C. For ac coupling the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

**Bandwidth Limit Mode** — Bandwidth limited to 20 MHz.

**Deflection Factor** — 5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Dc accuracy: ±2% 0°C to +40°C; ±3%, –15°C to 0°C, +40°C to +55°C. Uncalibrated, continuously variable between settings, and to at least 12.5V/div.

**Common-Mode Rejection Ratio** — 25:1 to 10 MHz; 10:1 from 10 to 50 MHz, 6 cm sinewave, (ADD Mode with CH 2 inverted.)

**Display Modes** — CH 1, CH 2 (normal or inverted), alternate, chopped (250 kHz rate), added, X-Y.

**Input R and C** — 1 MΩ ±2%, ≈20 pF.

**Maximum Input Voltage** — Dc or ac coupled: ±250 V dc + peak ac at 50 kHz, derated above 50 kHz.

**Cascaded Operation** — (CH 2 Out into CH 1), Bandwidth, dc to at least 40 MHz. Sensitivity, ≈1 mV/div when terminated in 50 Ω at CH 1 input with both CH 1 and CH 2 V/div switches set to 5 mV/div.

### HORIZONTAL DEFLECTION

**Time Base A** — 0.5 s/div to 0.05 μs/div in 22 steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 5 ns/div.

**Time Base B** — 50 ms/div to 0.05 μs/div in 19 steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 5 ns/div.

	Unmagnified	Magnified
+20°C to +30°C	±2%	±3%
–15°C to +55°C	±3%	±4%

### Mixed Sweep Accuracy

A Portion: ±4%.

B Portion: ±2%.

**Horizontal Display Modes** — A, A intensified by B, B delayed by A, and mixed.

### CALIBRATED SWEEP DELAY

**Calibrated Delay Time** — Continuous from 0.1 μs to at least 5 s after the start of the delaying A sweep.

**Differential Time Measurement Accuracy** — For measurements of two or more major dial divs: +15°C to +35°C, 1% + 0.1% of full scale  
0°C to +55°C, additional 1% allowed.

**Jitter** — 1 part or less in 20,000 (0.005%) of X10 the A TIME-DIV switch setting.

### TRIGGER

**A Trigger Modes** — Normal Sweep is triggered by an internal vertical amplifier signal, external signal, or internal power line signal. A bright baseline is provided only in presence of trigger signal. Automatic: A bright baseline is displayed in the absence of input signals. Triggering is the same as normal-mode above 40 Hz. Single (main time base only): The sweep occurs once with the same triggering as normal. The capability to re-arm the sweep and illuminate the reset lamp is provided. The sweep activates when the next trigger is applied for rearming.

**A Trigger Holdoff** — Increases A sweep holdoff time to at least X10 the TIME/DIV settings, except at 0.2 s and 0.5 s.

### Triggering Sensitivity and Coupling

Coupling	From 30 Hz to 25 MHz	At 100 MHz
Dc Internal	0.3 div	1.0 div
External	50 mV	150 mV
Ac	Attenuates signals below 30 Hz	
Ac LF Reject	Attenuates signals below 15 kHz	
Ac HF Reject	Attenuates signals below 50 kHz	

**Jitter** — 0.5 ns or less at 100 MHz and 5 ns/division, -15°C to +55°C.

**Trigger View** — View external and internal trigger signals; Ext 1X, 100 mV/division, Ext ÷10, 1 V/division.

**Level and Slope** — Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits continuously variable triggering on any level between +1.0 V and -1.0 V on either slope of the trigger signal.

**A Sources** — CH 1, CH 2, Normal (all display modes triggered by the combined waveforms from CH 1 and 2), LINE, EXT, EXT ÷10.

**B Sources** — B starts after delay time; CH 1, CH 2, Normal, EXT, EXT ÷10.

**X-Y OPERATION**

**Sensitivity** — 5 mV/division to 5 V/division in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5 V/division.

**X-Axis Bandwidth** — Dc to at least 4 MHz.

**Y-Axis Bandwidth** — Dc to 100 MHz.

**X-Y Phase** — <3° from dc to 50 kHz.

**SIGNAL OUTPUTS**

**A Gate** — ≈5.0 V positive-going pulse.

**B Gate** — ≈5.0 V positive.

**DISPLAY**

**CRT** — 5 in, rectangular tube; 8 x 10 cm display; P31 Phosphor.

**Graticule** — Internal, non-parallax; illuminated. 8 x 10 cm markings with horizontal and vertical centerlines further marked in 0.2 cm increments. 10% and 90% markings for rise-time measurements.

**Graticule Illumination** — Provides variable illumination from 0 to greater than optimum illumination.

**Beam Finder** — Limits the display to within the graticule area and provides a visible display when pushed.

**Z-Axis Input** — A female BNC connector is provided to permit intensity modulation over the dc to 15 MHz range. At optimum intensity, intensity modulation is accomplished with a Z-axis input of from -5 V (to intensity) to +5 V (to blank). Continuous operation maximum input shall be ±50 V (dc + peak ac).

**ENVIRONMENTAL CHARACTERISTICS**

**EMC** — Complies with the following limits as specified in MIL-T-28800B. CE01 (10 kHz to 20 kHz only), CE03, CS01, CS02, CS06, RE01 (relaxed 10 dB at fundamental, third harmonic, and fifth harmonic of the power source frequency) RE02 (limited to 7 GHz), RS01 and RS03 (limited to 1 GHz).

**Ambient Temperature** — Operating: -15°C to +55°C. Non-operating: -62°C to +85°C.

**Altitude** — Operating: to 4500 m (15,000 ft). Maximum operating temperature decreased 1°C/1,000 ft above 5,000 ft. Non-operating: to 15 200 m (50,000 ft).

**Vibration** — Operating: along each of the three major axes:  
a. cycling 5 to 25 to 5 Hz for 10 minutes at 0.025 in p-p;  
b. cycling 25 to 55 to 25 Hz for 5 minutes at 0.020 in p-p;  
c. dwelled at 55 Hz for 10 minutes at 0.020 in p-p.  
Total vibration time 75 minutes.

**Humidity** — Five cycles (120 hours) referenced to MIL-E-16400F (operating and nonoperating).

**Shock** — Operating: 30 g's, 1/2 sine, 11 ms duration, three shocks each direction per axis for a total of 18 shocks.

**OTHER CHARACTERISTICS**

**Calibrator Output Voltage** — 1.0 V ±1.0% to -15°C to +55°C. Frequency ≈1 kHz.

**Channel 2 Signal Output** — Through main module CH 2 OUT connector. Output voltage: ≈50 mV/division into 1 MΩ, ≈25 mV/division into 50 Ω. Output resistance: ≈50 Ω. Bandwidth: Dc to at least 40 MHz into 50 Ω.

**Power Requirements** — 100 V to 132 V RMS, 200 V to 264 V RMS. 48 Hz to 440 Hz. Maximum power consumption 60 W at 115 V, 60 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width (with handle)	347	13.6
Width (w/o handle)	317	12.5
Height (with feet)	179	7.0
Depth (including panel cover)	546	24.4
Depth (handle extended)	611	24.1
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net (w/o cover and accessories)	10.9	24.0
Net (with panel cover, modules, and accessories)	12.2	27.0
Shipping	15.5	34.2

**Transportation** — Meets the limits of National Safe Transit Committee test procedure 1A with a 30 in drop.

**INCLUDED ACCESSORIES**

One accessory and cover assembly (200-2055-01); one 1X probe (010-6101-00); two 10X probes (010-6104-00); three pincer tips (013-0107-03); two UHF male to BNC female adaptors (103-0015-00); two BNC male to UHF female adaptors (103-0032-00); one T connector (103-0030-00); one BNC male to dual binding post adaptor (103-0035-00); three probe tip adaptors (103-0051-01); three banana tips (134-0013-00); three 6 in. leads with spring clips (175-0124-01); three hooked probe tips (206-0105-00); one blue filter (337-2122-00); one clear filter (337-2122-01); three miniature alligator clips (344-0046-00); one power cord (161-0118-00).

**ORDERING INFORMATION**

**465M Portable Oscilloscope** ..... **\$3,860**  
**Option 49** — AN/USM 425 (v)1 ..... **NC**

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

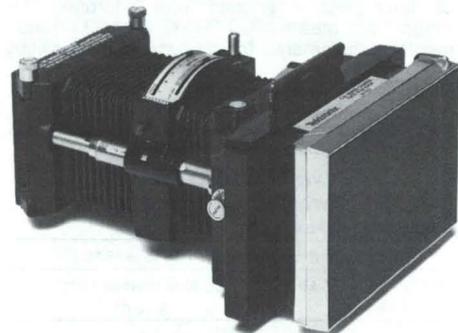
**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**

**OPTIONAL ACCESSORIES**

**Probe** — P6022 Current Probe, 9 ft cable with termination.  
 Order 015-0135-01 ..... **\$360**  
**Folding Polarized Viewing Hood**  
 Order 016-0180-00 ..... **\$40**  
**Mesh Filter** — Improves contrast and EMC filtering.  
 Order 378-0726-01 ..... **\$55**  
**SCOPE-MOBILE® Cart** — Occupies <18 in of aisle space.  
 Order 200C ..... **\$295**  
**Rack Adaptor (Cradle Mount) Kit** — Rack height 7 in, depth 18.75 in, width 19 in. Order 040-0825-01 ..... **\$350**

**RECOMMENDED CAMERA**

**C-30 BP Option 01 General Purpose Camera** — Includes 016-0301-01 mounting adaptor/corrector lens.  
 Order C-30BP Option 01 Camera ..... **\$1,402**  
**For further information see camera section.**



Tektronix offers service training classes on the 400 Series Oscilloscopes. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.



**1105 BATTERY POWER SUPPLY**

The 1105 is a rugged, portable power supply suitable for powering virtually any portable oscilloscope in the field. The 1105 is not recommended for the T912.

**Frequency** — Squarewave, 60 Hz ± 10%.

**Amplitude** — ≈108 V peak, operating from 24 V dc external or 22 V internal charge. ≈137.5 V peak, operating from 28 V dc external or 30 V internal charge.

**Amplitude (Option 01)** — ≈216 V peak, from 24 V dc external or 22 V internal charge. ≈275 V peak, operating from 30 V dc external or 28 V internal charge.

**Charging Power Source** — 100 to 132 V ac, 48 to 440 Hz (or internal connections expand range). Option 01 — 200 to 264 V ac, 48 to 440 Hz (or internal connections expand range).

**Battery Operating Time** — ≈100 W hours.

**Recommended Maximum Output Current** — 0.9 A.

**Weight** — 8.8 kg (19.5 lb).

**ORDERING INFORMATION**

**Order 1105 Battery Power Supply** ..... **\$1,375**  
**Option 01** — 230 V Operation ..... **NC**

2335



**2335/2336/2337**

**Dc to 100 MHz Bandwidth**

**5 mV/div to 5 V/div**

**5 ns/div Sweep Rate with X10 Magnifier**

**Rugged for Field Service**

Compact and lightweight for ultra-portability, these oscilloscopes are designed and built for on-site trouble-shooting. The 2335, 2336, and 2337 are useful for high speed logic and digital applications. They feature an innovative and protective flip-top cover that doubles as a front panel with  $\Delta$ Time on the 2336 and  $\Delta$ Time/DMM on the 2337 versions. The entire outside case of all three instruments is made of durable, one-piece aluminum and the front panels are coated with scratch resistant plastic. When the flip-tops are latched shut, the entire scope can withstand the abuse and heavy usage of field service environments.

Vertical channels have calibrated deflection factors from 5 mV/div to 5 V/div with a variable gain control to increase the sensitivity to at least 2 mV/div. An internal delay line permits observation of the leading edge of a waveform. Variable sweep speeds range from 0.5 s/div to 50.0 ns/div and a 10X magnifier can increase the sweep rate to 5 ns/div. An auto-trigger mode allows triggering on waveforms with repetitive rates down to approximately 10 Hz. The sweep rate will run freely and provide a base line trace in the absence of an adequate trigger signal.

Many exterior features have been incorporated into these new ultra-portable scopes to make them fast and convenient to use. The CRT produces bright, high resolution traces that are readily visible in most light conditions. The  $\Delta$ Time/DMM readouts are distinct, backlit Liquid Crystal Displays (LCD) for clear viewing in any lighting condition. All knobs and switches have been located in logical groupings to avoid errors and delays during operation. And for the 2336 and 2337 models,  $\Delta$ Timing and DMM display and controls are in the hinged, flip-top cover.

All three oscilloscopes come with detachable power cord, integral EMI shielding, and an accessories pouch. They are manufactured to withstand impact shocks of 50 g's, almost twice that of other portable scopes from Tektronix. This ruggedness meets MIL-T-28800, Class 3 environmental requirements for aerospace and military qualification.

**CHARACTERISTICS**

The following characteristics are common to the 2335, 2336, and 2337 Oscilloscopes except where indicated.

**VERTICAL DEFLECTION  
(TWO IDENTICAL CHANNELS)**

Bandwidth* and Risetime	
-15 to +40°C	+40 to +55°C
Dc to at least 100 MHz, 3.5 ns	Dc to at least 85 MHz, 4.15 ns

\*Measured at -3 dB point at all deflection factors from a 50- $\Omega$  source terminated in 50  $\Omega$ . Bandwidth may be limited to  $\approx$ 20 MHz by bandwidth limit switch.

Lower -3 dB Point (ac coupling) 1X probe — 10 Hz or less; 10X probe: 1 Hz or less.

**Deflection Factor** — 5 mV/div to 5 V/div. 1-2-5 sequence, accurate  $\pm$ 3%. Uncalibrated, continuously variable between steps and to at least 2 mV/div.

**Display Modes** — CH 1, CH 2, ADD CH 2 (normal and inverted), alternate, chopped ( $\approx$  275 kHz rate).

**CMRR** — Common-mode rejection ratio at least 10:1 at 50 MHz for common-mode signals of 6 div or less.

**Input R and C** — 1 M $\Omega$   $\pm$ 2% paralleled by 20 pF  $\pm$ 10%.

**Maximum Input Voltage** — Ac or dc coupled, 400 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.

**HORIZONTAL DEFLECTION**

**Time Base A** — 0.05  $\mu$ s/div to 0.5 s/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

**Time Base B** — 0.05  $\mu$ s/div to 50 ms/div (1-2-5 sequence). X10 magnified extends maximum sweep rate to 5 ns/div.

**Variable Time Control** — Time base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

**Time Base A and B Accuracy, full 10 div**

	+20° to +30°C	-15° to +55°C
Unmagnified	$\pm$ 2%	$\pm$ 3%
Magnified	$\pm$ 3%	$\pm$ 4%

**Display Modes** — A, A intensified by B, B delayed.

**CALIBRATED SWEEP DELAY**

**Delay Time Range** — Continuous from 50 ns to at least 5 s after start of delaying sweep.

**Differential Time Measurement Accuracy**

	+15° to +35°C	-15° to +55°C
2335	0.75% +0.015 major dial div	1.5% +0.015 major dial div
2336/2337	$\pm$ 1% of reading $\pm$ 1 count	$\pm$ 2.5% of reading $\pm$ 1 count

**Jitter** — 1 part or less in 20,000 (0.005%) of 10 times the A SWEEP TIME/DIV setting.

**TRIGGERING, A AND B**

**A Trigger Mode** — Normal (sweep runs when triggered). Automatic (sweep free runs in absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs once on first triggering event after reset selector is pressed). LED indicates when sweep is triggered and when single sweep is ready.

**Sensitivity and Coupling**

	Coupling	To 25 MHz	At 100 MHz
Dc	Internal	0.3 div deflection	1.5 div deflection
	External	50 mV	150 mV
	External $\div$ 10	500 mV	1.5 V
Ac		Requirements increase below 60 Hz	
Ac LF Reject		Requirements increase below 50 kHz	
Ac HF Reject		Requirements increase above 50 kHz	

**A Trigger Hold Off** — Adjustable control permits a stable presentation of repetitive waveforms.

**$\Delta$ TIME B Trigger Modes (2336 and 2337 only)** — Provides two intensified zones on the CRT trace for differential time measurements. Time difference between the two intensified zones is determined by B DELAY TIME POSITION and  $\Delta$ TIME POSITION controls, and is displayed on the LCD readout.

**RUNS AFTER DELAY** — B Sweep starts immediately after the delay time selected by the DELAY TIME POSITION control and is independent of B trigger signal.

**TRIGGERABLE AFTER ADJUSTABLE DELAY TIME** — The B Sweep Trigger is sourced from a composite of CH 1 and CH 2; CH 1 only, 2 only or from the EXT Trigger input connector.

**Jitter** — 1.0 ns or less at 100 MHz and 5 ns/div.

**A Trigger View** — A spring loaded pushbutton overrides other vertical controls to display the signal used to trigger the A Sweep. This control provides quick verification of the (trigger) signal and permits a time comparison between the vertical input signal and the trigger signal. Deflection Factor is 100 mV/div  $\pm$ 40% (1 V/div with EXT  $\div$  10).

**Level and Slope** — Internal, permits selection of triggering at any point on positive or negative slope of vertical input signal. Level adjustment through at least  $\pm$ 1 V in external, through at least  $\pm$ 10 V in external  $\div$  10.

**A Sources** — Vertical Mode, CH 1, CH 2, LINE, EXT, EXT + 10.

**B Sources (2336 and 2337 only)** — ΔTime runs after delay, Vertical Mode, CH 1, CH 2, EXT (All modes ac coupled).

**External Inputs** — R and C 1 MΩ ± 10%, 20 pF ± 30%. 400 V (dc + peak ac) or 500 V ac p-p at 1 kHz or less.

### X-Y OPERATION

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ± 5% from 0° to +40°C, accurate ± 8% from -15° to +55°C. X-axis bandwidth is dc to at least 2 MHz. Y-axis bandwidth is dc to at least 100 MHz. Phase difference between amplifiers is 3° or less from dc to 200 kHz.

### DISPLAY

**CRT** — 8 X 10 div (8 mm/div) display. Horizontal and vertical centerlines further marked in 0.2 div increments. P31 Phosphor standard. 18 kV accelerating potential.

**Graticule** — Internal, nonparallax, non-illuminated; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area to locate an off screen signal.

**Z-Axis Input** — Positive-going, dc coupled signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 20 MHz.



## DIGITAL MULTIMETER (2337 only)

### DC VOLTAGE

**Full Scale Ranges** — 2 V (Auto-ranging to 200 mV); 200 V (auto-ranging to 20 V); and 500 V.

**Resolution** — 100 μV at 200 mV full scale.

### Accuracy

+15° to +35°C	Within ± 0.15% of reading ± one count
-15° to +15°C	Add 0.01% for every °C below +15°C
+35° to +55°C	Add ± 0.01% for every °C above +35°C
> 80% Relative Humidity	Add ± 0.25% of reading ± 3 counts

**Input Resistance** — 10 MΩ ± 0.25%.

**Rejection Ratio** — Normal-Mode 60 dB minutes at 50 and 60 Hz. Common-Mode 100 dB minutes at dc, 60 dB minutes at 50 and 60 Hz.

**Response Time** — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).

**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

### AC VOLTAGE

**Full Scale Ranges** — 2 V (auto-ranging to 200 mV); 200 V (auto-ranging to 20 V); and 350 V.

**Crest Factor** — (When peak voltage input is < 3 times full scale) Six.

### Accuracy\*

+15° to +35°C	Within ± 3%, ± 6 counts*, 20 Hz to 20 kHz
-15° to +15°C	Add ± 0.05% for every °C below +15°C
+35° to +55°C	Add ± 0.05% for every °C above +35°C

\*Non sinewaves: Derate to 50 Hz to 20 kHz. For crest factors > 3, add +0, -1% of reading.

**Input Impedance** — Resistance 10 MΩ ± 0.25% in series with input blocking cap. Capacitance (20 V, 200 V, and 350 V range) < 150 pF; (200 mV, 2 V range) < 220 pF.

**Common-Mode Rejection Ratio** — 60 dB minimum at 50 and 60 Hz, 2 V range; 53 dB minimum at 50 and 60 Hz, 200 V/ and 300 V range.

**Response Time** — Within 3 s (no autorange); within 9 s (up range); within 7 s (down range).

**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

### RESISTANCE

**Full Scale Ranges** — 2 kΩ (auto-ranging to 200 Ω); 200 kΩ (auto-ranging to 20 kΩ); 20 MΩ (auto-ranging to 2 MΩ).

**Resolution** — 0.1 Ω.

### Accuracy

+15° to +35°C	Within ± 0.5% ± 1 count + 0.4 Ω
-15° to +15°C	Add 0.05% for every °C below +15°C
+35° to +55°C	Add 0.05% for every °C above +35°C
> 80% Relative Humidity	Add ± 1% of reading ± 8 counts

**Response Time** — < 4 s.

**Maximum Input Voltage** — 500 V (dc + peak ac) at 60 Hz (between positive and negative inputs or between either input and ground).

### ENVIRONMENTAL CAPABILITIES\*

**Operating Temperature Range** — -15° to +55°C (forced air ventilation during normal operation).

**Operating Temperature Range, Rackadapted (2335 Option 1R only)** — Temperature inside equipment rack must be between -15 and +55°C. 2335 exhaust fan temperature must not exceed +65°C.

**Storage Temperature Range (2335 only)** — -62° to +85°C.

**Storage Temperature Range (2336 and 2337)** — -40° to +80°C.

**Operating Altitude Range** — Sea level to 4500 m (15,000 ft).

**Nonoperating Altitude Range** — Sea level to 15 000 m (50,000 ft).

**Vibration, Structural Integrity** — Test samples were subjected to sinusoidal vibration in the X, Y, and Z-axes with the frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute cycles for a duration of 15 minutes. Total displacement was 0.025 in p-p at (4 g's at 55 Hz).

**Shock, Operating and Nonoperating** — Test samples were subjected to 3 shocks, both directions along each axis (X, Y, and Z) for a total of 18 shocks. Peak acceleration of each shock was 50 g's, 1/2 sine.

**Humidity, 2335 only, Operating and Nonoperating** — Test samples were exposed to 120 hrs (5 cycles) of 95% relative humidity as specified in MIL-T-28800B Paragraph 3.9.2.2.

**Humidity, 2336 and 2337 Oscilloscopes, Operating** — Test samples were subjected to 90% relative humidity at 55°C for a maximum of 72 hours.

**Humidity 2336 and 2337 DMM, Operating** — Test samples were subjected to 90% relative humidity at 35°C for a maximum of 24 hours and to 70% relative humidity at 50°C for a maximum of 24 hours.

**Humidity 2336 and 2337 Oscilloscope and DMM, Nonoperating** — Test samples were subjected to 90% relative humidity at 60°C for 72 hours.

**Electromagnetic Compatibility (EMC)** — Test samples were found in compliance with the Class 3 requirements of MIL-STD-461A using procedural steps outlined in MIL-STD-462.

(Increase RS03 requirements from 1 V/m to 10 V/m) for REO1, use 500 Hz to 30 kHz in place of 30 Hz to 30 kHz.)

\*The 2335 Oscilloscope meets all environmental requirements of MIL-T-28800, Class 3. The 2336 and 2337 Oscilloscopes meet the environmental requirements of MIL-T-28800, Class 3 except as indicated herein to avoid potential damage to the LCD readout.

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.2 V accurate ± 1% from 0° to +40°C, ± 1.5% from -15° to +55°C.

**Power Requirements** — Quick-change selector for operation from 100 V to 132 V ac or 200 to 250 V ac, 48 to 440 Hz. Maximum power consumption is 60 W at 132 V, 48 Hz. Typical power consumption is 35 W at 115 V, 60 Hz. Option 03 provides operation from 90 to 115 V ac or 180 to 230 V ac, 48 to 440 Hz.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	274	10.8
Width (with handle)	315	12.4
Height (without pouch)	135	5.3
Height (with feet and pouch)	210	8.3
Depth (with front cover)	430	17.0
Depth (handle extended)	528	20.8
Weights (2335)	kg	lb
Net (no accessories or pouch)	7.7	17.0
Net, Rackadapted Opt 1R	8.3	18.3
Net (with accessories and pouch)	8.6	19.0
Shipping, Domestic	10.6	23.5
Shipping, Export	14.7	32.5
Weights (2336)	kg	lb
Net (without accessories and pouch)	7.9	17.5
Net (with accessories and pouch)	8.8	19.5
Shipping	10.9	24.0
Weights (2337)	kg	lb
Net (without accessories and pouch)	8.0	17.6
Net (with accessories and pouch)	8.9	19.6
Shipping	10.9	24.1

### INCLUDED ACCESSORIES

Two P6108 10X Probes (010-6108-03); accessory pouch (016-0674-00); zip lock accessory pouch (016-0537-00); blue CRT implosion shield (337-2760-00) installed, clear CRT implosion shield (337-2781-00); two 1A fuses (159-0022-00); 1/2 A fuse (159-0025-00); power cord (161-0104-00). 2337 also includes test lead pair (012-0941-00).



Rackmount 2335 Option 1R

### ORDERING INFORMATION

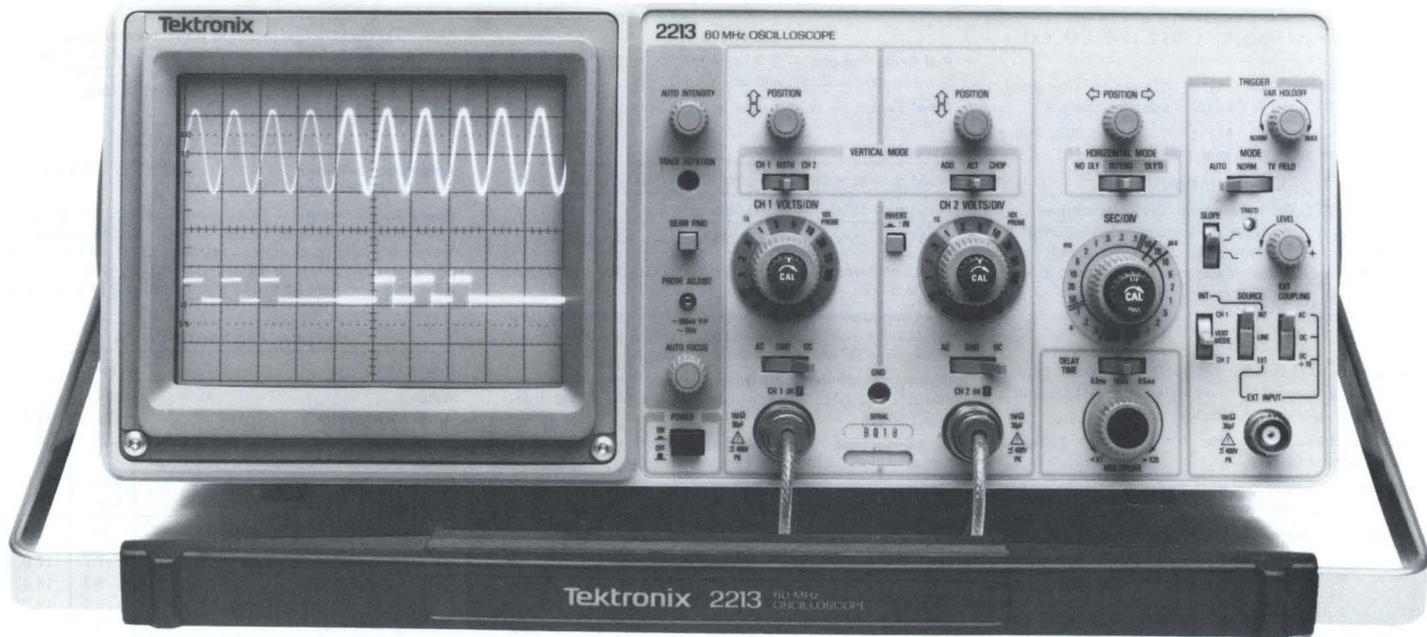
2335 Oscilloscope .....	\$2,550
2336 Oscilloscope with ΔTime .....	\$2,845
2337 Oscilloscope with ΔTime and DMM .....	\$3,145

### OPTIONS

Option 1R — Rack Conversion (2335 only) .....	+\$210
Option 03 — 100/200 V, ac nominal, 48 to 440 Hz .....	NC

### INTERNATIONAL POWER CORDS & PLUG OPTIONS

Option A1 — Universal Euro 220 V/16A, 50 Hz .....	NC
Option A2 — UK 240 V/13 A, 50 Hz .....	NC
Option A3 — Australian 240 V/10A, 50 Hz .....	NC
Option A4 — North American 240 V/15 A, 60 Hz .....	NC



## 2213/2215

Dc to 60 MHz Bandwidth

Light Weight

Easy to Use

2 mV Sensitivity

Advanced Trigger System

5 ns/div Sweep Speed

Delayed Sweep Measurements

Large, Bright CRT

New 10X Probes Included

Two 60 MHz, dual trace oscilloscopes from Tektronix offer unprecedented value in both initial and life cycle costs. They are ideal everywhere general purpose scopes are needed.

These oscilloscopes provide unexcelled performance in a small light-weight package; 6.1 kilograms (13.5 lb). With pouch and front cover, only 6.8 kilograms (15 lb).

X-Y operation is simple and easy to use. Both vertical input channels (CH 1 and CH 2) can be used through their full range of sensitivity settings. Vertical sensitivities range from 2 mV to 10 V/div. Sweep speeds range from 0.5 seconds per division to 50 nanoseconds per division. A 10X magnification provides 5 nanoseconds per division.

A pushbutton beamfinder allows easy scope setups. The scope bezel accepts a Tektronix C-5C Scope Camera with graticule illuminating flash (Option 04).

The advanced triggering system features true vertical mode alternate triggering; both the 2213 and 2215 will trigger alternately even with unrelat-

ed signals. Other features include variable trigger holdoff, TV line and TV field triggering at any sweep speed, and an enhanced auto mode. On the 2215, the dual time base operates in either run after A or trigger after A. The latter permits jitter-free B measurements.

The 2213's single time base delay provides the user with the performance of intensified and delayed sweep operations at a low price. Where dual time base performance is required, the 2215 delivers it with alternate sweep switching. The 2215 can display four traces; vertical channels 1 and 2 at the A sweep rate, and vertical channels 1 and 2, delayed, at the B sweep rate. Both scopes also incorporate new auto-intensity and auto-focus circuits that provide convenient operation over a wide range of sweep speeds.

Low life cycle cost is brought about by the inherent reliability of the new scopes. The parts count and cabling have been greatly reduced as compared to older designs. Even the traditional line transformer and line voltage selector switches have been eliminated, thanks to a new high-efficiency power supply. The advantages of these power supply improvements are that the 2213 and 2215 will operate from mains voltages of 90 to 250 Volts RMS at frequencies from 48 to 440 Hz. Additional reliability also results from superior mechanical design and packaging, soldered-in components, absolute minimum of connectors and very low power consumption.

### CHARACTERISTICS

The following electrical characteristics are common to both instruments except where noted:

#### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth\* and Risettime** — (At all deflection factors from 50  $\Omega$  terminated source).

0°C to +40°C	+40°C to +50°C
Dc to 60 MHz, 20 mV/div to 10 V/div, 5.8 ns reduced to 50 MHz for 2 mV to 10 mV/div, 7 ns	50 MHz, 7 ns

\*Measured at -3 dB.

**Deflection Factor** — 2 mV/div to 10 V/div  $\pm 3\%$  (+20°C to +30°C) or  $\pm 4\%$  (0°C to +50°C).

1-2-5 sequence. Uncalibrated, continuously variable between steps to at least 25 V/div.

**Display Modes** — CH 1, CH 2, CH 2 ADD (normal and inverted), alternate, chopped —  $\approx 250$  kHz rate, electronically switched.

**CMRR** — Common-mode rejection ratio at least 10:1 at 10 MHz for common-mode signals of 6 division or less.

**Input R and C** — 1 M $\Omega$   $\pm 2\%$  paralleled by  $\approx 30$  pF.

#### Maximum Input Voltage

Dc coupled	400 V (dc + peak ac) 800 V (p-p ac at 1 kHz or less)
Ac coupled	400 V (dc + peak ac) 800 V (p-p ac at 1 kHz or less)

**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL DEFLECTION

**Time Base A** — (Both 2213 and 2215) — 0.05  $\mu$ s/div to 0.5 s/div (1-2-5 sequence). 10X magnifier extends maximum sweep rate to 5 ns/div.

**Time Base B** — (2215 only) — 0.05  $\mu$ s/div to 50 ms/div (1-2-5 sequence). 10X magnifier extends maximum sweep rate to 5 ns/div.

**Variable Time Control** — Time Base A (both 2213 and 2215) provides continuously variable uncalibrated sweep rates between steps to at least 1.25 s/div.

**Time Base A (both 2213 and 2215) and B (2215 only) Accuracy, Center 8 Divisions**

	+20°C to +30°C	0°C to +50°C
Unmagnified	$\pm 3\%$	$\pm 4\%$
Magnified	$\pm 5\%$	$\pm 6\%$

**Horizontal Display Modes (2213)** — A, A intensified after delay, delayed.

**Horizontal Display Modes (2215)** — A, alternate (A intensified by B and B), B. Electronic switching between intensified and delayed sweep.

#### 2213 SWEEP DELAY

**Delay Times** —  $< 0.5 \mu$ s, 10  $\mu$ s, and 0.2 ms.

**Multiplier** — Increases delay time by 20 to 1 or more.

**Jitter** — 5000 to 1 (0.02%) of maximum available delay time.



**2215 SWEEP DELAY**

**Delay Times** — Continuously variable by means of a 10 to 1 vernier control. Delayed (B) portion is intensified on the main (A) trace.

**Delay Position Range** — <0.5 div +300 ns to more than 10 div.

**Delay Dial Accuracy** — ±1.5% of reading past 1 div.

**A/B Sweep Separation** — Control permits main and delayed sweep to be separated by at least 3.5 div.

**Jitter** — 10,000 to 1 (0.01%) of maximum available delay time.

**TRIGGERING**

**2213 and 2215 A Time Base Trigger Modes** — Normal (sweep runs when triggered), automatic (sweep runs in the absence of a triggering signal and triggers automatically for signals down to 20 Hz), and tv field (with slope set for negative going transitions, and trigger level adjusted close to blanking level, sweep starts at first line of video; use NORMAL for tv line display). LED indicates when sweep is triggered.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms.

**Sensitivity** — Auto and Normal Internal: Below 2 MHz, signal must be at least 0.4 div amplitude; requirements increase above 2 MHz; at 60 MHz, signal must be at least 1.5 div amplitude.

**Auto and Normal External** — Up to 2 MHz, trigger signal must be at least 50 mV p-p; requirements increase up to 60 MHz, where signal must be at least 250 mV p-p.

**TV Field** — Composite video must be at least 2 div amplitude.

**Level and Slope (NORM Mode)** — Internal: Trigger level can be adjusted over the range of amplitudes displayed on the CRT. External, dc coupled: Level can be adjusted over a range of at least ±2 V, or 4 V p-p. External, dc coupled and attenuated (÷ 10): Level can be adjusted over a range of at least ±20 V, or 40 V p-p.

**External Inputs** — R and C ≈ 1 MΩ paralleled by ≈30 pF. 400 V (dc + peak ac) or 800 V ac p-p at 1 kHz or less.

**2215 DELAYED (B) TIMEBASE**

**Level and Slope** — Separate slope and level controls for triggering B sweep.

**Sensitivity** — Up to 2 MHz, signal must be at least 0.4 div in vertical amplitude; requirements increase up to 60 MHz, where signal must be at least 2 div in amplitude.

**X-Y OPERATION**

**Full Sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 2 mV/div to 10 V/div, accurate ±5%. Bandwidth is dc to at least 2 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

**DISPLAY**

**CRT** — 8 x 10 cm display. Horizontal and vertical center lines further marked in 0.2 cm increments. P31 Phosphor standard. 10 kV accelerating potential, mesh grid, halo suppressed.

**Graticule** — Internal, non-parallax, not illuminated; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in locating an off-screen signal. A pre-set intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 5 MHz.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: 0°C to +50°C. Nonoperating: -55°C to +75°C.

**Altitude** — Operating: To 4500 m, (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to (15,000 ft). Nonoperating: 15 200 m to (50,000 ft).

**Vibration** — Operating test samples were subjected to sinusoidal vibration in the X, Y, and Z axis with the frequency varied from 10 Hz to 55 Hz to 10 Hz in 1 minute sweeps for a duration of 15 minutes per axis and a dwell of 10 minutes at 55 Hz. Total displacement was 0.015 in p-p (2.4 g's at 55 Hz).

**Humidity** — Operating and nonoperating: Test samples were subjected to 5 cycles (120 hours) of humidity testing.

**Shock** — Operating and nonoperating: Test samples were subjected to 3 shocks, both directions along each axis for a total of 18 shocks. Peak accelerations of each 1/2-sine shock were 30 g's.

**OTHER CHARACTERISTICS**

**Probe Adjust Signal** — Squarewave, 0.5 V ±20%, 1 kHz ±20%.

**Power Requirements** — 90 to 250 V, 48 to 440 Hz without range switching, 50 W maximum at 115 V and 60 Hz.

**PHYSICAL CHARACTERISTICS**

Cabinet Dimensions	mm	in
Width (with handle)	360	14.2
Width (without handle)	237	12.9
Height (with feet and handle)	137	5.4
Depth (with front cover)	445	17.5
Depth (without front cover)	440	17.3
Depth (with handle extended)	511	20.1
Weights ≈	kg	lb
Net (with cover accessories, and pouch)	7.6	16.8
Net (without cover accessories, and pouch)	6.1	13.5
Shipping (domestic)	8.2	18.0

**INCLUDED ACCESSORIES**

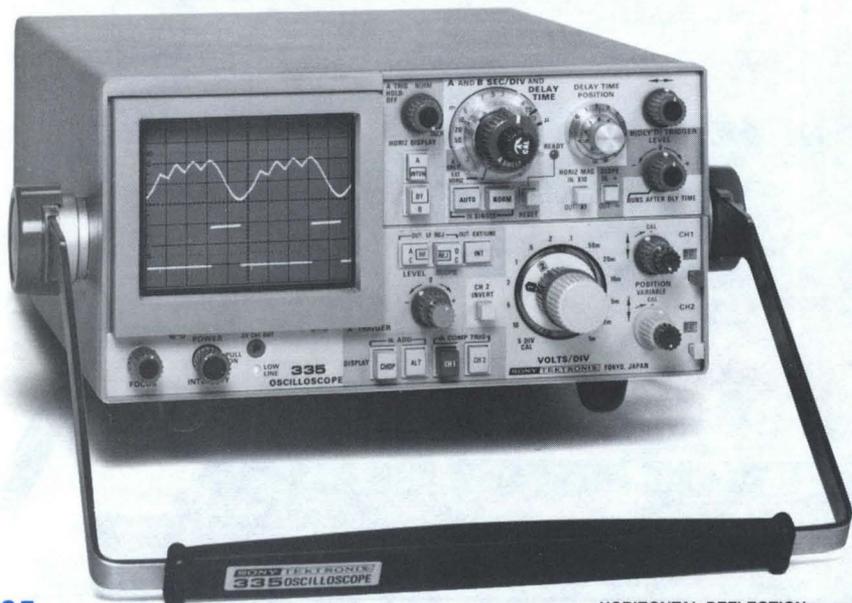
Two P6120 10X voltage probes (010-6120-01), two IC grabber probe accessories (013-0191-00).

**ORDERING INFORMATION**

<b>2213 Single Time Base Oscilloscope with Delayed Sweep</b> .....	<b>\$1,200</b>
<b>2215 Delayed Alternate Time Base Oscilloscope</b> .....	<b>\$1,450</b>
<b>Power Cords</b> — Standard: 110 V ac North American plug.	
<b>INTERNATIONAL POWER CORDS &amp; PLUG OPTIONS</b>	
<b>Option A1</b> — Universal Euro 220 V/16A, 50 Hz..	
Order 020-0859-00 .....	<b>\$15</b>
<b>Option A2</b> — UK 240 V/13A, 50 Hz.	
Order 020-0860-00 .....	<b>\$31</b>
<b>Option A3</b> — Australian 240 V/10A, 50 Hz.	
Order 020-0861-00 .....	<b>\$23</b>
<b>Option A4</b> — North American 240 V/15A, 60 Hz.	
Order 020-0862-00 .....	<b>\$24</b>
<b>Option A5</b> — Switzerland 220 V/10A, 50 Hz.	
Order 020-0863-00 .....	<b>\$15.75</b>

**OPTIONAL ACCESSORIES**

<b>Front Panel Cover</b> Order (200-2520-00) .....	<b>\$5.00</b>
<b>Accessory Pouch</b> Order (016-0677-00) .....	<b>\$42</b>
<b>Pouch and Cover</b> Order (020-0672-00) .....	<b>\$47</b>
<b>Viewing Hood</b> Order (016-0566-00) .....	<b>\$15</b>
<b>C-5C Option 04 Scope Camera</b> .....	<b>\$525</b>
<b>Model 200C SCOPE-MOBILE® Cart</b> .....	<b>\$295</b>
<b>Rack Adaptor Kit</b> Order (016-0466-00) .....	<b>\$100</b>



## 335

35 MHz at 10 mV/div

Small Size, Weighs ≈ 4.7 kg, (10.5 lb)

1 mV/div Vertical Sensitivity at 25 MHz

Delay Lines Input

Rugged Construction

The portability of the 335 is a big plus in many digital and analog trouble-shooting applications. And it weighs only 10.5 pounds.

1 mV/div (at 25 MHz) vertical sensitivity insures that low level signals from magnetic recording heads, optical read heads, or industrial control transducers can be accurately and easily measured. Delay line allows viewing the leading edge of the triggering signal. By using a composite of Channels 1 and 2 as a trigger source, stable displays of non-time-related signals can be obtained.

Operation from either ac (90 to 132 V, or 180 to 264 V, 48 to 440 Hz) or dc (+11 to +14 V or +22 to +28 V) assures that power can be obtained at nearly any location.

### CHARACTERISTICS VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

#### Bandwidth

	+20°C to +30°C	-15°C to +55°C
1 mV to 5 mV/div	dc to 25 MHz	dc to 20 MHz
10 mV to 5 V/div	dc to 35 MHz	dc to 30 MHz
10 V/div	dc to 25 MHz	dc to 20 MHz

For ac coupling, the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

**Deflection Factor** — 1 mV/div to 10 V/div (1-2-5 sequence) accurate ±3%. Uncalibrated, continuously variable between steps and to at least 25 V/div.

**Display Modes** — CH 1, CH 2 (normal or inverted) alternate, chopped (≈300 kHz rate) added, X-Y.

**Input R and C** — 1 MΩ ±2%, paralleled by ≈24 pF.

**Maximum Input Voltage** — ac or dc coupled, 300 V (dc + peak ac). 300 V p-p ac at 1 kHz or less.

**Delay Line** — Permits viewing leading edge of displayed waveform.

### HORIZONTAL DEFLECTION

**Time Base A** — 0.2 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

**Time Base B** — 0.2 μs/div to 50 ms/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

**Variable Time Control** — Time Base A provides uncalibrated, continuously variable sweep rates between steps and to at least 1.25 s/div.

#### Time Base A and B Accuracy, Center 8 Divisions

	+20°C to +30°C	-15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

**Horizontal Display Modes** — A only. A intensified by B, B delayed by A, B triggerable after A.

### CALIBRATED SWEEP DELAY

**Delay Time Range** — Continuously variable from 1 μs to at least 5 s after the start of the delaying (A) sweep.

#### Differential Time Measurement Accuracy

Delay Time Settings Between 1.0 and 9.0	+15°C to +35°C
One or more major dial divisions	±2%
Less than one major dial division	±0.02%

**Jitter** — 1 part or less in 20,000 (0.005%) of X10 the A time/div setting.

### TRIGGERING A AND B

**A Trigger Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs once on the first trigger signal after the reset button is pushed).

**Variable Trigger Holdoff** — For the A sweep an adjustable holdoff control permits a stable display of complex waveforms. Sweep holdoff time can be increased at least X10.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once in each of these modes, following the A sweep delay time.

#### Trigger Sensitivity and Coupling

Coupling	To 10 MHz		At 35 MHz
	Internal	External	Ext ÷ 10
Dc	0.35 div	70 mV	1.5 div 250 mV 2.5 V
Ac	requirements increase below 60 Hz		
Ac HF Rej	requirements increase above 20 kHz		
Ac LR Rej	requirements increase below 40 kHz		

**Trigger Sources** — Internal CH 1, internal CH 2, internal composite (uses a composite of CH 1 and CH 2 signals to produce trigger), external, external ÷ 10, and line. The B sweep can also be started automatically at the end of the time base A delay.

### X-Y OPERATION

**Input** — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

**X-Axis Deflection Factors** — Variable from ≈20 mV/div to ≈2 V/div. Dc to at least 500 kHz.

**Input Impedance** — ≈1 MΩ paralleled by 24 pF.

### DISPLAY

**CRT** — 8 x 10 div (0.6 cm/div) display. P31 Phosphor. 12 kV accelerating potential.

**Graticule** — Internal (non-parallax) non-illuminated. Vertical and horizontal centerlines marked in 5 minor division per major 0.6 cm.

**Z-Axis Input** — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 600 kHz.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: -15°C to +55°C. Non-operating: -40°C to +75°C.

**Altitude** — Operating: to 4500 m (15,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: to 15 200 m (50,000 ft) maximum.

**Vibration** — Operating and nonoperating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

**Humidity** — 5 cycles (120 hours) referenced to MIL-E-16400 F.

**Shock** — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.5 V (±1%) ≈1 kHz from 20°C to 30°C.

**Power Source** — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Maximum power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a maximum current drain of 2 A at +12 V or 1.0 A at +24V.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	236	9.3
Height	112	4.4
Depth (handle not extended)	347	13.6
Depth (handle extended)	448	17.6
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net (w/o accessories)	4.7	10.5
Shipping	7.6	17.0

### INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case and pouch (016-0485-00); external dc cable assembly (012-0406-00); strap assembly (346-0131-00); two 1-A fuses (159-0064-00); two 0.4-A fuses (159-0139-00); two 2-A fuses (159-0107-00); three 0.2-A fuses (159-0080-00).

### ORDER 335 Portable Oscilloscope .....\$3,015

The SONY®/TEKTRONIX® 335 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 335 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

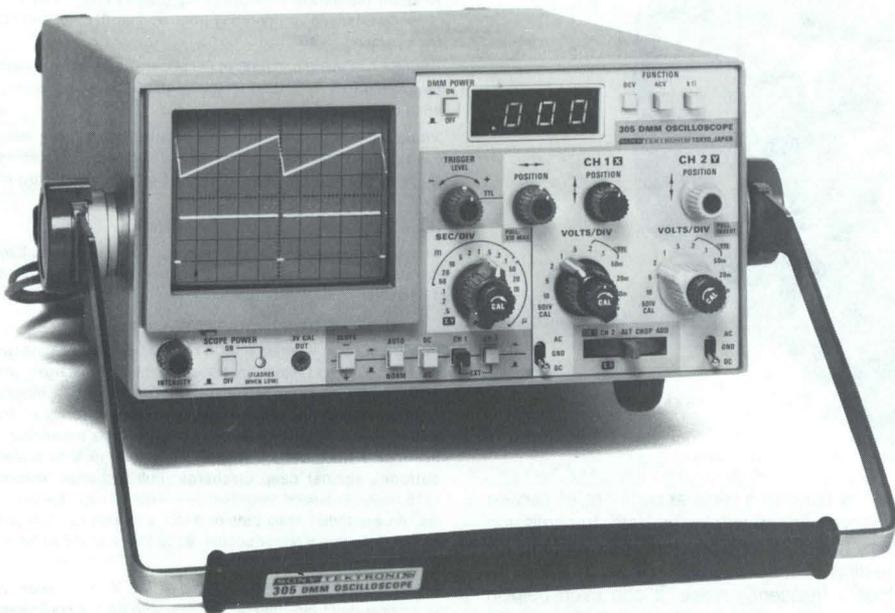
### OPTIONAL ACCESSORIES

**Viewing Hood** — Order 016-0297-00 .....\$6.50  
**CRT Filter** — Light blue. Order 378-2016-01 .....\$1.80  
**CRT Filter** — Light amber. Order 378-0843-01 .....\$1.80  
**CRT Mesh Filter** — With frame and holder. Order 378-0063-00 .....\$27

### RECOMMENDED CAMERA

**C-30BP General Purpose Camera** .....\$1,360  
**Camera Adaptor** — Mounts C-30B to 335. Order 016-0327-01 .....\$169

For further information see camera section.



## 305

**5 MHz at 5 mV/div**      **Full X-Y**  
**Dual-Trace**              **Weighs ≈ 10.6 lb**

The 305 Oscilloscope/DMM is the ideal oscilloscope for those who demand portability and multi-function versatility in their test instrumentation.

The SONY®/TEKTRONIX® 305 combines a 5 MHz oscilloscope with an integral auto ranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5 MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) CRT display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

### CHARACTERISTICS VERTICAL DEFLECTION

**Bandwidth** — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is ≈ 10 Hz.

**Deflection Factor** — 5 mV/div to 10 V/div (1-2-5 sequence) accurate ±3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.

**Display Modes** — CH 1, CH 2, Chopped, Alternate, Added, Invert CH 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.

**Input R & C** — 1 MΩ ±2%, paralleled by ≈47 pF.

**Maximum Input Voltage** — ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p at <1 kHz.

### HORIZONTAL DEFLECTION

**Time Base** — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 magnifier extends sweep rate to 0.1 μs/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

### Time Base Accuracy, Center 8 Divisions

	0°C to +40°C	-15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

(Excludes first 10 div and all sweep past 90 div in X10 magnifier.)

### TRIGGER

**Modes** — Normal and Auto (p-p).

**TTL Triggering** — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50 mV, 0.1 V and 0.2 V/div or external trigger signals.

**Trigger Sources** — Internal CH 1, internal CH 2, external. TTL Threshold voltage, internal (with 10X probe) 1.4 V within ±0.3 V, External (with 10X probe) 1.4 V within ±0.2 V.

### Trigger Sensitivity in Normal-Mode

	Coupling	To 0.5 MHz	At 5 MHz
Dc	Internal	0.3 div	0.75 div
	External	15 mV	50 mV

Ac Requirements increase below 60 Hz

### P-P Auto Operation Sensitivity

	Coupling	500 Hz to 0.5 MHz	0.5 MHz to 5 MHz
Dc, Ac	Internal	0.5 div	1.0 div
	External	35 mV	70 mV

**External Trigger** — Maximum Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C, ≈1 MΩ paralleled by ≈47 pF.

### X-Y OPERATION

**Input** — X-axis input is via the CH 1 connector; Y-axis input is via the CH 2 connector.

**X-Y Characteristics** — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.

**X-Axis Bandwidth** — Dc to 150 kHz.

### DISPLAY

**CRT** — 8 x 10 div (0.632 cm/div) display. P31 Phosphor. 2 kV accelerating potential.

**Graticule** — Internal, non-illuminated.

### DMM

#### DC VOLTAGE

**Ranges** — 2 V, 20 V, 200 V, 2000 V, 1000 V (autoranging).

**Accuracy** — Within 0.1% of reading, ±2 counts.

**Common-Mode Rejection** — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

**Normal-Mode Rejection** — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.

**Response** — <1 s plus range step time (<1 s/step).

**Input R** — 10 MΩ ±2%.

**Maximum Input Voltage** — ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

### AC VOLTAGE

**Ranges** — 2 V, 20 V, 200 V, 700 V, (autoranging).

**Accuracy** — Within 0.5% of reading, ±10 counts, 40 Hz to 500 Hz.

**Response Time** — <5 s plus range step time (<1 s/step).

**Input Impedance** — 10 MΩ paralleled by ≈70 pF.

**Maximum Input Voltage** — 700 V RMS if sinusoidal. ±1000 V (dc + peak ac) between HI and LO inputs or between HI and chassis. ±500 V (dc component) between HI and LO inputs. ±500 (dc + peak ac) between LO and chassis (LO Floating Voltage).

### RESISTANCE

**Ranges** — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.

**Accuracy** — Within 0.6% of reading ±3 counts.

**Response Time** — <5 s plus range step time (<1 s/step).

**Maximum Input Voltage** — ±100 V (dc + peak ac) between HI and LO inputs. 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: -15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM). Nonoperating: -25°C to +75°C.

**Altitude** — Operating: to 9000 m (30,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5,000 ft to 30,000 ft. Nonoperating: 15 200 m (50,000 ft) maximum.

**Vibration** — 15 minute along each of the three major axes, 0.025 in (0.06 cm) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one minute cycles.

**Humidity** — Nonoperating: five cycles (120 hours) of MIL-E-16400G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.

**Shock** — Operating and nonoperating: 30 g's, 1/2 sine, 11 ms duration. Total of 12 shocks.

### OTHER CHARACTERISTICS

**Amplitude Calibrator** — 0.3 V accurate ±1% from 20°C to 30°C ±2% from -15°C to +55°C.

**Power Sources** — External ac source, 90 V to 132 V or 180 V to 250 V with a line frequency of 48 Hz to 440 Hz. Maximum power dissipation of 17 W. External dc source +9 V to +32 V.

**Charge Time** — At least 16 hours for full charge.

**Operating Time** — Internal NiCd batteries provide ≈1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or two hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	236	9.3
Height	112	4.4
Depth (handle not extended)	371	14.6
Depth (handle extended)	458	18.0
<b>Weights</b> ≈	<b>kg</b>	<b>lb</b>
Net (without accessories)	4.8	10.6
Shipping	7.8	17.1

### INCLUDED ACCESSORIES

Two 10X probes (010-6149-03); one DMM probe package (012-0732-00); one carrying case (016-0401-00); one carrying case cover (200-2260-00); one carrying strap assembly (346-0131-00); one clear CRT filter (331-0394-01); one blue CRT filter (378-2016-01); one external dc cable assembly (012-0406-00).

### ORDERING INFORMATION

**305 DMM/Oscilloscope** ..... **\$2,315**

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by SONY/TEKTRONIX Corporation, Tokyo, Japan, Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### OPTIONAL ACCESSORIES

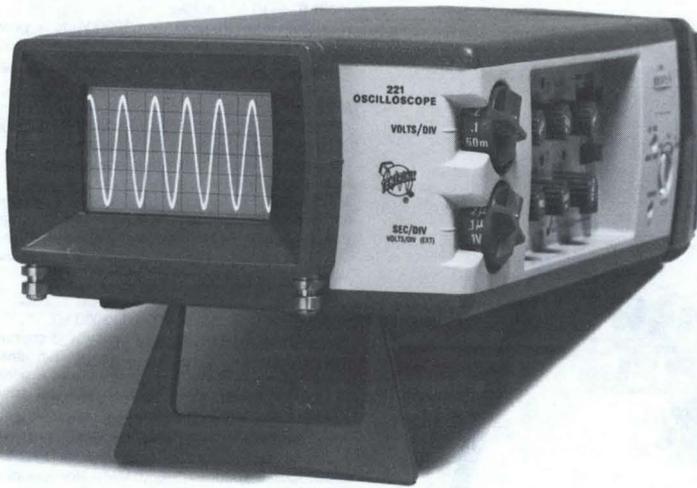
**Viewing Hood Order 016-0297-00** ..... **\$6.50**  
**Adaptor Connector BNC to binding post.**  
**Order 103-0033-00** ..... **\$4.75**

### RECOMMENDED CAMERA

**C-30BP General Purpose Camera.**  
**Order C-30BP** ..... **\$1,360**

**Camera Adaptor Mounts C-30B to 305.**  
**Order 016-0327-01** ..... **\$169**

For further information see camera section.



**221**

5 MHz, 5 mV/div to 100 V/div

0.1 μs/div Sweep Rate with X10 Sweep Magnifier

Internal Battery Pack

Integral 1 MΩ Probe

Weights ≈ 1.6 kg, (3.5 lb)

The 221 Miniscope weighs just 3.5 pounds and easily fits into a tool box or brief case; it measures only 3 x 5.2 x 9 inches. Yet it has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least two hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 to 250 V, 48 to 62 Hz ac, or 80 to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200 Series Miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

**CHARACTERISTICS**

**VERTICAL DEFLECTION**

**Bandwidth** — Dc to 5 MHz (–3 dB point) at all calibrated deflection factors. Lower –3 dB point ac coupled is ≈2 Hz.

**Deflection Factor** — 5 mV/div to 100 V/div, accurate ±3% from 0°C to +40°C and ±5% from –15°C to 0°C and +40°C to +55°C. Uncalibrated, continuously variable between steps to at least 300 V/div.

**Input R and C** — ≈1 MΩ paralleled by ≈29 pF via attached signal acquisition probe.

**Maximum Input Voltage** — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

**HORIZONTAL DEFLECTION**

**Time Base** — 1 μs/div to 200 ms/div, accurate ±3%.

**Magnifier** — Increases all sweep speeds X10 with a maximum sweep speed of 0.1 μs/div.

**Variable Time Control** — Extends minimum sweep rate to ≈0.5 s/div. Continuously variable between calibrated settings.

**TRIGGER**

**Modes** — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity**

Source	To 1 MHz	At 5 MHz
Internal	0.5 div	1 div
External	0.5 V	1 V

**X-Y OPERATION**

**Input** — X-axis input is via the external trigger or the external horizontal input.

**X-Axis Deflection Factor** — 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

**Maximum External Horizontal Input Voltage** — 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

**Input Impedance** — ≈0.5 MΩ paralleled by ≈30 pF.

**DISPLAY**

**CRT** — 6 x 10 div (0.52 cm/div) display. P31 Phosphor normally supplied. 1 kV accelerating potential.

**Graticule** — Internal, black line, non-illuminated.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: (battery only), –15°C to +55°C. Charging or operating from ac line: 0°C to +40°C. Nonoperating: –40°C to +60°C.

**Altitude** — Operating: 7600 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 200 m (50,000 ft).

**Vibration** — Operating and nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — 5 days at +50°C, 95% humidity.

**Shock** — Operating and nonoperating: 100 g's, 1/2 sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

**OTHER CHARACTERISTICS**

**Power Sources** — Internal NiCd batteries provide at least two hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge. External power source, 90 to 250 V ac (48 to 62 Hz) or 80 to 250 V dc, 5 W or less.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 x line + (dc + peak ac) not to exceed 350 V.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	mm	in	mm	in
Width	133	5.2		
Height	76	3.0		
Depth	228	9.0		
<b>Weights</b> ≈	<b>kg</b>	<b>lb</b>		
Net (w/o accessories)	1.6	3.5		
Shipping	3.6	8.0		

**INCLUDED ACCESSORIES**

Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); two spare fuses (159-0080-00).

**ORDERING INFORMATION**

221 Oscilloscope, includes batteries and probe ..... **\$1,765**

**OPTIONAL ACCESSORIES**

**Alligator Clip Kit** A pair of alligator clips that allow connecting the probe and ground lead to large (up to 3/8 in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).

Order 015-0231-00 ..... **\$20**

**Probe-tip to BNC Panel Connector Adaptor.**

Order 013-0084-01 ..... **\$8.00**

**Probe-tip to BNC Cable Adaptor.**

Order 103-0096-00 ..... **\$11**

**Power Cable Adaptor Assembly** A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.

Order 161-0077-01 ..... **\$7.00**



213

1 MHz at 20 mV/div

0.4 μs/div Sweep Rate with X10 Sweep Magnifier

DMM and Miniscope in One Unit

Rugged Construction

Internal Battery

Compact, Weighs ≈1.7 kg (3.7 lb)

True RMS Voltage & Current Measurements

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and lightweight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the light-weight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

CHARACTERISTICS

VERTICAL DEFLECTION (VOLTAGE)

**Bandwidth** — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower −3 dB point for ac coupling is ≈1 Hz.

**Deflection Factor** — 5 mV/div to 100 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 V/div.

**Input R and C** — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Maximum Input Voltage

Input Condition	Maximum Input Voltage
Dc coupled, 5 mV/div to 1 V/div	500 V (dc + peak ac) at 1 MHz or less
Ac coupled, 5 mV/div to 1 V/div	800 V (dc + peak ac) 500 V peak ac component
Ac, Dc coupled, 2 V/div, to 100 V/div	800 V (dc + peak ac) at 1 MHz or less

VERTICAL DEFLECTION (CURRENT)

**Bandwidth** — Dc to at least 400 kHz (−3 dB point) for 20 μA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (−3 dB point) for 5 μA/div and 10 mA/div.

**Deflection Factor** — 5 μA/div to 100 mA/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 mA/div.

**Maximum Input Current** — 2 A RMS or 3 A peak for any range (fuse and diode protection).

HORIZONTAL DEFLECTION

**Time Base** — 2 μs/div to 500 ms/div (1-2-5 sequence), accurate ±5%.

**Variable Magnifier** — Increases all sweep speeds to at least X5 with a maximum sweep speed of 0.4 μs/div.

TRIGGER

**Modes** — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).

**Trigger Sensitivity and Coupling** — Ac Internal, (auto and normal, 1 MHz) 0.5 div. Dc External, 1 MHz, 1 V.

DISPLAY

**CRT** — 6 x 10 div (0.52 cm/div) display. P43 Phosphor is standard.

**Graticule** — Internal, black line, non-illuminated.

ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: (battery only). −15°C to +55°C. Charging or operating from ac line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

**Altitude** — Operating: To 7500 m (25,000 ft), decrease maximum temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 12 500 m (40,000 ft).

**Vibration** — Operating and nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. Held for 3 minute at 55 Hz.

**Humidity** — +40°C or less, 80% or less relative humidity.

**Shock** — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

**Power Sources** — Internal NiCd batteries provide three to five hours operation at maximum trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. External power source, 90 to 136 V ac (48 to 62 Hz). Option 01 allows operation from an external 180 to 250 V ac (48 to 62 Hz) or dc supply. Power consumption, 8 W or less.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS or 1.4 X line + (dc + peak ac) not to exceed 350 V.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	133	5.2
Height	76	3.0
Depth	226	8.9
Weights ≈	kg	lb
Net (without accessories)	1.7	3.7
Shipping	3.9	8.6

DMM

Provides true RMS readings of voltage and current.

DC AND AC VOLTAGE

**Range** — 0.1 V to 1000 V full scale in five ranges.

**Resolution** — 100 μV at 0.1 V full scale.

**Accuracy in Dc Mode** — For +25°C ±5°C.

Range (Full Scale)

0.1 V	±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading +0.04% of full scale) per °C
1 V	±0.1% of reading ±1 count. Temp coef is (±0.01% of reading +0.01% of full scale) per °C
10 V and 100 V	±0.15% of reading ±1 count. Temp coef is (±0.015% of reading +0.01% of full scale) per °C
1000 V	±0.2% of reading ±1 count. Temp coef is (±0.02% of reading +0.01% of full scale) per °C

**Accuracy in RMS Mode** — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale) per °C.

Range	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1 V, 10 V, & 100 V	2%	1%	1%
1000 V	2%	1%	2%

\*Accuracy limit increases linearly for crest factor >2 up to twice indicated limit for crest factor of five.

**Input Resistance** — 10 MΩ.

**Input Capacitance** — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.

**Settling Time** — Dc: 1.5 s to 0.1% of reading. RMS: 2 s to 1% of reading.

Maximum Input Voltage

Dc Coupled	Ac Coupled
0.1 V to 10 V	0.1 V to 10 V
500 V (dc + peak ac)	800 V (dc + peak ac)

DC AND AC CURRENT

**Range** — 0.1 mA to 1000 mA full scale in five ranges.

**Resolution** — 100 nA at 0.1 mA full scale.

**Accuracy in Dc Mode** — For +25°C ±5°C.

**Temperature Coef** — (±0.02% of reading ±0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.

Accuracy in Ac Mode

Range	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 mA to 1000 mA	2.5%	1.5%	3.5%

\*Accuracy limit increases linearly for crest factor >2 up to twice the indicated limit for crest factor of five.

**Settling Time** — 1.5 s to 0.1% of reading.

**Maximum Input Current** — 2 A RMS or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

**Ranges** — 1 kΩ to 10 MΩ full scale in five ranges.

**Resolution** — 1 Ω on 1 kΩ scale.

**Accuracy** — For 25°C ±5°C.

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 kΩ to 1 MΩ	0.5% ±3 counts
10 MΩ	1% ±1 count

**Settling Time** — Two seconds ±2 counts.

READOUT

**Number of Digits** — 3½ digits plus decimal point and sign.

**Display Size** — 1 cm high by 4 cm wide (five characters).

**Over-range Capability** — At least 200% of full scale.

**Over-range Indication** — Displays scrambled characters.

INCLUDED ACCESSORIES

Viewing hood (016-0199-01); carrying case (016-0512-00); two test leads (alligator clip to banana jack) (red 012-0015-00); (black 012-0014-00); neck strap (346-0104-00); two power line fuses (159-0080-00); power line plug adaptor (option 01 only) (161-0077-01); identification tag (334-2614-00); identification tag (000-7983-00).

ORDERING INFORMATION

213 Miniscope/DMM includes batteries and probe ..... \$2,320  
 Option 01 — 180 to 250 V ac (48 to 62 Hz) or dc (includes batteries and probe) ..... NC

OPTIONAL ACCESSORIES

**Alligator Clip Kit** A pair of alligator clips that allow connecting the probe and ground lead to large (up to ¾ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).  
 Order 015-0231-00 ..... \$20  
**Probe-tip to BNC Panel Connector Adaptor.**  
 Order 013-0084-01 ..... \$8.00  
**Probe tip to BNC Cable Adaptor.**  
 Order 103-0096-00 ..... \$11  
**Power Cable Adaptor Assembly** A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.  
 Order 161-0077-01 ..... \$7.00



**212**

500 kHz, 1 mV/div to 50 V/div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈ 1.6 kg, (3.5 lb)

The 212 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches).

Built of impact-resistant plastic and fully self-contained, this miniature portable is perfect for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 212 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

**CHARACTERISTICS**

**VERTICAL DEFLECTION**

**Bandwidth** — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower -3 dB point ac coupled is <2 Hz.

**Deflection Factors** — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ± 5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

**Display Modes** — CH 1 only, CH 2 only, or CH 1 and CH 2 chopped (chop rate ≈ 50 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

**Input R and C** — ≈ 1 MΩ paralleled by ≈ 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

**Maximum Input Voltage** (1X probe only)

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz.
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac 5 MHz or less

**HORIZONTAL DEFLECTION**

**Time Base** — 5 μs/div to 500 ms/div, accurate ± 5%.

**Variable Magnifier** — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

**External Horizontal Input** — (CH 1) 1 mV/div to 50 V/div ± 10%; dc to 100 kHz: X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

**Maximum External Horizontal Input Voltage and Impedance** — Same as for vertical inputs.

**TRIGGER**

**Modes** — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity and Coupling**

Dc Coupling	To 500 Hz
Internal (w/composite trigger source)	0.2 div
Internal (w/CH 2 trigger source)	0.2 div
External	1 V

**Maximum External Trigger Input Voltage** — 8 V (dc + peak ac), 16 V (p-p ac) at 1 MHz or less.

**Input Impedance** — R and C, 1 MΩ paralleled by ≈ 30 pF.

**DISPLAY**

**CRT** — 6 x 10 div (0.52 cm/div) display. P31 Phosphor.

**Graticule** — Internal, black line, non-illuminated.

**ENVIRONMENTAL CAPABILITIES**

**Ambient Temperature** — Operating: (battery only), -15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating: -40°C to +60°C.

**Altitude** — Operating: 7500 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 200 m (50,000 ft).

**Vibration** — Operating and nonoperating: 15 minutes along each of the three major axes. 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — Five cycles (120 hours). 95% relative humidity, referenced to MIL-E-16400F.

**Shock** — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

**OTHER CHARACTERISTICS**

**Power Sources** — Internal NiCd batteries provide ≈ three to five hours operation for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned off. Battery operation is automatically interrupted when battery voltage drops to ≈ 10 V to protect batteries against deep discharge. Full recharge requires ≈ 16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 10 minutes of operating time remaining in the batteries.

**External Ac Source** — 110 to 126 V, 58 to 62 Hz, 3 W. Can be operated at 104 to 110 V with resulting slow discharge of internal batteries.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + (dc + peak ac) not to exceed 350 V.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	133	5.3
Height	76	3.0
Depth	241	9.5
<b>Weights</b> ≈	<b>kg</b>	<b>lb</b>
Net (with out accessories)	1.6	3.5
Shipping	3.2	7.0

**INCLUDED ACCESSORIES**

Viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00).

**ORDERING INFORMATION**

212 Dual-Trace Oscilloscope, includes batteries and probes ..... **\$1,710**

**POWER OPTIONS**

**Option 01** — For 220-250 V, (48 to 52 Hz) includes batteries ..... **NC**

**Option 02** — For 90 to 110 V, 48 to 52 Hz includes batteries ..... **NC**

**OPTIONAL ACCESSORIES**

**10X Attenuator Package** A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈ 20 pF) and higher maximum input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adaptor (206-0203-00).

Order 010-0378-01 ..... **\$45**

**Alligator Clip Kit** A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).

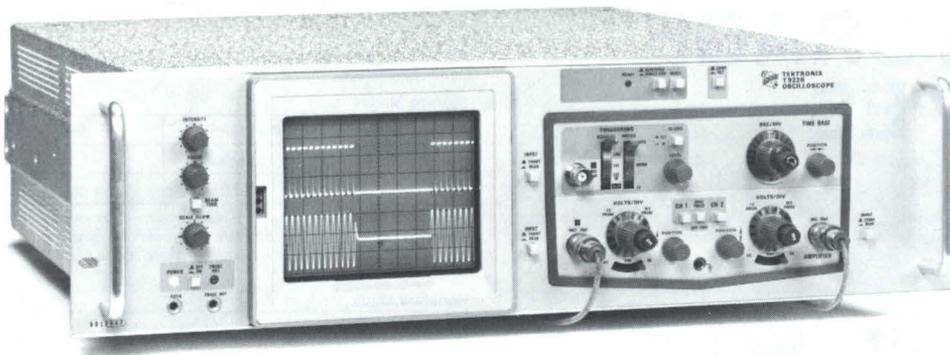
Order 015-0231-00 ..... **\$20**

**Probe-tip to BNC Panel Connector Adaptor.**  
Order 013-0084-01 ..... **\$8.00**

**Probe-tip to BNC Cable Adaptor.**  
Order 103-0096-00 ..... **\$11**

**Power Cable Adaptor Assembly** A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.

Order 161-0077-01 ..... **\$7.00**



**T922R**

**Dc to 15 MHz at 2 mV/div**

**Switchable Front and Rear Signal Inputs**

**Only 13.3 x 48.2 x 43.2 cm, 9.1 kg (5.25 x 19 x 17 in, 20 lb)**

**Single Sweep Operation**

**Bright (12 kV) Display**

The T922R is a rackmount multipurpose 15 MHz oscilloscope. It features: 15 MHz bandwidth at 2 mV/div vertical sensitivity, 20 ns/div maximum sweep rate with the X10 magnification control, switchable front and rear signal inputs, selectable chop and alternate sweeps, graticule illumination and rear panel outputs (gate out, sweep out and vertical signal out). The T922R fits any standard 48 cm (19 in) rack and weighs only 9.1 kg (20 lb). Option 01 adds the differential capability.

Many companies are using the T922R for their production testing applications—often as an inexpensive replacement for aging instruments which require frequent repair and calibration.

**CHARACTERISTICS**

Seven recessed rear panel BNC connectors provide: CH 1, CH 2 vertical signal input, External trigger input, Z-axis input, Sweep Output, Gate Output, Vertical Output.

**VERTICAL SYSTEM**

**Mode Selections**

CH 1 — Displays only the CH 1 signal.  
CH 2 — Displays only the CH 2 signal.  
Dual Trace — Displays CH 1 and CH 2 signals simultaneously. Alternate or chopped mode is manually selectable.

**Deflection Factor**

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

**Accuracy**

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

**Uncalibrated (VAR) Range** — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

**Frequency Response** — Dc to at least 15 MHz (measured at -3 dB).

**Risetime** — 23 ns or less.

**Chopped Mode Repetition Rate (Dual Trace)** — ≈250 kHz.

**Input Resistance** — ≈1 MΩ.

**Input Capacitance** — 30 pF.

**Maximum Input Voltage** — Dc coupled, 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less, Ac coupled, 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

**Delay Line** — Permits viewing edge of displayed waveform.

**HORIZONTAL SYSTEM**

**Calibrated Range** — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 20 ns/div.

**Accuracy**

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +40°C	Within 4%	Within 6%

**Z-AXIS INPUT**

**Sensitivity** — 5 V signal causes noticeable intensity modulation. Polarity of the voltage causing a decrease in intensity is internally selectable.

**Trigger Modes**

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Normal — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

TV — Provides triggering on TV field when SEC/DIV switch is set at 0.1 ms or slower. Trigger on TV line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out — In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

**Triggering Sensitivity**

Auto and Normal — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz.

TV — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

**External Trigger Input**

Maximum Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≈1 MΩ.

Input Capacitance — 30 pF.

**X-Y OPERATION**

**Sensitivity, Variable Magnifier** — From ≈100 mV/div (X10 mag) to ≈1 V/div (X1 mag) for X; Y is adjusted by vertical control.

**X-Axis Bandwidth** — Dc to at least 1 MHz (measured at -3 dB).

**Input Resistance** — ≈1 MΩ.

**Input Capacitance** — 30 pF.

**Phase Difference Between X- and Y-Axis Amplifiers** — Within 5° from dc to 50 kHz.

**CRT DISPLAY**

**Display Area** — 8 x 10 cm, illuminated internal graticule.

**Standard Phosphor** — P31.

**Beam Finder** — Locates off-screen display.

**Nominal Accelerating Potential** — ≈12 kV.

**PROBE ADJUST**

**Output Voltage** — ≈0.5 V.

**Repetition Rate** — ≈1 kHz.

**OUTPUTS**

**Sweep/Gate Out** — Output Voltage is ≈5 V positive going into 1 MΩ, ≈50 mV into 50 Ω load.

**Vertical Output** — A composite of CH 1 and CH 2 with ≈0.5 V output per displayed division into a 1 MΩ load. ≈50 mV with 50 Ω load. Bandwidth is at least 1 MHz.

**AC POWER REQUIREMENTS**

**Line Voltage Ranges** — 100-120 V, 220-240 V line voltage and HI/LO range are accessible externally.

**100-120 V Range** — HI: 108 to 132 V RMS. LO: 90 to 110 V RMS.

**220-240 V Range** — HI: 216 to 250 V RMS. LO: 198 to 242 V RMS.

**Line Frequency** — 50 to 60 Hz.

**Power Consumption** — 50 W (maximum), 0.35 A (maximum) at 120 V, 60 Hz.

Canadian Standards Association Certified.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	482	19.0
Height	133	5.3
Depth	432	17.0
Weight	kg	lb
Net	9.1	20.0

**ENVIRONMENTAL CAPABILITIES**

**Temperature** — Nonoperating: -55°C to +75°C. Operating: 0°C to +45°C.

**Altitude** — Nonoperating: To 15 200 m; (50,000 ft). Operating: To 4500 m; (15,000 ft) maximum. Operating temperature decreased 1°C/304.8 meters (1,000 ft) above 1524 m (5,000 ft).

**CAMERAS**

T922R interfaces to all Tektronix Cameras.

**ORDERING INFORMATION**

**T922R** — Rackmount Oscilloscope .... **\$1,970**  
Option 01 — Differential Input ..... **+\$100**

**OPTIONAL ACCESSORIES**

**Rackmount Hardware Kit**  
Order 016-0375-00 ..... **\$90**  
**Viewing Hood** Provides for convenient viewing in high ambient light conditions. Order 016-0377-00 ..... **\$8.00**



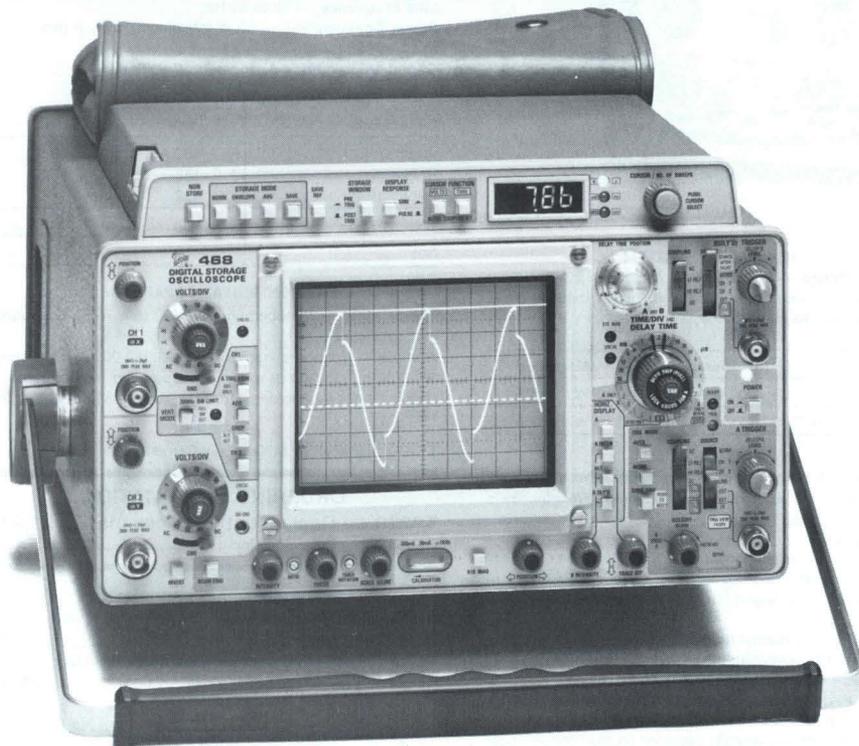
**C-5C Camera**

Recommended for all T900 Series Oscilloscopes, the C-5C attaches directly to the front panel without adaptors and uses Polaroid pack film. A fixed f/16 lens aperture, an electric shutter with timed speeds from 0.1 to five seconds, plus open shutter mode, and bulb, combine to make the C-5C Option 03 which includes a built-in Xenon flash unit that flashes to illuminate the graticule when the shutter opens. The T922R uses the C-5C Option 01, without the Xenon flash. Batteries are not included for either version.

**Order C-5C, Option 03** ..... **\$525**  
**C-5C, Option 01** ..... **\$505**

An NTSC IRE TV graticule is available. Ask your local Tek Sales Engineer or Representative.

# PORTABLE STORAGE OSCILLOSCOPES



## 468/R468

GPIB  
 IEEE-488

The 468 and R468 comply with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

10 MHz Useful Storage Bandwidth

Cursors for Time and Voltage Measurements

Signal Averaging

Envelope Mode

GPIB Option

100 MHz Nonstorage Bandwidth

Advancing the state-of-the-art in digital storage oscilloscopes is the Tektronix 468. This high performance portable scope is capable of accurately storing and displaying 10 MHz single shot events using a unique display interpolation system.

The 468 was designed with many features which enhance its usefulness in your applications. Cursors and a calibrated LED readout enable you to measure time or voltage differences easily and accurately.

Signal Averaging, now standard on the 468, can be used to remove random noise from a signal and improve measurement accuracy.

The ENVELOPE mode, a Tektronix exclusive, uses multiple sampling rates and digital memory to capture and record the maximum and minimum excursions of a waveform. The resulting waveform "envelope" can be used to catch glitches, view frequency drift and amplitude modulation, or detect aliasing. Unlimited storage time, expandable, repositionable stored traces; SAVE REFERENCE memory; pretrigger viewing; and correction for the trigger uncertainty inherent in digital storage make the 468 the most versatile digital storage scope available today.

In addition, the 468 features all the nonstorage performance of our 465B, the industry standard 100 MHz oscilloscope.

Options include a GPIB interface, a TV sync separator, EMC shielding, X-Y Recorder output.

### CHARACTERISTICS DIGITIZER, MEMORY

**Speed** — Digitizing rates from 10 samples per second at 5 sec/div to 25 mega-samples per second at 2  $\mu$ s/div and faster. Digitizing rate changes proportionate to sweep speed (50 data words per horizontal division). Chopped mode effectively halves the digitizing rate per waveform.

**Resolution** — Eight bit (One part in 256) vertical resolution.

**Memory Size** — Up to two 512 word waveforms or four 256 word waveforms can be stored and displayed.

**Interpolator** — Two firmware interpolators; one optimized for sine waveforms, one optimized for pulse waveforms.

### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth and Risetime** — (At all deflection factors from 50  $\Omega$  terminated source).

#### Storage Modes\*

Display Response	Bandwidth	Risetime
Sine	10 MHz	NA
Pulse	3.5 MHz	64 ns

\*Bandwidth measured at 5% envelope error and maximum sampling rate, using appropriate interpolator. Risetime is 1.6 times minimum sample interval. Chopped mode halves the bandwidth.

#### Nonstore Mode \*\*

-15°C to +40°C	+45°C to +55°C
Dc to 100 MHz, 3.5 ns	85 MHz, 4.1 ns

\*\*Measured at -3 dB. Bandwidth may be limited to  $\approx$  20 MHz by bandwidth limit switch.

Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50  $\Omega$ .

Lower -3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

#### Deflection Factor at Bandwidth —

0.5 mV/div to 5 V/div in storage modes  
5 mV/div to 5 V/div in nonstore  
1-2-5 sequence, accurate  $\pm$  3%

Uncalibrated, continuously variable between steps and to at least 12.5 V/div. In cascade mode sensitivity is  $\approx$  1 mV/div. Stored images can be expanded by factor of 10 vertically.

**Display Modes** — CH 1: CH 2 ADD (normal and inverted), Trigger View (nonstore only), alternate, chopped —  $\approx$  250 kHz rate, in any combination electronically switched in nonstore; in storage chop rate is  $\frac{1}{2}$  the digitizing rate.

**Envelope Mode** — Records waveform envelope over multiple sweeps. 5 MHz digitizing rate from 5 sec/div to 10  $\mu$ s/div; 10 MHz digitizing at 5  $\mu$ s/div; 25 MHz digitizing from 2  $\mu$ s/div and faster. Number of sweeps equals 1 to 256 plus continuous setting.

**Signal Averaging** — 2 to 256 sweeps can be averaged together to remove random noise.

**CMRR** — Common-mode rejection ratio at least 20 dB at 20 MHz (10 MHz in storage) for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two read-out lights behind the knob skins. All LEDs are off when the channel is not displayed.

**Ground Reference Display** — In storage modes moving the coupling selector to ground position will locate ground and display a reference dot at left edge of CRT.

**Input R and C** — 1 M $\Omega$   $\pm$  2% paralleled by  $\approx$  20 pF.

#### Maximum Input Voltage

Dc coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

**Delay Line** — Permits viewing leading edge of displayed waveform.



R468 Rackmount

**HORIZONTAL DEFLECTION**

**Time Base A** — 0.02  $\mu$ s/div to 5.0 s/div (0.5 s/div in nonstore mode) in a 1-2-5 sequence. X10 magnifier extends maximum sweep rate to 2 ns/div.

**Time Base B** — 0.02  $\mu$ s/div to 5.0 s/div (50 ms/div in nonstore mode) in a 1-2-5 sequence. X10 magnifier extends maximum sweep rate to 2 ns/div.

**Variable Time Control** — In storage modes has no effect. In nonstore mode Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div LED warning light indicates uncalibrated setting.

**Time Base Accuracy** — Full 10 cm Storage Modes 0.1%.

**Nonstorage Mode**

	+20°C to +30°C	-15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

**Horizontal Display Modes**

Storage — A, B delayed.

Nonstorage — A, A intensified, alternate, B delayed. B ends A for increased intensity in the delayed mode. Electronic switching between intensified and delayed sweep. A sweep and B sweep may be viewed simultaneously.

**CALIBRATED SWEEP DELAY**

**Delay Time Range** — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s.

**Differential Time Measurement Accuracy**

Delay Time Setting	+15°C to +35°C
Over one or more major dial div	±1%
<1 major dial div ±0.01 major dial div	

**Jitter** — One part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. One part in 20,000 (0.005%) when operating from 50 Hz line.

**TRIGGERING A AND B**

**A Trigger Modes** — Normal (sweep runs when triggered) automatic (sweep runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). LED lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms. Nonstore only.

**B Trigger Modes** — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B delayed sweep runs once, in each of these modes, following the A sweep delay time.

**Storage Trigger Positions** — Posttrigger point is at 1.25 div; Pretrigger at 8.75 div.

**Time Base A and B Trigger Sensitivity and Coupling**

Coupling	To 25 MHz		At 100 MHz	
	Internal	External	Internal	External
Dc	0.3 div deflection	50 mV	1.5 div deflection	150 mV
		External ÷ 10 500 mV		1.5 V
Ac	Requirements increase below 60 Hz			
Ac LF Reject	Requirements increase below 50 kHz			
Ac HF Reject	Requirements increase below 60 Hz and above 50 kHz			

**Digital Storage Jitter** — 0.5 ns or less at 100 MHz and 2 ns/div.

**Digital Trigger Uncertainty** — Correction circuit for the ±1/2 sample interval trigger uncertainty that is caused by asynchronous trigger/sample clock relationship.

**A Trigger View** — Electronically switched trigger view displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal which can be displayed simultaneously. The deflection factor is ≈100 mV/div (1 V/div with external ÷10). Nonstore mode only.

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷10.

**A Sources** — Normal, CH 1, CH 2, line, external, and external ÷10.

**B Sources** — Starts after delay, normal, CH 1, CH 2, and external.

**External Inputs** — R and C ≈1 M $\Omega$  paralleled by ≈20 pF. 250 V (dc + peak ac) maximum input.

**X-Y OPERATION**

**Full-sensitivity X-Y (CH 1 Horizontal, CH 2 Vertical)** — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz. Nonstore mode only.

**DISPLAY**

**CRT** — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 Phosphor standard; P11 optional. 18 kV accelerating potential.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an offscreen signal. A pre-set intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz. Nonstore mode only.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: -15°C to +55°C. Nonoperating: -55°C to +75°C. Filtered forced air ventilation is provided.

**Altitude** — Operating: To 4500 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5,000 to 15,000 ft. Nonoperating: To 15 200 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (four g's at 55 Hz) 10 to 55 to 10 Hz in one minute cycles.

**Humidity** — Operating and nonoperating: five cycles (120 hours) to 95% relative humidity as specified in MIL-T-28800B (par 3.9.2.2).

**Shock** — Operating and nonoperating: 30 g's 1/2 sine, 11 ms duration, three shocks per axis in each direction for a total of 18 shocks.

**OTHER CHARACTERISTICS**

**Amplitude Calibrator**

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	≈ 1 kHz	

**Vertical Signal Output** — CH 1 vertical signal is dc to at least 50 MHz (-3 dB), and ≈25 mV/div terminated into 50  $\Omega$ , and ≈50 mV/div terminated into 1 M $\Omega$ .

**Gate Outputs** — Positive gates from both time bases (≈5 V).

**Power Requirements** — Quick change line voltage selector provides four ranges to cover 90-132 V and 198-250 V. 48 to 440 Hz, 150 W maximum at 115 V and 60 Hz.

**PHYSICAL CHARACTERISTICS**

Dimensions (468)	mm		in	
	mm	in	mm	in
Width (with handle)	328	12.9		
Height (with feet & pouch)	191	7.5		
Depth (with panel cover)	550	21.7		
Depth (handle extended)	600	23.6		
Weights ≈ (468)	kg		lb	
Net (without panel cover)	13.6	30.0		
Net (with panel cover (and accessories)	15.0	33.0		
Shipping	21.7	47.0		
Dimensions (R468)	mm		in	
Width	483	19.0		
Height	223	8.8		
Depth	553	21.8		
Weights	kg		lb	
Net	18.6	41.0		
Shipping	25.5	56.0		

**INCLUDED ACCESSORIES**

Two P6105 10X probes (010-6105-03), blue accessory pouch (016-0594-00), clear pouch (016-0537-00), blue CRT light filter (337-1674-00), clear CRT light filter (337-1674-01), ground wire (134-0016-01), two 1 1/2-amp fuses (159-0016-00), one 3/4-amp fuse (159-0042-00).

**ORDERING INFORMATION**

468 Storage Oscilloscope ..... \$6,500

R468 Rackmount Storage Oscilloscope ..... \$6,760

**INSTRUMENT OPTIONS**

- Option 02 — GPIB Interface follows Tektronix Standard Codes and Formats ..... +\$860
  - Option 04 — EMC Environmental ..... +\$160
  - Option 05 — TV Sync Separator (Provides triggering on TV field and line) ..... +\$300
  - Option 11 — X-Y Recorder Output ..... +\$25
- Modification kits, for field conversion of existing 468s to Option 02, are available. These typically cost more than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

- Option A1 — Universal Euro 220 V/16A, 50 Hz ..... NC
- Option A2 — UK 240 V/13A, 50 Hz ..... NC
- Option A3 — Australian 240 V/10A, 50 Hz ..... NC
- Option A4 — North American 240 V/15A, 60 Hz ..... NC

**OPTIONAL ACCESSORIES**

**Service ROM**

This provides service and signature analysis routines for verification and troubleshooting the digital portion of the instrument. Recommended to be used with a Tektronix 308 Data Analyzer. Order 067-0989-00 ..... \$85

**Probes**

Probe Type	Attenuation	Input Impedance	Bandwidth*
P6063B 6 ft	1X	1 M $\Omega$ 105 pF	6 MHz
	Switchable 10X	100 M $\Omega$ 14pF	90 MHz
P6202 FET Probe 1 m	10X	10 M $\Omega$ 2 pF	100 MHz
	100X Head Ac Head	10 M $\Omega$ 2 pF 10 M $\Omega$ 4 pF	100 MHz 100 MHz
Current Probe	Calibration	Insertion Impedance	
P6022 5 ft	1 mA/mV	0.03 $\Omega$ at 1 MHz Increasing to 0.2 $\Omega$ @ 120 MHz	85 MHz
	10 mA/mV (Selectable)		

\*Nonstore modes — Bandwidths are measured at the upper -3 dB and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

**Folding Polarized Viewing Hood**

Order 016-0180-00 ..... \$40

**Collapsible Viewing Hood — Binocular.**

Order 016-0566-00 ..... \$15

**Protective Cover — Waterproof, blue vinyl.**

Order 016-0365-00 ..... \$21

**Mesh Filter — Improves contrast and EMC filtering.**

Order 378-0726-01 ..... \$55

**SCOPE-MOBILE® Cart** — Occupies <18 in aisle space, has storage area in base.  
Order 200C ..... \$295

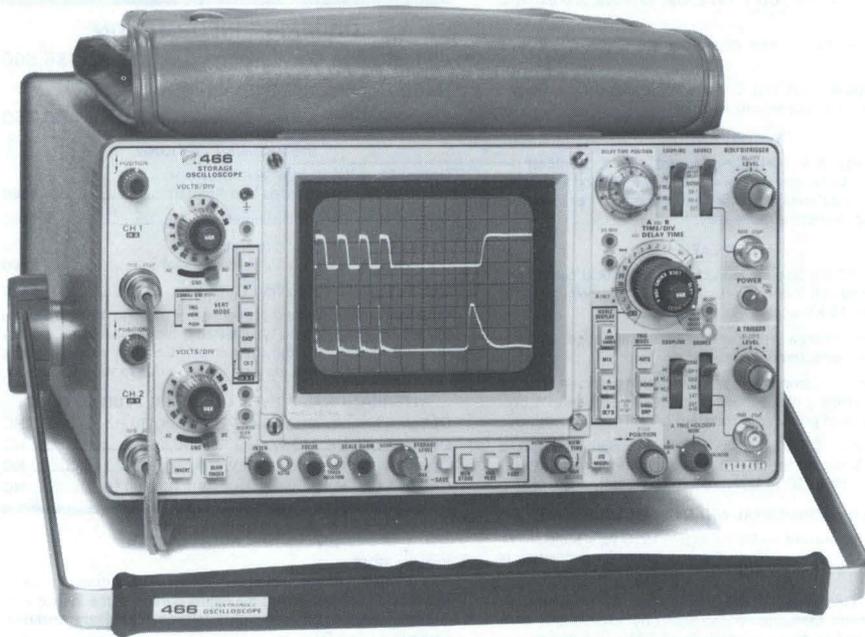
**1105 Battery Power Supply** ..... \$1,375

**Rack Adaptor** Order 016-0675-00 ..... \$325

**RECOMMENDED CAMERA**

**C-30BP Option 01** — General Purpose Compact Camera Includes 016-0301-00 mounting adaptor/corrector lens.  
Order C-30BP Option 01 ..... \$1,402

For further information see camera section.



## 466/464

100 MHz at 5 mV/div

5 ns/div Sweep Rate with X10 Sweep Magnifier

Variable Persistence and Fast Mesh Transfer Storage Modes

3000 div/ $\mu$ s Stored Writing Speed (466)

Battery Operation (Optional)

Third Channel Trigger View

Weights  $\approx$  11.8 kg, (26 lb)

The 466 and 464 Portable Storage Oscilloscopes are both designed to display nonrepetitive or slow moving signals. And with the exception of increased stored writing speed on the 466, both instruments offer similar performance.

Operating in a reduced scan mode, the stored writing speed of the 466 is 3000 div/ $\mu$ s (1350 cm/ $\mu$ s). The lower cost 464 doesn't offer a reduced scan mode and stores at 110 div/ $\mu$ s. Both instruments feature two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 div CRT on both instruments comprises 0.90 cm/divisions. In the 466, reduced scan graticule is superimposed over the center of the main graticule, measuring 8 x 10 divisions with 0.45 cm/division. All graticules are etched onto the inner face of the CRT to eliminate parallax problems. A third channel trigger view is included for the 466 and 464. This allows the simultaneous display of channels 1 and 2 with the external A trigger.

Tektronix P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the 464 or 466 front panel when the probe attenuation factor is switched.

Light weight plus the ability to use optional, external dc power makes both the 466 and 464 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

### CHARACTERISTICS

All characteristics apply to both the 466 and 464, except where indicated.

#### VERTICAL DEFLECTION (2 IDENTICAL CHANNELS)

**Bandwidth\* and Rise time** — at all deflection factors from 50  $\Omega$  terminated source.

-15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, $\leq$ 3.5 ns	Dc to 85 MHz, $\leq$ 4.15 ns

\*Measured at -3dB down. Bandwidth may be limited to  $\approx$ 20 MHz by bandwidth limit switch. Lower -3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.

**Deflection Factor** — 5 mV/div to 5 V/div (1-2-5 sequence); accurate  $\pm$ 3%. Uncalibrated, continuously variable between steps and to  $\approx$ 12.5 V/div. In cascade mode sensitivity is  $\approx$ 1 mV/div. Cascaded bandwidth is at least 50 MHz when signal out is terminated in 50  $\Omega$ .

**Display Modes** — CH 1, CH 2 (normal or inverted), alternate, chopped ( $\approx$ 250 kHz), added, X-Y.

**CMRR** — Common mode rejection ratio at least 20 dB at 20 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two read-out lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 M $\Omega$   $\pm$ 2% paralleled by  $\approx$ 20 pF.

#### Maximum Input Voltage

Dc coupled	250 V (dc + peak ac)
	500 V (p-p ac at 1 kHz or less)
Ac coupled	500 V (dc + peak ac)
	500 V (p-p ac at 1 kHz or less)

**Delay Line** — Permits viewing leading edge of displayed waveform.

#### HORIZONTAL DEFLECTION

**Time Base A** — 0.05  $\mu$ s/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends sweep rate to 5 ns/div.

**Time Base B** — 0.05  $\mu$ s/div to 50 ms/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

**Variable Time Control** — Time Base A — Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

#### Time Base A and B Accuracy, Full 10 Division

	+20°C to +30°C	-15°C to +55°C
Unmagnified	$\pm$ 2%	$\pm$ 3%
Magnified	$\pm$ 3%	$\pm$ 4%

**Horizontal Display Modes** — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

**Calibrated Mixed Sweep** — Displays A sweep for period determined by DELAY-TIME POSITION control, then displays B sweep for remainder of horizontal sweep.

#### CALIBRATED SWEEP DELAY

**Delay Time Range** — 0.2 to X10 delay time/div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

#### Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C	-15°C to +55°C
	$\pm$ 1%	$\pm$ 2.5%
Over one or more major dial div	$\pm$ 0.01 major dial div	$\pm$ 0.025 major dial div

**Jitter** — One part or less in 50,000 (0.002%) of X10 the A sweep time/div setting.

#### TRIGGER

**A Trigger Modes** — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

**A Trigger Holdoff** — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

**B Trigger Modes** — B starts after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

#### Time Base A and B Trigger Sensitivity and Coupling

Coupling	To 25 MHz	At 100 MHz
Dc	Internal	0.3 div deflection
	External	1.5 div deflection
	External $\div$ 10	50 mV 150 mV
Ac	Requirements increase below 60 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase below 30 Hz and above 50 kHz	

**Jitter** — 0.5 ns or less at 100 MHz and 5 ns/div (X10 magnifier).

**A Trigger View** — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is  $\approx 50$  mV/div (0.5 V/div with external  $\div 10$  source).

**Level and Slope** — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least  $\pm 2$  V in external, through at least  $\pm 20$  V in external  $\div 10$ .

**A Sources** — Normal, CH 1, CH 2 line, external and external  $\div 10$ .

**B Sources** — Starts after delay, normal, CH 1, CH 2, and external.

**External Inputs** — R and C  $\approx 1$  M $\Omega$  paralleled by  $\approx 20$  pF. 250 V (dc + peak ac) maximum input.

**Third Channel Trigger View** — Deflection Factor (Dc trigger coupling only).

EXT: 100 mV/div  $\pm 5\%$ .

EXT  $\div 10$ : 1 V/div  $\pm 5\%$ .

Delay Difference: 5.0  $\pm 0.5$  ns after vertical display.

Trigger Point:  $\approx$  center screen.

Risetime:  $\leq 5$  ns.

Aberration:  $<10\%$  p-p.

**X-Y OPERATION**

**Full Sensitivity X-Y (CH 1 Horiz. CH 2 Vert)** — 5 mV/div to 5 V/div, accurate  $\pm 4\%$ . Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

**DISPLAY**

**CRT** — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div reduced scan (466 only). 8.5 kV accelerating potential, normal-mode, 10 kV reduced scan (466 only). P31 Phosphor.

**Graticule** — Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

**Beam Finder** — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A pre-set intensity level provides a constant brightness.

**Z-Axis Input** — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

**STORED WRITING SPEEDS**

	466	464	Storage* View Time
Full Scan (Center 6 x 8 div; 0.9 cm/div)			
FAST TRANSFER	150 div/ $\mu$ s	110 div/ $\mu$ s	>15s
VARIABLE PERSISTANCE	0.5 div/ $\mu$ s	0.5 div/ $\mu$ s	>15s
Reduced Scan (Center 8 x 10 div; 0.45 cm/div)		Reduced Scan not available on 464	
FAST TRANSFER	3,000 div/ $\mu$ s		>15s
VARIABLE PERSISTANCE	3 div/ $\mu$ s		>15s

\*These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in SAVE Display Mode.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating:  $-15^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$ . Non-operating:  $-55^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ . Forced air ventilation is provided.

**Altitude** — Operating: To 4500 m (15,000 ft); maximum allowable ambient temperature decreased by  $1^{\circ}\text{C}/1000$  ft from 5000 to 15,000 ft. Nonoperating: To 15 200 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

**Humidity** — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

**Shock** — Operating and nonoperating: 30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

**OTHER CHARACTERISTICS**

**Amplitude Calibrator**

Output Voltage	0.3 V	1% $+0^{\circ}\text{C}$ to $+40^{\circ}\text{C}$
Output Current	30 mA	2% $+20^{\circ}\text{C}$ to $+30^{\circ}\text{C}$
Frequency	$\approx 1$ kHz	

**Vertical Signal Output** — CH 1 vertical signal is dc to at least 50 MHz and  $\approx 25$  mV/div terminated into 50  $\Omega$ , and  $\approx 50$  mV/div terminated into 1 M $\Omega$ .

**Gate Outputs** — Positive gates from both time bases ( $\approx 5$  V).

**Power Requirements** — Quick-change line voltage selector provides six ranges: 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each  $\pm 10\%$ . 48 to 440 Hz, 100 W maximum at 115 V and 60 Hz. Operation from 12 to 24 V dc is available with Option 07.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width (with handle)	330	13.1
Height (without pouch)	159	6.2
Depth (with panel cover)	550	21.7
Depth (handle extended)	597	23.8
Weights $\approx$	kg	lb
Net (without panel cover or accessories)	11.8	26.0
Net (with panel cover and accessories)	13.5	29.8
Shipping	18.8	41.5

**INCLUDED ACCESSORIES**

Two P6062B Probes (010-6062-13); blue accessory pouch (016-0535-02); clear pouch (016-0537-00); CRT light filter (337-1674-01); two 1 1/2-amp fuses (159-0016-00); one 3/4-amp fuse (159-0042-00); adaptor, ground wire (134-0016-01); viewing hood (016-0592-00).

**ORDERING INFORMATION**

- 466 Storage Oscilloscope ..... \$6,700
- 466 DM 44 Storage Oscilloscope/DMM
- DM 44 Multimeter info on p.317 ..... \$7,220
- 464 Storage Oscilloscope ..... \$5,695
- 464 DM 44 Storage Oscilloscope/DMM
- DM 44 Multimeter info on p.317 ..... \$6,215

**INSTRUMENT OPTIONS**

- Option 01 — Delete DM 44 Temperature Probe (466 DM 44, 464 DM 44 only) .....  $-\$90$
- Option 04 — EMC Modification .....  $+\$160$
- Option 05 — TV Sync Separator (Provides triggering on TV field) .....  $+\$300$
- Option 07 — External Dc Operation (not for DM 44).  $+\$245$

**INTERNATIONAL POWER CORDS AND PLUG OPTIONS**

- Option A1 — Universal Euro 220 V/16A, 50 Hz ..... NC
- Option A2 — UK 240 V/13A, 50 Hz ..... NC
- Option A3 — Australian 240 V/10A, 50 Hz ..... NC
- Option A4 — North American 240 V/15A, 60 Hz ..... NC

Modification kits for field conversion of existing 466s and 464s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Sales Engineer, Distributor, or Representative for information.

**OPTIONAL ACCESSORIES**

**Probes**

Probe Type	Attenuation	Input Impedance	Bandwidth* with 464/466
P6063B 6 ft	1X Switchable 10X	1 M $\Omega$ 105 pF 10 M $\Omega$ 14 pF	6 MHz 90 MHz
P6202 FET PROBE 2 m	10X 100X Head Ac Head	10 M $\Omega$ 2 pF 10 M $\Omega$ 2 pF 10 M $\Omega$ 4 pF	100 MHz
Current Probe	Calibration	Insertion Impedance	Bandwidth with 464/466
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 $\Omega$ @ 1 MHz Increasing to 0.2 $\Omega$ @ 120 MHz	85 MHz

\*Bandwidths are measured at the upper  $-3$  dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

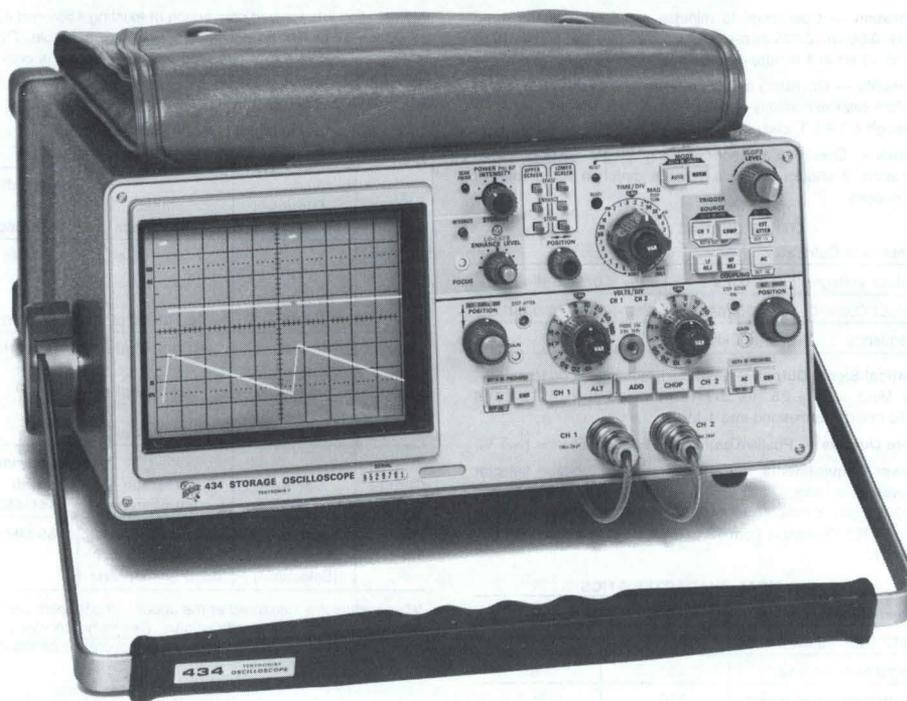


- 1106 Battery Pack (Used with Option 07). ..... \$1,000
- 1105 Battery Power Supply (See page 319). ..... \$1,375
- Mesh Filter Improves display contrast in high ambient light. Order 378-0726-01 ..... \$55
- Protective Cover Waterproof vinyl. (For 464/466.) Order 016-0365-00 ..... \$21
- Folding Viewing Hood Order 016-0592-00 ..... \$12
- Folding Binocular Hood Order 016-0566-00 ..... \$15
- Polarized Collapsible Viewing Hood Order 016-0180-00 ..... \$40
- SCOPE-MOBILE® Cart Occupies  $<18$  inches aisle space, has storage area in base. Order 200 C ..... \$295
- Rack Adaptor (Not for DM 44). Order 016-0676-00 ..... \$325

**RECOMMENDED CAMERA**

- C-30BP Option 01 General Purpose Camera Includes 016-0301-01 mounting adaptor/corrector lens. Order C-30BP Option 01 ..... \$1,402
- Camera Adaptor — Mounts C-30B Series Camera to 464/466 Oscilloscopes. Order 016-0301-01 ..... \$105

For further information see camera section.



**434**

**25 MHz at 10 mV/div**

**20 ns/div Sweep Rate with X50 Sweep Magnifier**

**Weights ≈ 9.4 kg (20.8 lb)**

A bistable, split-screen storage oscilloscope with a 25 MHz bandwidth, the compact 434 fills many needs. The split screen provides full-screen storage, or upper or lower screen storage, with the other half conventional.

Tektronix 434s are used for maintaining display boards, video monitors, automatic baggage handling systems, X-ray systems, and air-conditioning and heating systems.

**CHARACTERISTICS**

**VERTICAL DEFLECTION**

(2 Identical Channels)

**Bandwidth and Risetime** — (From 50 Ω terminated source, with or without 10X probe) Dc to at least 25 MHz at 3 dB down\*, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low frequency 3 dB down point with ac coupling is 14 Hz or less (<1 Hz with 10X probe).

**Deflection Factor** — 1 mV/div to 10 V/div, accurate ±3%. Uncalibrated, continuously variable between steps and to ≈25 V/div.

**Display Modes** — CH 1 only, CH 2 only (normal or inverted), alternate, chopped (≈100 kHz), added.

**CMRR** — Common mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

**Automatic Scale Factor** — Probe tip deflection factors for 1X or 10X coded probes are indicated by lights besides the knob skirts. Ground reference display selectable at probe (when dc coupled).

**Input R and C** — 1 MΩ ±2% paralleled by ≈24 pF.

**Maximum Input Voltage** — Dc coupled: 250 V (dc + peak ac); ac coupled: 500 V (dc + peak ac). In either mode the maximum ac is 500 V p-p at 1 kHz or less.

**Delay Line** — Permits viewing of leading edge of displayed waveform.

\*Bandwidth derated to 22 MHz above +30°C.

**HORIZONTAL DEFLECTION**

**Time Base** — 0.2 μs/div to 5 s/div (1-2-5 sequence). X50 magnifier extends fastest sweep rate to 20 ns/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to 12.5 s/div.

**Time Base Accuracy, Full 10 Division**

	+20°C to +30°C	-15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±4%	±5%

**External Horizontal Input** — Deflection factor is ≈0.5 V/div. Input resistance is ≈50 kΩ.

**TRIGGER**

**Modes** — Auto trigger (sweep free-runs in absence of triggering signal, normal trigger, single sweep).

**Trigger Sensitivity and Coupling**

Coupling	At 25 MHz	
	To 5 MHz	At 25 MHz
Dc	0.3 div deflection	1 div deflection
External	50 mV	125 mV
Ac	Requirements increase below 20 Hz	
Ac LF Reject	Requirements increase below 50 kHz	
Ac HF Reject	Requirements increase above 50 Hz	

**Sources** — CH 1 only, composite line, external and external ÷10. External trigger level range is at least +2 V to -2 V or +20 V to -20 V.

**External Inputs** — Input R ≈1 MΩ paralleled by 100 pF ÷1 or 70 pF ÷10. 250 V (dc + peak ac).

**DISPLAY**

**CRT** — 8 x 10 div (1 div = 0.975 cm) horizontal and vertical divisions further marked in 0.2 div increments. P1 Phosphor. 4 kV accelerating potential.

**Graticule** — Internal, non parallax; non-illuminated.

**Beam Finder** — Compresses trace to within graticule area for ease in locating an off-screen signal.

**Z-Axis Input** — Dc coupled, positive going signal decreases intensity, 5 V p-p signal causes noticeable modulation; dc to 20 MHz usable frequency range.

**STORAGE FEATURES**

**Display Modes** — Split-screen with storage on upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display. Independent operation of halves.

**Stored Writing Speed** (Center 8 div) — Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 01, 500 div/ms, normal; to 5000 div/ms, enhanced).

**Erase Time** — 300 ms or less.

**Locate** — Beam can be positioned left of the graticule area to determine vertical position of next sweep without disturbing stored display.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: -15°C to +55°C. Non-operating: -55°C to +75°C.

**Altitude** — Operating: to 4500 m (15,000 ft); maximum allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: to 15,200 m (50,000 ft).

**Vibration** — Operating: 15 minutes along each of the three axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

**Humidity** — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

**Shock** — Operating and nonoperating: 30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

**OTHER CHARACTERISTICS**

**Amplitude Calibrator** — 0.6 V ±1.0%, 1 kHz ±1.0% (+20°C to +30°C). Output resistance is 575 Ω.

**Power Requirements** — Operates on all voltages from 90 V to 136 V and 180 V to 272 V, 48 to 440 Hz, 60 W maximum. Also operates from 220 V dc to 350 V dc.

**PHYSICAL CHARACTERISTICS**

Dimensions	Cabinet		Rackmount	
	mm	in	mm	in
Width (with handle)	330	13.0	483	19.0
Height (w/o pouch)	142	5.6	133	5.3
Depth	475	18.7	457	18.0
Weight ≈	kg	lb	kg	lb
Net	9.4	20.8	10.5	23.1
Shipping	13.6	30.0	22.0	49.0

**INCLUDED ACCESSORIES**

Two P6105 Probes (010-6105-03); accessory pouch (016-0165-00). Rack models also include mounting hardware and slide out assemblies, but not pouch.

**ORDERING INFORMATION**

<b>434 Storage Oscilloscope</b> .....	<b>\$4,840</b>
<b>R434 Rackmount Storage Oscilloscope</b> .....	<b>\$5,060</b>
<b>Option 01 — Increased Writing Speed</b> .....	<b>+ \$350</b>

**OPTIONAL ACCESSORIES**

Probe Type	Attenuation	Input Impedance	Bandwidth*
P6062A 6 ft	1X Switchable 10X	1 MΩ 5 pF 10 MΩ 14 pF	6.7 MHz 25 MHz
Current Probe	Calibration	Insertion Impedance	Bandwidth with 434
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	25 MHz

\*Bandwidths are measured at the upper -3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth.

<b>1105 Battery Power Supply</b> (See page 319.)	
<b>Mesh Filter</b> Improves contrast and EMC filtering. Order 378-0682-00 .....	<b>\$45</b>
<b>Portable to Rackmount Assembly</b> Includes hardware for standard 434 in 19 inch rack mounting. Order 016-0272-00 .....	<b>\$200</b>
<b>Folding Polarized Viewing Hood</b> Order 016-0180-00 .....	<b>\$40</b>
<b>SCOPE-MOBILE® Cart</b> Occupies <18 inches aisle space, has storage area in base. Order 200C .....	<b>\$295</b>

**RECOMMENDED CAMERA**

<b>C-30BP Option 01 General Purpose Camera</b> Includes 016-0301-00 mounting adaptor/corrector lens. Order C-30BP Option 01 .....	<b>\$1,402</b>
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For further information see camera section.



## 314

10 MHz at 1 mV/div

100 ns/div Sweep Rate with X10 Sweep Magnifier

Stored Viewing Time to 4 Hours

Integrate Mode for Intensifying Fast Rise-time, Low Repetition Rate Signals

Operates from Ac Line, 12 V Dc, or 24 V Dc

Small Size, Weights ≈4.7 kg, (10.5 lb)

The 10.5 pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a 4 hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast risetime, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac, dc or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large CRT.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth and Risetime** — Dc to at least 10 MHz. Risetime, 35 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

**Deflection Factor** — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Continuously variable between steps and to at least 25 V/div (uncalibrated).

**Display Modes** — CH 1, CH 2 (normal or inverted), chopped, alternate, added, and X-Y.

**Input R and C** — 1 MΩ paralleled by ≈47 pF.

**Maximum Input Voltage** — Ac or dc coupled, 300 V (dc + peak ac).

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Amplitude Calibrator** — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from -15°C to +55°C.

### HORIZONTAL DEFLECTION

**Time Base** — 1 μs/div to 5 s/div. X10 magnifier extends sweep rate to 100 ns/div.

**Variable Time Control** — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

### Time Base Accuracy, Center 8 Divisions

Unmagnified		
1 μs/div to 0.2 s/div		±3%
0.5 s/div to 5 s/div		±4%
Magnified		
50 ms/div to 0.5 s/div		±5%
0.5 μs/div to 20 ms/div		±4%
0.1 μs/div and 0.2 μs/div		±5%

### TRIGGER

**Modes** — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment). Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

**Trigger Sources** — Internal: CH 1, CH 2 or composite, external.

### Sensitivity and Coupling

Coupling	To 50 MHz		To 350 MHz
	0.3 div deflection	150 mV	1 div deflection
Dc	Internal		500 mV
	External		
Ac	requirements increase below 30 Hz		
Ac LF Reject	requirements increase below 50 kHz		

### X-Y OPERATION

**Input** — X-axis input is via the external horizontal input connection. Both CH 1 and CH 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

**X-Axis Deflection Factors** — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

**Input Impedance** — 1 MΩ ±2% paralleled by ≈62 pF.

### DISPLAY

**CRT** — 8 x 10 div (0.6 cm/div) display. P44 Phosphor. 2 kV accelerating potential.

**Graticule** — Internal, non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

**Z-Axis Input** — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Maximum input voltage, 50 V (dc + peak ac).

### STORAGE FEATURES

**Display Modes** — Direct view, bistable storage, and non-store modes. Enhance mode to increase stored writing rate in the single sweep mode. Auto erase mode to automatically erase stored display after each sweep. Viewing time before auto erase can be varied from 1 sec or less to at least 5 sec. Integrate mode increases stored brightness of very fast repetitive signals.

**Stored Writing Speed** — Normal, at least 80 div/ms. Enhanced, increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

**Erase Time** — 300 ms.

### AC POWER REQUIREMENTS

**Line Voltage Ranges** — 90 to 130 V ac or 180 to 264 V ac.

**Line Frequency** — 48 to 440 Hz.

**Power Consumption** — 29 W maximum at 115 V ac.

**External Dc Source** — +11 to +14 V dc or +22 to +28 V dc.

**Dc Current Drain** — 1.6 A at +12 V or 0.8A at +24 V.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Operating: -15°C to +55°C. Nonoperating: -40°C to +75°C.

**Altitude** — Operating: to 6000 m (20,000 ft) maximum, decrease maximum temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 15 200 m (50,000 ft) maximum.

**Vibration** — Operating: 15 minutes along each of the three major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

**Humidity** — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

**Shock** — Operating and nonoperating: 30 g's, 1/2 sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width (with handle)	236	9.3
Height (without pouch)	112	4.4
Depth (handle not extended)	347	13.6
Depth (handle extended)	448	17.6
Weight ≈	kg	lb
Net (without accessories)	4.7	10.5
Shipping	7.6	17.0

### INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03); carrying case and pouch (016-0612-00); external dc cable assembly (012-0406-00); strap (346-0131-00); two 1.6-A fuses (159-0098-00); two 0.8-A fuses (159-0132-00); two 0.15-A fuses (159-0130-00); three 0.16-A fuses (159-0131-00).

### ORDERING INFORMATION

314 Storage Oscilloscope ..... \$3,655

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

### RECOMMENDED CAMERA

C-30BP General Purpose Camera ..... \$1,360

Camera Adaptor — Mounts C-30BP to 314.

Order 016-0327-01 ..... \$169

For further information see camera section.



**214**

**500 kHz, 1 mV/div to 50 V/div**

**Internal Battery**

**Integral 1 MΩ Probe**

**Weights ≈ 1.6 kg, (3.5 lb)**

The 214 features these signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. It is lightweight (only 3.5 pounds) and compact (3 x 5.25 x 9.5 inches). The 214 offers bistable storage capabilities. This is useful for viewing non-repetitive or slow moving signals.

Built of impact-resistant plastic and fully self contained, this miniature portable is ideal for applications in severe environments. And it permits "floating" measurements since it is double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

The 214 features integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument—you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

**CHARACTERISTICS**

**VERTICAL DEFLECTION**

**Bandwidth** — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower -3 dB point ac coupled is <2 Hz.

**Deflection Factors** — 1 mV/div to 50 V/div (1-2.5 sequence), accurate ±5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

**Display Modes** — CH 1 only, CH 2 only, or CH 1 and CH 2 chopped (≈ chop rate — 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from .1 ms/div to 5 μs/div of time base.

**Input R and C** — ≈ 1 MΩ paralleled by ≈ 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

**Maximum Input Voltage (1X Probe Only)**

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac; 5 MHz or less

**HORIZONTAL DEFLECTION**

**Time Base** — 5 μs/div to 500 ms/div, accurate ±5%.

**Variable Magnifier** — Increases each sweep rate X5 with a maximum sweep speed of 1 μs/div.

**External Horizontal Input** — (CH 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz; X-Y phasing to 5 kHz <3°. Input characteristics same as CH 1.

**Maximum External Horizontal Input Voltage and Impedance** — Same as for vertical inputs.

**Input Impedance** — R and C, 1 MΩ paralleled by ≈30 pF.

**TRIGGER**

**Trigger Modes** — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

**Trigger Sensitivity and Coupling**

Dc Coupling	to 500 Hz
Internal (w/composite trigger source)	0.2 div
Internal (w/CH 2 trigger source)	0.2 div
External	1 V

**Maximum External Trigger Input Voltage** — 8 V (dc + peak ac), 16 V (p-p) at 1 MHz or less.

**Single Sweep** — Sweep generator produces one sweep when trigger is received.

**DISPLAY**

**CRT** — Bistable storage, 6 x 10 div (0.52 cm/div) display. P44 Phosphor.

**Graticule** — Internal, black line, non-illuminated.

**STORAGE FEATURES**

**Stored Writing Speed** — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhancement is automatic from 0.1 ms to 5 μs/div in single sweep.

**Stored Luminance** — At least 8 fL at 25°C.

**Storage Viewing Time** — ≈ 1 hour.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Operating: (battery only), -15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating: -40°C to +60°C.

**Altitude** — Operating: 7500 m (25,000 ft), decrease maximum temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 15 200 m (50,000 ft).

**Vibration** — Operating and nonoperating: 15 minutes along each of the 3 major axes, 0.06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

**Humidity** — 5 cycles (120 hours) to 95% relative humidity, referenced to MIL-E-16400F.

**Shock** — Operating and nonoperating: 150 g's, 1/2 sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

**OTHER CHARACTERISTICS**

**Power Sources** — Internal NiCd batteries provide ≈3.5 to 5 hours operation (≈ 2.5 to 3.5 hours in 214 stored mode) for a charging and operating temperature between 20°C and 30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to ≈10 V to protect batteries against deep discharge. Full recharge requires ≈16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 5 minutes of operating time remaining in the batteries.

**External Ac Source** — 110 to 126 V, 58 to 62 Hz, 3 W. Can be operated at 104 to 110 V with resulting slow discharge of internal batteries.

**Insulation Voltage** — 500 V RMS or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4X line + peak ac) not to exceed 350 V.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	133	5.3
Height	76	3.0
Depth	241	9.5
<b>Weight</b> ≈	<b>kg</b>	<b>lb</b>
Net (without accessories)	1.6	3.5
Shipping	3.2	7.0

**INCLUDED ACCESSORIES**

Viewing hood (016-0199-01); carrying case (016-0512-00); two 4-A fuses (159-0121-00); identification tags (000-7983-00); identification tag (334-2614-00); carrying strap (346-0104-00).

**ORDERING INFORMATION**

**214 Dual-Trace Storage Oscilloscope, Includes Batteries and Probes ..... \$2,320**

**POWER OPTIONS**

**Option 01** — For 220-250 V, (48 to 52 Hz)  
includes batteries ..... **NC**

**Option 02** — For 90 to 110 V, (48 to 52 Hz)  
includes batteries ..... **NC**

**OPTIONAL ACCESSORIES**

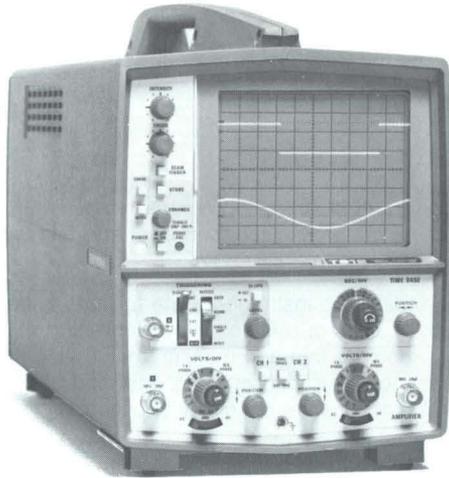
**10X Attenuator Package** A slip-on tip to provide lower circuit loading (4.4 MΩ, ≈20 pF) and higher maximum input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adaptor (206-0203-00).  
Order 010-0378-01 ..... **\$45**

**Alligator Clip Kit** A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to 3/8 in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adaptor (103-0051-01).  
Order 015-0231-00 ..... **\$20**

**Probe-tip to BNC Panel Connector Adaptor**  
Order 013-0084-01 ..... **\$8.00**

**Probe-tip to BNC Cable Adaptor**  
Order 103-0096-00 ..... **\$11**

**Power Cable Adaptor Assembly** A short length of two-wire power cord. One end has a female NEC socket fitting the 200 Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.  
Order 161-0077-01 ..... **\$7.00**



**T912**

- 10 MHz at 2 mV/div**
- 250 cm/ms Stored Writing Speed**
- 50 ns/div Sweep Rate (with X10 Sweep Magnifier)**
- 8 x 10 cm Bistable Storage CRT**
- Weighs ≈7.9 kg, (17.5 lb)**
- Differential Input Option**

The T912 Storage Oscilloscope is well suited for a wide range of applications in education and industry. As a training aid in basic electricity and electronics courses, the storage feature is highly useful in creating visual representations of electrical signals. In physics and engineering courses, storage permits the user to capture and display single-shot events like the pressure curve generated in the compression chamber of an engine or the stress-strain characteristics of a material undergoing destructive testing.

The T912 has similar industrial applications, where it can also be used to compare input vs feedback signals in servo-mechanisms for shock and vibration analysis, and countless other transducer-aided measurements.

Besides bistable storage, the T912 offers other features seldom found in economy-model oscilloscopes including a delay line, that allows you to view the leading edge of fast-rising signals, a 12-step calibrated vertical attenuator and constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimeter. Additional features include 19 calibrated sweep rates ranging from 0.5 s to 500 ns/cm, 3% amplitude and timing accuracy; and minimal corner shift over a broad vertical dynamic range.

The T912 may be ordered with a differential input option. In DIFF mode, the T912 displays the difference between Channel 1 and Channel 2 signals. The Channel 2 signal is automatically inverted. The algebraic sum of the Channel 1 signal and the inverted Channel 2 signal is then displayed on the CRT.

**CHARACTERISTICS  
VERTICAL SYSTEM**

**Mode Selection**

- CH 1 — Displays only the CH 1 signal.
- CH 2 — Displays only the CH 2 signal.

Dual Trace — Displays CH 1 and CH 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting, chopped mode is selected for settings  $\geq 1$  ms/div, alternate for settings  $\leq 500$   $\mu$ s/div. Trigger is derived from CH 1 signal only.

**Deflection Factor Range** — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

**Accuracy**

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

**Uncalibrated (VAR) Range** — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

**Frequency Response** — Dc to at least 10 MHz (measured at -3 dB).

**Risetime** — 35 ns or less.

**Chopped Mode Repetition Rate** —  $\approx 250$  kHz.

**Input Resistance** —  $\approx 1$  M $\Omega$ .

**Input Capacitance** —  $\approx 30$  pF.

**Maximum Input Voltage** — Dc Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac Coupled: 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

**Delay Line** — Permits viewing edge of displayed waveform.

**HORIZONTAL SYSTEM**

**Calibrated Range** — 0.5 s/div to 0.5  $\mu$ s/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 50 ns/div.

**Accuracy**

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

**Trigger Modes**

Auto — Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz.

Normal — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Single Sweep — Displays one sweep only. Sweep cannot be triggered again until reset.

Slope + Out — In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

**Trigger Sensitivity** — Auto and Normal: 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.

**External Trigger Input** — Maximum Input: 400 V (dc + peak ac) 800 V p-p ac at  $\leq 1$  kHz. Input Resistance:  $\approx 1$  M $\Omega$ . Input Capacitance:  $\approx 30$  pF.

**X-Y OPERATION**

**Sensitivity, Variable Magnifier** —  $\approx 100$  mV/div (X10 magnifier),  $\approx 1$  V/div (X1 magnifier), for X; Y is adjusted by vertical control.

**X-Axis Bandwidth** — Dc to at least 1 MHz (measured at -3 dB).

**Input Resistance** —  $\approx 1$  M $\Omega$ .

**Input Capacitance** —  $\approx 30$  pF.

**Phase Difference Between X and Y Axis Amplifiers** — Within 5° from dc to 50 kHz.

**CRT STORAGE DISPLAY**

**Writing Rate** — At least 25 cm/ms.

**Enhanced Writing Rate** — At least 250 cm/ms.

**Display Area** — 8 x 10 cm, internal graticule.

**Storage Phosphor** — P1.

**Beam Finder** — Locates off-screen display.

**Nominal Accelerating Potential** —  $\approx 2.76$  kV.

**AC POWER REQUIREMENT**

**Line Voltage Ranges** — HI-LO range accessible externally; 110-120 V, 220-240 V line selector visible but not accessible externally.

**100-120 V Range** — HI: 108 to 132 V RMS. LO: 90 to 110 V RMS.

**220-240 V Range** — HI: 216 to 250 V RMS. LO: 198 to 242 V RMS.

**Line Frequency** — 50 to 60 Hz.

**Power Consumption** — 65 W maximum, 0.6A maximum, at 120 V, 60 Hz.

**PROBE ADJUST**

**Output Voltage** —  $\approx 0.5$  V.

**Repetition Rate** —  $\approx 1$  kHz.

**Z-AXIS INPUT**

**Sensitivity** — 5 V causes noticeable modulation.

**Usable Frequency Range** — Dc to 5 MHz.

**Input Impedance** —  $\approx 10$  k $\Omega$ .

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Nonoperating: -55°C to +75°C. Operating: 0°C to +45°C.

**Altitude** — Nonoperating: To 15 200 m; (50,000 ft). Operating: To 4500 m; (15,000 ft) maximum. Operating temperature decreased 1°C/304.8 m (1,000 ft) above 1524 m (5,000 ft).

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	mm	in	kg	lb
Width	180	7.1		
Height	254	10.0		
Depth	475	18.7		
<b>Weight</b> $\approx$				
Net (with panel cover)	8.2	18.0		
Net (without panel cover)	7.9	17.5		

**INCLUDED ACCESSORIES**

Two P6006 10X Probes, 3-5 ft. (010-0127-00); 2 m (010-0160-00).

**ORDERING INFORMATION**

**T912** — Storage Oscilloscope ..... **\$2,170**

**Option 01** — Differential Input ..... **+\$100**

**INTERNATIONAL POWER CORDS & PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**

**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**

**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**

**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**

**OPTIONAL ACCESSORIES**



**Protective Front Panel Cover** Snaps over the oscilloscope front panel to protect controls during transport or storage. Molded from high-impact-resistant plastic. Storage compartment for two probes and cables is built into inner side. Order 016-0340-00 ..... **\$20**

**Dust Cover/Rain Jacket** (not shown). Provides protection against dust accumulation when not in use, and against rain and snow during transportation. Constructed of 15 mil tough durable vinyl. An opening at the top allows access to the oscilloscope handle. Order 016-0361-00 ..... **\$20**

**C-5C Camera** (not shown). Order C-5C, Option 03 ..... **\$525**

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**Designed for Configurability; for Programming Ease; for Productivity.**

**Test and Measurement set-up has never been this friendly, has never been this fast.** With our new line of Tek programmables, you can continue to build on the concept of configurability.

Now you can link together customized, automated test packages with the GPIB bus. Our IEEE Standard 488 compatible TM 5000 programmables are configurable, with the same plug-in, pull-out ease as our TM 500 plug-ins. And they're compatible between themselves and with almost 40 TM 500 manual instruments.

You'll find these fully programmable instruments are among the friendliest and fastest to integrate you can buy.

Standardized instrument data formats open up the lines of bus communication, and makes your test and measurement system easy to set-up and operate. Test and control functions are changed quickly and easily.





Start with our two newest mainframes, the TM 5003 and TM 5006. They hold up to three or six plug-ins, yet are very compact. So your test package takes up less than half the space of ordinary rackmounted test equipment.

Add our new instrument-optimized controller, the 4041. It has a detachable keyboard that you attach for program development and detach for program protection. Built around a 16-bit microprocessor with 160 k byte memory capacity, this sophisticated controller offers two GPIB and two RS-232 ports (with Option 01), so you can optimize system set-up. Three data transfer speeds are provided: normal, fast transfer, and DMA, so you can optimize program run-time.

Choose your programmable test gear from our fully programmable Function Generator (the FG 5010), Universal Counter/Timers (DC 5010 and DC 5009), Digital Multimeter (DM 5010), and Power Supply (PS 5010) and incorporate TM 500 Plug-ins for special functions.

The vital link between your specific device under test and the programmable system is the multifunction interface, MI 5010. The multifunction interface acts as the "systems glue" for your application. The multifunction interface is a card-based instrument. To customize its' capabilities you choose from four available function cards:

Digital-to-Analog Converter, Digital I/O, Relay Scanner, and (to customize your own card), a Development card. An extender is available for additional card capacity.

Simplify system routing and switching with a Scanner Interface. The SI 5010, lets you pre-set a 16-channel, software configurable RF switching matrix to make test connections on command.

#### **Manual instruments that perform in hundreds of combinations.**

Configurability is the watchword for TM 500 Instruments and Mainframes. You can create multifunction packages that encompass a wide diversity of applications. Or solve one unique application problem.

You choose from almost forty ready-to-go, compact plug-ins for a range of test and measurement needs. TM 500 Instruments include digital counters, pulse generators, function generators, amplifiers, signal processors, audio oscillators, a distortion analyzer, ramp generators, calibration instruments, power supplies, oscilloscopes, digital delay, word recognizer, and a digital latch. Plus a blank plug-in kit for customizing special functions.

You put your instruments together in the mainframe that best suits your environment. There's a travel mainframe for service work and field test-

ing; a rackmount model for production and test; or standard mainframes, compact and convenient for bench or desk, that accept one or up to six instruments. Rollabout carts are available for lab configurations with Tek oscilloscopes.

All TM 500 Instruments and mainframes are electrically and mechanically compatible. So, through interfacing, you can configure an instrument more powerful than the sum of its parts: an audio lab with distortion analyzer and storage scope, for example.

Cost efficiency is as important a part of the TM 500 concept as solving applications problems. You add on performance capabilities when you need them. And when you do add them, you can still use the same mainframe and power supply you started with.

#### **Application and Construction Notes**

The General Purpose Instrument line is supported by an on-going program to keep you informed of how to achieve optimal performance and versatility from your TM 500/5000 Instruments. Tektronix' goal of providing you with solutions to difficult measurement problems does not end with your purchase of TM 500/5000 Instruments.

Application Notes take you through the steps necessary to solve complex problems, or to make more useful measurements with your TM 500/5000 Instruments. Subjects include integration through v to f conversion, generating delayed pulses, and current sinking with power supply modules.

Construction Notes provide information necessary to build custom circuits using a blank plug-in kit and standard components. These notes are developed from the actual construction of more common special circuits and include parts lists, schematics and other construction details. Some of the available TM 500 notes include: power supply circuits, thermal true RMS converter, and analog multipliers.

# PROGRAMMING EASE . . .

## Another Order of Magnitude in Measurement Convenience

### TM 5000 Programming... A Commitment to Compatibility

The new TEKTRONIX TM 5000 Series of instruments is, in many respects, the same as its predecessor, the TM 500 Series. There's the same range of instruments—digital multimeter, universal counter/timers, triple power supply, function generator, and others. And there's the same commitment to excellence in each instrument.

It's the additions and enhancements that make TM 5000 something new. First, each TM 5000 Plug-in Instrument is programmable. Plus, there are new kinds of plug-ins—a Programmable Scanner and a Programmable Multifunction Interface—for further test automation. And every instrument is compatible with IEEE Standard 488-1978, the instrument-interfacing standard specifying what is often called the General Purpose Interface Bus or GPIB.

#### TM 5000 Speaks Your Language

With TM 5000, compatibility is the key. And it's more than just IEEE Standard 488 compatibility. It's total system compatibility, from configuring to programming. This higher level of compatibility is achieved through conformance to the additional standard of TEK *Codes and Formats*, the same standard governing other Tektronix IEEE Standard 488-compatible products, including a variety of instrument controllers, waveform digitizers, and special signal analyzers. TM 5000 and Tek *Codes and Formats* extend compatibility through:

- An ASCII-coded language for easy, English-like programming.
- Command names that are descriptive abbreviations of instrument functions for simple and direct instrument control.
- Universal message and data formats for instrument-to-instrument consistency.

In short, TM 5000 Instruments speak a system language that is the same as your language.

Need to set your power supply to 5 volts?

It's easy with the TM 5000 Series Programmable Power Supply. Just send the message VPOS 5 over the IEEE 488 bus to the power supply, and it will change its positive output to 5 volts.

Want to set the negative supply to -9 volts? Just send VNEG 9, or even VNEG -9. All the TM 5000 Instrument commands are simple, English abbreviations for the instrument functions, with direct matches to the front-panel control labels where appropriate. So, if you know how to operate the instrument, you essentially know what commands to send it.

What could be simpler than DCV .2 to change your TM 5000 Programmable Multimeter to the 200 mV range for dc voltage measurements? Or ACV 2 to switch it to the 2 V range for ac measurements? But then, you may not always be sure of the range you need. So just send DCV or ACV without specifying the range, and the multimeter will auto-range to give you the best measurement. You don't have to learn a new language to speak to an instrument or understand instrument control messages—they're self documenting.

#### Getting Your Message Across

It doesn't take long to become familiar with the command set for any TM 5000 Instrument. And, once you have that familiarity, you'll want to begin actually programming for automated measurements. First, though, you'll need to know something about IEEE 488 bus communication.

IEEE Standard 488 specifies overall bus functioning, leaving many implementation options to designer discretion. One option is how controllers and instruments signal message endings to each other. Some controllers end messages by asserting End Or Identify (EOI) concurrent with sending the last character of a message, others by adding a line feed (LF) character and asserting EOI concurrent with that. For compatibility, your instruments and controller must use the same message termination mode.

Whatever your choice of IEEE Standard 488 instrument controller, TM 5000 Instruments are designed for compatibility. A switch on each TM 5000 Instrument lets you match it to your controller by selecting the EOI only or EOI/LF message termination mode. But, if you've chosen a Tektronix controller, you won't have to bother with this switch. All Tektronix-supplied instrument controllers use EOI only, and all TM 5000 Instruments are shipped set for EOI only.

Along with the Message Terminator switch, you'll also find that each TM 5000 Instrument has a bank of at least five additional switches. These are used to set the instrument's primary bus address.

For an IEEE Standard 488 system to work, each instrument on the bus must have a different address. Valid addresses range from 0 to 30, with 0 reserved in some cases for the controller. Before connecting your TM 5000 Instrument to the IEEE 488 bus, make sure each instrument is set to a different address. For powered-up instruments, address checks can be done with the INST ID button. Pressing INST ID causes the primary address to appear on the instrument's display. Also, a decimal point will be displayed after the address if the message terminating mode is set for EOI/LF; absence of a decimal indicates EOI only.

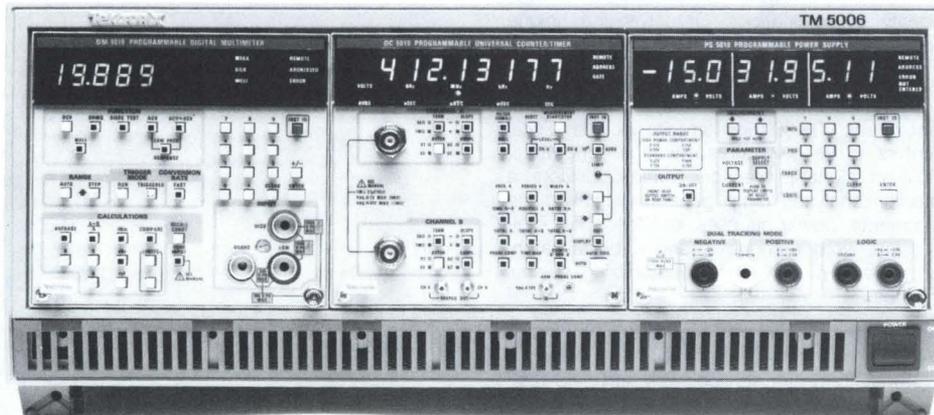
The primary address links the controller to a specific instrument. For example, when using a Tektronix 4050 Series Controller with 4050 BASIC Software, just primary addresses are used. 4050 BASIC automatically converts primary addresses to talk and listen addresses. For example, a 4050 BASIC statement to send VPOS 5 to a PS 5010 Programmable Power Supply with a primary address of 22 would have the following format:

```
PRINT @22:"VPOS 5"
```

PRINT is the 4050 BASIC statement for sending a message to an instrument. The instrument's primary address, 22 in this case, is always preceded in the statement by an "at" sign (@) and followed by a colon. The instrument message, VPOS 5, follows the colon and is always enclosed in quotes. Since the instrument will be receiving the message, PRINT causes the primary address to be automatically incremented to a listen address.

Keep in mind, though, PRINT @22:"VPOS 5" is a statement format specific to 4050 BASIC. Other instrument controllers and software packages may use different statement formats, however the device dependent message is always the same.

In addition to being easy to program, TM 5000 Instruments are friendly and informative in respect to sending SRQ interrupts.



TM 5000: IEEE Standard 488 compatibility in an attractive, high-density package for minimum use of bench top or system rack space.

GENERAL PURPOSE INSTRUMENTS



**PRODUCT SUMMARY**

When the TM 500 approach to test and measurement instrumentation was developed, it was based on a simple yet unique concept; a family of compact, interchangeable instruments that could easily function individually or in combination. The TM 500 line now includes almost forty instruments designed to meet your manual test and measurement requirements.

To satisfy the demand for increased productivity in automated systems, Tektronix developed the TM 5000 line with the same ideas in mind; compactness, interchangeability, and the ability to function alone or in combination with other instruments of the same family.

The TM 500/TM 5000 mainframe families allow the multifunctionality of a package of instruments. Literally hundreds of combinations of instrumentation packages can be configured for specific tasks by using TM 500 plug-ins.

The TM 500 plug-in instruments operate in any of eight power-module mainframes that accept instruments or combinations of up to six single-width plug-ins. One single-width plug-in instrument is accommodated by the TM 501. A six-wide power module mainframe is available in either benchtop or rackmount versions. Three- and four-wide versions are also available and a five-wide Traveler mainframe provides for applications that require instrument portability.

The TM 5000 mainframe extends the convenience of the TM 500 concept into the programable instrument/IEEE Standard 488 area. TM 5000 plug-ins operate in either of two power-module mainframes: TM 5003 is a half-rack width power-module capable of accepting three single-width plug-in instruments at one time; the TM 5006 power-module can provide power for up to six single-wide plug-in instruments at one time. TM 5000 instruments will operate only in TM 5000 mainframes. But, all the TM 500 manual plug-in instruments will also operate in these same mainframes allowing manual and programable instruments to be mounted together in adjacent slots. This capability permits unique compact combinations of test instruments to be assembled for specific test applications.

While the TM 5000 power-modules are used for GPIB compatible plug-ins, the power-modules themselves do not occupy a bus address location. Each module has its own bus address, and the interconnect scheme will allow as many as six (typically three) instruments to be connected to the system with only one GPIB cable.

**Benchtop**

The six benchtop mainframes are the TM 501, TM 503, TM 504, TM 506, TM 5003 and the TM 5006. The TM 503 and TM 5003 are the most

compact of the multiple instrument units, each accommodating three single-wide plug-ins. The TM 504, TM 506, and the TM 5006 each include a high-power compartment at the right-hand end to supply higher current levels to instruments that provide higher performance or higher output levels. The TM 506, TM 5003 and TM 5006 incorporate a quiet fan for optimum cooling. All benchtop models have feet, tilt-bails, handles, and front-panel power switches. All operate from 110 or 220 V ac.

**Portability**

All benchtop models have carry handles for portable applications. TM 500 models further enhance portable applications with sturdy cord-wrap rear feet plus optional protective front covers. The TM 515, however, was designed for superior, multi-instrument portability. In its carrying configuration, it is a handsome piece of luggage with molded feet on the bottom and a comfortable, luggage-type handle. The TM 515 is extremely moisture and dust resistant and is designed to withstand the rigors of transport in car trunks and pickup trucks. Once at the destination, its rear cover is popped off to access the power cord and power switch and allow airflow for the built-in fan. Removing the front cover exposes up to five TM 500 plug-in instruments to reveal an operational electronics lab traveling as a suitcase.

**Rackmount**

The RTM 506 Rackmount Mainframe is electrically identical to the TM 506. The TM 5006 Option 10 is electrically identical to the standard TM 5006. Each instrument features a slide assembly and handles plus a higher-power fan than the bench version, to accommodate the higher ambient temperatures often found in enclosed racks and consoles. It is also possible to convert two TM 503's into a rackmount assembly with a kit. This kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications, but lacks the fan and the high-power compartments. Other kits are available to rackmount a single TM 503, a TM 503 with a monitor, or a TM 5003 with a 4041 System Controller. A custom modification kit is required to rackmount a 4041 by itself.

**Rear Interface Capability**

Most TM 500 and TM 5000 plug-in modules contain a duplication of the front-panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some plug-in modules also have additional signal or control lines that are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front-panel clutter or to perform functions not otherwise available.

For example, the trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage setups without any need to move test leads. Any module can be internally connected through the mainframe and also can be externally interfaced out the back panel.

Mainframes can be interfaced in a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with Option 02. This factory-installed option comes equipped with a special wire kit consisting of prepared jumper coax cables and interconnection jack barriers in addition to a rear-panel male connector, mating cable connectors, and one BNC connector per plug-in compartment. To provide as much flexibility as possible, these three connectors are not pre-wired. Option 02 also provides square-pin connectors on the rear interface circuit board with mating square-pin receptacles. The square-pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframe. Other Option 02 components offer a variety of interfacing alternatives, limited only by the imagination and ingenuity of the user.

**Economy**

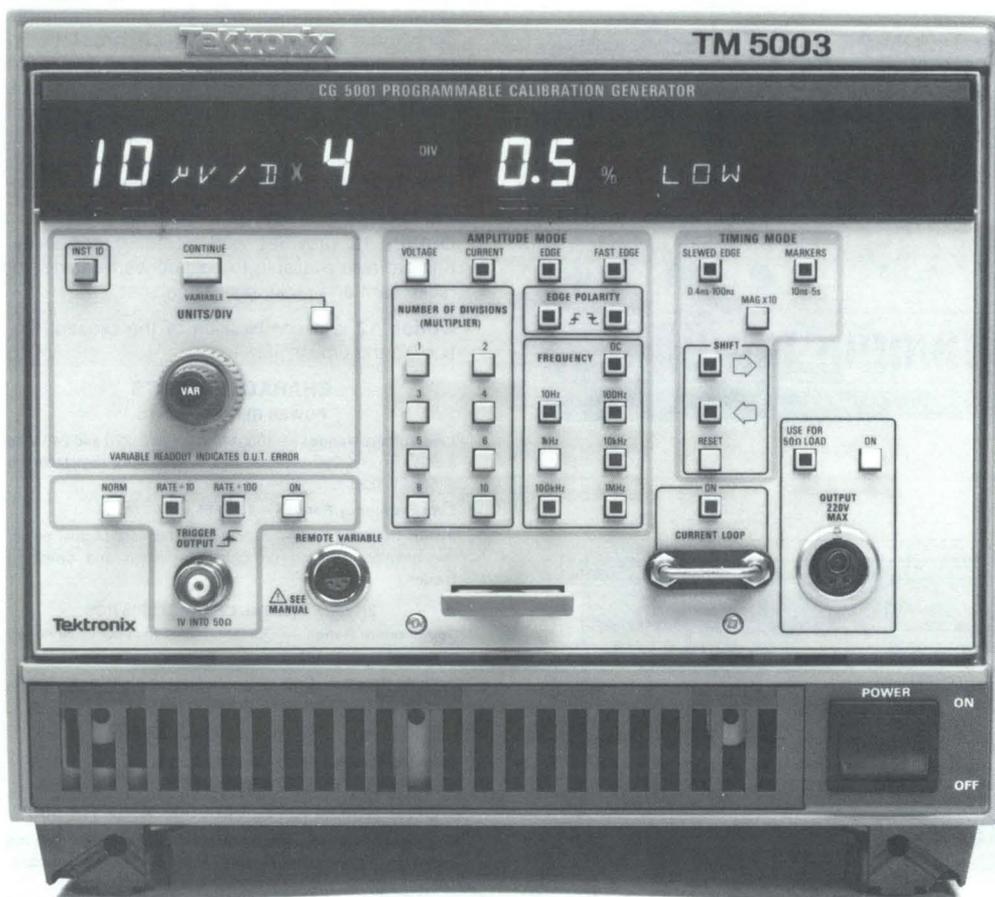
TM 500 and TM 5000 mainframes represent a most economical approach in test and measurement instrumentation. Relatively fixed packaging costs for frames, covers, primary power circuits, unregulated secondary power circuits, and other items are a significant portion of the cost of a typical instrument. Since (so called) fixed costs associated with packaging are shared by many functional instruments in the TM 500/TM 5000 lines, the cost-per-function may be lower than comparable, one- or two-function monolithic instruments. Because of its modularity, expandability, and versatility, the modular concept represented by TM 500 and TM 5000 mainframes may provide the lowest cost-per-test/measurement when you are considering multifunction usage.

The ability to upgrade to a higher-performance system without replacing the entire investment, made possible by the compatibility between the TM 500 and TM 5000 lines; reduced cabling costs made possible by the rear-interface capability; the requirement for fewer GPIB cables for an equal number of instruments in the TM 5000 line; and the reduced space requirements for a measurement system, all contribute to unprecedented economy for test and measurement requirements.

**MAINFRAMES DIMENSIONS AND WEIGHTS**  
(without Plug-ins)

Dimensions	TM 5003		TM 5006		TM 501		TM 503		TM 504		TM 506		RTM 506		TM 515	
	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in
Width	230	9.0	445	17.5	99	3.9	221	8.7	305	12.0	442	17.4	483	19.0	381	15.0
Height	194	7.6	194	7.6	152	6.0	152	6.0	152	6.0	152	6.0	133	5.3	173	6.8
Depth	488	19.2	488	19.2	389	15.3	432	17.0	508	20.0	508	20.0	480	18.9	508	20.0
Weight ≈	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Net	8.6	19.0	14.5	32.0	2.4	5.4	4.3	9.5	8.4	18.5	13.2	29.0	14.4	32.0	10.2	22.5
Shipping	12.0	26.5	20.9	46.0	5.9	13.0	7.7	17.0	11.8	26.0	18.6	41.0	21.0	46.0	13.6	30.0

TM 5003



**Power Module Mainframe**

**TM 5003**



IEEE Standard 488 Compatibility

Three-Compartments

Compatible With TM 500/TM 5000 Series Plug-ins

Pulse-Width Modulated, Switching Dc Power Supply

Regulated Dc Voltages

Forced-Air Cooling

Interface Connections on Rear Panel Via Option 02

UL 1244 Listed

The TM 5003 can accept and provide power for up to three single-width TM 500/TM 5000 plug-ins. The power module features a pulse width modulated switching dc power supply. All dc voltages are electronically regulated.

Three individual connectors, one for each compartment, provides connections to each GPIB compatible plug-in. These connectors feed an IEEE Standard 488 interface board, and a single standard GPIB connector on the rear panel. All GPIB connections are separate from the interface board connector.

The TM 5003 may be operated without all the compartments filled. Use only those needed to accomplish the task. Each plug-in has access to a pair of heat-sunk, series-pass transistors — one NPN, the other PNP. These transistors enable the plug-ins to operate in power ranges not possible if the power were to be dissipated in the plug-ins themselves. Forced-air cooling is standard.

**Option 02** provides interfacing connections on the rear panel to reduce front-panel clutter and to allow interconnection of special features between plug-ins or with external devices to perform functions not otherwise available. This factory-installed option comes equipped with square-pin connectors on the rear interface circuit board and a special wire kit consisting of prepared jumpers, coax cables, and interconnection jack barriers. Option 02 also adds one BNC connector per plug-in compartment, a rear panel male connector, and mating cable connectors. To provide as much flexibility as possible, these connectors are not pre-wired.

A field modification kit is available to rackmount the TM 5003 with the Tektronix 4041 System Controller.

**CHARACTERISTICS**  
**AC POWER REQUIREMENTS**

**Line Voltage Ranges** — 100, 110, 120, 200, 220 and 240 V ac; (not to exceed 250 V ac on 240 V ac range), selectable via internal jumper.

**Line Frequency Range** — 48 to 66 Hz.

**Power Consumption** — ≈300 VA maximum. (Actual power consumption depends on plug-in selection and operating modes.)

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature Range** — Operating: 0°C to +50°C. Storage: -55°C to +75°C.

**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Storage: Sea level to 15 200 m (50,000 ft).

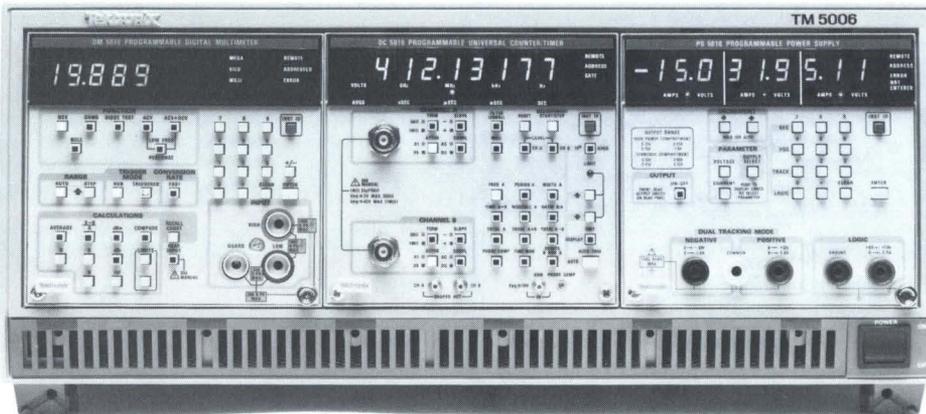
**ORDERING INFORMATION**

<b>TM 5003 Power Module Mainframe</b> .....	<b>\$750</b>
<b>Option 02</b> — Rear Interface .....	<b>+\$100</b>

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 26 for additional information.

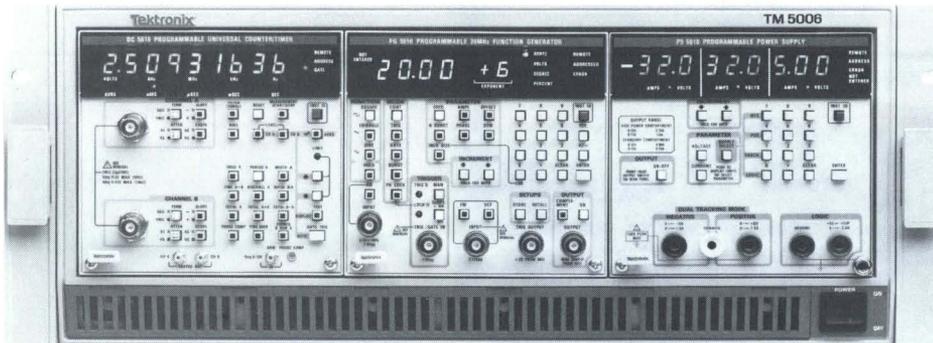
**Order 4932 GPIB Extender** ..... **\$1,195**

## TM 5006



Power Module Mainframe

## TM 5006 Opt 10 Rackmount



Power Module Mainframe

## TM 5006



IEEE Standard 488 Compatibility

Six Compartments

Compatible With TM 500/TM 5000 Series Plug-ins

High-Power Compartment

Regulated Dc Voltages

Pulse-Width Modulated, Switching Dc Power Supply

Forced Air Cooling

Interface Connections on Rear Panel Via Option 02

Rackmounting Capability Via Option 10

Both Option 02 and Option 10 in One Configuration

UL 1244 Approved

The TM 5006 power module can accept and provide power for up to six single-width TM 500/TM 5000 plug-ins. The right hand compartment is a high-power compartment. The power module features a pulse-width modulated switching dc power supply. All dc voltages are electronically regulated.

Six individual connectors, one for each compartment, provide connections to each GPIB compatible plug-in. These connectors feed an IEEE Standard 488 interface board, and a standard GPIB connector on the rear panel. All GPIB connections are separate from the interface board connector.

It is not necessary that all compartments be filled to operate the power module. Use only those needed to accomplish the task. Each plug-in has access to a pair of heat sunk series-pass transistors — one NPN, the other PNP. These transistors enable the plug-ins to operate in power ranges not possible if the power were to be dissipated in the plug-in themselves. Forced-air cooling is standard.

**Option 02** provides interfacing connections on the rear panel to reduce front-panel clutter and to allow interconnection of special features be-

tween plug-ins or to external devices to perform functions not otherwise available. This factory-installed option comes equipped with square-pin connectors on the rear interface circuit board and a special wire kit consisting of prepared jumpers, coax cables, and interconnection jack barriers. Option 02 also adds one BNC connector per plug-in compartment, rear panel male connector, and mating cable connectors. To provide as much flexibility as possible, these connectors are not pre-wired.

**Option 10** provides rackmounting capability. Kits are also available to field-convert cabinet-to-rackmount and rackmount-to-cabinet.

**Option 12** is a combination of the present Option 02 and Option 10.

### CHARACTERISTICS

#### POWER REQUIREMENTS

**Line Voltage Ranges** — 100, 110, 120, 200, 220 and 240 V ac (not to exceed 250 V ac on 240 V ac range); selectable via internal jumper.

**Line Frequency Range** — 48 to 66 Hz.

**Power Consumption** — ≈650 VA maximum. (Actual power consumption depends on plug-in selection and operating modes.)

#### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: +55°C to +75°C

**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

### RACKMOUNT-TO-CABINET AND CABINET-TO-RACKMOUNT

#### CONVERSION KITS, TM 5003 AND TM 5006

**Cabinet-to-rackmount conversion kit**, equipped with slide out assembly, required to convert a TM 5006 to rackmount capability.

Order 040-0982-00 ..... **\$160**

**Rackmount-to-cabinet conversion kit**, equipped to convert a TM 5006 with rackmount capability to cabinet style.

Order 040-0983-00 ..... **\$60**

**Cabinet-to-rackmount conversion kit**, equipped with slide-out assembly to rackmount a 4041 Instrument Controller to the left of a TM 5003.

Order 040-0984-00 ..... **\$190**

### ORDERING INFORMATION

**TM 5006 Power Module Mainframe ... \$1,000**

**Option 02** — Rear Interface ..... **+\$200**

**Option 10** — Rackmount ..... **+\$120**

**Option 12** — Option 02 and Option 10 Combined ..... **+\$270**

#### OPTIONAL ACCESSORIES

**GPIB Cable, 2 meter**

Order 012-0630-01 ..... **\$75**

**GPIB Cable, 4 Meter**

Order 012-0630-02 ..... **\$115**

**GPIB Cable, 0.5 Meter**

Order 012-1015-00 ..... **\$65**

**Plug-in GPIB Extender Cable**

Order 067-0996-00 ..... **\$110**

The Tektronix 4932 GPIB Extender provides a cost-effective way to interconnect remotely located GPIB instruments, allowing communication at distances of up to 500 meters (1650 feet). See page 26 for additional information.

**Order 4932 GPIB Extender ..... \$1,195**

## TM 501



Power Module Mainframe

### TM 501

Single Compartment Power Module

Compatible With Most TM 500 Plug-Ins

Nondedicated Power Transistors for Plug-In Usage

Interface Connections on Rear Panel Via Option 02

The TM 501 Power Module was built for use with one, single-width TM 500 plug-in. TM 500 Series instruments are interchangeable in seconds, so you can use one type plug-in instrument for one test, then use another for a completely different application. Set one or more benchtop mainframes in the mounting trays of a Tektronix Lab Cart, and combine them mechanically or electrically with monolithic instruments on the same cart to create an extremely versatile, rollabout test laboratory.

**Option 02** provides an interface connection on the rear panel to reduce front panel clutter and to permit interconnection of special features between plug-ins.

#### CHARACTERISTICS

##### AC POWER REQUIREMENTS

**Line Voltage Ranges** ( $\pm 10\%$ ) — Selectable 100, 110, 120, 200, 220 and 240 V ac.

**Line Frequency Range** — 48 Hz to 440 Hz.

**Power Consumption** —  $\approx 120$  W maximum. (Actual power consumption depends on plug-in selection and operating modes.)

##### ENVIRONMENTAL CHARACTERISTICS

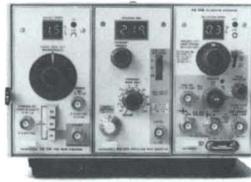
**Temperature Range** — Operating:  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . Nonoperating:  $+40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

#### ORDERING INFORMATION

<b>TM 501</b> .....	<b>\$325</b>
<b>Option 02</b> — Rear Interface Connectors for Special Features .....	<b>+\$60</b>

## TM 503



Power Module Mainframe

### TM 503

Three-Compartment Power Module

Compatible With Most TM 500 Plug-Ins

Interface Connections on Rear Panel Via Option 02

Option 07 Compatibility

The TM 503 accepts up to three, single-width TM 500 plug-ins. This light-weight, portable, benchtop mainframe includes a front panel power switch and tilt bail. It also easily fits into the shelf of a Tek Model 3 Lab Cart. A carrying case is available to protect the mainframe during transportation.

It is not necessary that all compartments be filled to operate the power module. Use only those needed to accomplish the task. For increased power dissipation each plug-in has access to a pair of heat-sunk series-pass transistors.

**Option 02** provides rear interface connections on the rear panel to allow interconnection of special features between plug-ins or with external devices to perform additional functions.

**Option 07** provides rear interface connections between a DC 508A Counter Plug-in containing Option 07, and the TR 502, TR 503, and SW 503. Once Option 07 has been installed, the three connectors are system-dedicated and these three slots should be used exclusively for system-dedicated plug-ins.

#### CHARACTERISTICS

##### AC POWER REQUIREMENTS

**Voltage Ranges** ( $\pm 10\%$ ) — 100, 110, 120, 200, 220, and 240 V ac selectable.

**Power Consumption** —  $\approx 120$  W maximum. (Actual power consumption depends on plug-in selection and operating modes.)

##### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating:  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . Nonoperating:  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

##### RACKMOUNT-TO-CABINET AND CABINET-TO-RACKMOUNT CONVERSION KITS

**Cabinet-to-rackmount conversion kit**, equipped with slide-out assembly, required to rackmount two TM 503's side-by-side in a standard rack width. Order 040-0616-02 ..... **\$135**

**Cabinet-to-rackmount conversion kit**, equipped with slide-out assembly required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is used. Order 040-0617-02 ..... **\$190**

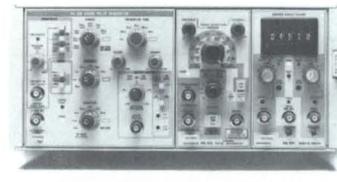
**Rackmount-to-cabinet conversion kit**, equipped to convert a rackmount TM 503 to a cabinet style. Order 040-0618-01 ..... **\$70**

**Cabinet-to-rackmount conversion kit**, equipped with slide-out assembly, required to rackmount a TM 503 and a 603, 603A, 604, 604A, 605, 606, 606A, 607, 607A, 608, or 624 in a standard rack width. Order 040-0624-01 ..... **\$120**

#### ORDERING INFORMATION

<b>TM 503</b> .....	<b>\$325</b>
<b>Option 02</b> — Rear Interface Connections for Special Features .....	<b>+\$80</b>
<b>Option 07</b> — Rear Interface Connections for System Dedicated Plug-ins .....	<b>+\$55</b>

## TM 504



Power Module Mainframe

### TM 504

Four-Compartment Power Module

Compatible With TM 500 Plug-Ins

Nondedicated Power Transistors for Plug-In Usage

High-Power Compartment

Interface Connections on Rear Panel Via Option 02

Option 07 Compatibility

The TM 504 mainframe can be fitted with up to four single-width TM 500 plug-ins and is designed to fit into the shelves of the Tek Model 3 Lab Cart for test station mobility. Each TM 504 also comes equipped with front panel switch, tilt bail, and a handle. An optional carrying case is available for protection transportation.

It is not necessary that all compartments be filled to operate the power module. Use only those needed to accomplish the task. For increased power dissipation each plug-in is provided access to a pair of heat sunk series-pass transistors.

**Option 02** provides rear interface connections on the rear panel and allows interconnection of special features between plug-ins or with external devices to perform additional functions.

**Option 07** provides rear interface connections between the TM 500 instruments containing Option 07, (i.e., TR 502, TR 503, and SW 503). With Option 07 installed, three connectors are system-dedicated and these three slots should be used only for system-dedicated plug-ins.

#### CHARACTERISTICS

##### AC POWER REQUIREMENTS

**Voltage Ranges** ( $\pm 10\%$ ) — 100, 110, 12, 200, 220, and 240 V ac.

**Power Consumption** —  $\approx 320$  W maximum. (Actual power consumption depends on plug-in selection and operating modes.)

##### ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating:  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . Nonoperating:  $-40^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$ .

**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

#### ORDERING INFORMATION

<b>TM 504</b> .....	<b>\$360</b>
<b>Option 02</b> — Rear Interface Connections for Special Features .....	<b>+\$110</b>
<b>Option 07</b> — Rear Interface Connections for Dedicated Plug-ins .....	<b>+\$55</b>

TM 515



Power Module Mainframe

TM 515

Portable Power Module

Up to Five Plug-In Modules

Forced Air Cooling

Interface Connections on Rear Panel Via Option 05

Line Frequency to 400 Hz Via Option 06

Option 07 Compatibility

The TM 515 Traveler Mainframe is designed to protect up to five separate instruments during transportation to and from the work site. Included with this rugged mainframe are pop-off front and back covers that protect the instruments and also store accessories. The Traveler Mainframe will slide easily under an airline seat when traveling and comes equipped with a heavy duty handle and tilt bail.

It is not necessary that all compartments be filled to operate the power module. Use only those needed to accomplish the task. Each plug-in is provided access to a pair of heat sunk series-pass transistors — one NPN, the other PNP. These transistors enable the plug-ins to operate in power ranges not possible if the power were to be dissipated in the plug-ins themselves.

**Option 05** provides rear interface connections on the rear panel to reduce front panel clutter and permit interconnection of special features between plug-ins or with external devices to perform functions not otherwise available. This factory-installed option comes equipped with square-pin connectors on the rear interface circuit board and a special wire kit consisting of prepared jumpers, coax cables, and interconnection jack barriers.

**Option 06** extends the upper limit of the line frequency range to 400 Hz. The standard instrument has a 48 Hz to 60 Hz line frequency range for fan operation.

**Option 07** adds bus wires and barrier keys to the connector boards of the power module mainframes providing rear interface connections between a DC 508A Counter plug-in containing Option 07, and the TR 502, TR 503, and SW 503. Once Option 07 is installed, these connectors are system-dedicated and these three slots should be used exclusively for system-dedicated plug-ins.

CHARACTERISTICS  
POWER REQUIREMENTS

**Voltage Range** ( $\pm 10\%$ ) — 100, 110, 120, 200, and 240 V ac selectable.

**Line Frequency Ranges** — 48 Hz to 66 Hz (to 400 Hz with Option 06).  
**Power Consumption** —  $\approx 240$  W maximum. (Actual power consumption depends on plug-in selection and operating modes.)

ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: -40°C to +75°C.  
**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

ORDERING INFORMATION

<b>TM 515 Power Module Mainframe</b> .....	<b>\$585</b>
<b>Option 05</b> — TM 515 Interface .....	<b>+\$80</b>
<b>Option 06</b> — 48 to 440 Hz Fan .....	<b>+\$160</b>
<b>Option 07</b> — TM 515 Interface .....	<b>+55</b>

TM 506



Power Module Mainframe

TM 506

Six-Compartment Power Module

Compatible With All TM 500 Plug-Ins

High-Power Compartment

Forced Air Cooling

Nondedicated Power Transistors for Plug-In Usage

Interface Connection on Rear Panel Via Option 02

Option 07 Compatibility

The TM 506 mainframe can power up to six different plug-ins, providing a complete test station with one power cord. Like most TM 500 mainframes, the TM 506 is available with the Option 02 which allows rear-interfacing of different modules, reducing front panel clutter.

**Option 02** provides rear interface connections at the rear panel and allows interconnection of special features between plug-ins or with external devices to perform functions not otherwise available.

It is not necessary that all compartments be filled to operate the power module. Use only those needed to accomplish the task. Each plug-in is provided access to a pair of heat sunk series-pass transistors — one NPN, the other PNP. These transistors enable the plug-ins to operate in power ranges not possible if the power were to be dissipated in the plug-ins themselves.

**Option 07** adds bus wires and barrier keys to the connector boards of the power module mainframes providing rear interface connections between a DC 508A Counter plug-in containing Option 07, and the TR 502, TR 503, and SW 503.

Once Option 07 has been installed, the three connectors are system-dedicated and these three slots should be used exclusively for system-dedicated plug-ins.

CHARACTERISTICS

POWER REQUIREMENTS

**Line Voltage Ranges** — International transformer selectable: 100, 110, 120, 200, 220, 240 V ac, all with 10%; but not to exceed 250 V ac. Range changing accomplished by moving an easily accessed internal jumper.

**Line Frequency Ranges** — 48 Hz to 66 Hz.  
**Power Consumption** — Maximum primary power  $\approx 320$  W. Actual power consumption depends on plug-in selection and operating modes.

ENVIRONMENTAL CHARACTERISTICS

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: -40°C to +75°C.  
**Altitude Range** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

ORDERING INFORMATION

<b>TM 506 Power Module Mainframe</b> .....	<b>\$470</b>
<b>Option 02</b> — TM 506 Interface .....	<b>+\$165</b>
<b>Option 07</b> — TM 506 Interface .....	<b>+\$55</b>
<b>Cabinet-to-rackmount conversion kit</b> , equipped with slide-out assembly, requiring to convert a TM 506 (cabinet style) to an RTM 506. Order 040-0761-04 .....	<b>\$150</b>

RTM 506



Power Module Mainframe

RTM 506

Designed for a Standard 19-inch Rack

Six-Compartment Power Module

Compatible With All TM 500 Plug-Ins

High-Power Compartment

Forced Air Cooling

Interface Connections on Rear Panel; Option 02

Option 07 Compatibility

The RTM 506 is a rackmount version of the TM 506. It contains all the same features and characteristics, with the added front panel handles and rackmount rails for built-in, configurable test stations. This mainframe saves you space and money in tight situations.

ORDERING INFORMATION

<b>RTM 506 Rackmount Power Module</b>	
Mainframe .....	<b>\$650</b>
<b>Option 02</b> — RTM 506 Interface .....	<b>+\$165</b>
<b>Option 07</b> — RTM 506 .....	<b>+\$55</b>
<b>Rackmount-to-cabinet conversion kit</b> , equipped to convert an RTM 506 to cabinet style TM 506. Order 040-0762-00 .....	<b>\$75</b>

**MAINFRAME RETAINER BAR**

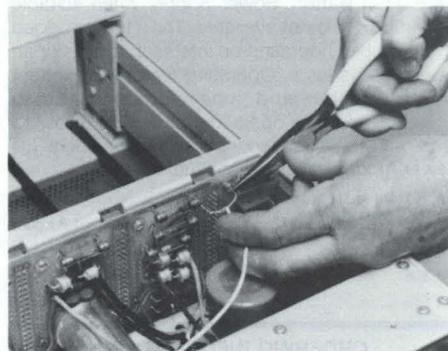


The mainframe retainer bar modification kit comes complete with the retainer bar, all necessary parts and instructions.

You may modify the TM 504 or RTM 506/TM 506 Mainframe; each has a separate kit. Initial installation requires replacement of an existing bottom member of the mainframe with a new part supplied in the kit. Then, the retainer bar can be simply added or removed with four screws accessible from the bottom of the mainframe.

**ORDERING INFORMATION**

- TM 504 Mainframe Retainer Bar Kit**  
Order 020-0548-00 ..... **\$45**
- TM 506/RTM 506 Mainframe Retainer Bar Kit**  
Order 020-0549-00 ..... **\$50**
- TM 5000 Series Plug-in Retainer-Kits-in Process**



**MAINFRAME REAR INTERFACE**

TM 500 and TM 5000 Mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage set-ups without any need to move test leads. Any module can be internally connected through the mainframe and can also be externally interfaced out the back panel.

Most TM 500 and TM 5000 Plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines which are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

The TM 515 Mainframe is available with an Option 05 interface that includes everything in the Option 02 except for the rear panel male connector, mating cable connector and the BNC connectors.

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 500 and TM 5000 Mainframe except the TM 501. The kit includes fourteen square pins, and three coaxial cables, all with female pin receptacles. Installation instructions also included. For "do-it-yourself" modification kit:

- Order 040-0846-01 ..... \$49**

**ACCESSORY POUCH**



While the TM 501, TM 503, TM 504, and TM 506 TM 5003/5006 Mainframes were designed primarily for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500/5000 Mainframe or Tektronix Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions  $\approx 9\frac{1}{4}$  in long x  $5\frac{3}{4}$  in wide x 2 in high.

- Order 016-0351-00 ..... \$25**

**TM 500 CARRYING CASE**



These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures  $23\frac{1}{2}$  inches long by  $8\frac{1}{2}$  inches thick by  $15\frac{1}{2}$  inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200 Series Miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert that will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 610 mm long x 216 mm thick x 445 mm high, (24 in. long by 8.5 in. thick by 17.5 in high) and weighs  $\approx 14$  pounds empty.

**ORDERING INFORMATION**

- Carrying Case for TM 503**  
Order 016-0565-00 ..... **\$395**
- Carrying Case for TM 504**  
Order 016-0608-00 ..... **\$425**
- Carrying Case for TM 515**  
Order 016-0643-00 ..... **\$225**

**TEK LAB CART MODEL 3**



This Lab Cart is especially designed for a rollabout configuration combining TM 500/5000 Instrumentation with the Tektronix oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray accepts any Tektronix 7000 Series, 5000 Series, or portable oscilloscope. The Model 3 comes standard with one lower shelf that will support either a TM 503 or TM 504 with plug-ins. Additional shelves are available as optional accessories. Maximum capacity of the lower shelf area is two TM 503's or TM 504's, stacked, or up to a Tektronix 7000 Series oscilloscope in size—with TM 500 packages placed on the tray at your option. The power distribution module on the rear underside of the top tray provides four power outlets and a 15 foot line cord.

International modification (Option 01) deletes power distribution module.

**ORDERING INFORMATION**

<b>TEK Lab Cart Model 3</b> .....	<b>\$525</b>
Option 01 — Power Distribution Module .....	NC
<b>Additional Lower Shelf,</b> Order 436-0132-01 (TM 500 only) .....	<b>\$37</b>
<b>Safety Belt</b> to secure oscilloscopes or TM 500/5000 to top tray or lower shelves (not needed for 5000 or 7000 Series on top tray). Order 346-0136-01 .....	<b>\$24</b>

**PROTECTIVE FRONT COVER**



A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 Mainframes. The cover adds 45 mm (1.75 in) to the length of the TM 503, TM 504, and TM 506 Mainframes, and clears the longest knob projections on any of the instruments.

**ORDERING INFORMATION**

<b>TM 503</b> Front Panel Cover Order 200-1566-00 .....	<b>\$18</b>
<b>TM 504</b> Front Panel Cover Order 200-1727-00 .....	<b>\$17</b>
<b>TM 506</b> Front Panel Cover Order 200-1728-00 .....	<b>\$20</b>

**RAIN COVERS**

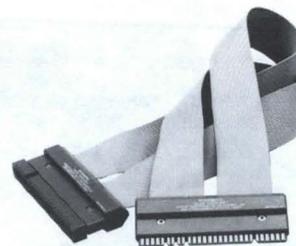


These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 instrumentation packages and include adequate space for protective front covers, as well. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 instrumentation packages. The color is Tek blue.

**ORDERING INFORMATION**

<b>TM 504</b> Rain Cover Order 016-0621-00 .....	<b>\$45</b>
<b>TM 503</b> Rain Cover Order 016-0620-00 .....	<b>\$35</b>

**FLEXIBLE PLUG-IN EXTENDER CABLE**



Designed to couple a TM 500 or TM 5000 Plug-in with the mainframe rear interface board connection extender cables provide a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

**ORDERING INFORMATION**

<b> GPIB</b> Extender Cable Order 067-0996-00 .....	<b>\$110</b>
Extender Cable Order 067-0645-02 .....	<b>\$130</b>

**TYPE 1105 BATTERY POWER SUPPLY**

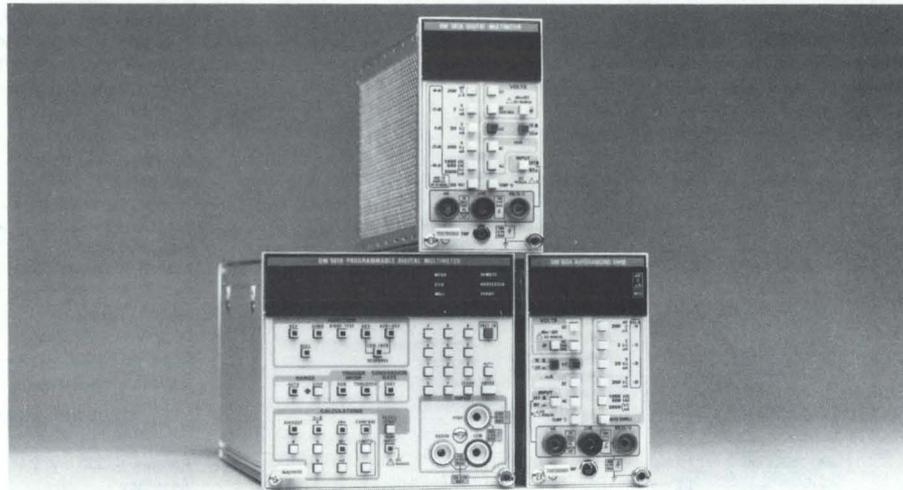


TM 500 Instruments may be operated with the Type 1105 Battery Power Supply when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full power module in a typical situation.

TM 501 .....	5.0 hours
TM 503 .....	1.6 hours
TM 504 .....	1.3 hours
TM 506 .....	0.9 hours
TM 515 .....	1 hour

**ORDERING INFORMATION**

<b>1105</b> Battery Pack .....	<b>\$1,375</b>
Option 01 — 230 V operation .....	NC



### PRODUCT SUMMARY

With the possible exception of the oscilloscope, the digital multimeter is the most widely used electronic test instrument employed today. Modern digital techniques have vastly improved resolution and accuracy while simplifying instrument use and reducing the possibility of human error.

The TM 500 Digital Multimeter line consists of two general purpose instruments, the DM 501A and DM 502A. Both provide exceptional versatility in function and range. In addition to the usual ac and dc voltage, resistance, and ac/dc current functions, both meters offer a dB function and a platinum-resistance temperature-measurement function. Applying the tip of the temperature probe to a power transistor, integrated circuit, mechanical component, or any other surface provides an immediate digital readout of the surface temperature in degree Centigrade.

The dB feature is valuable in the general audio and communications industry. Applications include mobile radio, microwave, telephone communications, computer time sharing, data transmission via voice links, broadcasting, recording industries, sonar, acoustics, audio-metrics and many other fields.

The DM 501A and DM 502A are similar instruments in many respects. Each measures dc voltage to 1000 V, ac voltage to 500 V, both ac and dc current to 2 A, true RMS voltages, and resistance to 20 MΩ. The most significant differences are increased resolution provided by the extra digit on the DM 501A, increased temperature measurement range of the DM 501A and autoranging on the DM 502A.

The DM 501A gives 4 1/2 digits of readout resolution. And seven distinct measurement functions, with 0.05% dc volts accuracy and true RMS capability. The DM 502A adds testing convenience through autoranging. Seven full functions are displayed on 3 1/2 digits.

TM 500 digital multimeters offer a compact solution to your measurement needs without compromising wide performance range. The DM 501A and DM 502A provide accuracy and flexibility in laboratory, bench, field service, and maintenance applications.

The DM 5010 is the digital multimeter for the TM 5000 family of programmable instruments. The addition of the new DM 5010 brings full programmability, IEEE Standard 488 compatibility,

modularity and versatility together for the first time. Excellent performance and the programming ease of a high-level language make the DM 5010 an attractive link in any IEEE Standard 488 system requiring a digital multimeter. DM 5010 features include full programmability, 0.015% dc accuracy, autoranging capabilities, true RMS, diode test, and all standard functions. Internal math capabilities include dB, average, offset, scale, and a HI/LO pass test. Measurements and calculations may be triggered via internal circuitry, a front panel push button, a rear interface connector, or a GPIB command. The DM 5010 provides extensive self-test capability both on power-up and on command. It also provides extensive error reporting and was designed to aid signature analysis.

With full-scale precision measuring capabilities, backed by Tektronix design and engineering expertise, the DM 5010, DM 502A and the DM 501A are designed for almost any test and measurement application.

### DIGITAL MULTIMETER SELECTION CHART

Model Number	Number of Digits	Dc Volts			Ac Volts			Ac or Dc Current	dB	Resistance (HI-LO)	Temp	True RMS	Auto Range	IEEE Standard 488	Mainframe Compatibility
		Ranges	Accuracy	Best Resolution	Ranges	Accuracy	Best Resolution	Ranges	Ranges	Ranges	Range				
DM 501A	4 1/2	200 mV to 1000 V	±0.05%	10 μV	200 mV to 500 V	±0.6%	10 μV	200 μA to 2 A	+54 dB to -60 dB	200 Ω to 20 MΩ	-62°C to +240°C	X		No	TM 500/ TM 5000
DM 502A	3 1/2	200 mV to 1000 V	±0.1%	100 μV	200 mV to 500 V	±0.6%	100 μV	200 μA to 2 A	+50 dB to -60 dB	200 Ω to 20 MΩ	-55°C to +200°C	X	X	No	TM 500/ TM 5000
DM 5010	3 1/2/4 1/2*1	200 mV to 1000 V	±0.015%	10 μV	200 mV to 700 V	±0.2%	10 μV		Calculated	200 Ω*2 to 20 MΩ		X	X	Yes	TM 5000

\*1 Measurement rate of 3 readings/second at 4.5 digits and 26 readings/second at 3.5 digits resolution.

\*2 Low Ω plus diode test.

Compatible accessories begin on page 410.

**DM 5010**



**Programmable Digital Multimeter**

**DM 5010**



The DM 5010 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

**Fully Programmable**

**4.5 Digit, 0.015% Accuracy**

**Autoranging**

**Dc Volts, 0.015% +1 Count**

**Ohms, 0.015% +2 Count**

**Easy Calibration**

**Fast-Slow Mode**

**Microprocessor Nulling**

**Math Functions (dB, average, offset, scale, HI/LO/PASS test)**

**True RMS**

**Diode Test**

**UL 1244 Listing**

The fully programmable DM 5010 Digital Multimeter measures dc voltage, resistance, true RMS ac voltage, and true RMS (ac+dc) voltage. The Ohms function allows in-circuit resistance measurements without turning on diode and transistor junctions. A Diode Test function is provided for testing diode and transistor junctions. All controls and features of the DM 5010 are fully addressable via the GPIB. The English-like programming commands make GPIB control exceptionally straightforward. The front panel controls may be used in conjunction with the GPIB or may be "locked out" entirely. Measurements and calculations are triggered via internal circuitry, a front panel pushbutton, a rear interface connec-

tor, or a GPIB command. Measurement rates of 3 readings/second at 4.5 digit resolution and 26 readings/second at 3.5 digit resolution are available. Powering up the DM 5010 automatically initiates the instrument's self-test cycle. The autoranging feature eliminates the need for operator-selected ranges. The math functions resident in the DM 5010 permit various capabilities including: averaging of up to 19,999 readings; calculation of dB referenced either to 1 mW and 600 Ω or to an operator-supplied constant (dB subject to limitations of ac measurement capabilities); offsetting of measurements by an operator-supplied constant; scaling of measurements by an operator-supplied constant; comparing measurements to operator-supplied upper and lower limits (DM 5010 responds with HI/PASS/LO); or any combination of these. Note that through the use of an external shunt resistor and a scaling factor equal to the shunt resistor, current values may be displayed directly on the DM 5010 display. A single button Null function provides rapid nulling in any mode. A special Low Frequency Response function provides stable readouts at low frequency ac voltages.

**CHARACTERISTICS**

**DC VOLTS**

Ranges — 200 mV, 2 V, 20 V, 200 V, 1000 V.

**Accuracy\***

+18°C to +28°C	Normal Conversion Rate	Fast Conversion Rate
200 mV	±(0.015% of reading +0.01% of full scale)	±(0.05% of reading +0.05% of full scale)
2 V through 200 V	±(0.015% of reading +0.005% of full scale)	±(0.05% of reading +0.05% of full scale)
1000 V	±(0.020% of reading +0.010% of full scale)	±(0.05% of reading +0.1% of full scale)
0°C to 18°C, +28°C to +50°C	Normal Conversion Rate	Fast Conversion Rate
200 mV	±(0.06% of reading +0.035% of full scale)	±(0.1% of reading +0.1% of full scale)
2 V through 200 V	±(0.06% of reading +0.03% of full scale)	±(0.1% of reading +0.1% of full scale)
1000 V	±(0.065% of reading +0.035% of full scale)	±(0.1% of reading +0.15% of full scale)

\*Valid for six months or 1000 operating hours, whichever occurs first.

**Common-Mode Rejection Ratio** — (with 1 kΩ imbalance)  
 Unguarded — ≥130 dB at dc. ≥80 dB at 50 to 60 Hz.  
 Guarded — ≥140 dB at dc. ≥100 dB at 50 to 60 Hz.

**Normal Mode Rejection Ratio** — ≥40 dB at 50 or 60 Hz ±0.2 Hz.

**Maximum Resolution** — 10 μV.

**Step Response Time (To Rated Accuracy)** —  
**RUN Mode**

Normal Conversion Rate — ≤0.53 s.  
 Fast Conversion Rate — ≤0.08 s.

**Triggered Mode**  
 Normal Conversion Rate — ≤0.33 s.  
 Fast Conversion Rate — ≤0.06 s.

**Input Resistance** —  
 200 mV — 20 V Range — >10<sup>9</sup> Ω.  
 200 V — 1000 V Range — 10 MΩ ±0.25%.

**Maximum Input Voltage** — 1000 V peak.

**TRUE RMS AC VOLTS (ACV AND AC+DC)**

**Input Signal** — Must be between 5% and 100% of full scale.

**Ranges** — 200 mV, 2 V, 20 V, 200 V, 700 V.

**Accuracy\***

+18°C to +28°C	Normal and Fast Conversion		
Voltage Ranges	20 Hz to 100 Hz	100 Hz to 20 kHz	20 kHz to 100 kHz
200 mV through 200 V	±(0.8% of rdg +0.2% of full scale)	±(0.2% of rdg +0.2% of full scale)	±(1.0% of rdg +0.5% of full scale)
700 V (15 kHz max)	±(0.8% of rdg +0.6% of full scale)	±(0.2% of rdg +0.6% of full scale)	
0°C to +18°C, +28°C to +50°C	Normal and Fast Conversion		
200 mV through 200 V	±(1.25% of rdg +0.35% of full scale)	±(0.65% of rdg +0.3% of full scale)	±(1.45% of rdg +0.65% of full scale)
700 V (15 kHz max)	±(1.25% of rdg +0.95% of full scale)	±(0.65% of rdg +0.95% of full scale)	

**Ac Volts + Dc Volts Only**

+18°C to +28°C	Normal and Fast Conversion Rate; 10 to 20 Hz
200 mV through 200 V	±(0.8% of rdg +0.3% of full scale)
700 V	±(0.8% of rdg +0.9% of full scale)
0°C to +18°C, +28°C to +50°C	Normal and Fast Conversion Rate; 10 to 20 Hz
200 mV through 200 V	±(1.25% of rdg +0.45% of full scale)
700 V	±(1.25% of rdg +1.25% of full scale)

\*Valid for a period of six months or 1000 hours, whichever occurs first.

**Common-Mode Rejection Ratio** —

Unguarded — Typically ≥80 dB from dc to 60 Hz.

Guarded — Typically ≥100 dB from dc to 60 Hz.

**Maximum Resolution** — 10 μV.

**Response Time** — <1.2 s (except for LOW FREQUENCY RESPONSE mode).

**Input Impedance** — 2 MΩ ±0.1% paralleled by <150 pF.

**Maximum Input Voltage** — 1000 V peak ac, 500 V dc.

**Crest Factor** — 4 (subject to maximum peak input voltage).

### RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

#### Accuracy\*

+18°C to +28°C		
Resistance Range	Normal Conversion Rate	Fast Conversion Rate
200 Ω	±(0.015% of reading + 0.015% of full scale) (using null)**	±(0.05% of reading + 0.05% of full scale) (using null)**
2 kΩ to 200 kΩ	±(0.015% of reading + 0.01% of full scale) (using null on) (2 kΩ only)**	0.05% of reading + 0.05% of full scale
2 MΩ	±(0.10% of reading + 0.01% of full scale)	±(0.10% of reading + 0.05% of full scale)
20 MΩ	±(0.15% of reading + 0.005% of full scale)	±(1.0% of reading + 0.05% of full scale)

0°C to +18°C, +28°C to +50°C

Resistance Range	Normal Conversion Rate	Fast Conversion Rate
200 Ω	±(0.06% of reading + 0.06% of full scale) (using null)**	±(0.1% of reading + 0.1% of full scale) (using null)**
2 kΩ to 200 kΩ	±(0.06% of reading + 0.035% of full scale) (using null on 2 kΩ only)**	±(0.1% of reading + 0.1% of full scale)
2 MΩ	±(0.54% of reading + 0.035% of full scale)	±(0.55% of reading + 0.1% of full scale)
20 MΩ	±(0.9% of reading + 0.01% of full scale)	±(1.6% of reading + 0.05% of full scale)

\*Valid for a period of six months or 1000 hours, whichever occurs first.

\*\*When the null function is not used add ±0.2 Ω to all readings.

Maximum Resolution — 10 mΩ.

Step Response Time (To Rated Accuracy) —

**RUN Mode**

Normal Conversion Rate — ≤1.24 s.

Fast Conversion Rate — ≤0.33 s.

**TRIGGERED Mode**

Normal Conversion Rate — ≤0.73 s.

Fast Conversion Rate — ≤0.19 s.

Maximum Input Volts — 400 V peak.

Maximum Open Circuit Voltage Developed — <5 V.

### DIODE TEST

**Operation** — A 1 mA current is generated and the resultant voltage is measured on the 2 V dc range. This produces a voltage sufficient to turn on diode and transistor junctions.

### OTHER CHARACTERISTICS

**Overrange Indication** — For OHMS and DIODE TEST, "OC" is displayed; for ACV, DCV, ACV+DCV, the display blinks.

**Measurement Rate**

ACV, DCV, ACV+DCV, Diode Test — 3/s at 4.5 digits; 26/s at 3.5 digits.

OHMS — 1.6/s at 4.5 digits; 7.1/s at 3.5 digits.

**Power Consumption** — ≈20 VA.

**GPIO Commands** — Addressable by 30 English-like GPIB commands.

**Mainframe Compatibility** — The DM 5010 requires a TM 5003 or a TM 5006 Mainframe.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C. Nonoperating: -20°C to +65°C.

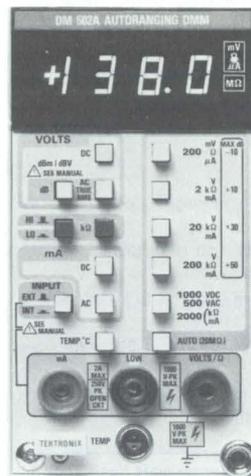
### INCLUDED ACCESSORIES

One set Test Leads (003-0120-00).

**Order DM 5010 Programmable**

Digital Multimeter ..... **\$1,995**

### DM 502A



### Digital Multimeter

## DM 502A

### True RMS

### Autoranging

### Seven Functions Including Temperature and dB

### 0.1% Dc Volts Accuracy

### 3 1/2 Digit Display

The DM 502A Digital Multimeter measures seven different functions with pushbutton convenience. Autoranging, in all modes except current, eliminates any need for operator selected ranges. The DM 502A measures dc and ac voltage, dc and ac current, dB, resistance and temperature. True RMS provides more accuracy in ac measurements on distorted, noisy, random or other nonsinusoidal ac waveforms. The resistance mode features HI-LO voltage (2 V to 0.2 V). The low voltage is user-selectable for making in-circuit ohms measurements without turning on diode and transistor junctions. The high voltage is available for testing junctions for forward and reverse resistance. The LED indicators provide a bright, readable 3 1/2 digit display.

### CHARACTERISTICS

#### DC VOLTS

Ranges — 2000 mV, 2 V, 20 V, 200 V, and 1000 V. Automatic or manual ranging.

#### Accuracy\*

-18°C to +28°C		Normal and Fast Conversion
20 mV to 200 V		±[0.1% of reading + 0.05% of full scale (1 count)]
1000 V		±[0.1% of reading + 0.1% of full scale (1 count)]
0°C to +18°C, +28°C to +50°C		Normal and Fast Conversion Rate
200 mV to 200 V		±[0.2% of reading + 0.1% of full scale (2 counts)]
1000 V Range		±[0.2% of reading + 0.2% of full scale (2 counts)]

\*Valid for a period of six months or 1000 hours, whichever occurs first.

**Common-Mode Rejection Ratio** — ≥100 dB at dc. ≤80 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

**Normal-Mode Rejection Ratio** — ≥50 dB at 50 Hz or 60 Hz ±0.2 Hz.

**Maximum Resolution** — 100 μV.

**Step Response Time** — 1 s within a range, +1.5 s for each range change in autoranging mode.

**Input Resistance** — 10 MΩ.

**Maximum Input Voltage** — 1000 V peak.

#### TRUE RMS AC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V. Automatic or manual ranging (ac coupled).

#### Accuracy\*

0°C to +18°C	Normal and Fast Conversion Rate		
	20 Hz	40 Hz	20 kHz
200 mV to 200 V	±[1.5% of reading + 0.3% of full scale (6 counts)]	±[0.6% of reading + 0.3% of full scale (6 counts)]	
500 V	±[1.5% of reading + 1.2% of full scale (6 counts)]	±[0.6% of reading + 1.2% of full scale (6 counts)]	
0°C to +18°C, +28°C to +50°C		Normal and Fast Conversion Rate	
	20 Hz	40 Hz	20 kHz
200 mV to 200 V Range	±[1.8% of reading + 0.35% of full scale (7 counts)]	±[0.8% of reading + 0.35% of full scale (7 counts)]	
500 V Range	±[1.8% of reading + 1.4% of full scale (7 counts)]	±[0.8% of reading + 1.4% of full scale (7 counts)]	

\*Valid for a period of six months or 1000 hours whichever occurs first. Typically usable to 100 kHz.

**Common-Mode Rejection Ratio** — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

**Maximum Resolution** — 100 μV.

**Resolution Time** — 1 s within a range, +1.5 s for each range change in autoranging mode.

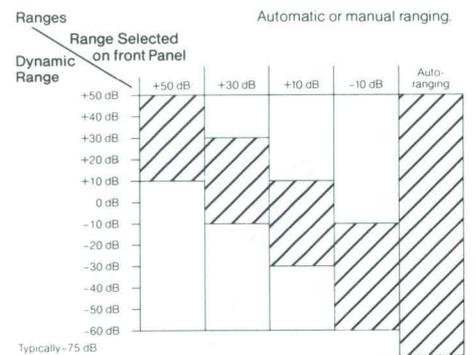
**Input Impedance** — 10 MΩ paralleled by <100 pF.

**Maximum Input Voltage** — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

**Crest Factor** — 4 at full scale all ranges (≤2 on 500 V range).

#### dB (TRUE RMS)

**Zero dB Reference** — 1 mW in 600 Ω (0.775 V) (dBm). Internal jumper change for zero dB reference of 1,000 V (dBV).



Typically -75 dB

▨ Indicates dynamic operating range.

□ Indicates over or under range with blinking display.

#### Accuracy\*

+50 dB to -50 dB	±0.5 dB		
	20 Hz	2 kHz	10 kHz
-50 dB to -60 dB	±0.5 dB	±1.5 dB	Typically ±2.5 dB

\*From 0°C to +18°C and +28°C to +50°C, add 0.6 dB to above accuracy specifications. For example, at 0°C the accuracy in the +50 dB to -50 dB range from 20 Hz to 20 kHz would be ±1.1 dB.

**Noise Level** — Typically -75 dB.

**Maximum Resolution** — 0.1 dB.

**Response Time** —  $\leq 1$  s within a range,  $\leq 1.5$  s for each range change in autoranging mode.

**Input Impedance** — 10 M $\Omega$  paralleled by  $< 100$  pF.

**Maximum Input Voltage** — 500 V RMS, not to exceed 1000 V peak.

**Crest Factor** — 4 at full scale ( $\leq 2$  above 40 dB).

### RESISTANCE

**Ranges** — 200  $\Omega$ , 2 k $\Omega$ , 20 k $\Omega$ , 200 k $\Omega$ , 2000 k $\Omega$ , and 20 M $\Omega$ . Automatic or manual ranging.

### Accuracy\*

#### +18°C to +28°C

200  $\Omega$  to 2000 k $\Omega$  Ranges  $\pm [0.5\%$  of reading  $+ 0.05\%$  of full scale (1 count)  $+ 0.2 \Omega]$

20 M $\Omega$  Range  $\pm [1\%$  of reading  $+ 0.05\%$  of full scale (1 count)]

#### 0°C to +18°C and +28°C to +50°C

200  $\Omega$  to 2000 k $\Omega$  Ranges  $\pm [0.8\%$  of reading  $+ 0.1\%$  of full scale (2 counts)  $+ 0.2 \Omega]$

20 M $\Omega$  Range  $\pm [1.3\%$  of reading  $+ 0.1\%$  of full scale (2 counts)]

\*Valid for a period of six months or 1000 hours whichever occurs first.

**Response Time** —  $\leq 1$  s within a range,  $\leq 1.5$  s for each range change in autoranging mode.

**Maximum Input Volts** — 130 V dc or ac RMS indefinitely. 230 V dc or ac RMS for 30 minutes maximum.

**HI-LO Ohms Operation** — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

**Maximum Resolution** — 0.1  $\Omega$ .

**Maximum Open-Circuit Voltage Developed** —  $\approx 14$  V.

### DC AND TRUE RMS AC CURRENT

**Ranges** — 200  $\mu$ A, 2 mA, 20 mA, 200 mA, and 2000 mA. Manual ranging only.

### Dc Current Accuracy —

+18°C to +28°C:  $\pm [0.2\%$  of reading  $+ 0.05\%$  of full scale (1 count)].

0°C to +18°C and +28°C to +50°C:  $\pm [0.3\%$  of reading  $+ 0.1\%$  of full scale (2 counts)].

**Ac Current Accuracy** — (from 40 Hz to 10 kHz) Usable to 20 kHz.

+18°C to +28°C:  $\pm [0.6\%$  of reading  $+ 0.3\%$  of full scale (6 counts)].

0°C to +18°C and +28°C to +50°C:  $\pm [0.7\%$  of reading  $+ 0.5\%$  of full scale (10 counts)].

### Input Resistance

Ranges	Approximate Resistance
200 $\mu$ A	1.0 k $\Omega$
2 mA	100.0 $\Omega$
20 mA	10.2 $\Omega$
200 mA	1.2 $\Omega$
2000 mA	0.4 $\Omega$

**Response Time** —  $\leq 1$  s.

**Maximum Open Circuit Input Voltage (mA to LOW)** — 250 V peak, fused with 2 A fast blow.

**Maximum Floating Voltage** — 1000 V peak.

**Maximum Resolution** — 0.1  $\mu$ A.

### TEMPERATURE

**Range** — -55°C to +200°C.

**Resolution** — 0.1°C.

### Accuracy\*

Temperature to be Measured	+18°C to +28°C		
	-55°C	+150°C	+200°C
P6601 Probe and DM 502A calibrated as a pair	$\pm 2.5^\circ\text{C}$	$\pm 3.5^\circ\text{C}$	
P6601 and instrument not calibrated as a pair	$\pm 4.5^\circ\text{C}$	$\pm 5.5^\circ\text{C}$	

\*For 0°C to +18°C and +28°C to +50°C ambient temperatures, add  $\pm 1.5^\circ\text{C}$  to accuracy specifications.

### OTHER CHARACTERISTICS

**Overrange Indication** — Blinking display (except 1000 V dc and 500 V ac).

**Measurement Rate** — 3 per second.

**Power Consumption** —  $\approx 8$  W.

**Inputs** — Maximum input voltage is 1000 V. The front panel volts/ $\Omega$ , or LOW, or mA terminal can be floated 1000 V peak maximum above ground, the rear input 200 V peak. For the rear input, ac volts, ohms and maximum input specifications are derated.

### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: 0°C to +50°C.

Nonoperating: -55°C to +75°C.

### INCLUDED ACCESSORIES

One pair test leads (003-0120-00); P6601 Temperature Probe (010-6601-01).

### ORDERING INFORMATION

**DM 502A Digital Multimeter** ..... \$570

**Option 02** — (Deletes temperature probe and capability) ..... - \$100



### P6601 Temperature Probe

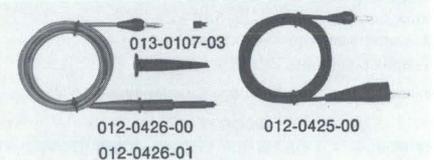
The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the sensing element to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

The thermal time constant on the P6601 Probe is 0.5 s  $\pm$  0.2 s. The P6601 is totally immersable except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a maximum of 240°C, and cable is limited to a maximum of 140°C.

**P6601 Temperature Probe**  
Order 010-6601-01 ..... \$201

### OPTIONAL ACCESSORIES

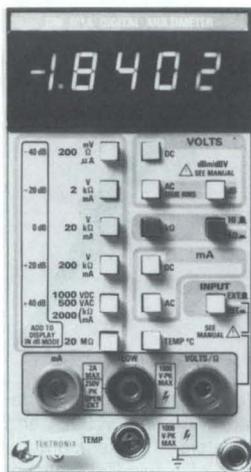
The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.



- Test Lead** black, 4 ft. Order 012-0425-00 ..... \$12
- Test Lead** red, 4 ft. Order 012-0426-00 ..... \$17.50
- Test Lead** black, 4 ft. Order 012-0426-01 ..... \$17.50
- Test Lead Set** of 012-0425-00, 012-0426-00, and 013-0107-03. Order 012-0427-00 ..... \$29
- High Voltage Probe** to 40 kV (complete information page 354). Order 010-0277-00 ..... \$127
- P6420 RF Probe** 2 m cable included (complete information page 433). Order 010-6420-03 ..... \$131
- Female BNC** to dual banana adaptor. Order 103-0090-00 ..... \$7.50

Tektronix offers service training classes on the TM 500/TM 5000 Measurement Product Systems and a multi-media training package on Digital Counter and Meter concepts. For further training information, contact your local Sales-/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

DM 501A



Digital Multimeter

DM 501A

0.05% dc Voltage Accuracy

Seven Functions Including dB

4 1/2 Digits of Readout Resolution

True RMS Capability

The DM 501A Digital Multimeter measures dc and ac voltage, dc and ac current, resistance, dB and temperature. The DM 501A gives 4 1/2 digits of readout resolution. All with 0.05% accuracy and true RMS capability. True RMS allows accurate measurement of distorted waveforms. DB is useful when making critical audio and communication measurements. Fast accurate temperature measurements to 240°C come from the Tektronix P6601 platinum film temperature sensing probe. The P6601 reaches 90% of final reading in 1.5 seconds.

CHARACTERISTICS

DC VOLTS

Ranges — 200 mV, 2 V, 20 V, 200 V, and 1000 V.

Accuracy\*

+18°C to +28°C	
200 mV Range	± [0.05% of reading + 0.015% of full scale (3 counts)]
2 V to 200 V Ranges	± [0.05% of reading + 0.01% of full scale (2 counts)]
1000 V Range	± [0.05% of reading + 0.02% of full scale (2 counts)]

0°C to +18°C and +28°C to +50°C	
200 mV to 200 V Ranges	± [0.1% of reading + 0.025 of full scale (5 counts)]
1000 V Range	± [0.1% of reading ± 0.05% of full scale (5 counts)]

\*Valid for a period of six months or 1000 hours, whichever occurs first.

Common-Mode Rejection Ratio — ≥100 dB at dc. ≥80 dB at 50 Hz and 80 Hz with 1 kΩ imbalance.

Normal-Mode Rejection Ratio — ≥60 dB at 50 Hz or 60 Hz ± 0.2 Hz.

Maximum Resolution — 10 μV.

Step Response Time — <1 second.

Input Resistance — 10 MΩ.

Maximum Input Voltage — 1000 V peak.

TRUE RMS AC VOLTS

Input Signal — Must be between 5% and 100% of full scale.

Ranges — 200 mV, 2 V, 20 V, 200 V, and 500 V (ac coupled).

Accuracy\*

+18°C to +28°C			
	20 Hz	40 Hz	10 kHz to 20 kHz
200 mV to 200 V Ranges	± [1% of reading + 0.05% of full scale (10 counts)]	± [0.6% of reading + 0.05% of full scale (10 counts)]	± [1% of reading + 0.05% of full scale (10 counts)]
500 V Range	± [1% of reading + 0.2% of full scale (10 counts)]	± [0.6% of reading + 0.2% of full scale (10 counts)]	± [1% of reading + 0.2% of full scale (10 counts)]

0°C to +18°C and +28°C to +50°C			
	20 Hz	40 Hz	10 kHz to 20 kHz
200 mV to 200 V Ranges	± [1.3% of reading + 0.075% of full scale (15 counts)]	± [0.8% of reading + 0.075% of full scale (15 counts)]	± [1.3% of reading + 0.075% of full scale (15 counts)]
500 V Range	± [1.3% of reading + 0.3% of full scale (15 counts)]	± [0.8% of reading + 0.3% of full scale (15 counts)]	± [1.3% of reading + 0.3% of full scale (15 counts)]

\*Valid for a period of six months or 1000 hours whichever occurs first.

Common-Mode Rejection Ratio — ≥60 dB at 50 Hz to 60 Hz with 1 kΩ imbalance.

Maximum Resolution — 10 μV.

Response Time — <2 s.

Input Impedance — 10 MΩ paralleled by 160 pF.

Maximum Input Voltage — 500 V ac RMS, 600 V dc, not to exceed 1000 V peak.

Crest Factor — 4 at full scale.

dB (TRUE RMS)

Zero dB Reference — 1 mW in 600 Ω (0.775 V) (dBm) Internal jumper change for zero dB reference of 1.0000 V (dBV).

Accuracy\*

+18°C to +28°C			
	20 Hz	2 kHz	10 kHz to 20 kHz
+20 dB to -15 dB			± 0.5 dB
-15 dB to -20 dB	± 0.5 dB	± 1.5 dB	Typically ± 2.5 dB

\*From 0°C to +18°C and +28°C to +50°C, add 0.6 dB to above accuracy specifications.

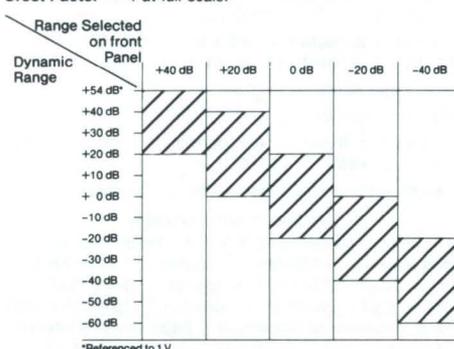
Maximum Resolution — 0.1 dB.

Response Time — <2 s.

Input Impedance — 10 MΩ paralleled by <160 pF.

Maximum Input Voltage — 500 V RMS, not to exceed 1000 V peak. Equivalent to +54 dBV or +56.2 dBm.

Crest Factor — 4 at full scale.



▨ indicates dynamic operating range  
▨ indicates out of range with blinking display

To obtain the correct dB reading, algebraically add the range selected to the display reading ("dynamic range" should be ± 20 dB from range reflected on front panel except +54 dB).

RESISTANCE

Response Time — <2 seconds in 200 Ω to 2000 kΩ ranges; <10 seconds in 20 MΩ range.

Maximum Input Volts — 250 V peak.

Maximum Resolution — 10 mΩ.

HI-LO OHM Operation — A low voltage is user-selectable for making in-circuit ohms measurements without turning on silicon diode and transistor junctions. A high voltage is also available for testing junctions for forward and reverse resistance.

Maximum Open-Circuit Voltage Developed — <6 V.

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, and 20 MΩ.

Accuracy\*

+18°C to +28°C		
200 Ω Range	LO Ω	± [0.15% of reading + 0.015% of full scale (3 counts)]
2 kΩ to 2000 kΩ Ranges	HI Ω	± [0.15% of reading + 0.015% of full scale (3 counts)]
2 kΩ to 200 kΩ Ranges	LO Ω	± [0.15% of reading + 0.015% of full scale (3 counts)]
2000 kΩ Range	LO Ω	± [0.3% of reading + 0.015% of full scale (3 counts)]
20 MΩ Range	HI Ω only	± [0.5% of reading + 0.015% of full scale (3 counts)]

0°C to +18°C and +28°C to +50°C		
200 Ω Range	LO Ω	± [0.3% of reading + 0.025% of full scale (5 counts)]
2 kΩ to 2000 kΩ Ranges	HI Ω	± [0.3% of reading + 0.025% of full scale (5 counts)]
2 kΩ to 200 kΩ Ranges	LO Ω	± [0.3% of reading + 0.025% of full scale (5 counts)]
20 MΩ Range LO Ω 2000 kΩ Range	HI Ω	± [1.2% of reading + 0.025% of full scale (5 counts)]

\*Valid for six months or 1000 hours whichever occurs first.

DC AND TRUE RMS AC CURRENT

Input Signal — Must be between 5% and 100% of full scale (ac only).

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, and 2000 mA.

Dc Current Accuracy — +18°C to +28°C: ± [0.2% of reading + 0.015% of full scale (3 counts)]. 0°C to +18°C and +28°C to +50°C: ± [0.3% of reading + 0.025% of full scale (5 counts)].

Ac Current Accuracy\* — From 20 Hz to 10 kHz. +18°C to +28°C: ± [0.6% of reading + 0.05% of full scale (10 counts)]. 0°C to 18°C and 28°C to 50°C: ± [0.7% of reading + 0.075% of full scale (15 counts)]. Usable to 20 kHz.

Response Time — <1 s dc current, <2 s ac current.

Range	Approximate Resistance
200 μA	1.0 kΩ
2 mA	100.0 Ω
20 mA	10.2 Ω
200 mA	1.2 Ω
2000 mA	0.4 Ω

Maximum Open-Circuit Input Voltage (mA to LOW) — 250 V peak, fused with 2 A fast blow.

Maximum Floating Voltage — 1000 V peak.

Maximum Resolution — 10 nA.

TEMPERATURE

Range — -62°C to +240°C.

Resolution — 0.1°C.

Accuracy\* — (+18°C to +28°C ambient temperature.)

Temperature to be measured			
	-62°C	+150°C	+240°C
P6601 and DM 501A calibrated as a pair	± 2°C		0°C to -6°C
P6601 and instrument not calibrated as a pair	± 4°C		+2°C to -8°C

\*For 0°C to +18°C and +28°C to +50°C ambient temperatures, add 1.5°C to above limit in each direction.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display (except on 1000 V dc and 500 V ac ranges).

Measurement Rate — 3 1/3 per second.

Power Consumption — ≈ 9 W.

Inputs — Maximum input voltage is 1000 V. The front panel Volts/, or LOW, or mA terminals can be floated to 1000 V peak maximum. above ground, the rear input only 200 V peak. For the rear input, ac volts, ohms, and maximum input specifications are derated.

ENVIRONMENTAL CHARACTERISTICS

Temperature — Operating: 0°C to +50°C. Nonoperating: -55°C to +75°C.

INCLUDED ACCESSORIES

One pair of test leads, (003-0120-00); P6601 Temperature Probe, (010-6601-01).

ORDERING INFORMATION

DM 501A Digital Multimeter	\$650
Option 02 — (Deletes P6601 Temperature Probe and temperature measurement capability)	—\$100

**PROBES AND OPTIONAL ACCESSORIES FOR DIGITAL MULTIMETERS**

The following accessories may be ordered as options for use with all of the three TM 500/TM 5000 Digital Multimeters.

**HIGH VOLTAGE PROBE**



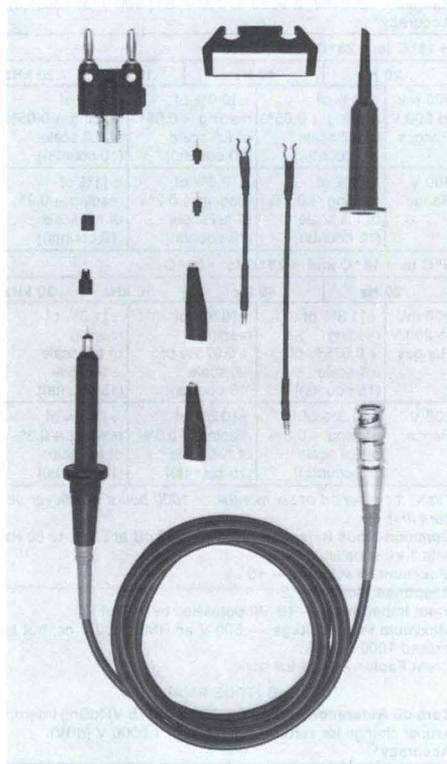
The High Voltage Probe will measure dc voltages from 1 kV to 40 kV with an accuracy of 1% at 25 kV. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes. Probe plugs directly into the front end of the multimeter.

**CHARACTERISTICS**

- Voltage Range** — 1kV to 40 kV dc.
- Input Resistance** — 1000 MΩ.
- Division Ratio** — 1000:1.
- Overall Accuracy** — 20 kV to 30 kV 2%.
- Upper Limit Accuracy** — Changes linear from 2% at 30 kV to 4% at 40 kV.
- Lower Limit Accuracy** — Changes linear from 2% at 20 kV to 4% at 1 kV.
- Input Z at Meter** — 10 MΩ required.

**High Voltage Probe Order 010-0277-00 . \$127**

**P6420 RF Probe**



The P6420 RF Probe is compatible with DMM's that have an input impedance of 10 megaohms or less and comes with a two meter cable. See page 433 for complete information including accessories and other cable lengths.

**CHARACTERISTICS**

- Voltage Range** — 5 V to 25 V RMS (70.7 V p-p).
- Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS ±10% (+15°C to +35°C). 5.0 V to 25 V RMS ±5% (+15°C to +35°C).
- Frequency Response** — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB).
- Input Capacitance** — ≈3.7 pF.
- Maximum Input Voltage** — 42.4 V (peak ac + dc).
- Temperature Range** — Nonoperating: -55°C to +75°C. Operating: +15°C to +35°C.
- Length** — Probe only 96 mm. Cable only 2 meters.

**INCLUDED ACCESSORIES**

TIP, probe, retractable (013-0097-01); adaptor, BNC female to dual banana (103-0090-00); clip, alligator (344-0046-00); holder, probe (352-0351-00); lead, ground, 76.2 mm (3 in) (175-0849-00); lead, ground, 152.8 mm (6 in) (175-1017-00); insulating sleeve, electrical (166-0404-01); 2 tips, probe replaceable\*  
 \*Available In package of 10 only, Order 206-0230-03

**ORDERING INFORMATION**

- P6420 RF Probe, 2 m Cable Included,**  
Order 010-6420-03 ..... **\$131**
- For a 1 meter length cable,** (does not change specifications).  
Order 175-1661-00 ..... **\$27**
- For a 3 meter length cable,** (does not change specifications)  
Order 175-1661-02 ..... **\$27**

**P6601 Temperature Probe**



The P6601 Probe is a temperature measuring device designed to operate with the DM 502A and DM 501A Digital Multimeters. The temperature sensing element consists of a thin-film platinum resistor on the tip of the probe. Measurements are made by touching the sensing element to the surface whose temperature is in question. The thermal signal is transmitted to the associated digital multimeter through a two-conductor cable.

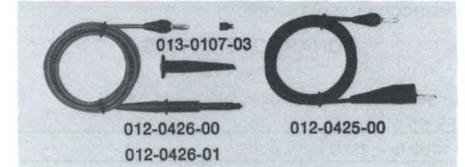
The thermal time constant on the P6601 Probe is 0.5 seconds ±0.2 seconds. The P6601 is totally immersible except in liquids that are not compatible with Dow Corning 308 molding compound, BeO, silicone rubber, or epoxy adhesives. The sensor and tip are limited to a maximum of +240°C, and cable is limited to a maximum of +140°C.

**P6601 Temperature Probe**

Order 010-6601-01 ..... **\$201**

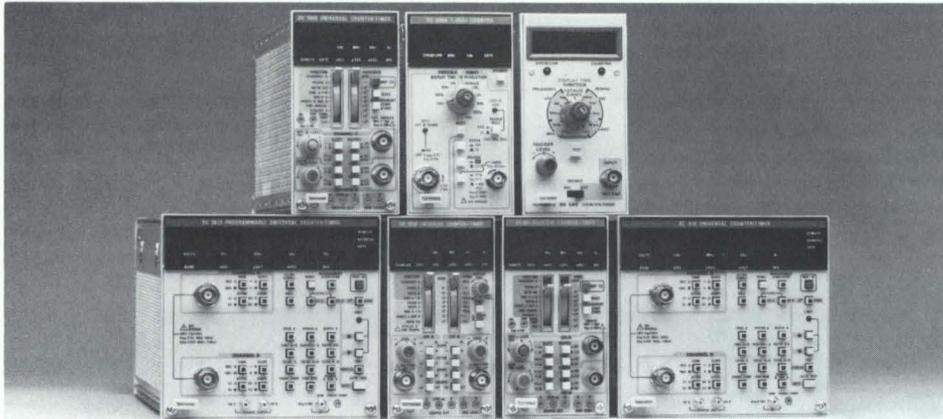
**DMM OPTIONAL ACCESSORIES**

The following accessories may be ordered as options for use with any of the three TM 500/TM 5000 Digital Multimeters.



- Test Lead, Black, 4 ft.** Order 012-0425-00 ..... **\$12**
- Test Lead, Red, 4 ft.** Order 012-0426-00 ..... **\$17.50**
- Test Lead, Black, 4 ft.** Order 012-0426-01 ..... **\$17.50**
- Test Lead Set** (012-0425-00, 012-0426-00, 013-0107-03).  
Order 012-0427-00 ..... **\$29**
- Female BNC to dual banana adaptor**  
Order 103-0090-00 ..... **\$7.50**

Additional Accessories begin on page 410.



**PRODUCT SUMMARY**

**Now, more counter capability than ever before: The DC 5009/DC 5010.** The 135 MHz DC 5009 and the 350 MHz DC 5010, both fully programmable, IEEE Standard 488 compatible Universal Counter/Timers feature Reciprocal Frequency, Auto-Trigger, Probe Compensation, and more. The DC 509 and DC 510 provide all of the performance of the DC 5009 and DC 5010 except IEEE Standard 488 compatibility. And that can be added as a field modification at a later date.

Add the DC 508A, the DC 503A, and the DC 504 and you have a counter selection to satisfy virtually any application.

The DC 508A is a 1.3 GHz communications counter ideal for high frequency applications. The DC 508A, which features an audio frequency resolution multiplier, is particularly applicable to telecommunications, aerospace and two-way communications.

The DC 503A is a 125 MHz Universal Counter/Timer designed for laboratory applications. The DC 503A is designed to offer a wide choice of performance features at an affordable price.

The DC 504 is an 80 MHz, General Purpose Counter available at an affordable price. The compact size of the DC 504 makes it particularly suitable for field service applications.

**Selecting to Match Requirements**

Perhaps the toughest part of selecting a counter is matching an appropriate instrument to the task to be performed. To simplify that job, Tektronix provides a choice of seven counters with a selection of measurement capabilities including frequency to 1.3 GHz, time interval resolution to 1 ps, autotrigger capabilities, improved resolution of low frequency signals, IEEE Standard 488 compatibility, automatic triggering, and full programmability. Matching your measurement requirement with a Tektronix TM 500/5000 Universal Counter/Timer or Frequency Counter is easier than ever before.

**Microprocessor-Based High Performance**

Because the 350 MHz DC 510 Universal Counter/Timer is microprocessor-based, many quality features were incorporated into the design. These include autotriggering, diagnostic self-test, and a reciprocal frequency counting technique that provides improved resolution of low frequency signals. For example, with the push of a button the autotrigger feature senses an applied signal and automatically sets both A and B channel trigger levels to the optimum trigger points. Also, front panel controls permit precise manual trigger adjustment, which is essential for accurate time interval measurement.

The DC 510 uses a powerful dual-register architecture to provide high-resolution counting of low-frequency signals. Much faster than conven-

tional counting techniques, it displays eight digits in about one-third of a second. The DC 510/DC 5010 features 3.125 ns single-shot resolution for time-interval measurements.

Other features of the DC 510 include an arming input for added versatility when measuring complex analog and digital waveforms, auto-averaging to provide the best possible combination of resolution and measurement time, and a phase-modulated time base to eliminate clock synchronous errors in all time averaging modes. In all, the DC 510 features thirteen separate functions including a Risetime and Falltime function and a Null mode.

The addition of a GPIB interface to the DC 510 has yielded a more versatile Tektronix product, the DC 5010, a fully programmable, IEEE Standard 488 compatible instrument. In the DC 5010, all capabilities that can be exercised from the front panel, including input conditioning, can be exercised over the IEEE-488 bus.

The DC 509/DC 5009 is a microprocessor-based, 135 MHz Universal Counter/Timer providing ten measurement functions and most of the features of the DC 510/DC 5010 except Risetime and Falltime and Null. The DC 509/DC 5009 also features 10 ns single-shot resolution in all timing functions. The addition of a GPIB interface turns the DC 509 into the fully programmable DC 5009.

Both the DC 509/DC 5009 and DC 510/DC 5010 feature a unique probe compensation function that will quickly and accurately compensate a high-impedance probe to a counter without using an oscilloscope or disassembling the counter.

**Versatility in Counting: The DC 503A**

The DC 503A features eight measurement functions including single-shot resolution to 100 ns. Both input channels have a full 0 to 125 MHz frequency range, 20 mV RMS sensitivity, and separate controls for triggering level, triggering slope, attenuation, and coupling. Signals to be counted or timed can be applied to front panel BNC connectors, or through rear interface connections. The front panel BNC connectors are probe compatible for easy signal acquisition and minimum circuit loading.

**Frequencies for Communications and Navigation: The DC 508A**

The DC 508A Frequency Counter is optimized for applications in the 10 Hz to 1.3 GHz frequency range. Its direct input covers the frequencies from 10 Hz through 100 MHz; its prescaler input measures frequencies from 100 MHz to 1.3 GHz. Events can be totalized from 0 to 999,999,999 over the 10 Hz to 100 MHz range. Because of its high-frequency capabilities, the DC 508A is ideally suited for communications applications including avionics repair and testing. This counter also features a nine-digit LED display that allows resolutions of 1 kHz to 1 Hz (0.1 Hz when using the direct input). An audio frequency resolution multiplier increases the resolution by a factor of 100 from 10 Hz to 25 kHz. This allows resolution of 0.01 Hz in 1 second. The decimal point is automatically positioned and leading zeros (to the left of the most significant digit or decimal point) are blanked. Digit overflow is indicated by a front panel LED.

An optional accessory probe, the Tektronix P6125, has been especially designed for digital counters to allow more accurate time-interval measurements of high-speed logic families. Five times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. Low input capacitance permits acquisition of high-frequency signals with minimum loading of the circuits under test.

**DIGITAL COUNTERS—SELECTION GUIDE**

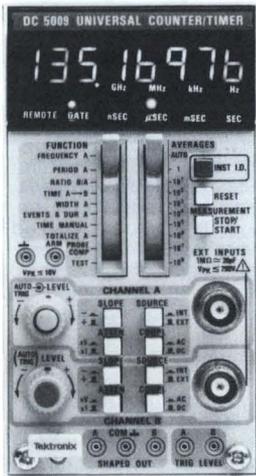
	DC 503A	DC 504	DC 508A	DC 509/DC 5009	DC 510/DC 5010
Frequency Range	125 MHz	80 MHz	1.3 GHz	135 MHz	350 MHz
Number of Digits	8	5	9	8	9
Ratio Architecture	No	No	No	Yes	Yes
Period	Yes, plus Averaging	Yes	No	Yes, plus Averaging	Yes, plus Averaging
Width Averaging (single input)	Yes	No	No	Yes	Yes
Time Interval Averaging	Yes	No	No	Yes	Yes
Auto-Trigger	No	No	No	Yes	Yes
Gated Events Averaging	A during B	No	No	B during A	B during A
Ratio Averaging	Yes	No	No	Yes	Yes
Other	Option 01, trigger level and shaped outputs, time manual, totalize	Option 01, rpm operation	Option 01, resolution multiplier, 1 M $\Omega$ or 50 $\Omega$ input	Option 01, trigger level and shaped outputs, self-test, phase modulated clock, probe compensation IEEE Standard 488 fully programmable (DC 5009)	Option 01, C shaped outputs self-test, phase modulated clock probe compensation 1 ps resolution 50 $\Omega$ /1 M $\Omega$ , (time A-B average) IEEE Standard 488 fully programmable (DC 5010)
Mainframe Compatibility	TM 500 TM 5000	TM 500 TM 5000	TM 500 TM 5000	DC 509 TM 500/TM 5000 DC 5009 TM 5000 only	DC 510 TM 500/TM 5000 DC 5010 TM 5000 only

**PHYSICAL CHARACTERISTICS**

	DC 503A		DC 504		DC 508A		DC 509/5009		DC 510/5010	
	mm	in	mm	in	mm	in	mm	in	mm	in
Width	67	2.7	67	2.7	67	2.7	67	2.7	67	2.7
Height	127	5.0	127	5.0	127	5.0	127	5.0	127	5.0
Depth	286	11.3	272	10.7	297	12.0	297	12.0	279	11.0
Weight	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb
Net	1.0	2.2	0.6	1.6	1.0	2.5	1.0	2.6	1.6	3.7

For compatible accessories — refer to page 410.

**DC 5009**



**Programmable Universal Counter Timer**

**DC 509**

**DC 5009**



The DC 5009 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*. The DC 509 is identical to the DC 5009 except that it is not GPIB compatible.

**Fully Programmable (DC 5009)**

**Frequency and Period to 135 MHz**

**Eight Measurement Functions:**

**Reciprocal Frequency (8 Digits in  $\leq 1$  s)**

**Period and Period Average**

**Width and Width Average**

**Time A  $\rightarrow$  B and Time A  $\rightarrow$  B Average**

**Events B During A and Events B During A Average**

**Totalize**

**Time Manual**

**Ratio B/A and Ratio B/A Average**

**Duty Cycle Independent Auto-Trigger from 20 Hz to 100 MHz in 2.5 s for Both Channels**

**Trigger Level and Shaped Outputs for Ease of Triggering**

**10 ns Single-shot Resolution in all Timing Modes**

**Designed for Serviceability Including Power-up Self Test and Signature Analysis**

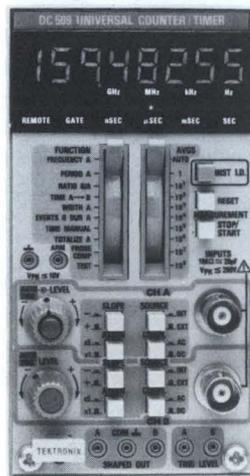
**Auto or Selected Averaging from 1 to  $10^8$  in all Modes**

**Probe Compensation Mode for True Probe Compatibility**

**Arming for Added Measurement Capability with Complex Waveforms**

**UL 1244 Listed**

**DC 509**



**Universal Counter Timer**

The DC 509/DC 5009 Universal Counter/Timer makes frequency and period measurements to 135 MHz using the powerful reciprocal counting technique. This method provides high resolution of low frequency signals much faster than conventional counting techniques. Signals to be counted or timed can be applied to channels A or B via front panel BNC connectors or rear interface connections.

The DC 5009 is designed to operate in TM 5000 mainframes. The DC 509 will operate in both the TM 500 and the TM 5000 Series mainframes. The DC 509/ DC 5009 offers a broad range of versatile features including Auto Trigger, Auto Averaging, and Probe Compensation.

Auto Trigger, at the push of a button, senses the applied signal and sets both trigger levels to the optimum trigger points. Channel A and B trigger levels can be monitored at front panel jacks or via rear interface connections. Buffered voltages corresponding to the trigger levels set by the front panel controls or the Auto Trigger. Also available over the GPIB bus are the minimum and maximum peak signal voltage values as well as the mid point value for both channels. Trigger level outputs are essential for accurate time interval measurements, especially when the risetime and falltime of the signal accounts for a sizable portion of the time interval to be measured. The outputs of the signal shaping circuits can be monitored also. These outputs are useful in setting the trigger points on complex waveforms.

The DC 509/DC 5009 provides eight measurement functions, and an averaging feature allows measurements to be averaged from 1 to  $10^8$  times with usable resolution to 5 picoseconds. A pseudo-random, phase-modulated time base, standard in the DC 509/DC 5009, provides increased accuracy by eliminating clock-synchronous errors in the time-interval and width-averaging modes.

The DC 509/DC 5009, a microprocessor-based instrument, executes an extensive self-test routine when powered up. A unique feature, Probe Compensation, permits quick and accurate compensation of attenuator type probes. An arming input allows measurements of selected events within complex waveforms.

The English-like programming language makes GPIB control of the DC 5009 easy. The GPIB commands allow full access to all DC 5009 controls and features.

The DC 509/DC 5009 can be equipped with an optional temperature-controlled, 10 MHz (self contained-oven) crystal oscillator (Option 01) to obtain a more accurate, highly stable time base.

A conversion kit is available to owners of DC 509's who desire IEEE Standard 488 capabilities. This option is a field modification kit which easily converts a DC 509 to DC 5009.

**DC 509/DC 5009 CHARACTERISTICS**

**Display** — Eight-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate. Overflow is indicated by a blinking display.

**CHANNEL A AND B INPUT CHARACTERISTICS**

**Frequency Range** — 0 to 135 MHz dc coupled, 10 Hz to 135 MHz ac coupled.

**Sensitivity** — 20 mV RMS sinewave to 100 MHz, 40 mV RMS sinewave to 135 MHz, 115 mV p-p at minimum. pulse width of 3 ns.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 M $\Omega$  paralleled by  $\leq 30$  pF.

**Dynamic Range** — V p-p  $\leq 3 \times$  Attenuation, tr  $\leq 5$  ns. V pk  $\leq 3.2 \times$  Attenuation.

**Trigger Level**

Accuracy —  $\pm 45$  mV  $\pm 40$   $\mu$ V/ $^{\circ}$ C referenced to 25 $^{\circ}$ C.

DC 509 — Adjustable  $\pm 3.2$  V x Attenuation.

DC 5009 —  $(+3.200$  to  $-3.175) \times$  Attenuation, 25 mV resolution.

Auto Trigger Frequency Range — 20 Hz to 100 MHz (V<sub>in</sub>  $\geq 125$  mV p-p).

**Independent Controls** — Slope +/–, Attenuation 1X/5X, Couple ac/dc, Source Internal/External.

**Maximum Input Voltage**

1X — 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p at 135 MHz.

5X — 200 V peak; 400 V p-p from dc to 5 MHz, derate to 25 V p-p at 135 MHz.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms. Amplitude 0 to  $\geq +0.3$  V from 50  $\Omega$ .

**Trigger Level Out** — A dc level corresponding to the actual trigger level. Accuracy within  $\pm 30$  mV of internal trigger level.

**Arming Input** — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

**FREQUENCY A**

**Range** — 100  $\mu$ Hz to 135 MHz.

**Resolution** —

$$\pm \text{LSD} \pm 1.4 \times \frac{\text{Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

**Accuracy** —

Resolution  $\pm$  (Time Base Error x Frequency A)

**PERIOD A**

**Range** — 7.40 ns to 3.05 hours.

$$\text{Resolution} - \pm \text{LSD} \pm 1.4 \times \frac{A \text{ Trigger Jitter Error}}{N}$$

**Accuracy** — Resolution  $\pm$  (Time Base Error x Period A).

**RATIO B/A**

**Range** —  $10^{-7}$  to  $10^8$  (Frequency Range: CH A to 135 MHz; CH B to 125 MHz.)

**Resolution** —

$$\pm \text{LSD} \pm 1.4 \times \frac{B \text{ Trigger Jitter Error} \times \text{Frequency B}}{N}$$

**Accuracy** — Same as Resolution.

**TIME A  $\rightarrow$  B**

**Range** — 15 ns to 3.05 hours.

**Minimum Dead Time** — 15 ns (stop to start).

**Resolution** —

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} \times (\pm \text{CH A Trigger Jitter Error} \pm \text{CH B Trigger Jitter Error})$$

**Accuracy** — Resolution  $\pm$  (Time Base Error x Time A  $\rightarrow$  B) + (CH B Slew Rate Error – CH A Slew Rate Error)  $\pm$  Channel Delay Mismatch.

**Channel Delay Mismatch** —  $< 2$  ns between front panel inputs and  $< 3$  ns between rear interface inputs.

**EVENTS B DURING A**

**Range** —  $10^{-7}$  to  $10^8$ .

**Maximum B Frequency** — 125 MHz.

**Minimum A Pulse Width** — 15 ns.

**Minimum Time Between A Pulses** — 15 ns.

**Minimum Time Between "A" Start Edge and First "B" Event** — 15 ns.

**Resolution** —

$$\pm \text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} (\pm \text{Trigger Jitter Error CH A start edge} \pm \text{Trigger Jitter Error CH A stop edge.})$$

**Accuracy** — Resolution + FREQ B (Stop Slew Rate Error – Start Slew Rate Error).

**WIDTH A**

**Range** — 15 ns to 3.05 hours.

**Minimum Dead Time Between Pulses** — 15 ns.

**Resolution** —

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} (\pm \text{Start Error} \pm \text{Stop Trigger Jitter Error})$$

**Accuracy** — Resolution  $\pm$  (Time Base Error x Width) + (Stop Slew Rate Error – Start Slew Rate Error)  $\pm 5$  ns.

**TIME MANUAL**

**Range** — 0 to 3.05 hours. May be extended with GPIB (DC 5009).

**Resolution** —  $\pm$  LSD (100 ms).

**Accuracy** —  $\pm$  Resolution  $\pm$  (Time Base Error x TIME).

**TOTALIZE A**

**Range** — 0 to  $1.09 \times 10^{12}$  counts. May be extended with GPIB (DC 5009).

**Repetition Rate** — 0 to 135 MHz.

**PROBE COMPENSATION**

**Display** — 1 or 0 for each channel.

**Accuracy** —

Probe Atten X 50 mV X 100 (%)

V<sub>in</sub> at Probe

(2.5% nominal for X5 probe with 10 V p-p at the probe).

**RESOLUTION AND ACCURACY DEFINITIONS**

**Trigger Jitter Error (seconds RMS) —**

$$\sqrt{(e_{n1})^2 + (e_{n2})^2} \text{ (Volts RMS)}$$

Input Slew Rate at trigger point (V/s)

Where:  $e_{n1} = 120 \mu\text{V RMS typical counter input noise}$

$e_{n2} = \text{RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.}$

**Slew Rate Error (seconds) —**

Input Hysteresis/2

Input Slew Rate at trigger point (V/s)

Note: Input hysteresis is typically 20 mV p-p.

**N = Number of Averages**

The minimum number of averages is selected by the Averages control in decade steps from 1 to  $10^8$ . At CH A repetition rates above  $\approx 250$  Hz, the number of averages will be:

$$N = [\text{Frequency A (Hz)} \times 4 \text{ ms}] + \text{Averages.}$$

N = Averages setting below 250 Hz.

In the Auto mode, the counter measures with a fixed measurement time of about 300 ms.

N (Auto)  $\approx$  Frequency A (Hz) x 0.3 seconds.

N is always  $\geq 1$ .

**Time Base Error** — The sum of all errors specified for the time base used.

**STANDARD TIME BASE**

**Crystal Frequency** — 10 MHz.

**Temp Stability** —  $\pm 5 \times 10^{-6}$ , 0 $^{\circ}$ C to +50 $^{\circ}$ C.

**Aging Rate** —  $1 \times 10^{-6}$  per year.

**Stability** — Adjustable to within  $\pm 1 \times 10^{-7}$  or better.

**HIGH STABILITY TIME BASE (OPTION 01)**

**Crystal Frequency** — 10 MHz.

**Stability** —  $\pm 2 \times 10^{-7}$  after warm-up, 0 $^{\circ}$ C to +50 $^{\circ}$ C.

**Warm-up Time** — Within  $2 \times 10^{-7}$  of final frequency in  $< 10$  minutes when cold-started at 25 $^{\circ}$ C.

**Aging Rate** —  $1 \times 10^{-8}$ /day at time of shipment,  $4 \times 10^{-8}$ /week after 30 days of continuous operation,  $1 \times 10^{-6}$ /year after 60 days of continuous operation.

**Stability** — Adjustable to within  $2 \times 10^{-8}$ .

**REAR INTERFACE**

**Inputs** — Channel A and B input to 50 MHz (50  $\Omega$  impedance, maximum input 3.6 V peak); arming; reset; external time base (1, 5, or 10 MHz), prescale.

**Outputs** — Channel A and B shaped outputs; Channel A and B trigger level outputs; 10 MHz clock; gate out.

**OTHER CHARACTERISTICS**

**Power Consumption**

DC 509 —  $\approx 11.1$  W  $\approx$  (15 W with Option 01).

DC 5009 —  $\approx 12$  W  $\approx$  (15 W with Option 01).

**GPIB Data Output Rate (DC 5009 only)** —  $\approx 10$  readings/s maximum.

**GPIB Commands (DC 5009 only)** — Addressable by 36 English-like ASCII GPIB commands.

**TM 5000 Power Module Compatibility** — Due to the extended GPIB interface connector the DC 5009 is not compatible with TM 500 Series Mainframes.

**INCLUDED ACCESSORIES**

Tip jack to BNC adaptor cable (175-3765-01).

**ORDERING INFORMATION**

**DC 509 Universal Counter Timer ..... \$1,850**

**DC 5009 Programmable Universal Counter Timer ..... \$2,200**

**Option 01 — High Stability Time Base ..... +\$295**

**Field Option 01 Kit for DC 509/DC 5009**

Order 040-0966-00 ..... **\$250**

**Field GPIB Kit for DC 509.**

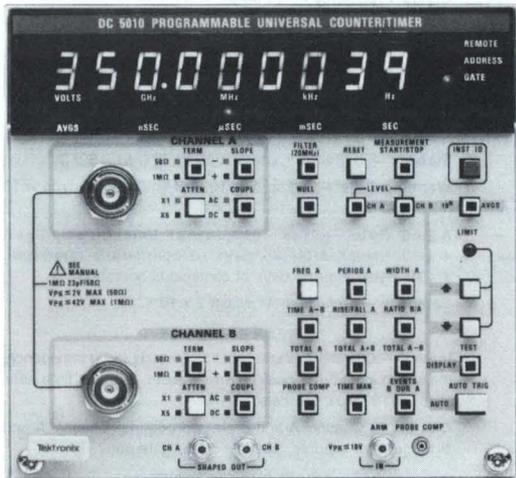
Order 040-0957-01 ..... **\$500**

**RECOMMENDED PROBE**

**P6125 5X Passive Probe.**

Order 010-6125-01 ..... **\$58**

**DC 5010**



**Programmable Universal Counter/Timer**

**DC 510**

**DC 5010** GPIB  
IEEE-488

The DC 5010 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*. The DC 510 is identical to the DC 5010 except that it is not GPIB compatible.

**Fully Programmable (DC 5010)**

**350 MHz both A and B Channels**

**3.125 ns Single-shot Resolution**

**9 Digits in < 1/3 Seconds**

**12 Measurement Functions:**

**Period and Period Average**

**Width and Width Average**

**Time A → B and Time A → B Average**

**Events B During A and Events B During A Average**

**Totalize (A, A+B, A-B)**

**Time Manual**

**Ratio B/A and Ratio B/A Average**

**Risetime A/Falltime A (With Averaging)**

**Duty Cycle Independent Auto-Trigger from 10 Hz to 350 MHz in < 2.5 Seconds**

**DVM Mode for Displaying Trigger Level Setting**

**Shaped A and B Channel Outputs**

**Selected Averaging from 1 to 10<sup>9</sup> or Auto**

**Hysteresis Compensation**

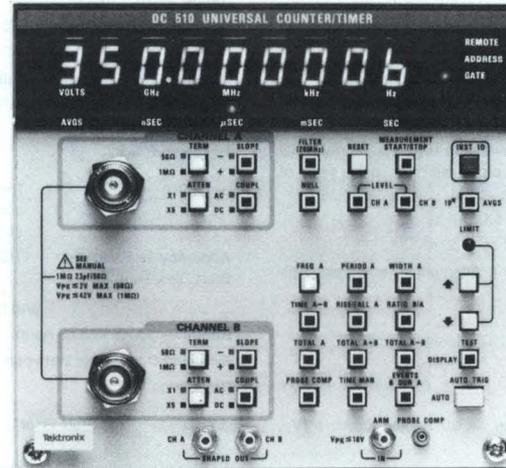
**Probe Compensation Mode for Probe Compatibility**

**Arming for Added Measurement Capability with Complex Waveforms**

**Designed for Serviceability with Powerful Self-Test and Signature Analysis**

**UL 1244 Listed**

**DC 510**



**Universal Counter/Timer**

The DC 510/DC 5010 Universal Counter/Timer features reciprocal frequency, period, ratio, and events B during A measurements to 350 MHz. The powerful reciprocal technique provides high resolution of low frequency signals much faster than conventional counting techniques. A 3.125 ns, single-shot resolution is featured for the risetime and falltime functions and for the timing, time interval, and width measurements. For all of these above measurements, identical A and B channels and averaging provide increased accuracy. The averaging feature allows measurements to be averaged from 1 to 10<sup>9</sup> times with usable time interval resolution to 1 picosecond. A pseudo-random, phase modulated time base in the DC 510/DC 5010, provides increased accuracy by eliminating clock synchronous errors in the Time Interval and Width Averaging modes. Also included is a Time Manual mode, as well as three 350 MHz Totalize modes: A, A+B, and A-B.

The DC 510/DC 5010 also has an auto-trigger feature for ease of set-up. Auto-trigger, at the push of a button senses the applied signal and sets both trigger levels to the optimum trigger points. In the DC 5010, trigger levels are available over the bus, as are the minimum and maximum peak signal voltage values. In both the DC 510 and DC 5010, the trigger voltage setting can be displayed. Such trigger level information is essential for accurate time interval measurements, especially when the risetime and falltime of the signal accounts for a sizable portion of the time interval to be measured. Hysteresis compensation is automatic in the DC 510/DC 5010. The outputs of the signal shaping circuits can also be monitored. These outputs are useful for setting the trigger points on complex waveforms.

The DC 510/DC 5010 microprocessor based instruments execute an extensive self-test routine when powered up. The test modes and signature analysis contribute to a reduced life-cycle cost of ownership. A unique feature, Probe Compensation permits quick and accurate compensation of signal probes. An arming input allows measurement of selected events within complex waveforms. The DC 510/DC 5010 use proprietary amplifiers and Schmitt trigger circuitry to provide flat sensitivity and low distortion signal acquisition.

The DC 5010 is an IEEE Standard 488 compatible, fully programmable version of the DC 510 and allows every manually selectable function or mode to be operated over the GPIB bus, including all input conditioning controls. The English-like programming commands makes bus control of the DC 5010 easy. The GPIB bus commands allow full access to all DC 5010 controls and features.

The DC 510/DC 5010 can be equipped with an optional temperature-controlled (self-contained oven), 10 MHz crystal oscillator (Option 01) to obtain an even more accurate highly stable time base.

A conversion kit is available to owners of DC 510's who desire IEEE Standard 488 capabilities. The field modification kit easily converts a DC 510 to a DC 5010.

The DC 5010 is designed to operate in TM 5000 Mainframes. The DC 510 will operate in both the TM 500 and the TM 5000 Series Mainframes.

**DC 510/DC 5010 CHARACTERISTICS**

**Display** — Nine-digit LED display, automatic decimal point positioning, LED indicators for units, and measurement gate, and bus conditions. Overflow is indicated by a blinking display.

**CHANNEL A AND B INPUT CHARACTERISTICS**

**Frequency Range**

50 Ω Termination — 0 to 350 MHz dc coupled. 100 kHz to 350 MHz ac coupled.

1 MΩ Termination — 0 to 300 MHz dc coupled. 16 Hz to 300 MHz ac coupled.

**Sensitivity**

50 Ω Termination Dc — 25 mV RMS sinewave to 350 MHz. 70 mV p-p pulse.

1 MΩ Termination Ac — 25 mV RMS to 200 MHz, 42 mV RMS to 300 MHz, dc coupled. 25 mV RMS, 16 Hz to 200 MHz, 42 mV RMS to 300 MHz, ac coupled.

**Attenuation** — Selectable 1X, 5X.

**Impedance** — 1 MΩ paralleled by 23 pF ± 2 pF or 50 Ω.

**Trigger Level Range** — +2 V to -2 V (X1). +10 V to -10 V (X5).

**Trigger Level Accuracy** — ±2% of reading for a dc input V, ±40 mV x attenuator.

**Dynamic Range** — 4 V p-p x attenuation.

**Auto-Trigger Frequency Range** — 10 Hz to 350 MHz.

**Independent Controls** — Slope +/-, atten 1X/5X, Coupl ac/dc., Imped 1 MΩ/50 Ω.

**Maximum Input Voltage** — 1 MΩ input impedance.

1X — ±42 V (dc + peak ac) to 200 kHz; ±2 V (dc + peak ac) to 300 MHz.

5X — ±42 V (dc + peak ac) to 1 MHz; ±10 V (dc + peak ac) to 300 MHz.

In 50 Ω input impedance, signals > ±2 V x attenuator will cause input protection circuitry to switch input to 1 MΩ.

**Shaped Output** — Shaped replica of signal being measured, aids proper triggering on complex waveforms (≥100 mV typically to 350 MHz into 50 Ω load).

**Arming Input** — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

**FREQUENCY A**

**Range** — 36 μHz to 350 MHz.

**Resolution** —

$$\pm \text{LSD} \pm 1.4 \times \frac{A \text{ Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

**Accuracy** — Resolution ± (Time Base Error x Frequency A.)

**PERIOD A**

**Range** — 3.125 ns to 7.6 hours.

**Resolution** —

$$\pm \text{LSD} \pm \frac{1.4 \times A \text{ Trigger Jitter Error}}{N}$$

**Accuracy** — Resolution ± (Time Base Error) x Period A.

**RATIO B/A**

**Range** — 10<sup>-8</sup> to 10<sup>9</sup> (Frequency range 36 μHz to 350 MHz).

**Resolution** —

$$\pm \text{LSD} \pm \frac{1.4 \times B \text{ Trigger Jitter Error} \times \text{Frequency B}}{N}$$

**Accuracy** — Same as Resolution.

**TIME A → B**

**Range** — 2.0 ns to 7.6 hours.

**Resolution** —

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} \times (\pm \text{CH A Trig Jitter Error} \pm \text{Ch B Trig Jitter Error})$$

**Accuracy** —

Resolution ± (Time Base Error x Time A → B) + (B Trigger Slew Error) - (A Trigger Slew Error) ± (Channel Delay Mismatch\*).

**Resolution** — Best time A → B Avg resolution = ±1 ps.

**Minimum Dead Time** — 12.5 ns (stop to start).

**Rep Rate** — <70 MHz.

\*Can be removed with "Null".

**EVENTS B DURING A**

**Range** — 10<sup>-8</sup> to 10<sup>9</sup>.

**Maximum B Frequency** — 350 MHz.

**Maximum A Frequency** — 80 MHz.

**Minimum A Pulse Width** — 4.0 ns (and 8.5 ns minimum time between pulses).

**Resolution** —

$$\pm \text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} \pm (\text{Trig Jitter Error CH A start edge} \pm \text{Trig Jitter Error CH A stop edge}).$$

**Accuracy** — Resolution + Freq B (Stop Slew Rate Error - Start Slew Rate Error) + Freq B x (5 ± 2 ns).

**WIDTH A**

**Range** — 4 ns to 7.6 hours.

**Resolution** —

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} (\pm \text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

**Accuracy** — Resolution ± (Time Base Error x Width A) + (Stop Slew Rate Error - Start Slew Rate Error) ± 2 ns.

**Minimum Dead Time Between Pulses** — ≤8.5 ns.

**Repetition Rate** — 50 MHz maximum.

**TIME MANUAL**

**Range** — 0 to 3.125 x 10<sup>4</sup> s (≈8 hours).

**Resolution** — ± LSD (100 ms).

**Accuracy** — ± Resolution ± (Time Base Error x TIME).

**TOTALIZE A**

**Range** — 0 to 10<sup>9</sup> counts.

**Repetition Rate** — 0 to 350 MHz.

**TOTALIZE A+B**

**Range** — 0 to 10<sup>9</sup> counts (A+B ≤10<sup>9</sup>).

**Repetition Rate** — 0 to 350 MHz.

**TOTALIZE A-B**

**Range** — -1 x 10<sup>8</sup> to +1 x 10<sup>9</sup> (either A > 10<sup>12</sup> or B > 10<sup>12</sup> will cause overflow).

**Repetition Rate** — 0 to 350 MHz.

**RISE/FALL A**

**Range** — 4 ns to 10<sup>4</sup> s (50 Ω) 5 ns to 10<sup>4</sup> s (1 MΩ).

**Repetition Rate** — Minimum time between rising (falling) edges is 12.5 ns (80 MHz).

**Input Amplitude** — (1.4 V to 8 V) x Attenuation (50 Ω), (0.7 V to 4 V) x Attenuation (1 MΩ).

**Resolution** —

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} (\pm \text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

**Accuracy** — Resolution ± (Time Base Error x Risetime/Fall-time) ± 2 ns ± 4 mV x Slew Rate A Error (near 10%) ± 4 mV Slew Rate A Error (near 90%).

**Resolution and Accuracy Definitions** —

$$\text{Trigger Jitter Error (seconds RMS)} = \sqrt{(\text{en}_1)^2 + (\text{en}_2)^2} \text{ (Volts RMS)}$$

$$\text{Input Slew Rate at trigger point (V/s)}$$

Where: en1 = 140 μV RMS typical counter input noise for 1 MΩ filter on; 250 μV RMS typical for 1 MΩ filter off and 340 μV RMS typical for 50 Ω.  
en2 = RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.

**Slew Rate Error (seconds) —**  
trigger level error (V)

Input slew rate at trigger point (V/s)

\*Trigger level error =

All functions except Width and Events B During A	Positive Slope	Trigger accuracy times ATTN factor
		Negative Slope
Width A 	start edge	trigger accuracy times ATTN factor
	stop edge	(trigger accuracy + hyst) times ATTN factor
	start edge	(trigger accuracy + hyst) times ATTN factor
	stop edge	trigger accuracy times ATTN factor
Events B During A	Same as Width, except each number is multiplied by (Frequency B)	

Note: Input hysteresis is typically 50 mV p-p x attenuation. N = Number of Averages

The minimum number of averages is selected by the Averages button and the ↑ + buttons in decade steps from 1 to 10<sup>9</sup>. At Channel A repetition rates above ≈250 Hz the actual number of averages will be:

$$N = [\text{Frequency A (Hz)} \times 4 \text{ ms}] + \text{Averages.}$$

$$N = \text{Averages setting (below 250 Hz).}$$

This calculation typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. It does mean, however, that Arming must be used where only N = 1 is desired for signals ≥250 Hz.

In the Auto mode the counter measures with a fixed measurement time of about 300 ms (or the time for one event, whichever is greater).

$$N = \text{Frequency A (Hz)} \times 0.3 \text{ s (N always } \geq 1).$$

Probe Comp display indicates 1 for over comp, 0 for under comp. Accuracy = (A x 0.300)% . A = Probe Attenuation times counter attenuator setting.

**Time Base Error** — The sum of all errors specified for the time based used.

**STANDARD TIME BASE**

**Crystal Frequency** — 10 MHz.

**Temperature Stability** — ±5 x 10<sup>-6</sup>, 0 to +50°C.

**Aging Rate** — ≤1 x 10<sup>-6</sup>/year.

**Stability** — Adjustable to within ±5 x 10<sup>-8</sup>.

**HIGH STABILITY TIME BASE (OPTION 01)**

**Crystal Frequency** — 10 MHz.

**Temperature Stability** — ±2 x 10<sup>-7</sup> of final frequency in <10 minutes when cold started at 25°C.

**Aging Rate** — ≤1 x 10<sup>-8</sup>/day at time of shipment, 4 x 10<sup>-8</sup>/week after 30 days of continuous operation, 4 x 10<sup>-6</sup>/year after 60 days of continuous operation.

**Stability** — Adjustable to within ±2 x 10<sup>-8</sup>.

**REAR INTERFACE**

**Inputs** — Arming; reset; external time base (1, 5, or 10 MHz).

**Outputs** — 1 MHz clock.

**OTHER CHARACTERISTICS**

**Power Consumption** — DC 510: 14.6 W ≈(19 W with Option 01). DC 5010: 14.5 W ≈(19.3 W with Option 01).

**GPIB Data Output Rate (DC 5010 only)** — ≈10 readings/s maximum.

**GPIB Commands (DC 5010 only)** — Addressable by 45 English-like GPIB commands.

**TM 5000 Power Module Compatibility** — Due to the extended GPIB interface connector the DC 5010 is not compatible with TM 500 Series mainframes.

**INCLUDED ACCESSORIES**

Shaped output cable (012-0532-00).

**ORDERING INFORMATION**

**DC 510 Universal Counter/Timer ..... \$3,380**

**DC 5010 Programmable Universal**

**Counter/Timer ..... \$3,900**

**Option 01 — High Stability Time Base ..... \$295**

**Field Option 01 Kit for DC 510/5010**

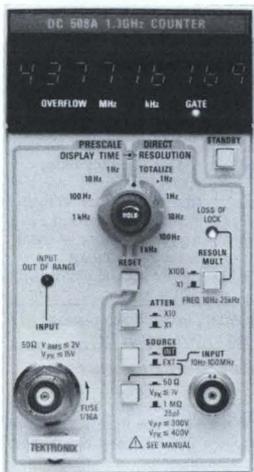
**Order 040-0966-00 ..... \$250**

**Field GPIB Kit for DC 510 Order 040-1023-02 ..... \$500**

**RECOMMENDED PROBE**

**5 X Passive Probe, Order 010-6125-01 ..... \$58**

**DC 508A**



**Frequency Counter**

**DC 508A**

Frequency up to 1.3 GHz

Sensitivity to 20 mV RMS Prescale, 15 mV RMS Direct

X100 Resolution Multiplier to 25 kHz

Input Out-of-Range Light

Nine Digit LED Readout

Front Panel Fuse Protection on Prescale Input

Designed to operate in TM 500/TM 5000 Series Mainframes, the DC 508A Counter measures frequency from 10 Hz to 1.3 GHz. A nine-digit LED display shows frequency or total events from 0 to 999,999,999. The prescaler input allows it to measure frequency from 100 MHz to 1.3 GHz, and the direct input from 10 Hz to 100 MHz. The decimal point is automatically positioned and leading zeros suppressed. Digit overflow is indicated by a front panel LED. Option 01 includes a high-stability time base, and Option 07 includes Option 01 and an interface for the TR 502 and TR 503 Tracking Generator/Spectrum Analyzer. An audio frequency resolution multiplier multiplies the resolution by 100 from 10 Hz to 25 kHz. This allows resolution of 0.01 Hz in 1 second. Detent position of Display Time knob provides a hold mode.

**CHARACTERISTICS**  
**DISPLAY**

Nine-digit LED display, leading zeros blanked, automatic decimal point positioning, LED front panel indicators for gate open, overflow, kHz, and MHz.

**DIRECT INPUT**

Frequency Range — 10 Hz to 100 MHz.

Sensitivity — 15 mV RMS.

Impedance — Selectable 50 Ω and 1 MΩ paralleled by 25 pF.

**Maximum Operating Input Voltage** — For 50 Ω is  $\leq 7$  V peak. For 1 MΩ 1X attenuation, V peak  $\leq 400$  V; V p-p  $\leq 300$  V from 10 Hz to 0.75 MHz, V p-p 225/fMHz V from 0.75 MHz to 22 MHz, V p-p  $\leq 10$  V above 22 MHz; for a pulse, V peak  $\leq 400$  V and dV/dt  $\leq 5$  V/ns. For 1 MΩ, 10X attenuation, V peak  $\leq 400$  V; V p-p  $\leq 300$  V from 10 Hz to 1 MHz, V p-p  $\leq 300$ /fMHz V from 1 MHz to 6 MHz, V p-p  $\leq 100$  V above 6 MHz.

**Attenuation** — 1X, 10X.

**Resolution (without resolution multiplier)** — 0.1 Hz with 10 s gate, 1 Hz with 1 s gate, 10 Hz with 100 ms gate, 100 Hz with 10 ms gate, and 1 kHz with 1 ms gate.

**Rear Interface Internal Input Sensitivity** — 125 mV RMS to 50 MHz.

**Rear Interface Internal Input Impedance** — 50 Ω.

**Rear Interface Internal Input Maximum Input Voltage** — 4 V.

**Resolution Multiplier Frequency Range** — 10 Hz to 25 kHz.

**Resolution Multiplier Multiplication** — X100.

**Resolution Multiplier Lock Time** —  $\leq 5$  s.

**PRESCALE INPUT (+8)**

**Frequency Range** — 100 MHz to 1.3 GHz.

**Sensitivity** — 20 mV RMS from  $\leq 100$  MHz to  $\geq 1.1$  GHz ( $-21$  dBm) 40 mV RMS ( $-15$  dBm) from 1.1 to 1.3 GHz.

**Impedance** — 50 Ω.

**Vswr** —  $\leq 2.2:1$ .

**Maximum Operating Input Voltage** — V peak  $\leq 15$  V, V RMS  $\leq 2$  V (+19 dBm).

**Resolution** — 1 Hz with 8 s gate, 10 Hz with 800 ms gate, 100 Hz with 80 ms gate, and 1 kHz with 8 ms gate.

**Input Protection Voltage** — Input fuse opens at  $\approx 9$  V RMS (+30 dBm).

**Input Out-of-Range LED** — Indicates voltage or frequency too low for error-free counting.

**TIME BASE**

**Frequency** — 10 MHz; may also be used with external time bases with TTL levels at 1, 5, and 10 MHz.

**Temperature Stability** — 0 to 50°C —  $\pm 5 \times 10^{-6}$ .

**Aging Rate** —  $1 \times 10^{-6}$  per year.

**OPTION 01 TIME BASE (OVEN OSCILLATOR)**

**Frequency** — 10 MHz.

**Temperature Stability, 0 to 50°C After Warmup** — Within 0.2 parts in  $10^6$  after warmup.

**Warmup Time** — Within  $\pm 0.2$  ppm of final frequency in  $< 10$  minutes when cold-started at 25°C.

**Aging Rate** —  $\leq 1 \times 10^{-9}$ /day at time of shipping.  $\leq 4 \times 10^{-9}$ /week after a month of continuous operation.  $\leq 1 \times 10^{-6}$ /year after two months of continuous operation.

**Stability** —  $\pm 2 \times 10^{-8}$ .

**Rear Inputs** — Frequency, reset, external clock, start count.

**Rear Outputs** — BCD, decimal point, time slot zero, scan clock, data good, overflow, reset, gate out.

**ACCURACY**

The overall DC 508A accuracy is:

$$\text{Accuracy (\% of reading)} = \pm (\text{time base accuracy} + \frac{1}{(\text{total displayed counts})}) \times 100$$

Time base accuracy  $\leq \pm$  [calibration accuracy + temperature stability + (aging rate x time since calibration) + short-term stability].

**ORDERING INFORMATION**

**DC 508A Frequency Counter** ..... **\$1,630**

**Option 01** — (Time Base) ..... **+\$295**

**Option 07** — (Includes Option 01 Time Base)

for use with TR 502 ..... **+\$340**

For recommended probes — refer to page 430.

**DC 503A**



**Universal Counter/Timer**

**DC 503A**

125 MHz both A and B Channels

Eight Measurement Functions:

Frequency

Period and Period Average

Width and Width Average

Time A → B and Time A → B Average

Events A During B and Events A During B Average

Totalize

Time Manual

Ratio A/B Average

10 ps Resolution in Time Interval

Average with 10<sup>8</sup> Averages

Shaped Outputs for Ease of Triggering

40 MHz Rep Rate in Time Interval Average

Simplified Width Measurement

Designed for True Probe Compatibility

Trigger Level Outputs for

Accurate Trigger Setting

The DC 503A offers a broad range of measurement features at an affordable price. The instrument has two input channels, A and B, each with 125 MHz capability. Each channel has separate triggering level, triggering slope, attenuator, and coupling mode controls. Eight measurement functions are available with the DC 503A and an averaging feature allows measurements to be averaged from 1 to 10<sup>8</sup> times. Signals to be counted or timed can be applied to channels A and B via front panel BNC connectors, or through rear interface connections. The DC 503A features an easy access front panel and an LSI based design for increased instrument reliability.

The DC 503A can be equipped with an optional 10 MHz crystal oscillator, (temperature controlled self contained oven) Option 01, to obtain a highly stable and precise internal time base. Both the optional oscillator and the standard 10 MHz crystal oscillator provide 100 ns resolution of single-shot time intervals.

**CHARACTERISTICS**

**Display** — Eight digit LED; indicators for units, gate open, and overflow.

**Display Time** — ≈0.2 seconds to 5 seconds and hold.

**CHANNEL A AND B INPUT**

**Frequency Range** — 0 to 125 MHz, dc coupled. 10 Hz to 125 MHz, ac coupled.

**Sensitivity** — 20 mV RMS sinewave to 100 MHz, 35 mV RMS sinewave to 125 MHz. 60 mV p-p; at minimum pulse width of 5 ns to 100 MHz. 100 mV p-p at minimum pulse width of 4 ns to 125 MHz.

**Impedance** — 1 MΩ paralleled by ≈27 pF.

**Attenuation** — Selectable 1X, 5X.

**Dynamic Range** — V p-p ≤3 V x attenuation. V peak ≤3.5 x attenuation.

**Trigger Level** — Adjustable ±3.5 V x attenuation.

**Independent Controls** — Slope +/–, Attenuation 1X/5X, Coupled ac/dc, Source Internal/External.

**Maximum Input Voltage**

**1X:** 200 V peak; 400 V p-p from dc to 50 kHz, derate to 15 V p-p from 1.33 MHz to 125 MHz.

**5X:** 200 V peak; 400 V p-p from dc to 5 MHz, derate to 20 V p-p from 100 MHz to 125 MHz.

**Shaped Out** — Shaped replica of signal being measured, aids proper triggering on complex waveforms. ≥200 mV p-p from 50 Ω.

**Trigger Level** — A dc level corresponding to the actual trigger level. Accuracy ±20 mV ±0.5% of reading.

**FREQUENCY A**

**Range** — 0 to 125 MHz.

**Resolution** — 0.1 Hz to 10 MHz in decade steps.

**Accuracy\*\*1** = ±1 count ± time base error x Frequency A.

**PERIOD B (SINGLE SHOT)**

**Range** — 100 ns to 10<sup>9</sup> s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy\*\*1\*2** = ±1 count ± time base error x Period B ± 1.4 x CH B trigger jitter error.

**Frequency Range** — 0 to 125 MHz.

**PERIOD B (Average)**

**Range** — 8 ns to 10 s.

**Resolution** — 1 fs (10<sup>-15</sup>) to 100 ns in decade steps.

**Number of Averages** — N = 1 to 10<sup>8</sup>.

**Accuracy\*\*1\*2\*3** = ±  $\frac{100 \text{ ns}}{N}$  ± time base error x Period B ±  $\frac{1.4 \text{ x CH B trigger jitter error}}{N}$

**Frequency Range** — 0 to 125 MHz.

**WIDTH B (SINGLE SHOT)**

**Range** — 100 ns to 10<sup>9</sup>s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy\*\*1\*3\*4** = ±1 count ± time base error x Width B. ± CH B start trigger jitter error ± CH B stop trigger jitter error ±(CH B stop slew rate error—CH B start slew rate error).

**WIDTH B (AVERAGE)**

**Range** — 5 ns to 10 s.

**Resolution** —  $\frac{100 \text{ ns}}{\sqrt{N}}$

**Number of Averages** — N = 1 to 10<sup>8</sup> in decade steps.

**Accuracy\*\*1\*2\*3\*4** = ±  $\frac{100 \text{ ns}}{\sqrt{N}}$  ± time base error x width B.

±  $\frac{\text{CH B start trigger jitter error}}{\sqrt{N}}$

±  $\frac{\text{CH B stop trigger jitter error}}{\sqrt{N}}$

+ (CH B stop slew rate error — CH B start slew rate error)

**Frequency Range** — 0 to 100 MHz.

**TIME A → B (SINGLE SHOT)**

**Range** — 100 ns to 10<sup>9</sup>s.

**Resolution** — 100 ns to 10 s in decade steps.

**Accuracy\*\*1\*3\*4** = ±1 count ± time base error x Time A → B ± CH A trigger jitter error ± CH B trigger jitter error ±(CH B stop trigger slew error — CH A start trigger slew error) ± 4 ns.

**TIME A → B (AVERAGE)**

**Range** — 12.5 ns to 10 s.

**Resolution** —  $\frac{100 \text{ ns}}{\sqrt{N}}$

**Minimum Dead Time** — 12.5 ns (Stop-to-Start).

**Number of Averages** — N = 1 to 10<sup>8</sup> in decade steps.

**Accuracy\*\*1\*2\*3\*4** = ±  $\frac{100 \text{ ns}}{\sqrt{N}}$  ± time base error x Time A → B

±  $\frac{\text{CH A trigger jitter error}}{\sqrt{N}}$

±  $\frac{\text{CH B trigger jitter error}}{\sqrt{N}}$

+ (CH B stop trigger slew error — CH A start trigger slew error) ± 4 ns

**EVENTS A DURING B (AVERAGE)**

**Maximum A Frequency** — 125 MHz.

**Minimum B Pulse Width** — 5 ns.

**Number of Averages** — N = 1 to 10<sup>8</sup> in decade steps.

**Accuracy\*\*2\*3\*4** — ±  $\frac{\text{Period A}}{\text{Width B x } \sqrt{N}}$  x Events A during B

±  $\frac{\text{CH B start trigger jitter error}}{\sqrt{N}}$  x Frequency A (in MHz)

±  $\frac{\text{CH B stop trigger jitter error}}{\sqrt{N}}$  x Frequency A (in MHz)

+ (CH B stop trigger slew error — CH B start trigger slew error) x Frequency A (in MHz)

**RATIO A/B**

Averaged over 1 to 10<sup>8</sup> cycles of CH B signal.

**Frequency Range** — 0 to 125 MHz (both CH A and CH B).

**Accuracy\*\*2\*3** — ±  $\frac{\text{Frequency B}}{\text{Frequency A x N}}$  ±  $\frac{1.4 \text{ x CH B trigger jitter error x Frequency A}}{N}$

±  $\frac{\text{Frequency A}}{0.3 \text{ x } 10^8}$

**TOTALIZE A**

1 to 99,999,999 counts at maximum rate of 125 MHz. Start, stop and reset controlled by front panel pushbuttons or rear interface signal lines.

**TIME MANUAL**

Electronic stopwatch, accumulates and displays time between activation of front panel start/stop button or rear interface signal line. Clock rates selectable from 100 ns to 10 s in decade steps. Range 100 ns to 10<sup>9</sup> s.

**STANDARD TIME BASE**

**Crystal Frequency** — 10 MHz.

**Temp Stability** — < ±5 x 10<sup>-6</sup>, 0°C to +50°C.

**Aging Rate** — < 1 x 10<sup>-6</sup> per year.

**Setability** — Adjustable to within 5 x 10<sup>-8</sup>.

**OPTION 01 HIGH STABILITY TIME BASE**

**Crystal Frequency** — 10 MHz.

**Temp Stability** — < ±2 x 10<sup>-7</sup> after warm-up, 0°C to +50°C.

**Warmup Time** — Within 2 x 10<sup>-7</sup> of final frequency in <10 minutes when cold started at 25°C.

**Aging Rate** — 1 x 10<sup>-8</sup>/day at time of shipment, 4 x 10<sup>-9</sup>/week after 30 days of continuous operation, 1 x 10<sup>-6</sup>/year after 60 days of continuous operation.

**Setability** — Adjustable to within 2 x 10<sup>-8</sup>.

**REAR INTERFACE**

**Inputs** — Direct count input to 50 MHz, (50 Ω impedance, resistor may be removed for 1 MΩ impedance, remote start/stop, reset; external time base.

**Outputs** — BCD serial-by-digit, decimal point, overflow, scan clock; trigger level; time base reference.

**NOTES**

\*1) Time base error is the sum of all errors specified for the time base used.

\*2) N is the number of periods averaged in Period B (AVGS) mode, the number of intervals averaged in the Time A → B (AVGS) mode, the number of widths of B averaged in Width B (AVGS) and Events A During B modes, and the number of periods of B in the Ratio A/B mode.

\*3) Trigger jitter error (in μs) =  $\frac{\sqrt{(en_1)^2 + (en_2)^2}}{\text{Input slew rate at trigger point (V/μs)}}$   
Where: en<sub>1</sub> = 100 μV RMS typical internal noise.  
en<sub>2</sub> = RMS noise of signal input at trigger point for a 125 MHz bandwidth.

\*4) Trigger slew rate error (in μs) =  $\frac{\text{Input hysteresis (V)}/2}{\text{Input slew rate at set trigger point V/μs}}$   
Where: Input hysteresis = 20 mV peak-to-peak typical.

**ORDERING INFORMATION**

**DC 503A Universal Counter/Timer ..... \$1,020**  
**Option 01** — High Stability Time Base ..... +\$295  
**Field Option Kit Order 040-0966-00 ..... \$250**

**RECOMMENDED PROBE**

**P6125 5X Passive Probe,**  
**Order 010-6125-01 ..... \$58**

**DC 504**



**Counter/Timer**

**DC 504**

Direct Frequency Counting to 80 MHz

Period Measurement for Resolution at Low Frequency

Rpm Counting

5 Digit LED Display

Low Cost

The DC 504 Counter/Timer measures frequency from 0 Hz (with 0.1 Hz resolution) to 80 MHz, period from 1 microsecond to 999.99 seconds, and totalizes events from 0 to 99,999 at a maximum rate of at least 80 MHz. A resolution of 0.1 Hz can be obtained by allowing the more significant figures of the counter to overflow. Five 7-segment light emitting diodes (LEDs) provide a visual numerical display. The decimal point is automatically positioned and leading zeros are blanked. Digit overflow is indicated by a front-panel LED. Signals to be counted/timed can be applied to either a front-panel BNC connector or to the rear interface connector. Internal switches select frequency or rpm operation, internal time base or external standard, and override display storage.

**CHARACTERISTICS**

- Display** — 5 digits LED display.
- Accuracy** —  $\pm 1$  count  $\pm$  time-base accuracy ( $\pm$  trigger error in period mode only).
- Frequency (or rpm)** — Dc coupled: 0 Hz to at least 80 MHz. Ac coupled: 10 Hz to at least 80 MHz.
- Frequency/rpm (Maximum Resolution)** — kHz Positions: 0.1 Hz, 1 Hz, and 10 Hz (1 rpm, 10 rpm, and 100 rpm).\* MHz Positions: 0.1 kHz and 1 kHz (1000 rpm and 10 k rpm).\*
- Sensitivity** — 20 mV RMS (56.6 mV p-p) below 15 MHz, 35 mV RMS (99 mV p-p) at or below 50 MHz derating to typically <175 mV RMS (495 mV p-p) at 80 MHz.
- Triggering Level** — Adjustable from at least -1.5 V to +1.5 V.
- Trigger Slope** — + for all functions.
- Trigger Source** — Internal (rear connector interface) or external (front-panel BNC).

**Maximum Input Voltage** — (sinewave, dc + peak ac)  $\pm 250$  V at 500 kHz or less; derate -20 dB/decade to 25 MHz.  $\pm 5$  V from 25 MHz to 80 MHz.

**Impedance** — 1 M $\Omega$  paralleled by  $\approx 20$  pF.  
\* This assumes that the transducer output is one pulse per revolution.

**Coupling** — Dc or ac.

**Internal Time Base**

	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz temperature compensated
Stability (0°C to +50°C) after 1/2 hour warm-up	Within 1 part in 10 <sup>5</sup>	Within 5 part in 10 <sup>7</sup>
Long-Term Drift	$\leq 5$ parts in 10 <sup>6</sup> per month	$\leq 1$ part in 10 <sup>7</sup> per month
Setability	Adjustable to $1 \times 10^{-7}$	Adjustable to $5 \times 10^{-9}$

**Totalize Events (Resolution)** — 1 count.

**Period (Resolution)** — mSec Position: 1  $\mu$ s and 10  $\mu$ s Sec Position: 0.1 ms, 1 ms, and 10 ms.

**Display Time** — Variable from about 0.1 s to about 10 s. Dent position at cw position of DISPLAY TIME knob provides a HOLD mode.

**Data Inputs and Outputs** — Available at rear of plug-in for intra-compartment routing in any TM 500 Power Module/Main-frame. BCD serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

**ORDERING INFORMATION**

- DC 504 Counter/Timer ..... \$675
- Option 01 — (Time Base) ..... +\$215

**OPTIONAL COUNTER ACCESSORIES**

- P6101 X1 Probe, Dc to 34 MHz.  
Order 010-6101-03 ..... \$67
- P6106 X10 Probe, Dc to 300 MHz.  
Order 010-6106-03 ..... \$131
- P6201 FET Probe, Dc to 900 MHz.  
Order 010-6201-01 ..... \$1,090
- P6056 50  $\Omega$ , X10 Probe, Dc to 3.5 GHz.  
Order 010-6056-03 ..... \$154
- Power Divider, GR, 50  $\Omega$ .  
Order 017-0082-00 ..... \$260
- Adaptor, GR to BNC female.  
Order 017-0067-00 ..... \$55
- Adaptor, GR to BNC male.  
Order 017-0064-00 ..... \$75
- Cable, adaptor, BNC to tipjack (DC 503A, DC 509, DC 5009).  
Order 175-3765-01 ..... \$23
- Cable, Adaptor, BNC to Rf (DC 510, DC 5010).  
Order 012-0532-00 ..... \$23

**P6125 COUNTER PROBE 5X**



The P6125 is a low-capacitance, 5X attenuation passive probe specially designed for use with counter/timers. It makes possible more accurate time interval measurements of high speed logic signals. Five-times attenuation provides an optimum match between the counter input characteristics and the voltage levels of all common logic families. The low input capacitance permits acquisition of high frequency signals with minimum loading of the circuits under test.

**CHARACTERISTICS**

- Attenuation** — 5X.
- Input Resistance** — 5 M $\Omega$  Input.
- Capacitance** —  $\approx 20$  pF.
- Bandwidth** — Dc to 200 MHz.
- Voltage Rating** — 250 V (dc + peak ac) derated to 35 V at 100 MHz.
- Cable Length** — 1.5 meters.

**INCLUDED ACCESSORIES**

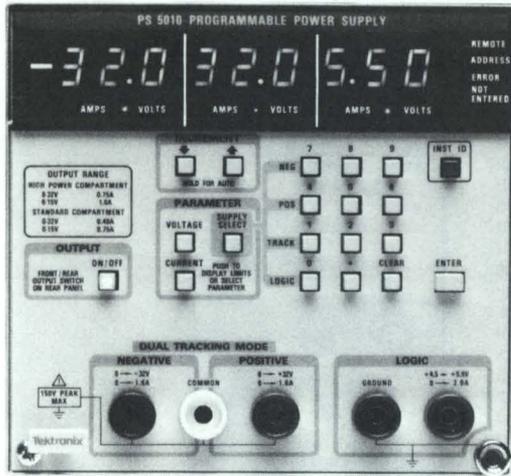
Lead, ground, 8 cm (175-0263-01); 2 clips, miniature, alligator, (344-0046-00); pouch, accessory, (016-0521-00); tip, IC tester\*; 2 tips, probe\*\* lead, ground, 13 cm, (175-0124-01); tip, retractable hook, (013-0107-03); Holder, probe, (352-0351-00); sleeve, insulating, (166-0404-01).

\* Available in packages of 10 (015-0201-04) or 100 (015-0201-05) only.  
\*\* Available in packages of 10 only (206-0191-03).

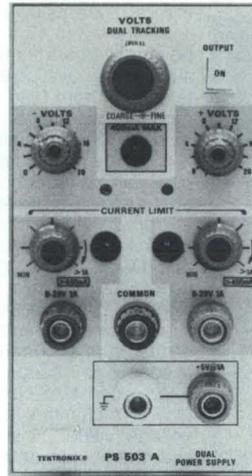
- P6125 Counter Probe, 5X, 1.5 m,  
Order 010-6125-01 ..... \$58

For recommended probes — refer to page 430.

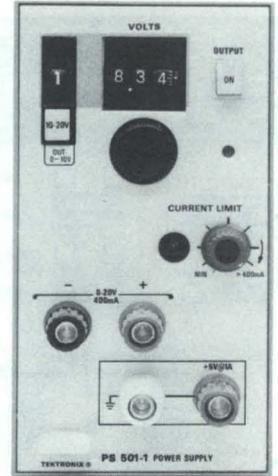
PS 5010



PS 503A



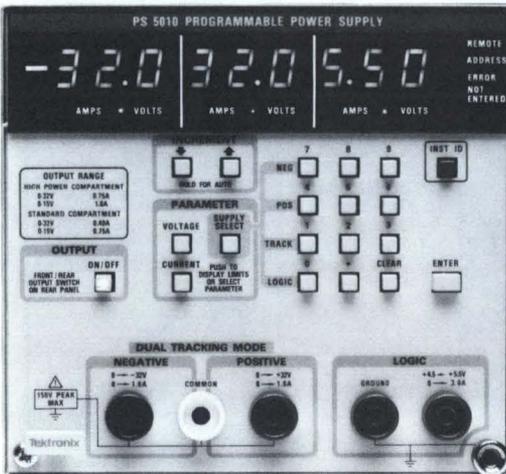
PS 501-1



	PS 5010		PS 503A		PS 501-1	
Power Supplies	+ and -32 V	Logic	+ and -20 V	+5 V	0 to 20 V	+5 V
Floating	150 V peak front panel, 42 V peak rear interface	Ground Referenced	350 V (dc + peak ac)	Ground Referenced	350 V (dc + peak ac)	Ground Referenced
Voltage Range	0 to ±32 V	4.5 to 5.5 V	0 to ±20 V	5 V	0 to 20 V	5 V
Current Range						
High Power Compartment	50 mA to 0.750 A (1.6 A up to 15 V)	100 mA to 3.0 A	100 mA to 1 A	1 A	40 mA to 400 mA	1 A
Standard Compartment	50 mA to 400 mA (0.750 A up to 15 V)		40 mA to 400 mA			
Voltage Mode (Constant)						
Overall Accuracy (total effect)	± (0.5% + 20 mV)	± 50 mV				
Accuracy				4.75 to 5.25 dc at 1 A	0.5%	4.75 to 5.25 dc 1 A
Source Effect (line regulation)	±(0.01% + 2 mV)	1 mV	5 mV	5 V ± 0.25 V	5 mV	50 mV
Load Effect (load regulation)	10 mV for 1 A change in load current 1 mV using remote sensing		3 mV for 1 A change in load current	100 mV for 1 A change in load current	1 mV for a 400 mA change in load current	100 mA for 1 A change in load current
Temperature Coefficient	Typically <(0.01% + 0.1 mV)/°C	Typically <500 μV/°C	Typically <0.025%/°C		Typically <0.01%/°C	
Resolution (step size)	10 mV up to 10.0 V 100 mV above 10.1 V	10 mV	50 mV		1.6 mV	
PARD (ripple and noise) (Periodic and Random Deviations)	10 mV p-p 1 mV RMS	10 mV p-p 2 mV RMS	3 mV p-p	5 mV p-p	0.5 mV p-p 0.1 mV RMS	5 mV p-p
Current Mode	Constant current	Current limit with fold back ±(5% + 20 mA)	Current limit	Current limit	Current limit	Current limit
Overall Accuracy (total effect)	±(5% + 20 mA)					
Source Effect (line regulation)	1 mA					
Load Effect (load regulation)	10 mA					
Temperature Coefficient	Typically <(0.1% + 1 mA)/°C					
Resolution (step size)	50 mA	100 mA				
PARD (ripple and noise)	10 mA p-p 5 mA RMS					
Display	Each supply has three digit LED display shared between voltage and current 10 LED mode and bus status indicators.		Voltage indicator lights. Brightness varies with output voltage		10 turn potentiometer with a three digit in-line dial and range pushbutton	
Voltage			None		None	
Current			Current limit indicator lights		LED indicator	
Programmability	IEEE Standard 488-1978 (GPIB) full listen and talk capability with interrupt status reporting		Voltage and resistance programming		Voltage Programming	
Voltage			None		None	
Tracking	Arithmetic	None	Ratio	None	None	None
Remote Sensing	Rear interconnect		Rear interconnect		Rear interconnect	
Output On/Off	Yes		Yes		Yes	
Mainframe Capability	TM 5000 Series		TM 500/TM 5000 Series		TM 500/TM 5000 Series	

For recommended accessories — refer to page 410.

**PS 5010**



**Programmable Triple Power Supply**

**PS 5010**

**GPIB IEEE-488**

The PS 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**Fully Programmable**

**Three Programmable Supplies 0 to  $\pm 32$  V Dual Floating Supply to 0.75A (1.6A to 15 V) in High Power Compartment, +4.5 V to +5.5 V Logic Supply to 3A.**

**Three Independent Digital Displays**

**Programmable Voltage and Current Over Full Range**

**Automatic Crossover**

**Powerful Set of GPIB Status Reporting Commands**

**Front Panel Lock-Out Capability**

**Programmable Output ON/OFF (Independent ON/OFF for Floating Supply and Logic Supply)**

**$\pm 0.5\%$  Accuracy**

**UL 1244 Listing**

The PS 5010 Programmable Power Supply is a two-wide TM 5000 module that provides a complete and rapid high performance solution for many system power supply applications. Its three supplies provide the most commonly used voltages, and the three digital displays automatically indicate all six voltage and current parameters. Automatic crossover from voltage to current limit and a powerful set of GPIB status reporting commands allow the user to be constantly aware of the power supply's status. Also, the user can program the output on or off and lock-out the front panel controls with GPIB commands.

The PS 5010's dual floating supply provides: 0 to +32 V and 0 to -32 V, both with respect to a

common front panel terminal, or voltages from 0 to 64 V are available across the dual supply terminals. Currents up to 0.75 A, from 0 to 32 V and 1.6 A from 0 to 15 V (installed in a TM 5006 high power compartment). Currents from 50 mA to 400 mA are available from 0 to 32 V and 50 mA to 0.75 A from 0 to 15 V (installed in two standard compartments of a TM 5006/5003 power module). The logic supply provides +4.5 V dc to +5.5 V dc with currents to 3 A. The three supplies can be independently programmed for voltage and current limits. Since the PS 5010's microprocessor monitors the voltage and current feedback loops of each supply, a simulation of true DMM output monitoring of all supplies is possible. This allows each display to automatically indicate the appropriate voltage or current limit, which will be the true output voltage or current of that supply. Whenever a load change causes a supply to change modes from constant voltage to constant current (or vice-versa), the display also changes to show the known current or voltage value. This condition can be reported over the bus via an interrupt when the PS 5010 is in the remote state.

With its English-like GPIB commands, performance, and combination of features, the PS 5010 Triple Power Supply reduces both software and hardware system development time.

**PS 5010 CHARACTERISTICS**

**POSITIVE AND NEGATIVE FLOATING SUPPLIES**

**Configuration** — Dual floating with shared common terminal.  
**Isolation** — 150 V peak front panel, 42 V peak from rear interface, 0.015  $\mu$ F typical shunt capacitance to ground.  
**Voltage Range** — 0 to +32.0 V; 0 to -32.0 V.  
**Voltage Accuracy** —  $\pm (0.5\% + 20$  mV) overall;  $\pm (0.01\% + 2$  mV) line regulation;  $\pm 10$  mV for 1A load current change (1 mV when using rear interface output with remote sensing).  
**Voltage PARD (Ripple and Noise)** — 10 mV p-p; 20 Hz to 20 MHz.  
**Voltage Resolution** — 10 mV  $\pm 10$  mV (typ  $\pm 2$  mV) to 10.0 V. 100 mV  $\pm 40$  mV (typ  $\pm 10$  mV)  $> 10.0$  V.  
**Load Transient Recovery** — 500  $\mu$ s to recover within 20 mV of nominal value for a 1A change.  
**Voltage Change Response Time** — 1 ms for up or down change with maximum load, 20 ms for down change with no load.  
**Current Range** — 50 mA to 0.75 A (1.60 A at 15 V and below) in high power compartment; 50 mA to 400 mA (0.750 A at 15 V and below) in two standard power compartments.  
**Current Accuracy** —  $\pm (5\% + 20$  mA) overall;  $\pm 1$  mA line regulation;  $\pm 10$  mA load regulation. Output impedance is typically 5 k $\Omega$  shunted by 20  $\mu$ F.  
**Current Mode PARD (Ripple and Noise)** — 10 mA p-p, 20 Hz to 20 MHz.  
**Current Change Response Time** — 20 ms up or down.  
**Current Resolution** — 50 mA  $\pm 15$  mA.

**LOGIC SUPPLY**

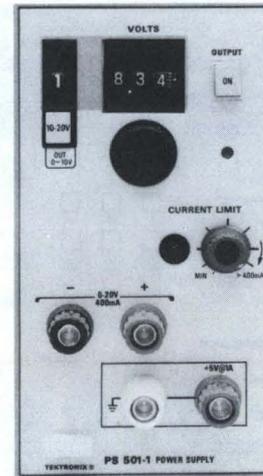
**Voltage Range** — +4.50 to +5.50 V, ground referenced.  
**Voltage Accuracy** —  $\pm 50$  mV overall;  $\pm 1$  mV line regulation;  $\pm 10$  mV for 1 A load current change (1 mV when using rear interface output with remote sensing).  
**Voltage PARD (ripple and noise)** — 10 mV p-p, 20 Hz to 20 MHz.  
**Voltage Resolution** — 10 mV  $\pm 10$  mV (typ  $\pm 2$  mV).  
**Load Transient Recovery** — 500  $\mu$ s to recover within 20 mV of nominal value.  
**Current Limit Range** — 100 mA to 3.0 A (Foldback characteristic below 4.5 V, maximum short circuit current is  $< 1.5$  A).  
**Current Limit Accuracy** —  $\pm (5\% + 20$  mA).  
**Current Resolution** — 100 mA  $\pm 30$  mA.  
**Scaled Current Output** — 10 mA = 1 mV  $\pm (2\% + 2$  mV) available at rear interface (not ground referenced).  
**Overvoltage Protection** — SCR crowbar typically trips at 6 to 7 V.

**OTHER CHARACTERISTICS**

**TM 5000 Power Module Compatibility** — Due to the extended GPIB interface connector the PS 5010 is not compatible with TM 500 mainframes.  
**Operating Temperature** — 0 to +50°C.  
**Storage Temperature** — -55°C to +75°C.  
**Operating Altitude** — 4.6 km (15,000 ft).  
**Storage Altitude** — 15 km (50,000 ft).  
**Power Consumption** — 250 VA maximum in high power compartment, 200 VA in standard compartment.

**Order PS 5010 Power Supply ..... \$2,690**

**PS 501-1**



**Power Supply**

**PS 501-1**

**Floating Output, 0-20 V**

**0 to 400 mA**

**Precise Regulation**

**Low Ripple and Noise**

**Fixed Output + 5 V @ 1 A**

**3 1/2 Digit Ten Turn Dial**

The PS 501-1 features precise regulation and better than 2 mV resolution (stability) over a 0 to 20 V range.

**CHARACTERISTICS**

**Output** — 0 to 20 V dc.  
**Maximum Rated Current** — 400 mA to +30°C derating to 300 mA at +50°C.  
**Accuracy** —  $\pm (0.5\% + 10$  mV).  
**Current Limit** —  $< 40$  to 400 mA.  
**Line Regulation** — Within 5 mV for a +10% line voltage change.  
**Load Regulation** — Within 1 mV for a 400 mA load change.  
**Ripple and Noise** — 0.5 mV p-p or less; 20 Hz to 5 MHz.  
**Temperature Coefficient** — Typically  $< (0.01\% + 0.1$  mV)/°C.  
**Minimum Resolution** — Typically 1.6 mV.  
**Transient Recovery Time** —  $\leq 20$   $\mu$ s to recover within 20 mV of final output voltage after a 400 mA change in output current.  
**Order PS 501-1 Power Supply ..... \$480**

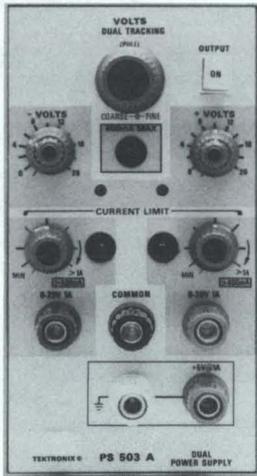
**CHARACTERISTICS COMMON TO PS 501-1, PS 503A 20 V FLOATING SUPPLY**

**Primary Power Input** — Determined by mainframe (TM 501, TM 503, etc).  
**Output** — Floating, isolated for 350 V dc + peak ac above ground.  
**Stability** — Typically (0.1% + 5 mV) or less drift in 8 hours of constant line, load, and temperature.  
**Indicator Lights** — Voltage variation and current limit.

**+5 V GROUND-REFERENCED SUPPLY**

**Output** — 5 V nominal,  $\pm 0.25$  V at 1 A.  
**Load Regulation** — Within 100 mV with a 1 A load change.  
**Line Regulation** — Within 50 mV for a 10% line voltage change.  
**Ripple and Noise (1A)** — 5 mV p-p or less, 20 Hz to 5 MHz.  
**Stability** — Typically 30 mV or less drift in 8 hours.  
**Overload Protection** — Automatic current limiting and over-temperature shutdown.

**PS 503A**



**Triple Power Supply**

**PS 503A**

Independent + and - Controls

Dual Tracking Voltage Control

0 to ±20 V at 1 A (in High-power Compartment)

Fixed Output + 5 V @ 1 A

Remote Resistance Programming

Over-Voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 Mainframe, the PS 503A provides up to 1 amp from both 0 to 20 volt supplies.

**CHARACTERISTICS**  
±20 V FLOATING SUPPLIES

**Outputs** — 0 to ±20 V dc with respect to the common terminal or 0 to 40 V dc across the + and - terminals. Outputs can be varied independently or at a constant ratio.

**Maximum Rated Current** — 400 mA (1 A in high power compartment to +30°C derating to 300 mA (750 mA) at +50°C.

**Tracking Mode Offset Error** — If the two supplies are set independently to any given voltage ratio and then varied by use of the VOLTS DUAL TRACKING control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

**Current Limit** — Adjustable from <100 mA to 1 A (high-power compartment) or <40 mA to 400 mA (standard compartment) on each supply.

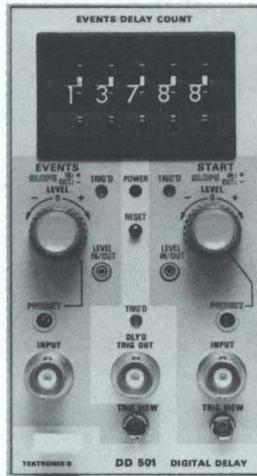
**Load Regulation** — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

**Ripple and Noise** — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

**Indicators** — Individual voltage indicators and current limiting indicators for both + and - supplies. Standard compartment (400 mA) indicator.

**Order PS 503A Power Supply ..... \$590**

**DD 501**



**Digital Delay**

**DD 501**

Digital Events Delay

Delay to 99,999 Events

Divide by N up to 20 MHz

Pulse Counting to 65 MHz

Time Delay with Ext Clock

Compatible with Most Attenuator Probes

The DD 501 is an events count or count down plug-in unit. The unit counts a predetermined number of events, from 0 to 99,999, selected by the front-panel thumb-wheel switches. The DD 501 can also function as a frequency divider, or it can be used in a "counted burst" mode with pulse or function generators that can be synchronously gated. Tektronix generators capable of being gated by the DD 501 are the FG 501A, FG 502, FG 504, FG 507, FG 5010, PG 508 and the PG 507.

**CHARACTERISTICS**  
EVENTS DELAY

**Count** — 10 to 99,999 events.  
**Maximum Count Rate** — 65 MHz.  
**Insertion Delay** — 30 ns or less from final event to trigger output pulse.  
**Recycle Time** — 50 ns or less.  
**Reset** — Manually resets delay counter.

**INPUT CHARACTERISTICS**

(All characteristics apply to both events and start inputs).  
**Input Impedance** — 1 MΩ, 20 pF.  
**Slope** — Either + or -, selectable.  
**Sensitivity** — 85 mV peak-to-peak @ 30 MHz.  
**Frequency Response** — Up to 65 MHz at 120 mV sensitivity.  
**Minimum Detectable Pulse Width** — 5 ns.  
**Threshold Level Range** — From -1.0 V to +1.0 V (-10 V to +10 V with 10X probe). Can be externally programmed or monitored at front panel jacks.  
**Trigger View Out** — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).  
**Events Triggered Light** — Visual indication that events are being detected.  
**Start Triggered Light** — Visual indication that delay is in progress.

**TRIGGER OUTPUT**

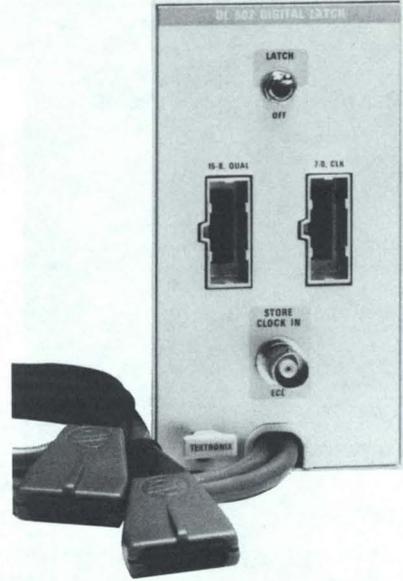
**Pulse Width** — Width of events pulse plus 6 ns or less.  
**Voltage Swing** — + 0.8 V or less to at least + 2.0 V with 3 TTL loads (≈5 mA).  
**Light** — Indicates output trigger.

**ENVIRONMENTAL CHARACTERISTICS**

**Temperature Range** — Operating: 0°C to +50°C. Nonoperating: -40°C to +75°C.  
**Altitude Range** — Operating: to 15,000 ft. Nonoperating: to 50,000 ft.

**Order DD 501 Digital Delay ..... \$1,270**

**DL 502**



**Digital Latch**

**DL 502**

16 Channel Latching Capability

Captures Glitches as Narrow as 5 ns at Probe Tips

Allows Expansion of Information Time Frame

TM 500 Compatibility

Companion For Logic Analyzers

The DL 502 Digital Latch extends the logic analyzer's measurement capabilities. The Digital Latch aids in detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. The 16 channel latch captures asynchronous glitches of less than one sample interval or as narrow as 5 ns.

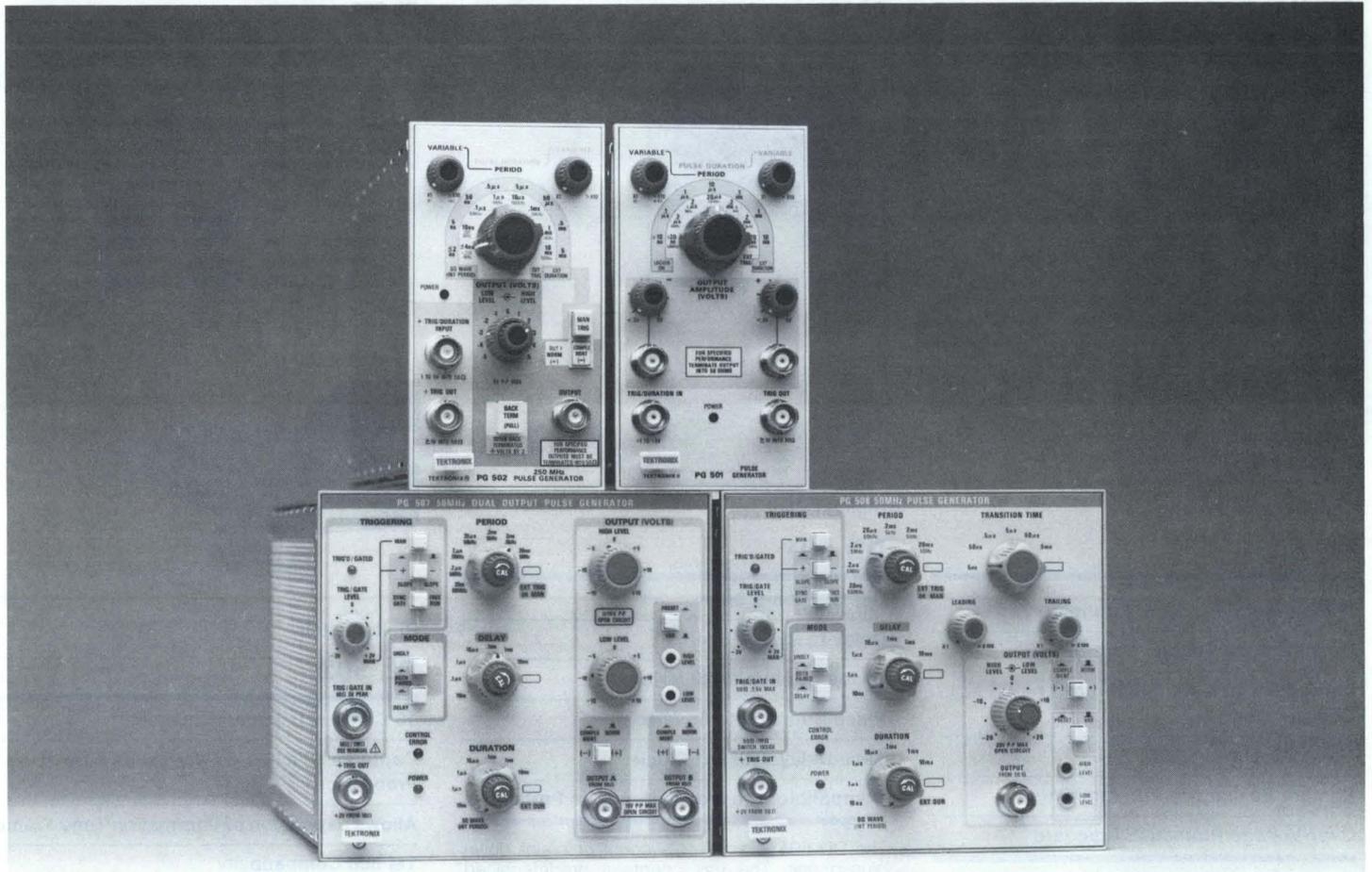
In asynchronous measurements without latching capability, high speed data anomalies go undetected if they do not appear on a clock edge. The DL 502 Digital Latch captures the glitch and holds it until the next clock edge, then expands and displays it for one sample interval.

The DL 502 Digital Latch plugs into any compartment of a TM 500/TM 5000 Mainframe and can be used in a variety of configurations.

**CHARACTERISTICS**

**Minimum pulse width to initiate latch** — 5 ns.  
**Minimum amplitude to initiate latch** — 500 mV centered at threshold.  
**Minimum sample interval asynchronous clock** — 50 ns.  
**INCLUDED ACCESSORY** — Six inch BNC cable.

**Order DL 502 Digital Latch ..... \$1,800**



**PRODUCT SUMMARY**

The TM 500 Pulse Generator family offers a wide variety of capabilities suitable for most pulse testing applications. Whether testing wide-band systems, simulating data transmission signals, or driving a laser, the versatile TM 500 Pulse Generators have the capabilities to meet your needs.

Particularly important in today's digital world is the capability to generate a variety of pulse signals compatible with the key logic families.

The newest addition to the TM 500 Pulse Generator family, the PG 507, features complementary dual outputs making it ideally suited for digital applications. The dual output feature is particularly useful when working with ECL logic families.

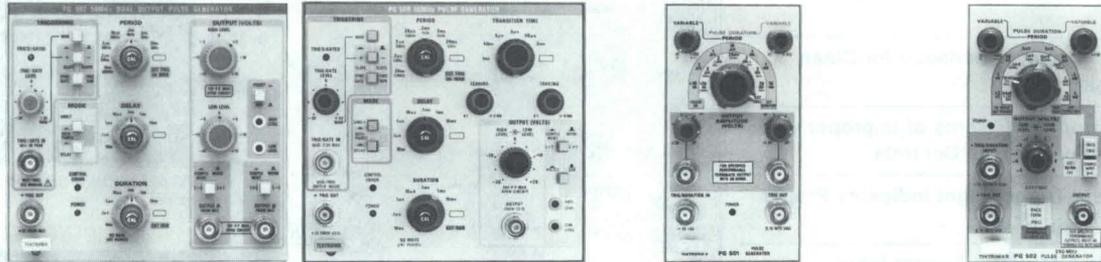
Similar to the PG 507 Pulse Generator is the 50 MHz PG 508 featuring independently variable rise and fall times. The PG 508's high level performance and versatility cover a broad range of test and measurement applications.

The PG 507 or PG 508's accurate 50 ohm output impedances deliver clean signals into logic families, reactive loads, or at the end of an unterminated cable. These 50 MHz multipurpose generators are also designed for high level performance on high impedance circuits (MOS, HTL, and CMOS logic).

In 50 ohm systems, our PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families, (TTL, DTL and ECL), in repetition rates, amplitudes and transition times.

Our TM 500 Pulse Generators' wide range of features afford you ease of operation, even on the most challenging test and measurement problems.

PULSE GENERATORS COMPARISON OF CHARACTERISTICS



	PG 507	PG 508	PG 501	PG 502
<b>Pulse Period</b>	≤20 ns to ≥200 ms (50 MHz to 5 Hz)		≤20 ns to ≥200 ms (50 MHz to 5 Hz)	≤4 ns to ≥100 ms (250 MHz to 10 Hz)
<b>Pulse Duration Duty Factor</b>	≤10 ns to ≥100 ms		≤10 ns to ≥100 ms	≤2 ns to ≥50 ms
	≥70% to 0.2 μs period, ≥50% at 20 ns period			≥50%
<b>Squarewave Mode</b>	Yes	Yes	No	Yes
<b>Pulse Delay Duty Factor</b>	≤10 ns to ≥100 ms*1	≤10 ns to ≥100 ms*1	Fixed, 20 ns from external trigger	Fixed, 17 ns from external trigger
	≥70% to 0.2 μs period, ≥50% at 20 ns period			
<b>Double Pulse</b>	Yes	Yes	No	No
<b>Transition Times</b>	Fixed, ≤3.5 ns, ≤4 ns @ >5 V	≤5.5 ns to ≥50 ms, Independently variable up to 100:1	Fixed, ≤3.5 ns	Fixed ≤1.0 ns
<b>Aberrations</b>	≤5% p-p +25 mV into 50 Ω load	≤5% p-p +50 mV for pulse within ±5 V into 50 Ω load	Within 3.5% at 5 V into 50 Ω load	Within 5% at 5 V p-p (durations ≥5 ns)
<b>Amplitude: Into 50 Ω</b>	≥7.5 V p-p, ±7.5 V window	≥10 p-p, ±10 V window	≥5 V	5 V, ±5 V window
<b>Open Circuit</b>	≥15 V p-p, ±15 V window	≥20 p-p, ±20 V window	Not specified	5 V, ±5 V window
<b>Source Impedance</b>	50 Ω	50 Ω	Not specified	1 kΩ or 50 Ω
<b>Simultaneous Outputs</b>	Yes, complementary	No	Yes, positive and negative	No
<b>Pulse Coincidence</b>	≤1 ns at 50% amplitude	NA	≤1 ns at 50% amplitude	NA
<b>Output Controls</b>	Independent pulse top and pulse bottom, normal or PRESET		Independent amplitude controls for + and - outputs, no offset	Independent pulse top and pulse bottom
<b>Normal/Complement</b>	Yes, both outputs	Yes	No	Yes
<b>Remote Amplitude</b>	Rear interface inputs	Rear interface inputs	No	No
<b>Locked On Mode</b>	No	No	Yes	No
<b>Back Termination</b>	Always back terminated	Always back terminated	No	Yes, switchable
<b>External Input</b>	1 MΩ to 50 Ω input impedance	1 MΩ or 50 Ω input impedance	50 Ω input Z	50 Ω input Z
<b>Trigger Level</b>	-3 V to +3 V, 80 mV p-p sensitivity to 10 MHz 250 mV p-p to 50 MHz TRIG'D/GATED light		+1 V required	+1 V required
<b>Slope</b>	+ or -	+ or -	+ Only	+ Only
<b>Trigger Mode</b>	Yes	Yes	Yes	Yes
<b>Manual Trigger</b>	Yes	Yes	No	Yes
<b>Duration Mode</b>	Yes	Yes	Yes	Yes
<b>Gate Mode</b>	Yes	Yes	No	No
<b>Counted Burst</b>	Yes, with DD 501 *2	Yes, with DD 501 *2	No	No
<b>Trigger Output (50% squarewave or follows external signal)</b>	≥+2 V from 50 Ω approximately 35 ns prior to pulse output (23 ns in squarewave or EXT DUR modes)		≥+2 V from 50 Ω, approximately 8 ns prior to pulse output	≥+2 V from 50 Ω, approximately 10 ns prior to pulse output
<b>Custom Timing Positions</b>	User installed capacitors	User installed capacitors	No	No
<b>Control Error Light</b>	Yes	Yes	No	No
<b>Temperature</b>	0°C to +50°C Operating, -55°C to +75°C Nonoperating			

\*1 Add 60 ns for delay from external trigger.  
 \*2 Exact count to 20 MHz, usable to 50 MHz.

For recommended accessories — refer to page 410.

**PG 507/PG 508**

**Common Characteristics**

**5 Hz to 50 MHz Plus Custom Range**

**Delay and Double Pulse Capability**

**Independent Pulse Top and Bottom Level Controls**

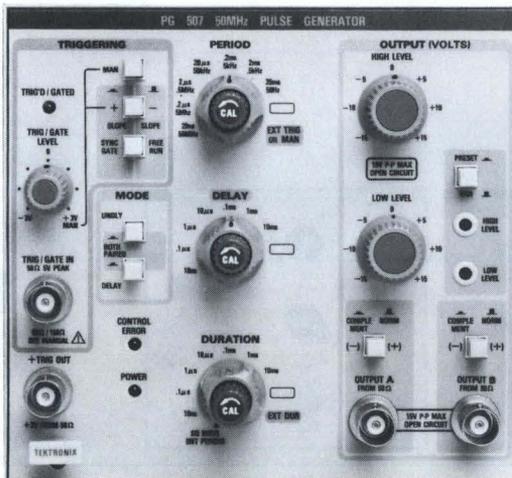
**True 50 Ω Output Impedance for Clean Waveforms**

**Control Error Light Warns of Improperly Set Switch or Variable Controls**

**Three State Trigger Light Indicates Proper External Triggering**

**Selectable 1 MΩ/50 Ω Trigger Input Impedance for Optimum Match to Circuitry — Lets You Use Your Scope Probe**

**PG 507**



**50 MHz Dual Output Pulse Generator**

**PG 507**

**Dual Outputs with Tracking Level Controls**

**Normal or Complement Pulse Output on Both Channels**

**15 V Output in a ±15 V Window into High Impedance, 7.5 V into 50 Ω**

**3.5 ns Risettime/Falltime**

The PG 507 and PG 508 combine TM 500 configurability with state-of-the-art capabilities. Their high-level performance and unique versatility cover a broad range of test and measurement applications and logic design functions in MOS, CMOS, TTL and ECL.

With an output of up to 15 V peak-to-peak for the PG 507 and 20 V peak-to-peak for the PG 508, both instruments also feature independent controls for output period, delay and duration times. Other features include selectable 1 MΩ/50 Ω trigger input impedance, a control error light, a three-state trigger/gate light, and preset or external control of output voltage levels.

Simply pushing the preset button can change the output from variable top and bottom controls to front panel screwdriver adjustments, or track external supply voltages.

The complement mode of either generator allows an output duty cycle range approaching 100% to be conveniently set up with more accuracy, range and stability.

You can gate the PG 507 or PG 508 with a positive- or negative-going signal, or by pressing the Man button. Or dial up a predetermined number of pulses in a burst by adding the DD 501's independent digital delay capabilities for Counted Burst mode. This is especially useful for testing circuits at different frequencies with the same number of pulses.

With the trigger input switched to 1 MΩ impedance, you can explore circuitry using a 1X or 10X scope probe. The PG 507 or PG 508 can be used as a pulse regenerator, logic level translator, or sinewave to pulse converter.

The PG 507's and PG 508's output is capable of driving MOS, CMOS, DTL, HTL I<sup>2</sup>L, T<sup>2</sup>L or ECL.

The PG 507 is a high performance, 50 MHz pulse generator designed specifically for logic design applications.

The PG 507 features complementary dual outputs which greatly increase its applicability in logic design areas, especially interfacing within systems or to peripherals. For instance, the complementary outputs allow simulation of line drivers or opposite phase clocks.

The PG 507 also offers versatility to the design engineer in an analog environment. For example, the dual outputs can be used to test differential input amplifiers or multiplexers.

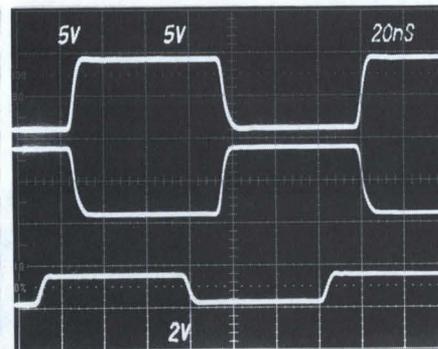
The PG 507 features four output modes: normal complement mode (Channel A output positive going, Channel B output negative going), opposite phase complement mode (Channel A output negative going, Channel B output positive going), simultaneous negative mode (Channel A output negative going, Channel B output negative going), and simultaneous positive mode (Channel A positive going Channel B output positive going). In addition, the Output High Level and Low Level voltage controls track between channels, making amplitude settings easy.

This unique output flexibility within the normal and complement modes is particularly useful in logic design or control applications requiring simultaneous signals.

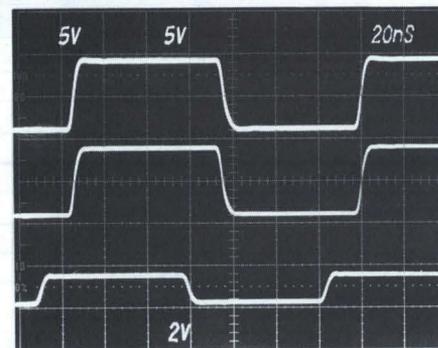
**ORDERING INFORMATION**

- PG 507 50 MHz Pulse Generator ..... \$2,000**
- DD 501 Digital Delay (page 365) ..... \$1,270**

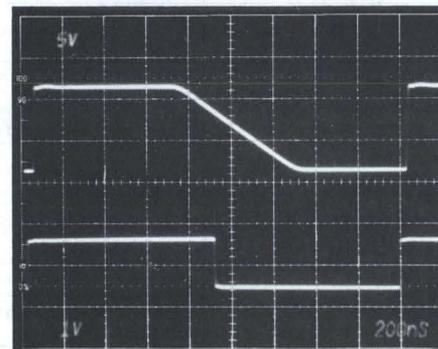
P6062B and P6108 Probes are recommended.  
For recommended accessories — refer to page 410.



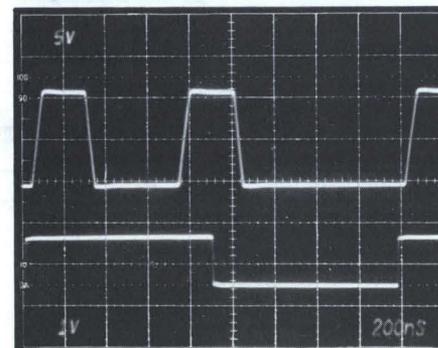
PG 507 trigger output and outputs switched to complementary mode.



PG 507 trigger output and outputs switched to positive going mode.

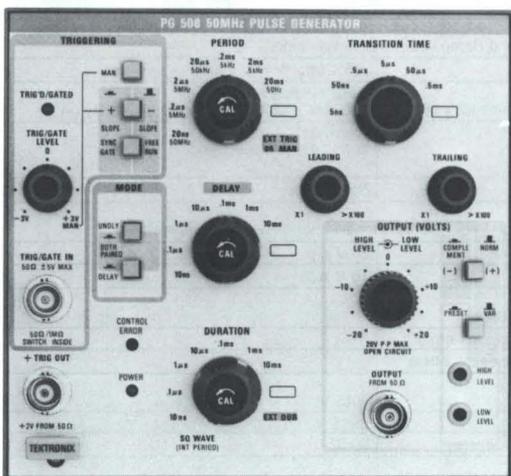


PG 508 output with falltimes set 100 times longer than risetime.



PG 508 output in paired pulse mode with risetimes set equally.

PG 508



50 MHz Pulse Generator

PG 508

Independently Variable Rise- and Falltimes to 5 ns

20 V Output in a  $\pm 20$  V Window to Hi Impedance, 10 V into 50  $\Omega$

Normal or Complement Output

The PG 508 50 MHz Pulse Generator is a highly versatile, general purpose pulse generator. The circuitry of the PG 508 is designed so that rise and fall waveforms closely simulate real world waveforms. This capability is particularly useful in research and development applications demanding versatility in risetimes and falltimes like testing of amplifiers, slew rate testing, comparator simulation and logic circuitry performance tests.

For example, controllable risetimes and falltimes are extremely desirable when working with CMOS where logic power consumption increases with slower risetimes. Also, variable risetimes and falltimes are used to reduce ringing (transient distortion) problems associated with too fast a pulse.

The PG 508 features a vernier control on the risetimes and falltimes controllable from 100 to 1. This completely overlaps the next decade range and increases the PG 508's versatility in applications simulating different rise- and falltimes, especially the output of nonlinear devices. This overlap feature can also be used to generate a ramp signal or simulate unequal slew rates in an amplifier.

Also adding to the simplicity of using the PG 508, is the capability of changing output amplitude while variable rise- and falltimes remain constant.

ORDERING INFORMATION

PG 508 50 MHz Pulse Generator ..... \$1,970

PG 508T 50 MHz Pulse Generator ..... \$2,290

(includes PG 508, TM 503 Mainframe, and 016-0195-03 blank panel).

For counted Burst, order the

DD 501 Digital Delay (page 365) ..... \$1,270

Suggested 10 in BNC 50  $\Omega$  cable (2 required) for interconnecting PG 508 and DD 501:

Order 012-0208-00 ..... \$20

PG 501



50 MHz Pulse Generator

PG 501

5 Hz to 50 MHz

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns into 50  $\Omega$

Independent Period and Duration Controls

Trigger Out

The PG 501 is a 50 MHz Pulse Generator featuring simultaneous plus and minus outputs, a wide range of pulse-period durations and duty factors, trigger output and external trigger/duration input. Its performance and ease of operation make it well-suited to basic digital and analog applications.

Order PG 501 50 MHz Pulse Generator ..... \$710

MANUAL (ONE-SHOT) TRIGGER GENERATOR

RG 501 and PG 501



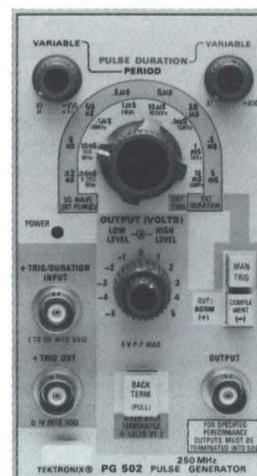
The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501.

The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally 2 ms in width and 3 V in amplitude with a rapid risetime and falltime. Output impedance is low (50  $\Omega$ ); the pulse amplitude drops from about 3.6 to 1.8 V when changed from a high impedance to a 50 ohm termination. Both voltages decrease with battery aging. The battery is a 5.4 V dry cell.

Order 016-0597-00 ..... \$155

PG 502



250 MHz Pulse Generator

PG 502

10 Hz to 250 MHz

1 ns Risettime

5 V Output  $\pm 5$  V Window

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Manual Trigger Button

The PG 502 (250 MHz Pulse Generator) features: fast risetimes and falltimes; independent top and bottom pulse levels; and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

Order PG 502 250 MHz Pulse Generator \$2,520

50  $\Omega$  PRECISION COAXIAL CABLE



For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50  $\Omega$  coaxial cable into a 50  $\Omega$  load.

50  $\Omega$  Cable Order 012-0482-00 ..... \$25

**PRODUCT SUMMARY**

For full programmability and IEEE Standard 488 compatibility, select the new FG 5010 Microprocessor based 20 MHz function generator featuring: 10 complete stored front panel setups, counted burst and phase lock capabilities as well as programmable symmetry and phase. Basic frequency accuracy is 0.1% and all signals can be AM and FM modulated.

For applications demanding logarithmic or linear sweep the FG 507 offers an accurate and versatile solution. The low distortion of the FG 507 (0.25%), combined with log and linear sweep is particularly useful in audio and linear communications-oriented applications.

For low-frequency function generator applications, set the FG 501A, FG 502, FG 503, or FG 507 to work on biological, geophysical and mechanical simulations or on servo systems.

Applying an external ramp to the VCF (voltage controlled frequency) input, allows our function generators to double as sweep generators. The VCF input fed from a low-level modulating signal can produce a frequency-modulated carrier. The FG 507 and FG 504 have sweep capabilities conveniently built in that simplify setting up start and stop frequencies in addition to providing logarithmic sweep.

Sweeping wide frequency ranges (100:1 or greater), with logarithmic sweep allows you to spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

You can control the starting phase of a waveform with the FG 501A, FG 504, FG 507 and FG 5010 in the gated (burst) or triggered mode. A gated or triggered waveform efficiently tests tone-controlled systems, loud speaker transient response characteristics, automatic gain control circuits, or other amplitude sensitive systems.

The FG 504's and FG 5010 phase lock mode feature lets you convert digital signals to high or low voltage sinewaves, pulses, or triangles; ideal for locking the function generators output to a house or system frequency standard. With the DD 501 Digital Delay Generator in the "divide by n" mode, the FG 504 or FG 5010 can be locked to your frequency reference at a lower frequency.

When your test and measurement problems require more waveforms for more applications, the high performance TM 500 Function Generators are a versatile solution singly or in combination with one another.

<sup>\*1</sup> +15°C to +35°C ambient

<sup>\*2</sup> +20°C to +30°C ambient

<sup>\*3</sup> 20 Hz to 20 kHz modulation frequency

<sup>\*4</sup> FG 504 requires forced air circulation above +40°C

<sup>\*5</sup> Fully programmable

<sup>\*6</sup> IEEE Standard 488 Compatible

<sup>\*7</sup> Percent of indicated frequency

<sup>\*8</sup> Absolute voltage accuracy

<sup>\*9</sup> Separate FM function provided (1%/V)

**FUNCTION GENERATORS**

	FG 501A	FG 507
<b>Waveforms</b>	Sine, Square, Triangle, Pulse and Ramp with variable symmetry	
<b>Symmetry</b>	≤5% to ≥95% Variable	≤5% to >95% Variable
<b>Frequency Range</b>	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on	0.002 Hz to 2 MHz 200 kHz ±10% with variable symmetry on
<b>Dial Accuracy (% of Full Scale) (except FG 5010)</b>	Within 3%	Within 3% Within 5% in sweep mode* <sup>2</sup>
<b>Custom Frequency Range</b>	No	No
<b>Frequency Stability (% of Full Scale)</b>	≤0.05% for 10 min., ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature	
<b>Amplitude: Open Circuit</b>	30 V p-p	30 V p-p
<b>Into 50 Ω</b>	15 V p-p	15 V p-p
<b>Attenuator</b>	0 to -60 dB in 20 dB Steps >20 dB additional with AMPL control	
<b>Offset: Open Circuit</b>	±13 V dc, step attenuator decreases offset	
<b>Into 50 Ω</b>	±6.5 V dc, step attenuator decreases offset	
<b>Pk Sig + Offset: Open Circuit</b>	±15 V	±15 V
<b>Into 50 Ω</b>	±7.5 V	±7.5 V
<b>Output Impedance</b>	50 Ω	50 Ω
<b>Amplitude Flatness (10 kHz ref, 50 Ω load)</b>	<b>Sine-wave</b> ±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz	±0.1 dB 20 Hz to 20 kHz ±0.5 dB 20 kHz to 1 MHz ±1 dB 1 MHz to 2 MHz
	<b>Triangle</b>	
	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz	±0.5 dB 20 Hz to 200 kHz ±2 dB 200 kHz to 2 MHz
	<b>Square-wave</b>	
	±0.5 dB 20 Hz to 2 MHz	±0.5 dB 20 Hz to 2 MHz
<b>Sinewave Distortion (Maximum output, 50 Ω load)</b>	≤0.25% 20 Hz to 20 kHz* <sup>2</sup> ≤0.5% 20 kHz to 100 kHz Harmonics: ≤-30dB, 100 kHz to 2 MHz	≤0.25% 20 Hz to 20 kHz* <sup>2</sup> ≤0.5% 20 kHz to 100 kHz Harmonics: ≤-30 dB, 100 kHz to 2 MHz
<b>Squarewave Response</b>	≤25 ns rise/fall <3% p-p aberrations	≤25 ns rise/fall <3% p-p aberrations
<b>Triangle Linearity (10% to 90%)</b>	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz	≥99% 20 Hz to 200 kHz ≥97% 200 kHz to 2 MHz
<b>Trigger Output</b>	≥+4 V from 50 Ω	≥+4 V from 50 Ω
<b>External Input</b>	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%	Impedance ≈2 kΩ Trigger threshold level +1 V ±20%
<b>Trigger</b>	±90° variable start phase control	±90° variable start phase control
<b>Gate</b>	±90° variable start phase control	±90° variable start phase control
<b>Phase Lock</b>	No	No
<b>Counted Burst</b>	With DD 501	With DD 501
<b>Internal Sweep</b>	No	Logarithmic or Linear, Separate Start/Stop Dials
<b>Duration</b>		1 ms to 100 s
<b>External Trigger</b>		±1 V ±20% trigger level ≈2 kΩ input impedance
<b>Ramp Output</b>	NA	≤0.3 V to 10 V from 1 kΩ ±5%
<b>Gate Output</b>		≥+4 V from 50 Ω
<b>Other Modes</b>		Manual Sweep Trig Manual Sweep Sweep and Hold
<b>Amplitude Modulation</b>	No	No
<b>Voltage Controlled Frequency (FM)</b>	Up to 1000; 1 Frequency change with 10 V external signal Slew rate ≥0.3 V/μs, 10 kΩ input impedance	
<b>Nominal Hz/Volt Sensitivity</b>	2 x Frequency Multiplier setting	2 x Frequency Multiplier
<b>Output Hold Mode</b>	No	No
<b>Temperature *<sup>4</sup></b>	0°C +50°C Operating, -55°C to +75°C Nonoperating	

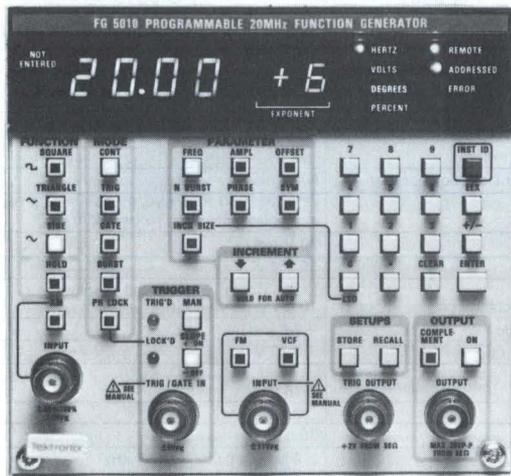
Compatible accessories begin on page 410.

COMPARISON OF CHARACTERISTICS

	FG 504	FG 502	FG 503	FG 5010*5*6
Waveforms	Sine, Square, Triangle, Pulse and Ramp with variable symmetry	Sine, Square, Triangle Pulse, or Ramp	Sine, Square, Triangle	Sine, Square, Triangle, Pulse and Ramp with variable symmetry
Symmetry	7% to 93% Variable	5%, 50%, 95% Fixed	50% Fixed	10% to 90%, 1% steps
Frequency Range	0.001 Hz to 40 MHz 4 MHz nominal with variable symmetry on	0.1 Hz to 11 MHz Pulse and Ramp, 1.1 MHz	1.0 Hz to 3 MHz Usable 0.01 Hz to 5 MHz	0.002 Hz to 20 MHz
Dial Accuracy (% of Full Scale) (except FG 5010)	Within 3% to 4 MHz <sup>11</sup> Within 6% to 40 MHz <sup>11</sup>	Within 3% to 1 MHz Within 5% to 10 MHz	Within 5%	Within 0.1% of selected frequency Digital LED Display
Custom Frequency Range	Shipped with capacitor for 20 Hz to 20 kHz	No	With user-installed capacitor	NA
Frequency Stability (% of Full Scale)	≤0.05% for 10 minutes, ≤0.1% for 1 hour, ≤0.5% for 24 hours, constant temperature			≤0.05% for 1 hr, 0.05% for 24 hrs (≤0.1% in trigger, gate, burst mode <200 Hz) <sup>17</sup>
Amplitude: Open Circuit Into 50 Ω	30 V p-p 15 V p-p	10 V p-p 5 V p-p	20 V p-p 10 V p-p	20 V p-p 10 V p-p
Attenuator	0 to -50 dB in 10 dB steps <10 mV p-p with VAR control	Variable control only	Variable control only	Digital Control of fixed and variable 10 mV p-p into 50 Ω
Offset: Open Circuit Into 50 Ω	±7.5 V dc ±3.75 V dc	±5 V dc ±2.5 V dc	±7.5 V dc ±3.75 V dc	±7.5 V dc ±3.75 V dc
Pk Sig + Offset: Open Circuit Into 50 Ω	±20 V ±11.25 V	±10 V ±5 V	±15 V ±6 V	±15 V ±7.5 V
Output Impedance	50 Ω	50 Ω	50 Ω	50 Ω
Amplitude Flatness (10 kHz ref, 50 Ω load)	Sine-wave ±0.5 dB 0.001 Hz to 40 kHz Triangle ±2 dB 40 kHz to 40 MHz Square-wave ±0.5 dB to 20 MHz ±2 dB to 40 MHz	±0.5 dB 20 Hz to 20 kHz ±1.5 dB 0.1 Hz to 11 MHz ±3 dB referenced to Sinewave	±0.5 dB 20 Hz to 20 kHz ±2 dB 0.1 Hz to 3 MHz ±1 dB referenced to Sinewave	±3% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 1 MHz ±5% from 1 MHz to 5 MHz +5%, -10% from 5 MHz to 20 MHz ±2% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 100 kHz ±4% from 100 kHz to 1 MHz +4%, -5% from 1 MHz to 5 MHz +4%, -20% from 5 MHz to 20 MHz ±2% from 0.002 Hz to 1 kHz ±3.5% from 1 kHz to 1 MHz ±5% from 1 MHz to 10 MHz ±10% from 10 MHz to 20 MHz
Sinewave Distortion (Maximum output, 50 Ω load)	≤0.5% 20 Hz to 40 kHz <sup>11</sup> Harmonics: ≤-30 dB 40 kHz to 1 MHz ≤-20 dB 1 MHz to 40 MHz	≤0.5% 10 Hz to 50 kHz <sup>2</sup> Harmonics: ≤-30 dB at all other frequencies	≤0.5% 1 Hz to 30 kHz ≤1.0% 30 kHz to 300 kHz ≤2.5% 300 kHz to 3 MHz	≤0.5% 20 Hz to 19.99 kHz <sup>11</sup> ≤1.0% 20 kHz to 99.99 kHz Harmonics >30 dB down, 100 kHz to 20 MHz
Squarewave Response	≤6 ns rise/fall fixed 10 ns to 100 ms variable ≤5% p-p +30 mV aberrations	≤20 ns rise/fall ≤3% p-p aberrations	≤60 ns rise/fall ≤3 p-p aberrations	≤10 ns rise/fall ≤5% p-p aberrations
Triangle Linearity (10% to 90%)	≥99% 10 Hz to 400 kHz ≥95% 400 kHz to 40 MHz type ≥98% 0.001 Hz to 10 Hz	≥99% 0.1 Hz to 100 kHz ≥97% 100 kHz to 1 MHz ≥95% 1 MHz to 11 MHz	≥99% 1 Hz to 100 kHz ≥95% 100 kHz to 3 MHz	>98% to 2 MHz >90% to 20 MHz
Trigger Output	≥+2 V from 50 Ω	+2.5 V to 50 Ω load	+2.5 V to 600 Ω load	+2 V from 50 Ω
External Input	Impedance ≥10 kΩ Sensitivity ≤1 V p-p Trigger level -1 V to +10 V	Impedance ≈1 kΩ ≥+2 V Gate Signal required	No	1 MΩ/50 Ω internal setability 0.0 V/0.5 V internal setability
Trigger	20 MHz maximum ±80° start phase control to 10 MHz	No	No	±90° variable start phase control
Gate		Fixed 0° start phase	No	±90° variable start phase control
Phase Lock	100 Hz to 40 MHz ±80° phase range	No	No	20 Hz to 20 MHz (Auto Scan)
Counted Burst	With DD 501	With DD 501	No	1 to 9999
Internal Sweep	Logarithmic or Linear, Separate Start/Stop Dials	No	No	No
Duration	0.1 ms to 100 s			
External Trigger	+1 V to +10 V trigger level 1 V p-p sensitivity			
Ramp Output	0 to +10 V from 1 kΩ ±5% to 1 ms, ±10% ≤1 ms	NA	NA	NA
Gate Output	No			
Other Modes	Manual Sweep Trig			
Amplitude Modulation	100% with nominal 5 V p-p input Dc to 100 kHz modulation frequency <5% distortion to 4 MHz at 70% <sup>3</sup> <10% distortion to 40 MHz at 65% <sup>3</sup>	No	No	100% with nominal 5 V p-p input Dc to 100 kHz modulation frequency <2% distortion to 2 MHz at 70% <4% distortion to 20 MHz at 70%
Voltage Controlled Frequency (FM)	Up to 1000: 1 Frequency change with 10 V external signal Slew rate ≥0.3 V/ms, 10 kΩ input impedance			Up to 1000: 1 frequency <sup>9</sup> change with 10 V external input
Nominal Hz/Volt Sensitivity	4 x Frequency Multiplier	1.1 x Frequency Multiplier	3 x Frequency Multiplier	10% of selected range
Output Hold Mode	0.001 Hz to 400 Hz	No	No	0.002 Hz to 200 Hz
Temperature*4	0°C to +50°C Operating, -55°C to +75°C Nonoperating			

Compatible accessories begin on page 410.

## FG 5010



### Programmable 20 MHz Function Generator

## FG 5010



The FG 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

**0.002 Hz to 20 MHz, 4 digits**

**20 mV to 20 V peak-to-peak,  $\pm 7.5$  V Offset**

**Sine, Square, and Triangle Waveforms**

**10%-90% Variable Symmetry in 1% Steps**

**Pulses to 25 ns, 10 ns Rise/Fall**

**Trigger, Gate and Burst**

**Phase Lock with Autoscan**

**AM, FM, and VCF**

**Waveform Complement and Hold**

**UL 1244 Listing**

The FG 5010 Programmable 20 MHz Function Generator is a two-wide TM 5000 module with versatile overall performance and an unusually high degree of programmability for many parameters and settings. Its Sine, Square, and Triangle modes are optimized for superior waveform capability and include trigger, gate, counted burst, phase lock, AM, and FM modes. The VCF mode allows the output frequency to be swept over 1000:1 ratio by an external input. Variable symmetry that is usable to 20 MHz extends pulse and ramp capabilities beyond those of normal generators; and variable phase enhances the trigger, gate, burst, and phase lock modes.

An error correction circuit maintains frequency accuracy within 0.1% over the full 0.002 Hz to

20 MHz range. Automatic phase lock to an external signal is possible from 20 Hz to 20 MHz.

Output amplitude is programmable from 20 mV to 20 V p-p from 50  $\Omega$  and dc offset is programmable from 20 mV to 7.5 V. For dc voltage applications, offset only can be programmed. Programmable waveform hold can freeze the output voltage of any 200 Hz or less waveform at its instantaneous value. Waveform complement and  $\pm$  trigger slope allow interfacing to circuits with the proper waveform phase, especially important in pulse and digital applications.

The ability to store ten front panel setups reduces GPIB programming time and enhances stand-alone bench applications. And the english-like GPIB commands reduce software development time.

### CHARACTERISTICS

**Waveform** — Sine, Square and Triangle with variable Symmetry providing Pulses and Ramps.

**Symmetry** — 10% to 90%, 1% steps,  $\pm 2\%$  accuracy. Range above 4 MHz is limited by 25 ns minimum triangle transition time (decreases to 50% at 20 MHz).

**Frequency** — Range: 0.002 Hz to 20 MHz. Accuracy: Continuous mode,  $\pm 0.1\%$ . Trigger, Gate, Burst modes: frequency  $\leq 200$  Hz,  $\pm 0.1\%$ ; frequency  $> 200$  Hz,  $\pm 5.0\%$ . Resolution: Continuous mode, 4 digits Trigger, Gate, Burst modes. Frequency  $\leq 200$  Hz, 4 digits. Frequency  $> 200$  Hz, 3 digits.

**Amplitude** — Range: 20 mV to 20 V p-p from 50  $\Omega$  into open circuit.

#### Accuracies

Frequency	Sine	Square	Triangle
0.002 Hz to 1 kHz	$\pm 3\%$	$\pm 2\%$	$\pm 2\%$
1 kHz to 100 kHz	—	—	$\pm 3.5\%$
1 kHz to 1 MHz	$\pm 3.5\%$	$\pm 3.5\%$	—
100 kHz to 1 MHz	—	—	$\pm 4\%$
1 MHz to 5 MHz	$\pm 5\%$	—	$+4\%, -5\%$
1 MHz to 10 MHz	—	$\pm 5\%$	—
5 MHz to 20 MHz	$\pm 5\%, -10\%$	—	$+4\%, -20\%$
10 MHz to 20 MHz	—	$\pm 10\%$	—

Measured at  $+25^\circ\text{C} \pm 10^\circ\text{C}$  into 50  $\Omega$  load at 50% symmetry. Resolution: 20 mV from 2.02 V to 20.00 V p-p, 2 mV from 202 mV to 2.000 V p-p, 0.2 mV from 20.0 mV to 200.0 mV p-p.

**Offset** — Range:  $-7.5$  V to  $+7.5$  V from 50  $\Omega$  into an open circuit. Maximum peak signal plus offset cannot exceed  $\pm 15$  V open circuit. Accuracy: All waveforms except squarewave  $> 2$  MHz  $\leq \pm 1\%$  of the selected offset,  $+ 2\%$  of the signal p-p amplitude,  $+ 20$  mV. Squarewave  $> 2$  MHz  $< \pm 1\%$  of the selected value  $+ 5\%$  of the signal p-p amplitude  $+ 20$  mV. Resolution: 10 mV open circuit, 5 mV into 50  $\Omega$  load. 0 V is also provided.

**Output Impedance** — 50  $\Omega$ .

**Sinewave Distortion** — 20 Hz to 19.99 kHz,  $\leq 0.5\%$ ; 20.0 kHz to 99.99 kHz,  $\leq 1.0\%$ ; 100 kHz to 20.0 MHz, harmonics  $> 30$  dB down from 100 kHz to 20 MHz. Valid at  $25 \leq 10^\circ\text{C}$  into 50  $\Omega$  load with 0 V offset, continuous mode, 50% symmetry, and AM, FM, VCF, and Complement off.

**Squarewave Response** — Risettime and falltime are  $\leq 10$  ns. Aberrations are  $\leq 5\%$  p-p  $+ 20$  mV.

**Typical Triangle Linearity (10% to 90%)** — 0.002 Hz to 200 Hz,  $\leq 1\%$ ; 200 Hz to 100 kHz,  $\leq 1\%$ ; 100 kHz to 2 MHz,  $\leq 2\%$ ; 2 to 20 MHz,  $\leq 10\%$ .

**Trigger Output** — 0 V  $\pm 100$  mV to  $\geq +2$  V from 50  $\Omega$  source impedance into an open circuit.

### TRIG, GATE, BURST, and PH LOCK INPUT

**Input Impedance** — 1 M $\Omega$  or 50  $\Omega$ , internally selectable.

**Trigger Threshold** — 0 V or  $\pm 0.5$  V, internally selectable.

**Amplitude sensitivity** —  $\leq 250$  mV p-p.

**Slope** — Plus or Minus, plus only in PH LOCK.

**Minimum Pulse Width** — 25 ns.

**Maximum Frequency** — 20 MHz.

**Maximum Input Amplitude** —  $\pm 5$  V peak into 50  $\Omega$ ,  $\pm 20$  V peak into 1 M $\Omega$ .

**Burst Range** — 1 to 9999 cycles.

**Phase Lock Range** — Automatic capture from 20 Hz to 20 MHz.

**Phase Lock Time** — Typically 8 ms to 88 s, depending on final frequency and start frequency.

### AM INPUT

**Input Impedance** — 10 k $\Omega$  ( $\pm 5\%$  when AM is selected).

**Sensitivity** — 5 V p-p produces  $\geq 100\%$  modulation.

**Distortion** —  $< 2\%$  at 70% modulation and  $\leq 2$  MHz;  $< 4\%$  at 70% modulation and  $> 20$  MHz.

**Bandwidth** — Dc to  $\geq 100$  kHz.

**Maximum Input Amplitude** —  $\pm 20$  V pk.

### FM INPUT

**Input Impedance** — 10 k $\Omega$ .

**Sensitivity** — 0 to  $\pm 1$  V modulates to  $\geq \pm 1\%$  deviation from center frequency.

**Distortion** —  $\leq 2\%$ .

**Bandwidth** — Dc to  $\geq 100$  kHz.

**Maximum Input** —  $\pm 20$  V peak.

### VCF INPUT

**Input Impedance** — 10 k $\Omega$   $\pm 5\%$ .

**Sensitivity** — 0 to 10.0 V produces a  $\geq 1000:1$  frequency change, positive going voltage increases frequency.

**Slew Rate** —  $\geq 0.063$  V/ $\mu$ s.

**Bandwidth** — Dc to  $\geq 100$  kHz.

**Maximum Input** —  $\pm 20$  V peak.

### OUTPUT HOLD MODE

**Range** — 0.002 Hz to 200 Hz. (Output holds at instantaneous value).

### PHASE (TRIG, GATE, and BURST MODES)

**Range** —  $\leq 90^\circ$  to 1 MHz, decreasing to  $\leq 80^\circ$  at 20 MHz.

**Accuracy** —

$\pm 3^\circ$  to 500 kHz;  $\pm [7^\circ + (\frac{\text{freq}}{20 \text{ MHz}} \times 28\% \times |\phi|)^\circ]$  for freq  $> 500$  kHz

At  $25 \pm 10^\circ\text{C}$  VCF off, output in Normal and symmetry at 50%.

**Resolution** —  $1^\circ$ .

### PHASE (PH LOCK MODE)

**At  $25 \pm 10^\circ\text{C}$ .**

**Range** —  $\leq 90^\circ$ , 20 Hz to  $\leq 10$  MHz;  $\leq 45^\circ$  to  $\geq 10$  MHz (Complementing the output extends effective 0 range to  $\pm 180^\circ$ ).

**Accuracy** —  $\pm (2^\circ + 5\%$  of selected value).

**Resolution** —  $1^\circ$ .

### OTHER CHARACTERISTICS

**TM 5000 Power Module Compatibility** — Due to the extended GPIB interface connector the FG 5010 is not compatible with TM 500 Series mainframes.

**Operating Temperature** —  $0^\circ\text{C}$  to  $+50^\circ\text{C}$ .

**Storage Temperature** —  $-55^\circ\text{C}$  to  $+75^\circ\text{C}$ .

**Operating Altitude** — 4500 m (15,000 ft).

**Storage Altitude** — 15,000 m (50,000 ft).

**Power Consumption** — 60 W.

**Net Weight** — 6.2 lb.

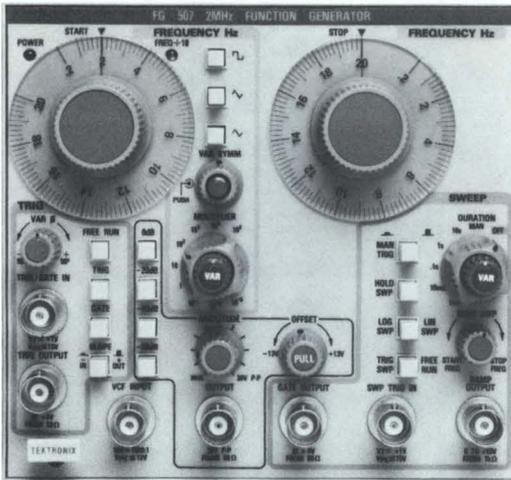
### INCLUDED ACCESSORIES

Extender board kit (067-0152-00), rear interface signal cable kit (020-0701-00), service kit (067-1041-00).

**Order FG 5010 20 MHz**

Function Generator ..... **\$4,300**

FG 507



2 MHz Sweeping Function Generator

FG 507

0.002 Hz to 2 MHz

Includes all FG 501A Features

Logarithmic or Linear Sweep

Separate Start/Stop Frequency Dials

Sweep Up or Down

Sweep and Hold

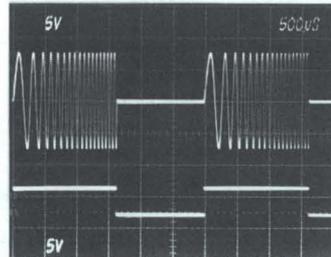
Manual Sweep

The FG 507 features the same basic performance as the FG 501A and adds flexible, easy-to-use log and linear sweep capability.

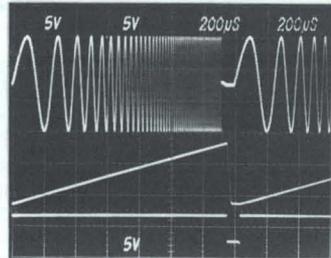
The log sweep of the FG 507 is mathematically correct and allows accurate frequency plots when using log scales, log paper, or a storage oscilloscope like the SC 503. Separate start and stop frequency dials make frequency settings easy to adjust and interpret. The instrument can be internally or externally swept up or down. A third frequency control allows you to manually sweep between the preset start and stop frequencies without disturbing their settings. This is especially convenient for examining frequency and amplitude anomalies of a circuit under test or in setting start and stop points. The sweep generator can be swept and the sweep gate output can be used to gate (burst) the generator on for swept bursts. The sweep hold mode allows the generator to sweep to the stop frequency and remain there until released.

The accurate log/linear sweep capability of the FG 507 plus the low distortion (0.25% over the audio range) make it ideally suited to audio testing.

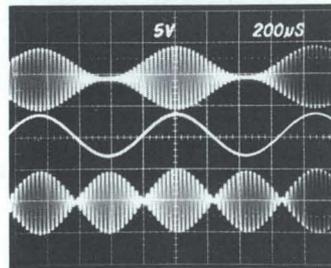
Order FG 507 2 MHz Sweeping Function Generator ..... \$1,420



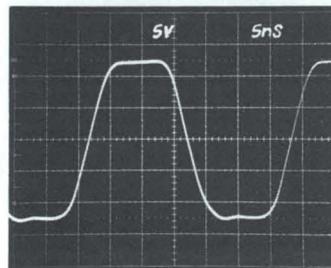
FG 507 triggered sweep mode with output gated on by sweep gate.



FG 507 in logarithmic sweep with sweep ramp and gate outputs.

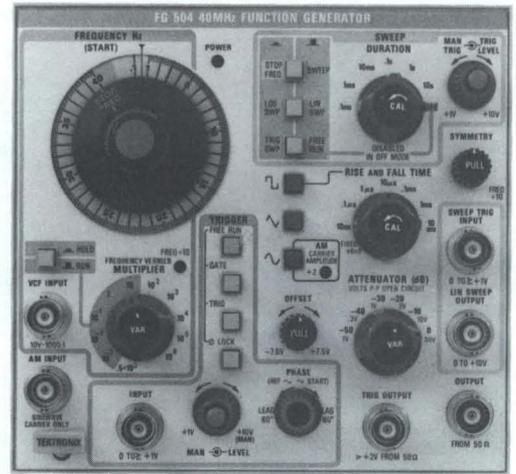


True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.



FG 504 30 volt output with 6 ns risetime and falltimes for superior pulse waveforms.

FG 504



40 MHz Function Generator

FG 504

0.001 Hz to 40 MHz

Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Risetimes and Falltimes and Symmetry Controls

Logarithmic or Linear Sweep

Separate Frequency Dials Set Lower (START) and Upper (STOP) Limits of Sweep

Up to 30 V p-p Output

Built-in Attenuator

Am and Fm

Phase Lock Mode

External and Manual Trigger or Gate

Counted Burst with DD 501

The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sinewaves, as well as adjust phase relationships. Post attenuator offset enables use of the full  $\pm 7.5$  V offset range with small signals. And the FG 504 output can be amplitude or frequency modulated by external signals.

The FG 504 also provides trigger output, external voltage control input, and sweep output.

ORDERING INFORMATION

FG 504 40 MHz Function Generator .. \$2,570

FG 504T 40 MHz Function Generator .. \$2,890

(includes FG 504, TM 503 Mainframe, and 016-0195-03 blank panel)

**FG 501A**



**2 MHz Function Generator**

**FG 501A**

0.002 Hz to 2 MHz

30 V Peak-to-Peak,  $\pm 13$  V Offset

5% to 95% Variable Symmetry

Trigger or Gate,  $\pm$  Slope

60 dB Step Attenuator

$\leq 0.25\%$  Sinewave Distortion

$\leq 25$  ns Rise/Fall

The FG 501A provides low-distortion outputs from 0.002 Hz to 2 MHz. It is capable of generating five basic waveforms — sinewave, squarewave, triangle, ramp, and pulse — at output levels up to 30 V peak-to-peak with up to  $\pm 13$  V of offset from a 50  $\Omega$  source. Waveform triggering and gating are provided with a variable phase control to permit up to  $\pm 90^\circ$  of phase shift for generating haversines,  $\sin^2$  pulses, and havers triangles. A step attenuator provides 60 dB of output signal attenuation in 20 dB steps with an additional 20 dB of variable attenuation. Variable symmetry from 5% to 95% provides ramps and pulses. Pulse risetime is  $\leq 25$  ns. Audio sinewave distortion is less than 0.25% and audio amplitude flatness is within 0.1 dB.

Because of its ability to generate low distortion sinewaves, the FG 501A is uniquely appropriate for applications demanding audio signals.

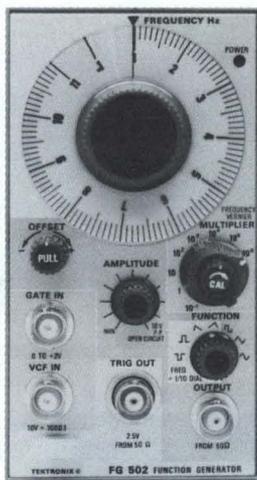
Also useful in audio applications is the 0 to 60 dB attenuator designed into the FG 501A.

The wide range variable symmetry of the FG 501A is useful for generation of pulses and ramps.

**Order FG 501A 2 MHz**

Function Generator ..... \$760

**FG 502**



**11 MHz Function Generator**

**FG 502**

0.1 Hz to 11 MHz

Five Waveforms

VCF and Gated Burst

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. Voltage controlled frequency input permits the FG 502 to be used as a sweep generator. The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireless or radio remote control equipment and in certain phases of the telephone industry.

**Order FG 502 11 MHz**

Function Generator ..... \$840

**FG 503**



**3 MHz Function Generator**

**FG 503**

1.0 Hz to 3 MHz

Three Waveforms

VCF

The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multiplier steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V peak-to-peak can be developed across a 50  $\Omega$  load (20 V peak-to-peak open circuit). Selectable offset up to 3.75 V dc across 50  $\Omega$  (7.5 V dc open circuit) is also featured.

**Order FG 503 3 MHz**

Function Generator ..... \$570

**PRODUCT SUMMARY**

The TM 500 Signal Processors offer unique capabilities for solving electrical measurement and analysis problems. Compact portability and plug-in flexibility allow complete lab instrumentation set-ups, within stringent space and budget limitations.

These versatile signal alteration devices are applicable to a broad range of measurement needs including: preamplification of low level signals, addition or removal of dc offset, integration, differentiation, or summing of multiple signals; impedance transformation; or amplification (to 80 V peak-to-peak).

The AM 503 is specifically designed to work with the A6303/A6302 Current Probes (up to 50 MHz), and incorporates a feature that limits the bandwidth to 5 MHz, to eliminate transients or noise. An illuminated knob skirt indicates calibrated current per division.

To use these current probes to their full bandwidth, the bandwidth of the oscilloscope should be greater than the probe/AM 503 combination. For example, with the A6302/AM 503, a scope such as the 80 MHz SC 504 can be used to obtain full bandwidth capability.

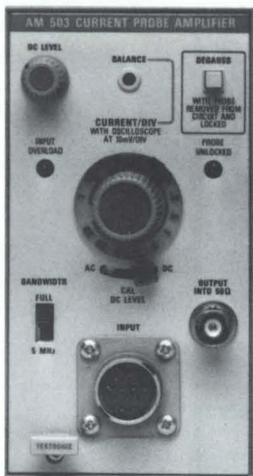
The A6302/AM 503 and A6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. These probes use inductive coupling to minimize interference with the circuit under test.

The versatile AM 502 Differential Amplifier lets you control gain, dc offset, low-frequency and high-frequency response for maximum rejection of unwanted signals. Adjustable dc offset allows high amplification even when low-level signals have a dc component of up to 1 V. High performance features of the AM 502 are a dc to 1 MHz bandwidth and 100 dB common-mode rejection ratio.

The AM 501 Operational Amplifier's output power ( $\pm 40$  V and  $\pm 50$  mA across 800  $\Omega$  loads) is more than adequate for most electronic and electromechanical applications. This high-output unit has front panel connectors that let you change configurations by selecting feedback components. The AM 501 is easily set up for differentiation, integration, summing and impedance transformation problems.

Our extremely versatile AF 501 Bandpass Filter/Amplifier has a center frequency that is one-knob tunable over the entire audio range (3 Hz to 35 kHz). It's switch-selectable in broad ( $Q=5$ ,  $\approx 1/3$  octave) and narrow ( $Q=15$ ,  $\approx 1/10$  octave) bandwidths. It provides sinewave generation to 35 kHz and flat signal amplification to 50 kHz. You can select amplification from 1 to 500 in a 1-2-5 sequence in both filter and amplifier modes.

**AM 503**



**Current Probe Amplifier**

**AM 503**

**Displays Current Signals on an Oscilloscope**

**Current Range, Maximum Current, and Bandwidth Determined by the Probe Used**

The AM 503 is a modular current-probe plug-in amplifier that operates in TM 500 Mainframes. It allows display of current on any oscilloscope with 10 mV/div sensitivity, 50  $\Omega$  or 1 M $\Omega$  input, and (for performance to full bandwidth specifications) at least 75 MHz when using the A6302 or 50 MHz when using the A6303. The amplifier attenuator is calibrated in 12 steps with a 1, 2, 5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to Full (where it is limited by the probe in use) or to 5 MHz. Coupling may be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.

**CHARACTERISTICS**

(AM 503 Current Probe Amplifier with A6302 Probe or A6303 Probe)

**Maximum Input Current** — 20 A (dc + peak ac) for A6302. 100 A (dc + peak ac) for A6303.

**Maximum Voltage for Current Under Test (Bare Conductor)** — 500 V (dc + peak ac) for A6302. 700 V (dc + peak ac) for A6303.

**Bandwidth (-3 dB)** — Dc to at least 50 MHz with A6302. Dc to at least 15 MHz with A6303.

**Risetime (Full Bandwidth)** — 7 ns or less with A6302. 23 ns or less with A6303.

**Deflection Factor** — 1 mA/div to 5 A/div for A6302. 20 mA/div to 50 A/div for A6303. In a 1, 2, 5 sequence for both probes.

**Attenuator Accuracy** — Within 3% of indicated Current/Div for both probes.

**INCLUDED ACCESSORIES**

50  $\Omega$  cable with BNC (012-0057-01); 50  $\Omega$  terminator (011-0049-01).

**Order AM 503 Current Probe Amplifier . \$980**



**A6303 Current Probe**

**Ac and Dc Current Measurements to 100 A**

**Dc to 15 MHz Bandwidth**

**Peak Pulse Measurements to 500 A**

**Ac or Dc Coupling**

**1 Inch by 0.830 Inch Jaw Opening**

**One-hand Operation**

This clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the A6303 can easily be clamped to cables up to 0.830 in. Other measurement parameters of the probe include: 100 A continuous and 500 A peak.

By combining an oscilloscope, like the SC 504, with the A6303/AM 503 Current Probe Amplifier in a TM 500/TM 5000 Mainframe you will have a convenient and compact high current amplification/measurement system.

**Order A6303 Current Probe ..... \$930**



**A6302 Current Probe**

**1 mA to 20 A Current Measurement Range**

**50 A Peak Pulse Measurements**

**Dc to 50 MHz Bandwidth**

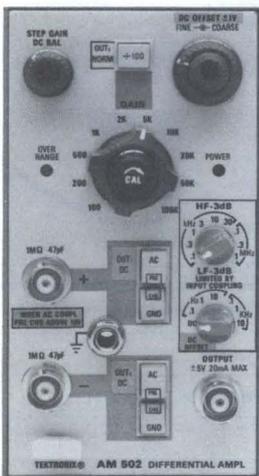
When a A6302 Current Probe is used with the AM 503 Current Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A, not to exceed a product of 100 A  $\mu$ s. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

**INCLUDED ACCESSORIES**

Five inch ground lead (175-0124-01); three inch ground lead (175-0263-01); two alligator clips (344-0046-00).

**Order A6302 Current Probe ..... \$490**

## AM 502



### Differential Amplifier

## AM 502

1 to 100,000 Gain

100 dB CMRR

Selectable Upper and Lower -3 dB Points

Dc to 1 MHz Maximum Bandwidth

Adjustable Dc Offset

The AM 502 Differential Amplifier features wide bandwidth; high CMRR; and selectable calibrated gain and filtering. Well-suited for general purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to  $\pm 1$  V is provided.

### CHARACTERISTICS AMPLIFIER

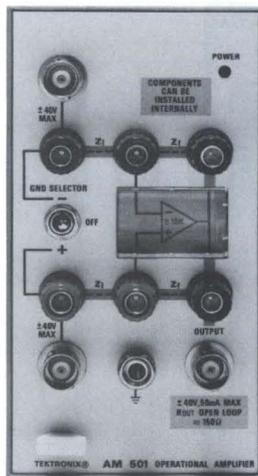
- Gain** — 100 to 100,000; 1-2-5 sequence; accurate within 2%. 1X gain obtained by 100X attenuation.
- HF -3 dB POINT** — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. Upper -3 dB point reduces to 500 kHz at 50 k gain; 250 kHz at 100 k gain.
- LF -3 dB POINT** — Selectable in 6 steps from 0.1 Hz to 10 kHz; ac coupling limits -3 dB point to 2 Hz or less.
- Variable DC Offset** — At least  $\pm 1$  V.
- Normal-Mode CMRR** — At least 100 dB, dc to 50 kHz,  $\pm 5$  V.
- 100 Mode CMRR** — At least 50 dB, dc to 50 kHz,  $\pm 50$  V.
- Maximum Input Voltage** — Normal mode dc coupled: 15 V (dc + peak ac).  $\div 100$  Mode dc coupled: 350 V (dc + peak ac). Ac coupled: 350 V (dc + peak ac) with coupling capacitor precharged.
- Input R and C** — 1 M $\Omega$  paralleled by  $\approx 47$  pF. Input impedance can be increased to a FET input via a simple internal jumper change.
- Maximum Voltage Drift** — 100  $\mu$ V/ $^{\circ}$ C referred to input Norm mode.
- Input Gate Current** —  $\pm 100$  pA for T  $\leq 30^{\circ}$ C.
- Maximum Noise** —  $\leq 25$   $\mu$ V or less (tangentially measured) referred to input NORM mode.

### OUTPUT

- Maximum Output** —  $\pm 5$  V,  $\pm 20$  mA, output resistance is 5  $\Omega$  or less.
- Minimum Load Impedance** — 250  $\Omega$
- Over Range** — Front-panel lamp indicates most over-range conditions.

Order AM 502 Differential Amplifier ... \$1,150

## AM 501



### Operational Amplifier

## AM 501

$\pm 40$  V, 50 mA Output

Open Loop Gain 10,000

50 V/ $\mu$ s Slew Rate

Symmetrical Differential Design

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 Modules. Components may be added externally or internally making it ideal for teaching operational amplifier theory.

### CHARACTERISTICS OPERATIONAL AMPLIFIER

- Open Loop Gain** — At least 10,000 at 60 Hz into 800  $\Omega$  load.
- Unity Gain Bandwidth** — At least 5 MHz into 800  $\Omega$  load.
- Common-Mode Rejection Ratio** — Typically  $>20,000$  to 1 at 60 Hz for common-mode signals up to  $\pm 40$  V.
- Slew Rate** — At least 50 V/ $\mu$ s into an 800  $\Omega$  load.

### INPUT

- Input Bias Current** — Typically  $<500$  pA at  $25^{\circ}$ C,  $<2$  nA at  $50^{\circ}$ C.
- Drift** —  $<100$   $\mu$ V/ $^{\circ}$ C.
- Noise** —  $<10$   $\mu$ V RMS.
- Maximum Differential Input Voltage** — 80 V.

### OUTPUT

- Voltage Range** — At least  $\pm 40$  V into 2 k $\Omega$ .
- Current Limit** — At least  $\pm 50$  mA.
- Open Loop Output R** —  $\approx 150$   $\Omega$ .

Order AM 501 Operational Amplifier ..... \$580

For compatible accessories — refer to page 410.

### AM 501 Accessory



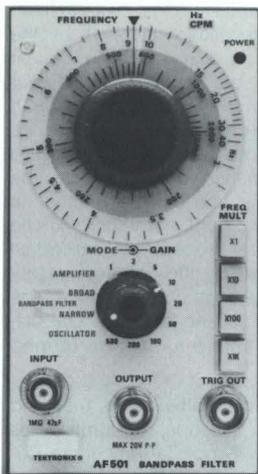
### AM 501 Auxiliary Circuit Board Kit

The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is a pc board that has six terminal studs for attachment to the amplifier's banana jacks and is approximately 2.5 inches square. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier.

An additional advantage of the kit is that it does not interfere with the other connectors on the face of the AM 501.

Order 013-0146-00 ..... \$22

**AF 501**



**Bandpass Filter/Amplifier AF 501**

**Tunable Bandpass Filtering to 35 kHz**

**Signal Amplification to 50 kHz**

**Sinewave Generation to 35 kHz**

**Strobe Trigger Synced to Oscillator or Filter Output**

**Dial Readings in Hz or Cycles per Minute**

The AF 501 is a Bandpass Filter/Amplifier, ac-coupled amplifier and sinewave generator. Used alone or in conjunction with other TM 500 instruments, the AF 501 is a highly versatile and accurate signal analysis tool. Developed primarily for the mechanical measurement domain, the AF 501 can be used as a manual-sweep spectrum analyzer for complex sound and vibration signals. Single-frequency tuning facilitates isolation of 1X rpm signals in dynamic balancing, or viewing higher order disturbances on a CRT monitor. An output pulse, synced to the filter or oscillator output signal, is available for triggering a stroboscope or oscilloscope and for frequency counting.

**CHARACTERISTICS BANDPASS FILTER**

- Center Frequency Range** — 3 Hz to 35 kHz in 4 decade steps.
- Frequency Dial Error** — <5% dial setting between 3 to 20. <10% dial setting between 20 to 30.
- Frequency Multiplier** — X1, X10, X100, X1 k.
- Phase Shift** — <10° at tuned frequency below 5 kHz.
- Dial Range** — 3 to 40 Hz/180 to 2400 cpm.
- Maximum Filter Attenuation** — >70 dB.
- Filter Selectivity** — Broad: Q = 5 ± 1. Narrow: Q = 15 ± 5.
- Bandwidth at Half-power Points**  

$$\Delta F - 3 \text{ dB} = \frac{\text{center frequency}}{Q}$$
- Gain Range** — 1,500; 1-2-5 sequence.
- Gain Accuracy** — ± 3 dB (Broad), ± 5 dB (Narrow).
- Input Impedance** — 1 MΩ ± 1% paralleled by ≈ 47 pF.
- Maximum Dc Input Voltage** — ± 100 V.
- Output Voltage** — 20 V p-p (maximum frequency times amplitude = 400 V kHz).

- Output Current** — 20 mA p-p maximum (at 20 V p-p).
- Output Impedance** — <1 Ω.

**AMPLIFIER**

- Gain** — 1 to 500; 1-2-5 sequence.
- Gain Accuracy** — ± 3%.
- Bandwidth** — <0.5 Hz to >50 kHz (at 3 dB point).
- Input Impedance** — 1 MΩ ± 1% paralleled by ≈ 47 pF.
- Noise** — 25 mV rms (referred to output).
- Output Voltage** — 20 V p-p (maximum frequency times amplitude = 400 V kHz).

**OSCILLATOR**

- Sinewave Outrange** — 3 Hz to 35 kHz.
- Dial Range** — 3 to 40 Hz/180 to 2400 cpm.
- Output Amplitude** — 1, 2, or 5 V p-p ± 20%, depending on gain position.
- Waveform Distortion** — <3%.
- Output Current** — Maximum 50 mA p-p.
- Output Impedance** — <1 Ω (within 50 mA output current limit).

**TRIGGER OUTPUT**

- Pulse Amplitude** — >10 V.
- Pulse duration** — 10 ± 5 μs.
- Minimum signal Required** — 500 mV, p-p.
- Risetime and Falltime** — <1 μs.
- Output Impedance** — ≈ 50 Ω.
- Order AF 501 Bandpass Filter/Amplifier** ..... \$920

**PRODUCT SUMMARY**

Downtime is one problem no production manager can afford ... and the time service engineers spend transporting oscilloscopes from the job site to the calibration bench is wasted time. In the end, for a production house or manufacturing unit, the production line is the bottom line.

With the CG 5001, Tektronix Oscilloscope Calibration Instruments come close to solving the entire range of oscilloscope calibration problems.

The CG 5001 is the computerized solution to large-scale scope calibration needs. The CG 5001 can be used as part of a computer based system to calibrate and verify all of the major oscilloscope parameters. The CG 5001 is specifically designed for use at those installations where many oscilloscopes are used and maintained. Its programmability, combined with state-of-the-art performance, helps to minimize calibration lab labor while maximizing accuracy of verification checks.

In addition to the CG 5001, TM 500 offers a complete set of calibration instruments that can be configured into a portable test set for in-field oscilloscope service and calibration. These TM 500 Oscilloscope Calibration instruments offer the widest range of standard amplitude squarewaves, fastest risetimes, lowest aberrations, fastest time marks and widest frequency range of leveled sinewaves available today.

In addition to its crystal-controlled mode, the TG 501 provides a variable mode. This means you can quickly adjust and accurately align the time mark spacing to your oscilloscope's graticule marks, and read the percentage timing error directly off the TG 501's digital display.

Our PG 506 Calibration Generator offers TM 500 portability plus state-of-the-art performance features. With the PG 506 in the amplitude calibration mode, you can generate a 1 kHz squarewave and vary its amplitude around the calibrated level until the squarewave aligns with your oscilloscope's verticle graticule divisions. At that point, you can

read the scope deflection error right off the PG 506's digital display in percentage high or low.

TM 500 leveled-sinewave generators, the SG 503 and SG 504, round out a scope calibration and verification package. These generators provide leveled sinewaves for bandwidth checks (-3 dB points) and triggering performance checks.

The SG 503 is a general-purpose leveled sinewave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands.

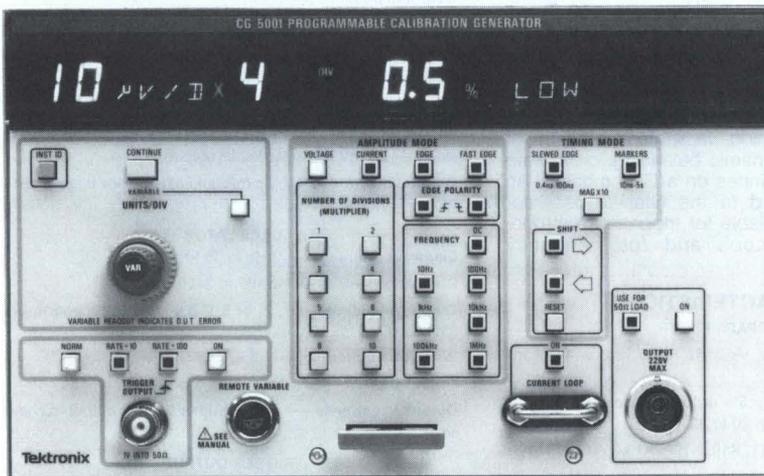
Another TM 500 plug-in, the SG 502 Oscillator, could also benefit calibration applications where verification of low frequency rolloff in ac modes and performance measurement of low frequency reject triggering modes is required.

For features that allow time and error reduction for on-the-job oscilloscope evaluation, our TM 500 Calibration instruments are the best value on the market today.

**OSCILLOSCOPE CALIBRATION COMPARISON GUIDE**

	<b>CG 5001 Programmable Calibration Generator</b>	<b>PG 506 Calibration Generator</b>	<b>TG 501 Time Mark Generator</b>	<b>SG 503 Signal Generator</b>	<b>SG 504 Signal Generator</b>
Primary Functions	Amplitude Calibration 40 μV to 200 V Time-Base Calibration 400 ps to 5 s	Amplitude Calibration 200 μV to 100 V	Time-Base Calibration 1 ns to 5 ns	Bandwidth Calibration 250 kHz to 250 MHz	Bandwidth Calibration 245 MHz to 1050 MHz
Secondary Functions	Risetime and transient response testing, attenuator compensation testing. Testing oscilloscope nonlinearity	Risetime and transient response testing, attenuator compensation testing	Testing oscilloscope nonlinearity	General leveled RF signal source	General leveled RF signal source with frequency modulation capability

## CG 5001



**NEW**

### Programmable Oscilloscope Calibration Generator

## CG 5001

**GPIB**  
IEEE-488

The CG 5001 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

The Tektronix CG 5001 Programmable Oscilloscope Calibration Generator is a microprocessor-based generator that can be used as part of a computerized system for the calibration and verification of major oscilloscope parameters, including:

Vertical Gain

Horizontal Timing and Gain

Vertical Bandwidth/ Pulse Characteristics

Probe Accuracy and Compensation

Current Probe Accuracy

Calibrator Output Accuracy

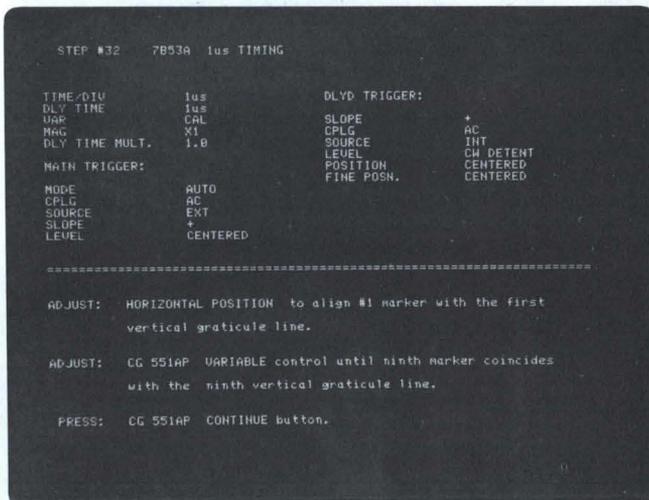
The CG 5001's front panel features a wide range of functions, many of which represent a new state-of-the-art in calibration performance. All these functions are programmable by a controller via the GPIB (General Purpose Interface Bus). A "Learn" mode allows any manually-set function or range to be acquired by a controller. Subsequent use of the resulting program requires a minimum of operator skill and makes data logging an automatic operation.

This computer-assisted test and calibration system can provide step-by-step instructions to the operator, thus significantly reducing the skill level required.

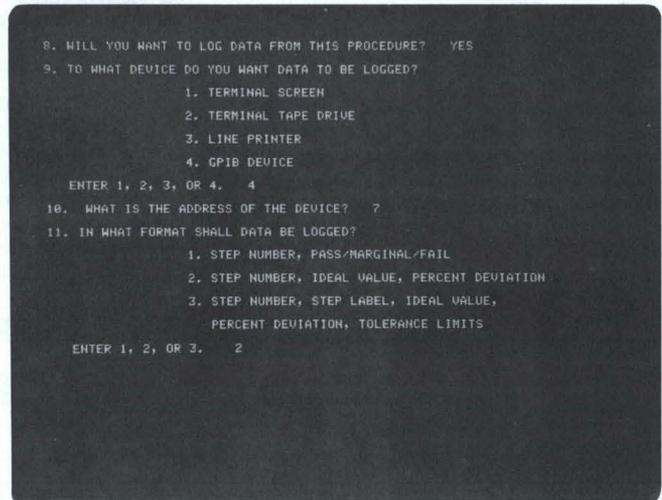
Many of the calibration and test steps previously performed by the operator can now be transferred to a computer which executes them in a consistent and error-free manner. To calibrate a particular oscilloscope, the computer's program can send control-setting information to the CG 5001, which then sends the appropriate calibration signals to the oscilloscope. At the same time, a series of operator instructions can be placed on a terminal to automatically coordinate the oper-

ator with the calibration signals being sent from the CG 5001. The operator follows these instructions to make the necessary settings of the oscilloscope controls as the calibration or test procedure progresses. The CG 5001 returns error or deviation information to the controller, where it can be compared with preprogrammed reference values for the oscilloscope. A permanent record of the entire maintenance procedure can be stored by the controller and can be printed via peripherals such as a hard copy unit or line printer. Throughout the process, all calibration settings are determined by the computer's program. All front panel settings on the oscilloscope are specified in detail for the operator. Calculations of error percentages are performed automatically.

To develop the specific software to test and calibrate different oscilloscopes, Tektronix has designed the CG 5001 ScopeCal Procedure Development Aid program (SCPDA). This program assumes you are not familiar with programming. To incorporate the calibrator's knowledge into the system software, the (SCPDA) program uses two simplified techniques. First is a series of questions that appear on the controller's CRT. The calibrator's answers to these questions form the foundation for the software that will eventually run the system. Second is the CG 5001's "Learn" mode, which allows the calibrator to set functions and ranges using the CG 5001's front panel controls (as would have been done on older generations of manually-operated calibration generators), and have these entries automatically transferred to the controller for use in forming the program. Once the calibrator has completed interacting with the ScopeCal Procedure Development Aid program, all the acquired information is automatically converted into a simpler program format that will govern the system's operation when a less experienced operator is using it. This operator-oriented program will take care of all the CG 5001's settings, while giving the operator a step-by-step description of any



Instruction to operator on CRT screen of 4052A Graphics Computing Controller



4052A Graphics Computer Controller showing the development of a typical calibration procedure using the ScopeCal Procedure Development Aid program

settings that must be made on the oscilloscope. It will also accept data from the CG 5001 or the controller keyboard.

The CG 5001 is designed to greatly reduce your maintenance costs. Built-in self test routines and hardware check the operation of all major circuits each time the power is turned on.

Modular construction means that all circuit boards unplug (except the Main Interconnect) for easy exchange if service is required. A signature analysis mode is included to facilitate troubleshooting of the digital portion of the instrument.

**CHARACTERISTICS**

**VOLTAGE (AMPLITUDE MODE)**

The standard voltage is used to calibrate vertical display accuracy.

**Range** — 40  $\mu$ V to 200 V (1-2-5 steps with multiplier).

**Multipliers** — 1,2,3,4,5,6,8,10 divisions.

**Polarity** — Positive from ground.

**Accuracy** —  $\pm 0.25\% \pm 1 \mu$ V.

**Frequency** — 40 mV to 80 mV: 10 Hz to 100 kHz. 100 mV to 10 V: dc or 10 Hz to 100 kHz. 12 V to 200 V: dc or 10 Hz to 10 kHz.

**Variable Range** —  $\pm 9.9\%$ .

**CURRENT (AMPLITUDE MODE)**

The standard current is used to calibrate current probes.

**Range** — 1 mA to 100 mA (1-2-5 sequence).

**Multipliers** — 1,2,3,4,5,6,8,10.

**Accuracy** —  $\pm 0.25\% \pm 2 \mu$ A.

**Frequency** — Dc or 10 Hz to 1 MHz (decade steps).

**Drop** —  $\leq 1\%$ .

**Variable Range** —  $\pm 9.9\%$ .

**LOW EDGE (AMPLITUDE MODE)**

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

**Range** — 20 mV to 1 V p-p (50  $\Omega$  load only) (1-2-5 steps with multipliers).

**Multipliers** — 1,2,3,4,5,6,8,10.

**Polarity** — Positive or negative transitions to ground.

**Risetime (Falltime)** —  $\leq 1.3$  ns.

**Aberrations** —  $\pm 2\%$ .

**Long Term Flatness** —  $\pm 0.5\%$  after first 10 ns.

**Frequency** — 10 Hz to 1 MHz (decade steps).

**Variable Amplitude Range** —  $> \pm 9.9\%$  from nominal.

**HIGH EDGE (AMPLITUDE MODE)**

The Low Distortion Pulse obtained in this mode is used to test oscilloscope input amplifier and attenuator compensation.

**Range** — 1.2 V to 100 V  $\geq 1$  M $\Omega$  load (1-2-5 steps with multipliers).

**Polarity** — Positive transition only (negative voltage to ground).

**Risetime** —  $\leq 100$  ns.

**Aberrations** —  $\pm 2\%$  of squarewave amplitude.

**Long Term Flatness** —  $\pm 0.5\%$  after first 500 ns.

**Frequency** — 10 Hz to 100 kHz (decade steps).

**Variable Amplitude Range** —  $> \pm 9.9\%$  from nominal.

**MARKERS (TIMING MODE)**

The markers obtained in this mode are used to calibrate oscilloscope time bases.

**Range** — 10 ns to 5 s (1-2-5 steps).

**X10 Magnifier** — Increase marker rate by a factor of ten (0.1  $\mu$ s to 5 s range).

**Accuracy** —  $\pm 0.01\%$  (optional TCXO  $\pm 0.0003\%$ ).

**Amplitude** — 1 V minimum into 50  $\Omega$ .

**Variable Range** —  $\pm 9.9\%$ .

**SLEWED EDGE (TIMING MODE)**

Slewed Edges are used to calibrate the very fastest ranges found on oscilloscope time bases.

**Range** — 0.4 ns to 100 ns (1-2-5 steps plus 0.4 ns).

**X10 Magnifier** — Increases Slewed Edge rate by a factor of ten (5 ns to 100 ns range).

**Accuracy** —  $\pm 0.01\%$  (Optional TCXO  $\pm 0.0003\%$ ).

**Edge Position Uncertainty** —  $\pm 40$  ps.

**Amplitude** —  $> 1$  V into 50  $\Omega$ .

**Variable Range** —  $\pm 9.9\%$ .

**TRIGGER OUTPUT**

The oscilloscope under test is normally triggered externally from this source.

**Output Amplitude** — 1 V minimum into 50  $\Omega$ .

**Trigger Rate — Marker Mode**

Normal — Slaved to marker rate from 100 ns to 5 s; remains at 100 ns for faster markers.

Divided by 10 — Reduces normal trigger rate by a factor of ten.

Divided by 100 — Reduces normal trigger rate by a factor of one hundred.

**Slewed Edge Mode** — One trigger per slewed edge.

**All Other Modes** —

Normal — Slaved to output frequency.

Divided by 10 — One-tenth output frequency.

Divided by 100 — One-hundredth output frequency.

**TIMING REFERENCE OUTPUT**

**EXTERNAL TIMING REFERENCE**

**Input Frequency** — Any integral multiple of 1 MHz up to 5 MHz.

**Required Accuracy** —  $\pm 0.001\%$ .

**Input Amplitude** — 1 V to 10 V RMS.

**Input Resistance** — 10 k $\Omega$  (nominal).

**ENVIRONMENTAL**

Meets or exceeds MIL-T-28800B, Class 5 requirements.

**Temperature** — Operating: 0°C to +50°C. Nonoperating: -20°C to +65°C.

**Relative Humidity** — 90% to 95% at +50°C for 5 days.

**Altitude** — Operating: 4500 m (15,000 ft). Nonoperating: 15 240 m (50,000 ft).

**Vibration** — Operating: Displacement (p-p), 0.015 inch. Vibration Frequency: 10 Hz to 55 Hz. Total time: 75 minutes.

**Shock** — Nonoperating: 30 g's, 1/2 sine, 11 ms duration, 3 shocks in each direction along 3 major axes; total shocks, 18.

**Bench Handling** — Operating: 45° 4 inches or point of balance, whichever occurs first.

**PHYSICAL CHARACTERISTICS**

Maximum Overall Dimensions (triple compartment Plug-in).

Dimensions	mm	in
Width	203	8.0
Height	124	4.9
Depth	305	12.0
Weights	kg	lb
Standard	3.9	8.5
Option 01	4.0	8.7

**PULSE HEAD**

**(Standard Accessory)**

**FAST EDGE (AMPLITUDE MODE)**

The Pulse Head is used to generate fast rise, low distortion pulses for testing higher bandwidth vertical amplifiers.

**Amplitude** — 1.1 V peak  $\pm 5\%$  into 50  $\Omega$ .

**Adjustable Range** —  $\pm 10\%$ .

**Risetime** —  $\leq 200$  ps.

**Polarity** — Positive or negative transitions from ground.

**Aberrations** —  $\pm 3\%$  of pulse amplitude; not to exceed 4% peak-to-peak for adjacent peaks.

**Frequency** — 100 Hz to 100 kHz (decade steps).

**REMOTE VARIABLE HEAD**

**(Optional Accessory)**

The Remote Variable Head permits the operator to concentrate on the oscilloscope CRT while remotely operating the following front panel controls: Units/Div control; Variable-Fixed button; Continue pushbutton and the VAR control.

**COMPARATOR HEAD**

**(Optional Accessory)**

The Comparator Head is used to calibrate built-in oscilloscope calibrators against the signals available from the CG 5001.

Both the oscilloscope calibrator and CG 5001 standard amplitude signals are applied to the Comparator Head and simultaneously displayed on the oscilloscope CRT. The CG 5001 signals are then varied to obtain congruent displays. Errors are then displayed on the CG 5001 readout.

**Input** — Ac Voltage —  $\pm 40 \mu$ V to  $\pm 100$  V.

Signal Frequency — 10 Hz to 1 MHz squarewave.

Dc Voltage — +100 mV to +100 V.

**Input Resistance** — "Open" position — The resistance of the oscilloscope input. "50  $\Omega$ " position — 50  $\Omega \pm 1\%$ .

**Chop Parameters** — Frequency — 30 Hz nominal. (Auto). Auto Timeout — Internally selectable. 0.5, 1 or 2 minutes.

**INCLUDED ACCESSORIES**

Output Cable Assembly (012-0884-00); Pulse Head (015-0311-01).

**MAINFRAMES**

CG 5001 requires either a TM 5003 or TM 5006. The CG 551AP is a TM 500 version of the CG 5001 and requires a TM 506 Mod JB, TM 515 Mod UB or RTM 506 Mod JB. The CG 5001 is not compatible with TM 500 power module mainframes.

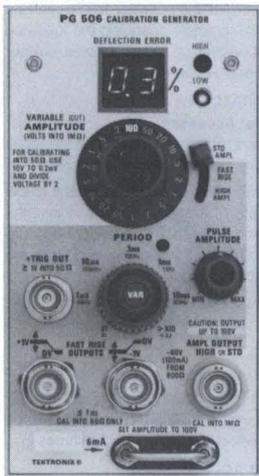
**ORDERING INFORMATION**

<b>CG 5001 Programmable Calibration Generator</b> .....	<b>\$13,000</b>
<b>CG 551AP Programmable Calibration Generator</b> .....	<b>\$13,000</b>
<b>Option 01</b> — Adds High Accuracy Time Base (TCXO) CG 5001/CG 551AP. ....	<b>+\$595</b>
<b>Option 02</b> — Deletes Pulse Head CG 5001/CG 551AP. ....	<b>-\$1,100</b>

**OPTIONAL ACCESSORIES**

<b>Comparator Head,</b> Order 015-0310-01 .....	<b>\$500</b>
<b>Remote Variable,</b> Order 015-0309-01 .....	<b>\$375</b>
<b>Pulse Head</b> Order 015-0311-01 .....	<b>\$1,400</b> (When purchased separately.)
<b>4052A Graphics Computing Controller</b> (32k bytes memory) (see page 98) .....	<b>\$9,900</b>
<b>Option 10</b> — Printer Interface .....	<b>+\$550</b>
<b>Blank 4052A Tape,</b> Order 119-0680-01 (box of 5) .....	<b>\$180</b>
Order 119-0680-00 (One each) .....	<b>\$40</b>
<b>4632 Hard Copy Unit</b> (See page 110) .....	<b>\$6,050</b>
<b>Option 01</b> — Copy counter .....	<b>+\$120</b>
<b>Paper, Carton of four rolls,</b> Order 006-1603-01 .....	<b>\$275</b>
<b>4642 Matrix Printer</b> (see page 112) .....	<b>\$2,900</b>
<b>Option 01</b> — Rear Feed Tractor Assembly .....	<b>+\$280</b>
<b>Paper, Carton of 2,500 sheets,</b> Order 002-0262-01 .....	<b>\$60</b>
<b>GPIB Cable, 2 meter Cable,</b> Order 012-0630-01 .....	<b>\$75</b>
<b>SCPDA I</b> (ScopeCal Procedure Development Aid and 465B Verification Program) .....	<b>\$3,140</b>
<b>Rigid Circuit Board Extender</b> Order 067-0975-00 .....	<b>\$65</b>
<b>Flexible Circuit Board Extender</b> Order 067-0974-00 .....	<b>\$80</b>
<b>CG 551AP Field Modification Kit</b> to convert to CG 5001 Order 040-1041-00 .....	<b>\$55</b>

**PG 506**



**Calibration Generator**

**PG 506**

**Three Squarewave Output Modes**

**10 Hz to 1 MHz**

**Direct Readout of Oscilloscope Deflection Error**

The PG 506 is a calibration generator for oscilloscopes. It provides three modes of squarewave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. The PG 506 can be used for checking attenuator performance and transient response of oscilloscopes. Simultaneous plus and minus low-level, fast rise (1.0 ns) squarewaves or high amplitude (60 V), extremely clean squarewaves are available at frequencies from 10 Hz through 1 MHz. A 5 mA calibration current loop is useful for current probe calibration. A 1 kHz squarewave can be generated in the amplitude calibration mode. Its amplitude may be varied around the calibrated level until the squarewave aligns with the oscilloscope vertical graticule divisions. Scope deflection error then can be read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

**CHARACTERISTICS  
AMPLITUDE CALIBRATOR MODE**

**Period** — Fixed at  $\approx 1$  ms or dc.  
**Amplitude** — From 100 V peak-to-peak to 200  $\mu$ V peak-to-peak in 1-2-5 sequence, accurate within  $\pm 0.25\%$  into 1 M $\Omega$ . 5 V peak-to-peak to 100  $\mu$ V peak-to-peak into 50  $\Omega$ .  
**Error Readout Range** —  $\pm 7.5\%$ .  
**Error Readout Resolution** — 0.1%.

**PULSE MODES**

**Period** — 1  $\mu$ s to 10 ms (within 5%) in decade steps with the Variable control in Cal position. Variable extends period to at least 100 ms.  
**Symmetry** —  $\approx 50\%$  duty cycle.

**HIGH AMPLITUDE OUTPUT**

**Risetime** — Underterminated: 100 ns or less. Terminated into 50  $\Omega$ : 10 ns or less.  
**Amplitude Range** — Underterminated: 6 V or less to at least 60 V. Terminated into 50  $\Omega$ : 0.5 V or less to at least 5 V.  
**Leading Edge Aberrations** — Within 2% or 50 mV peak-to-peak, whichever is greater, when terminated into 50  $\Omega$ .  
**Polarity** — Positive going from a negative potential to ground.  
**Output Resistance Source** — 600  $\Omega$  within 5%.

**FAST RISE OUTPUTS**

**Risetime (Terminated into 50  $\Omega$ )** — 1.0 ns or less.  
**Amplitude Range (Terminated into 50  $\Omega$ )** — 100 mV or less to at least 1.0 V.  
**Leading Edge Aberrations** — Within 2% or 10 mV peak-to-peak, whichever is greater, during first 10 ns.  
**Flatness** — Within 0.5% after first 10 ns.  
**Polarity** — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.  
**Output Resistance Source** — 50  $\Omega$  within 3% at + and - output connectors.

**Trigger Output (Terminated into 50  $\Omega$ )** — Positive-going signal of at least 1 V.

**Order PG 506 Calibration Generator .. \$2,460**

**TUNNEL DIODE PULSER**

The Tunnel Diode Pulser provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50  $\Omega$ , while rise time is  $\leq 125$  ps; aberrations are  $< 1\%$  in a 1 GHz system.

**Order 067-0681-01 ..... \$155**

**PRECISION VOLTAGE DIVIDER**

Designed for use with the PG 506 in the Standard Amplitude mode, this 0.4 divider allows your oscilloscope to display a constant four divisions when checking amplitude calibration from 20  $\mu$ V/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display five divisions of amplitude.

**CHARACTERISTICS**

**Input Z** — 50  $\Omega$  with output load  $\geq 100$  k $\Omega$ ,  
**Maximum Input** —  $\leq 5$  V RMS.  
**Output** — 0.4 x PG 506 amplitude.  
**Voltage Accuracy** —  $\pm 0.4\%$ .

**Order 015-0265-00 ..... \$140**

**TG 501**



**Time Mark Generator**

**TG 501**

**Marker Outputs, 5 s to 1 ns**

**Direct Readout of Oscilloscope Timing Error**

**External Trigger Output**

The TG 501 Time Mark Generator provides marker outputs from five seconds to one nanosecond. A unique feature on the TG 501 is a variable timing output with a front-panel two digit LED display. The display indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

**CHARACTERISTICS**

**Markers** — 1 ns through 5 s in a 1-2-5 sequence.  
**Marker Amplitude** —  $\geq 1$  V peak into 50  $\Omega$  on 5 s through 10 ns markers.  $\geq 750$  mV peak-to-peak into 50  $\Omega$  on 5 ns and 2 ns markers.  $\geq 200$  mV peak-to-peak into 50  $\Omega$  on 1 ns markers.  
**Trigger Output Signal** — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz
Stability (0° to 50°C) after 1/2 hour	within 1 part in 10 <sup>5</sup>	within 5 parts in 10 <sup>7</sup>
Long-term Drift	1 part or less in 10 <sup>5</sup> per month	1 part or less in 10 <sup>7</sup> per month
Setability	adjustable to within 1 part in 10 <sup>7</sup>	adjustable to within 5 parts in 10 <sup>9</sup>

**External Reference Input** — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

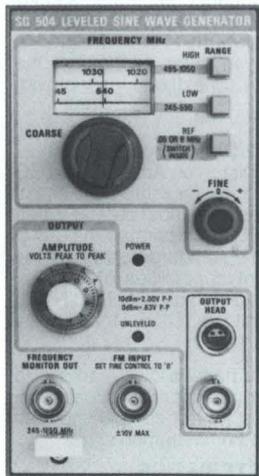
**Timing Error Readout Range** — To  $\pm 7.5\%$ .  
**Timing Error Measurement Accuracy** — Device under test error is indicated to within one least significant digit (to within one displayed count).

**ORDERING INFORMATION**

**TG 501 Time Mark Generator ..... \$1,970**  
**Option 01 — 5 MHz Time Base ..... +\$295**

For compatible accessories — refer to page 410.

SG 504



Signal Generator

SG 504

Leveled, Variable Output

245 MHz to 1050 MHz

Frequency Modulation Capability

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V peak-to-peak into 50  $\Omega$ .

CHARACTERISTICS

**Frequency Range** — Low Band: 245 MHz to 550 MHz High Band: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

**Frequency Accuracy** —  $\pm 2\%$  of dial indication.

**Amplitude Range** — 0.5 V to at least 4.0 V p-p.

**Amplitude Accuracy** — (at reference) Within 3% of indicated amplitude.

**Flatness** —  $\pm 4\%$  of amplitude at reference frequency.

**Harmonic Content** — 2nd harmonic at least 25 dB down; 3rd and all higher at least 40 dB down.

**Fm Input** — Frequency Range: dc to 100 kHz. Deviation Sensitivity:  $\pm 9$  V produces from  $\pm 0.05\%$  to  $\pm 0.5\%$  deviation of carrier, depending on output frequency.

**Frequency Monitor Output** —  $\geq 0.3$  V p-p into a 50  $\Omega$  load from 245 MHz to 1050 MHz.

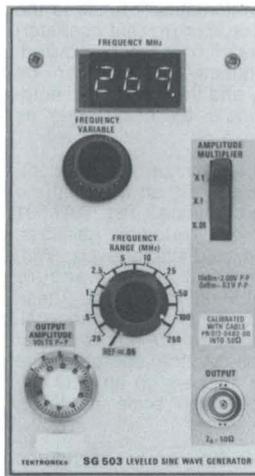
**Rear Card Edge Connections** — Address fm input, frequency monitor output, and amplitude control.



ORDERING INFORMATION

SG 504 Signal Generator (Includes Leveling Head) .....	\$3,000
Replacement Leveling Head, Order 015-0282-00 .....	\$450

SG 503



Signal Generator

SG 503

Leveled, Variable Output

250 kHz to 250 MHz

Digital Readout of Frequency

The SG 503 Signal Generator is a general-purpose leveled-sinewave oscillator. It provides a leveled output amplitude that is variable from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage is variable from 5 mV to 5.5 V peak-to-peak into 50 ohms.

CHARACTERISTICS

**Frequency Range** — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

**Accuracy** — Within  $\pm 0.7$  of least significant digit of indicated frequency.

**Amplitude Range** — 5 mV to 5.5 V p-p into 50  $\Omega$  termination in three decade ranges.

**Amplitude Accuracy** — (50 kHz reference) Within 3% of indicated amplitude on (X1) range, 4% on (X0.1) range, and 5% on (X0.01) range.

**Flatness** — (peak-to-peak) From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to  $+1.5\%$ ,  $-1\%$  variation may occur between 50 MHz and 100 MHz on amplitude multiplier X0.1 and X0.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

**Harmonic Content** — Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.

**Other** — Rear edge card connection available to address the leveling circuit.

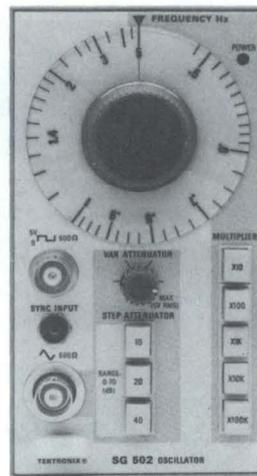
INCLUDED ACCESSORY

Precision 50  $\Omega$  cable, 3 ft long (012-0482-00).

Order SG 503 Signal Generator ..... \$1,940

Tektronix offers service training classes on the TM 500 Calibration Systems Package. For further training information, contact your local Sales/Service Office or request a copy of the Tektronix Service Training Schedule on the return card in the center of this catalog.

SG 502



Oscillator

SG 502

5 Hz to 500 kHz Sinewaves and Squarewaves

Low Distortion Sinewave

5 V RMS Open Circuit—600  $\Omega$  Source

0-40 dB Output Variable Plus 0-70 dB in 10 dB Steps

The SG 502 Oscillator features a wide frequency range of 5 Hz to 500 kHz with low distortion (0.035% between 20 Hz and 50 kHz) and is desirable for general test purposes where the extremely low distortion levels of the SG 505 are not required. Other SG 502 features include 70 dB amplitude control plus a simultaneous fixed amplitude squarewave.

CHARACTERISTICS

SINEWAVE

**Frequency Range** — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to  $<50$  kHz; within 10% of dial setting from 50 kHz to 500 kHz.

**Amplitude Response** — Flatness is 0.3 dB over entire range (1 kHz reference).

**Attenuation** — Selectable from 0 dB to 70 dB in 10, 20, and 40 dB steps with pushbuttons. Accurate within 0.2 dB for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to  $-40$  dB.

**Harmonic Distortion** —  $<0.035\%$  ( $-70$  dB) from 20 Hz to 50 kHz.  $<0.15\%$  from 50 kHz to 500 kHz ( $R_L \geq 600 \Omega$ ).

**Maximum Output Voltage** — 5 V RMS open circuit; 2.5 V RMS into 600  $\Omega$ .

**Output Impedance** — 600  $\Omega$ , grounded.

SQUAREWAVE

**Frequency Range and Accuracy** — Same as sinewave. The squarewave switches on the 0° phase of sine out.

**Rise and Falltime** — 50 ns or less.

**Amplitude** —  $+5$  V, fixed, open circuit.

**Output Impedance** — 600  $\Omega$ , grounded.

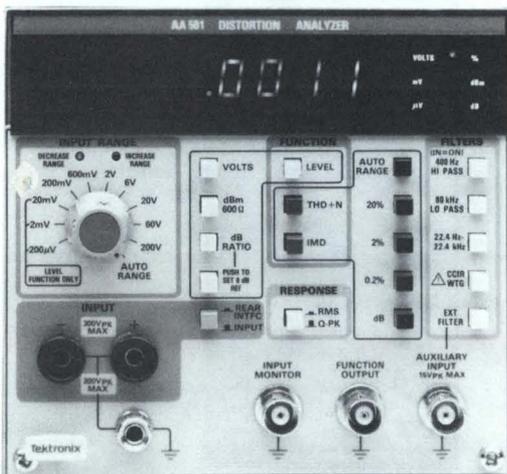
SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

**Input impedance** — 10 k $\Omega$ .

Order SG 502 Oscillator ..... \$800

## AA 501 Option 02



## AA 501 Distortion Analyzer

**Fully Automatic: No Level Setting, Tuning or Nulling**

**Total System Harmonic Distortion plus Noise (THD + N) — 0.0025% (Option 02 0.0032%)**

**Extremely Low Residual Noise — <3  $\mu$ V**

**Novel Analog-like "bar graph" plus Complete Digital Readout**

**True RMS or Average Responding (Option 02 — True RMS or Quasi-Peak Response) in All Modes**

**Intermodulation Distortion (Option 01) to SMPTE, DIN, and CCIF**

**Differential Input**

**Option 02 — Permits Noise Measurements in Accordance with CCIR Recommendation 468-2 and DIN 45405 (Includes Option 01)**

Used together, the AA 501 Distortion Analyzer and SG 505 Oscillator provide the easiest solution to your distortion measurement needs. The AA 501 and SG 505 combination permits harmonic distortion, intermodulation distortion, frequency response, gain/loss, and signal-to-noise ratio measurements to be accomplished with minimal operator skill level. At the same time, both instruments feature state-of-the-art performance in residual noise and distortion.

When using the Tektronix AA 501 Distortion Analyzer and SG 505 Oscillator, complex distortion measurements become a totally automated process. All steps previously requiring several minutes of skilled operator time, such as level setting, tuning and nulling are now done quickly, precisely, and automatically by the AA 501's internal circuitry.

Because the AA 501 Distortion Analyzer and SG 505 Oscillator are two separate plug-ins they may be used as a powerful package in the same mainframe or apart. For instance, the SG 505 can be left in a rackmount mainframe at a broadcast station while the AA 501 is transferred to a portable mainframe and taken to the transmit-

ter site for distortion measurements. Together or thousands of miles apart, the AA 501 Distortion Analyzer automatically tunes to the oscillator's (SG 505 or your present oscillator) signal with no operator assistance required. The SG 505's frequency or level can be changed repeatedly and the AA 501 will automatically accommodate these changes as they occur.

The AA 501 Distortion Analyzer makes complex measurements easier than ever with no compromise in performance. The AA 501 measures total harmonic distortion, gain/loss, signal to noise ratio, and audio levels. With Option 01 the ability to measure intermodulation distortion is added. These measurements are accomplished automatically, with no level setting, nulling, or meter ranging to be done by the operator. The measurement result appears on an LED display with no additional scale factoring necessary.

The AA 501 and SG 505 can be configured with several other audio-quality instruments from Tektronix. For instance, the FG 507 Sweeping Function Generator features a low distortion sine wave output (up to 2 MHz) and a log/lin sweep making it an ideal signal source in a communications test set. The FG 501A 2 MHz Function Generator is specifically designed for those audio/communications measurements not demanding log/lin sweep capability. (See pages 370-374 for information on the FG 507 and FG 501A).

To complete an audio test set add the DM 502A Digital Multimeter with an accuracy of 0.1% dc volts and seven functions including autoranging dB and temperature (see page 352). The SC 503 Storage Oscilloscope is also ideal for audio/communications applications with a bandwidth of 10 MHz and X-Y capability. Storage permits slow audio sweeps to be displayed or enables the long term monitoring of peak audio levels (see page 386).

### AA 501 Option 01 Distortion Analyzer

When used with the SG 505, residual distortion is 0.0025%. Residual noise in the analyzer is less than 3  $\mu$ V.

To measure Total Harmonic Distortion plus noise (THD+N) or Intermodulation Distortion (IMD) the operator simply feeds the audio signal to the analyzer. The AA 501 automatically locks on the signal, sets the proper level, and switches in the proper filter. In the THD+N measurement the filter nulling is totally automatic, with no presetting of controls required. When used with a separate oscillator, no loss of automatic features is experienced.

The optional IMD mode measures signals to any of three usual standards: SMPTE, DIN, or CCIF. Internal circuitry identifies the standard being used and configures itself to display the appropriate results.

The AA 501 has a 0 dB reference memory. This feature allows an audio level to be set to 0 dB with all subsequent signal levels compared to it. The result is expressed in dB on the display. Selection from the front panel allows readings to be expressed in true RMS or average response, RMS calibrated. Although true RMS is more accurate in most applications, the average response permits comparisons with measurements previously taken with older instrumentation.

The digital voltmeter is auto ranging on all scales, from the lowest, 200  $\mu$ V full scale, to the highest, 200 V full scale.

Four filters are included and can be switched in and out from the front panel. They are: 400 Hz high pass, 30 kHz low pass, 80 kHz low pass (all 18 dB per octave Butterworth), and "A" weighting. For user convenience, an extra position on the filter switch provides for an external, user-provided filter.

### AA 501 Option 02 Distortion Analyzer

The AA 501 Option 02 Distortion Analyzer and SG 505 Oscillator permit noise measurement in accordance with CCIR recommendation 468-2 and DIN 45405. The Option 02 incorporates the state-of-the-art features of the standard as well as the enhanced measurement capabilities of the Option 01 (intermodulation distortion SMPTE/DIN and difference tone testing CCIF frequency distortion).

Selection from the front panel allows readings to be expressed in true RMS or quasi-peak response. These features permit comparison with readings obtained on other instruments.

### CHARACTERISTICS

The following electrical characteristics are common to the standard AA 501, Option 01 and Option 02 unless otherwise noted:

#### THD

Complete automatic Total Harmonic Distortion (THD) measurements to specified accuracy in 7 s or less.

#### LEVEL

Autoranging digital voltmeter displays input signal level in volts, dBm, or dB ratios.

#### IMD

##### (OPTION 01, OPTION 02)

Fully automatic SMPTE, DIN, and CCIF difference frequency test measurements.

#### OPTION 02

Noise measurements to CCIR recommendation 468-2 and DIN 45402. True RMS or quasi-peak response. Total system THD+N = 0.0032% (90 dB) RMS response. Balanced input.

#### DISTORTION FUNCTION

**Fundamental Frequency Range** — 10 Hz to 100 kHz automatically tuned to input frequency.

**Distortion Ranges** — Auto (100%), 20%, 2%, 0.2%, and dB (autoranging).

**Accuracy (readings  $\geq$ 4% of range)** — 20 Hz to 20 kHz  $\pm$  1 dB, 10 Hz to 100 kHz  $\pm$  1, -3 dB. (Accuracy is limited by residual THD+N and filter selection.)

**AA 501/SG 505 System Residual THD + N** —  $V_{in} \geq$  250 mV, (all distortion, noise, and nulling error sources combined).

20 Hz to 20 kHz

$\leq$  0.0025% (-92 dB) Average Response with 80 kHz filter (standard and Option 01 only).

$\leq$  0.0032% (-90 dB) RMS Response with 80 kHz filter.

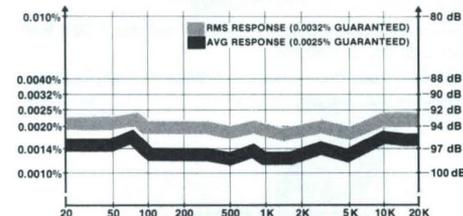
10 Hz to 50 kHz

$\leq$  0.0071% (-83 dB) RMS Response.

50 kHz to 100 kHz

$\leq$  0.010% (-80 dB) RMS Response.

#### TYPICAL THD + N



**Typical Fundamental Rejection** — At least 10 dB below specified residual THD + N or actual signal THD, whichever is greater.

**Minimum Input Level** — 60 mV (-22 dBm).

#### LEVEL FUNCTION

**Modes** — Volts, dBm (600  $\Omega$ ), or dB ratio with push to set zero dB reference.

**Level Ranges** — 200  $\mu$ V full scale to 200 V full scale in ten steps, manual or autoranging.

**Accuracy**

Frequency	Volts	dBm or dB ratio
20 Hz to 20 kHz	± 2%	± 0.3 dB
10 Hz to 100 kHz*	± 4%	± 0.5 dB

( $V_{in} > 100 \mu V$ , level ranging indicators extinguished).

**Bandwidth** —  $\geq 300$  kHz.

**Residual Noise** —  $\leq 3.0 \mu V$  (-108 dBm) with 80 kHz and 400 Hz filters.

$\leq 1.5 \mu V$  (-114 dBm) with "A" weighting filter.

\*On the 200  $\mu V$  range, accuracy above 50 kHz is +4%, -6% (+0.5 dB, -0.7 dB).

**INTERMODULATION DISTORTION FUNCTION (OPTION 01/02)**

**SMPTe and DIN Tests** — Lower frequency range: 50 Hz to 250 Hz.

Upper frequency range: 3 kHz to 100 kHz.

Level ratio range: 1:1 to 5:1 (lower:upper).

Residual IMD:  $\leq 0.0025\%$  (-92 dB) for 60 Hz and 7 kHz or 250 Hz and 8 kHz, 4:1 level ratio.

**CCIF Difference Frequency** — Frequency range: 4 kHz to 100 kHz.

Difference frequency range: 50 Hz to 1 kHz.

Residual IMD:  $\leq 0.0018\%$  (-95 dB) with 14 kHz and 15 kHz.

Minimum input level: 60 mV (-22 dBm).

**Accuracy** —  $\pm 1$  dB.

**ALL FUNCTIONS**

**Filters** — 400 Hz high pass: -3 dB at 400 Hz  $\pm 5\%$ ; at least -40 dB rejection at 60 Hz.

80 kHz low pass: -3 dB at 80 kHz  $\pm 5\%$ .

30 kHz low pass: -3 dB at 30 kHz  $\pm 5\%$  (standard and Option 01 only).

"A" weighting: Meets specifications for Type 1 sound level meters (ANSI S 1.4, IEC Recommendation 179) (standard and Option 01 only).

EXT: Allows connection of external filters.

22.4 Hz - 22.4 kHz: -3 dB  $\pm 5\%$  (Option 02 only).

CCIR WTG: CCIR Recommendation 468-2 and DIN 45405, functional only with Q-PK detector (Option 02 only).

**Input Impedance** — 100 k $\Omega$   $\pm 2\%$ , each side to ground, fully differential.

**Maximum Input** — 300 V pk, 200 V RMS either side to ground or differentially.

Fully protected on all ranges.

**Common Mode Rejection** —  $\geq 50$  dB at 50 or 60 Hz.

Typically  $\geq 40$  dB to 300 kHz.

**Detection** — Average or true RMS for waveforms with crest factors  $\leq 3$ .

**FRONT PANEL SIGNALS**

**Input Monitor** — Provides constant amplitude version of signal applied to input. Output voltage: 1 V RMS  $\pm 10\%$  for input signals  $> 50$  mV. Source impedance: 1 k $\Omega$   $\pm 5\%$ .

**Function Output** — Provides a scaled sample of selected function signal (1000 count display = 1 V RMS  $\pm 3\%$ ). Source impedance: 1 k $\Omega$   $\pm 5\%$ .

**Auxiliary Input** — Provides input to detector circuit when EXT FILTER button is depressed. Sensitivity: 1 V RMS  $\pm 3\%$  = 1000 count display. Impedance: 100 k $\Omega$   $\pm 5\%$ , ac coupled.

**REAR INTERFACE SIGNALS**

**Rear INTFC INPUT** — Front panel selected. Same as main INPUT except, maximum signal input is limited to 42 V pk, 30 V RMS. (Potential crosstalk at rear interface may degrade noise and distortion on performance).

**Monitor** — Same as front panel Input Monitor.

**Function Output** — Same as front panel Function Output.

**Auxiliary Input** — Same as front panel Auxiliary Input.

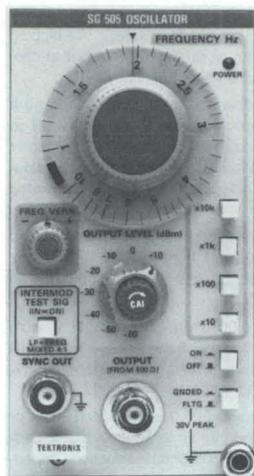
**Converter Output** — Dc output of selected response converter. 1 V  $\pm 5\%$  for 1000 count display. Source Z: 500  $\Omega$   $\pm 5\%$ .

**dB Output** — Dc output of logarithmic dB converter. 10 mV  $\pm 5\%$  per 1 dB of display. Source Z: 1 k $\Omega$   $\pm 5\%$ .

**ORDERING INFORMATION**

AA 501 Distortion Analyzer .....	\$2,130
Option 01 — Intermodulation Distortion .....	+\$690
Option 02 — CCIR/DIN (includes Option 01) .....	+\$1,050

**SG 505 Option 01**



**Oscillator**

**SG 505/Option 01/Option 02 Common Characteristics**

**10 Hz to 100 kHz Sinewave (typically 9 Hz to 110 kHz)**

**Ultra-Low Distortion—0.0008% THD (typically 0.0003%)**

**Floating or Grounded Output**

**Vernier Frequency Control**

**Isolated and Ground Referenced Sync Output**

**SG 505 Option 01**

**Calibrated Output into 600  $\Omega$  — +10 dBm to -60 dBm**

**600  $\Omega$  Source**

**Option 01 Adds Intermodulation Test Signal**

The SG 505 Oscillator features the lowest distortion level commercially available today in the 10 Hz to 100 kHz band (0.0008% between 20 Hz and 20 kHz). The SG 505 assures you of freedom from residual distortion effects; particularly critical when making audio and communication measurements. This extremely low distortion performance is coupled with many designed-in convenience features.

For instance, the main signal output may be floated to help avoid interference due to troublesome ground loops, or it may be ground referenced. The SG 505 also features an isolated and ground referenced sync output. This allows you to monitor the phase or the frequency of the output of the oscillator without disturbing the floating output of the main signal.

**COMMON CHARACTERISTICS**

**MAIN OUTPUT**

**Frequency Range** — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least  $\pm 1\%$  of frequency setting.

**Calibrated Output** — Selectable from +10 dBm to -60 dBm into 600  $\Omega$  in eight 10 dB steps. Accurate to within 0.2 dB at +10 dBm and 1 kHz. Step accuracy is  $\pm 0.1$  dB/10 dB step. An uncalibrated control provides continuous variation from at least +2.2 dB to  $< -10$  dB from calibrated position.

**Amplitude Response** — Level flatness  $\pm 0.1$  dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding  $> 50$  kHz on -60 dB output level range).

**Harmonic Distortion** —  $< 0.0008\%$  (-102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (-95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0032% (-90 dB) THD from 50 kHz to 100 kHz ( $R_L \geq 600 \Omega$ ).

**Output Impedance** — 600  $\Omega$   $\pm 2\%$ ; floating or grounded through  $\approx 30 \Omega$ . Output impedance does not change with OUTPUT ON/OFF selection. Maximum floating voltage  $\pm 30$  V peak.

**Maximum Output Voltage** — At least 6 V RMS open circuit; 3.16 V RMS (+10 dBV or +12.2 dBm) into 600  $\Omega$ .

**SYNC OUTPUT**

**Signal** — 200 mV RMS  $\pm 20\%$  sinewave to 20 kHz, at least 120 mV RMS at 100 kHz.

**Frequency** — Same as main output.

**Impedance** — Nominally 1 k $\Omega$ , ground referenced and isolated from main output.

**REAR INTERFACE SIGNALS**

**Buffered Main Output** — Buffered version of actual output signals from front panel connector.  $\approx 300 \Omega$  Output impedance.

**Sync Output** — Same as front panel SYNC OUTPUT except output impedance is  $\approx 50 \Omega$ .

**OPTION 01 IM TEST SIGNAL**

Selecting the IM Test Signal causes a LF sinewave to be mixed with the normal oscillator signal in a 4:1 amplitude ratio.

**LF Frequency** — Internally selectable 60 Hz ( $\pm 1$  Hz) or 250 Hz ( $\pm 3$  Hz).

**Main Output** — Composite peak-to-peak output within 0.2 dB of normal oscillator mode output.

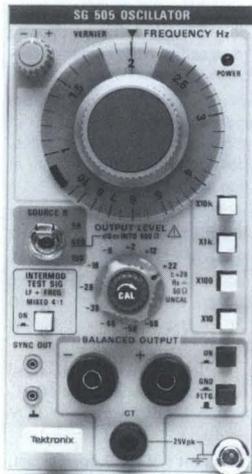
**Residual IMD** — Typically  $< 0.0005\%$  from 2.5 kHz to 10 kHz.

**Sync Output** — LF signal component only, 200 mV RMS  $\pm 20\%$ .

**ORDERING INFORMATION**

SG 505 Oscillator .....	\$710
Option 01 — (IM Test Signal) .....	+\$200
Option 02 — Oscillator described on following page (includes Option 01) .....	+\$550

## SG 505 Option 02



### Oscillator



## SG 505 Option 02

### Fully Balanced Output

Calibrated Output into 600  $\Omega$  (from 600  $\Omega$ ),  
+22 dBm to -68 dBm

Selectable Source Impedance, 50  $\Omega$ , 150  $\Omega$ ,  
or 600  $\Omega$

Ultra Low Distortion—0.0008% THD (typical-  
ly 0.0003%)

Three Banana Jack Outputs Including  
"Center Tap"

For communications and broadcast applications, Option 02 provides a fully balanced output with a maximum amplitude of +28 dBm into 600 ohms from 50 ohms. A ten-position (10 dB per step) attenuator and a variable attenuator with a minimum 10 dB range reduce the SG 505 Option 02 output to below -78 dBm into 600 ohms. These output signals appear on the front panel at 3/4 inch spaced banana jacks with a third banana jack providing a "CT" center tap. A pushbutton switch allows grounding or floating the center tap.

A front panel switch enables selection of three different source resistances: 50 ohms for low impedance applications (improves measurement accuracies on long cable runs and reduces loading effects), 150 ohms for matching microphone circuits, and 600 ohms for complying with audio/communication industry standard and general purpose applications. In the 50 ohm position, the SG 505 Option 02 delivers +28 dBm into a 600 ohm balanced load, or typically +30 dBm into 150 ohms. In the 600 ohm position, the SG 505 Option 02 delivers a calibrated +22 dBm into a 600 ohm balanced load.

The Option 02 retains the ultra-low distortion of the SG 505 through 50 kHz and includes the Option 01 intermodulation test signal.

## CHARACTERISTICS MAIN OUTPUT

**Frequency Range** — 10 Hz to 100 kHz in four overlapping bands. Accurate within 3% of dual setting (with Vernier at center). Vernier Range is at least  $\pm 1\%$  of frequency setting.

**Calibrated Output** — Selectable from +22 dBm to -68 dBm into 600  $\Omega$  in ten 10 dB steps. Accurate to within 0.2 dB at +22 dBm and 1 kHz. Step accuracy is  $\pm 0.1$  dB/10 dB step or 20 dB step change. An uncalibrated control provides continuous variation from  $< -10$  dB to +0.3 dB from calibrated position.

**Amplitude Response** — Level flatness  $\pm 0.1$  dB from 10 Hz to 20 kHz (1 kHz ref); within 0.2 dB from 20 kHz to 100 kHz (excluding  $> 50$  kHz on -58 dB and -68 dB output level ranges).

**Harmonic Distortion** —  $< 0.0008\%$  (-102 dB) THD from 20 Hz to 20 kHz (typically 0.0003%); 0.0018% (-95 dB) THD from 10 Hz to 20 Hz, and from 20 kHz to 50 kHz; 0.0056% (-85 dB) THD from 50 kHz to 100 kHz ( $R_L \geq 600 \Omega$ ).

**Output Impedance** — Selectable 600  $\Omega \pm 2\%$ , 150  $\Omega \pm 2\%$  or 50  $\Omega \pm 3\%$  floating or grounded through  $\approx 30 \Omega$ . Output impedance does not change with Output On/Off selection. Impedance to CT is 1/2 the selected impedance. Maximum floating voltage  $\pm 25$  V peak.

**Maximum Output Voltage** — At least 21 V RMS open circuit; 19.45 V RMS (+28 dBm) into 600  $\Omega$  from 50  $\Omega$ .

**Balance** —  $\leq 0.5\%$  mismatch of output open-circuit voltages referenced to CT for  $f \leq 20$  kHz with output Grounded.

### INCLUDED ACCESSORIES

Cable assembly for sync output (175-1178-00).

Order SG 505 Option 02 Oscillator .... **\$1,360**  
**SC 501**

### 5 MHz Bandwidth

### Single Compartment Size

### 6.4 cm (2.5 inches) CRT

### Versatile Operating Features

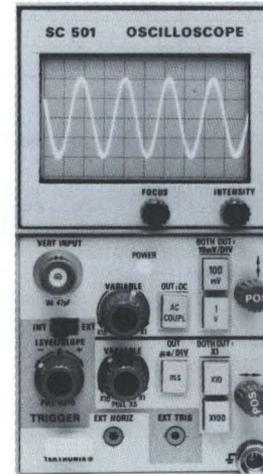
The SC 501 is a single-channel, 5 MHz plug-in unit oscilloscope with a 2.5 inch CRT display that occupies a single TM 500 Series plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500 Series Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500 Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 Mainframe, it can be used on the bench, in a rack, or on the road. The single-channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by pushbutton logic in decade steps from 1  $\mu$ s/div to 100  $\mu$ s/div (microsecond range), and from 1 ms/div to 100 ms/div (millisecond range). A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for

## SC 501



### 5 MHz Oscilloscope

many auxiliary functions, for example sweeping a voltage-controlled frequency oscillator.

The triggering circuits allow stable triggering from either internal or external sources. An Auto triggering mode and manual Level/Slope selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

An internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

## CHARACTERISTICS VERTICAL DEFLECTION

**Bandwidth** — Dc to  $> 5$  MHz.

**Deflection Factors** — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

**Input Coupling** — Ac or dc.

**Input Impedance** — 1 M $\Omega$  paralleled by 47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac).

## HORIZONTAL DEFLECTION

**Time Base** — Calibrated sweep rates: 1  $\mu$ s/div to 100 ms/div in decade steps. Uncalibrated (variable) range: extends slowest calibrated rate to  $\geq 1$  s/div. X5 magnifier (fixed): extends fastest calibrated sweep rate to 200 ns/div. Accuracy (over center 8 div):  $\geq 5\%$  for all sweep rates. Linearity (any two div portion within center eight div):  $\geq 5\%$ .

**External Horizontal Amplifier** — Bandwidth: dc to 100 kHz. Input Impedance:  $\geq 100$  k $\Omega$  paralleled by 25 pF. Maximum input voltage:  $\pm 3$  V.

## TRIGGER

**Normal Trigger Sensitivity (Trigger Level/Slope In)** — Internal: dc coupled, 0.4 major div of deflection at dc; Increasing to 1.0 major div of deflection at 5 MHz. External: dc coupled, 1 V minimum to 5 V maximum from dc to 5 MHz. External trigger input impedance: 22 k $\Omega$  paralleled by  $\approx 150$  pF.

**Auto (Trigger Level/Slope Out)** — Sweep free-runs without trigger signal, or for trigger repetition rates below 10 Hz.

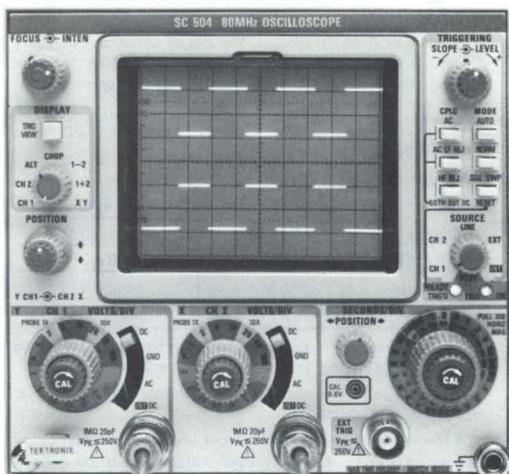
## CRT

**Phosphor** — P31.

**Graticule** — 6 X 10 div (0.203 in per div).

Order SC 501 5 MHz Oscilloscope .... **\$1,200**

SC 504



80 MHz Oscilloscope

SC 504

80 MHz Bandwidth

5 mV/div Maximum Sensitivity

5 ns/div Maximum Calibrated Sweep Rate

Enhanced Automatic Triggering

True X-Y Capability

Switchable Rear Interface Capability

The SC 504 Plug-in Oscilloscope makes many new configurations possible, especially for those applications demanding higher bandwidth capabilities. A double-wide plug-in, the SC 504 is compatible with all existing TM 500/TM 5000 Plug-ins and multi-compartment mainframes.

The SC 504 is a general purpose, dual-trace, non-delayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH 1 + CH 2), differential (CH 1 - CH 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable CH 1, CH 2 and ext trig inputs). Enhanced auto triggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use.

CHARACTERISTICS

VERTICAL DEFLECTION

**Bandwidth at -3 dB points** — Dc to at least 80 MHz from 0°C to +35°C; dc to at least 70 MHz from +35°C to +50°C.

**Risetime** — 4.4 ns or less from 0°C to +35°C; 5 ns or less from +35°C to +50°C.

**Ac Low Frequency Response (lower -3 dB points)** — Without probe, 10 Hz; with 10X probe, 1 Hz.

**Deflection Factors** — Calibrated Range: 5 mV to 10 V/div, 11 steps in a 1-2-5 sequence.

**Accuracy** — ±2%, +15°C to +35°C; ±3%, 0°C to +50°C. Uncalibrated Range — Continuously variable between calibrated steps. At least 2.5:1 range. Extends maximum deflection factors to at least 25 V/div.

**Modes** — CH 1, CH 2, Alt., Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

**Input R and C** — 1 MΩ ±1% paralleled by ≈20 pF.

**Maximum Input Voltage** — 250 V (dc + peak ac), 500 V peak-to-peak ac at 1 kHz or less.

**Common-Mode Rejection Ratios** — At least 50:1 up to 1 MHz, and 10:1 from 1 MHz to 10 MHz when using the same attenuator settings; common-mode signal 5 divisions or less.

**Position Range** — ±6 div.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Calibrator** — 0.6 V, ±1%, ≈1 kHz frequency.

HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates for 5 ns/div. Uncalibrated (variable) Range — The CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 0.5 s/div.

**Sweep Rate Accuracy** — Measured over center 8 divisions, excluding first 50 ns and all after the first 100 divisions of magnified sweep. Derate accuracies by an additional 1% from 0°C to +15°C, and +35°C to +50°C.

	+15°C to +35°C	
	X1	X10
20 ms/div to 0.2 μs/div	±2%	±3%
0.2 s/div to 50 ms/div	±3%	±4%
0.1 μs/div to 50 ns/div	±3%	±4%

**Trigger Holdoff** — CAL (variable) control, if selected by an internal switch, increases trigger holdoff time by a factor of at least 20.

**X-Y Mode** — Bandwidth: dc to at least 2 MHz. Deflection Factor, selected by Channel 2 controls and horizontal mag X1, X10 with 5% accuracy. X and Y amplifier phase difference, less than 3° at 50 kHz or less. Input parameters same as Channel 2.

TRIGGER

**Trigger Modes** — AUTO, NORM, and SGL SWP.

**Enhanced Auto Trigger** — The trigger circuit automatically adjusts to spread the peak-to-peak signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, LINE, EXT. INT.

**Trigger Coupling** — Ac, ac LF REJ, ac HF REJ, dc.

**Trigger Sensitivity** — Minimum Peak to Peak Signal Required.

Coupling	Source	Dc to 30 MHz	30 MHz to 80 MHz
Dc	CH 1, CH 2 External Interface	0.4 div 60 mV Typically 50 mV	1.0 div 150 mV Typically 100 mV to 50 MHz
Ac	Requirements increase below ≈50 kHz		
Ac LF REJ REJ	Requirements increase below ≈10 kHz		
HF REJ	Requirements increase above ≈50 kHz		

**External Triggering Level Range** — ≥ ±1.4 V.

**External Triggering Input** — Input R and C — 1 MΩ ±10% paralleled by approximately 24 pF. Maximum Input Voltage — 250 V (dc + peak ac); 250 V peak-to-peak at 1 kHz or less.

**AUTO Mode** — Sweep free runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approximately the peak-to-peak range of the triggering signal.

**Single Sweep** — Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only.

CRT

**Phosphor** — P31.

**Acceleration Potential** — ≈12 kV.

**Graticule** — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

REAR INTERFACE

**CH 1 and CH 2 Vertical Inputs** — Selected by CH 1 and CH 2 coupling in INT (interface) position. Input impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

**Trigger Input** — Selected by TRIGGER SOURCE switch in INT (interface) position. Input impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈40 pF.

**Z-Axis Input** — Input Impedance: ≈1.5 kΩ. +5 V turns beam ON from OFF condition, -5 V turns beam OFF from ON condition.

**Channel 1 Output** — At least 50 mV/div. Bandwidth: at least 30 MHz. Output Impedance: <50 Ω.

**Ramp Output** — 0 to +10 V ramp. Output resistance ≈50 Ω.

ENVIRONMENTAL CAPABILITIES

**Temperature** — Operating: 0°C to +45°C (to +50°C in mainframes equipped with fan). Nonoperating: -55°C to +75°C.

**Altitude** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

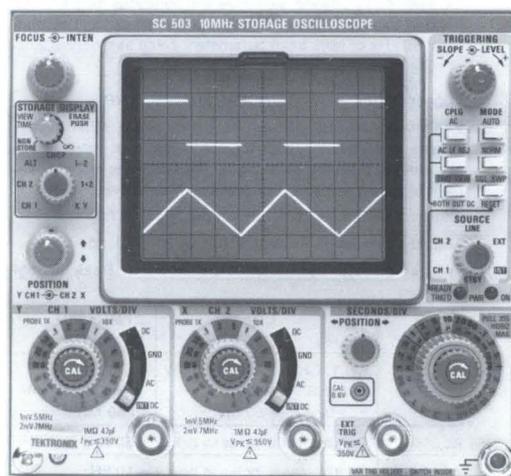
**Order SC 504 80 MHz Oscilloscope .. \$3,000**

RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X or 10X. See pages 438, 441.

Compatible accessories begin on page 410.

## SC 503



## SC 503

### 10 MHz Bandwidth

### Bi-stable Storage Auto-Erase

### Trigger View

### Variable Holdoff

### Switchable Front/Rear X and Y Inputs

### Rear Z-Axis Input

### True X-Y Capability

The SC 503 is a non-delayed sweep, general purpose storage oscilloscope that is compatible with five of our TM 500 Mainframes, (TM 503, TM 504, TM 515, TM 506 and RTM 506).

Because the SC 503 is a storage oscilloscope, it can be used to store and display waveforms after the input signal is removed. This feature is particularly useful when measuring slow repetition rates or single-shot signals, important in the biomedical and mechanical measurements fields. Low frequency signals at heart or respiration rates can be stored for detailed analysis. In the mechanical measurements field the SC 503 can "freeze" fast or transient signals from transducers, which is especially useful in pressure-and velocity-versus-time analysis and shock testing.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

Major features of the SC 503 also include an auto-erase mode that erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including : acoustic speech testing, nerve potential testing, and optical stimulus response testing.

## CHARACTERISTICS

### VERTICAL DEFLECTION

**Bandwidth at -3 dB points** — Dc to at least 10 MHz, (5 mV/div to 20 mV/div); dc to at least 7 MHz (2 mV/div), dc to at least 5 MHz (1 mV/div).

**Risetime** — 5 mV to 20 V/div, typically 35 ns or less.

**Ac Low-Frequency Response (lower -3 dB points)** — Without probe, 10 Hz; with 10X probe 1 Hz.

**Deflection Factors** — Calibrated Range: 1 mV/div to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy — 5 mV to 20 V/div (+15°C to +35°C) ±3%, 1 mV/div and 2 mV/div ±5%; (derate accuracy by additional 1% for 0°C to +50°C). Uncalibrated Range: at least 2.5:1 continuously variable between calibrated steps: Extends maximum uncalibrated deflection factor to at least 50 V/div.

**Modes** — CH 1, CH 2, ALT, CHOP, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

**Input Impedance** — 1 MΩ ±1% paralleled by ≈47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac), 700 V p-p ac at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.

**Common-Mode Rejection Ratio** — At least 50:1 at 1 MHz when using same attenuator setting, in CH 1 minus CH 2 mode.

**Delay Line** — Permits viewing leading edge of displayed waveform.

**Calibrator** — 0.6 V, ±1%, ≈1 kHz frequency.

**Position Range** — ±6 div.

**Channel Isolation** — 2% or less display related crosstalk to 10 MHz.

**Displayed Noise** — <0.2 mV p-p at 1 mV/div.

### HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated sweep rates: 2 s/div to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 50 ns/div. Uncalibrated (variable) range provides continuously variable sweep rates, between the calibrated rates, and extends the slowest rate of at least 5 s/div.

#### Sweep Rate Accuracy

+15°C to +35°C	X1	X10
2 s/div to 0.5 s/div	±4%	±5%
0.2 s/div to 5 μs/div	±3%	±4%
2 μs/div to 0.5 μs/div	±4%	±5%

Derate accuracy by an additional 1% from 0°C to +15°C and +35°C to +50°C.

**Trigger Holdoff** — At least 20:1 range internally selectable.

**X-Y Mode** — Bandwidth: dc to at least 500 kHz. Deflection Factor: selected by CH 2 controls and Horizontal Mag X1, X10. Phase Difference: <3° at 50 kHz or less.

## TRIGGER

**Trigger Modes** — AUTO (enhanced), NORM, and SGL SWP (single sweep).

**Enhanced Auto Trigger** — The trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Sources** — CH 1, CH 2, LINE, EXT, INT (rear interface).

**Trigger Coupling** — Dc, ac, ac LF REJ.

**Trigger Sensitivity\*** — Minimum p-p signal required.

Source	dc to 5 MHz	5 MHz to 10 MHz
CH 1, CH 2	0.4 div	1.0 div
External	60 mV	150 mV
Interface	Typically 35 mV	Typically 80 mV

\*With ac coupling requirements increase below ≈50 Hz. With ac LF REJ coupling requirements increase below ≈10 kHz.

**Triggering Level Range** — External: at least ±1.2 V. Internal: at least -6.0 divisions.

**External Triggering Input** — Input Impedance: 1 MΩ, paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac), 350 V p-p at 1 kHz or less. Above 1 kHz recommended p-p ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz.

**Auto Mode** — Sweep free-runs in the absence of a triggering signal. Level control range automatically varies with the triggering signal amplitude for frequencies above 100 Hz.

**Single Sweep** — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only.

## STORAGE SYSTEM

**Stored Writing Speed (center 6 x 8 divisions)** — At least 80 div/ms (50 cm/ms).

**Erase Time** — 400 ms to 600 ms.

**Auto-Erase Viewing Time** — Continuously variable from ≤0.5 s to ≥5 s.

**Maximum Recommended Storage Time** — ≈4 hours.

## CRT

**Phosphor** — P44.

**CRT Graticule** — 8 x 10 div., 0.25 in/div (0.64 cm/div). Internal graticule lines.

## REAR INTERFACE

**CH 1 and CH 2 Vertical Inputs** — Selected by CH 1 and CH 2 coupling in INT (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈100 pF.

**Trigger Input** — Selected by Trigger Source switch in Int (interface) position. Input Impedance: 50 Ω, when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by ≈60 pF.

**Z-Axis Input** — Input Impedance: ≈1.5 kΩ. +5 V turns beam On from Off condition, -5 V turns beam Off from On condition.

**CH 1 Output** — At least 50 mV/div. Bandwidth: at least 4 MHz. Output Impedance: 50 Ω.

**Ramp Output** — 0 to +10 V ramp Output impedance ≈500 Ω.

## ENVIRONMENTAL CAPABILITIES

**Temperature** — Operating: 0°C to +45°C (0°C to +50°C in mainframe equipped with a fan). Maximum operating temperature decreased by 1°C/1000 feet from 5000 feet to 15,000 feet. Nonoperating: -55°C to +75°C.

**Altitude** — Operating: to 4500 m (15,000 ft). Nonoperating: to 15 200 m (50,000 ft).

## Order SC 503 10 MHz Storage

Oscilloscope ..... **\$3,240**

## RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X or 10X. See pages 438, 441.

Compatible accessories begin on page 410.

SC 502



15 MHz Dual-Trace Oscilloscope

SC 502

15 MHz Bandwidth

Dual-Trace

20 ns/div Maximum Calibrated Sweep Rate

1 mV/div Maximum Sensitivity

Delay Line

Trigger View

Variable Trigger Hold-off

Enhanced Automatic Triggering

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope designed to operate in any two adjacent compartments of a TM 500 Power Module/Mainframe. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.

As with many Tektronix Products, the SC 502 features circuits, sub-circuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disk memories, key-to-tape, printers, plotters, punches, readers, and terminals. The CRT of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.

The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interfacing capability of the SC 502 and all TM 500 Instrumentation suggests exceptional applicability to systems of built-in test equipment or rackmounted installations. The TM 515 Traveler Mainframe with the SC 502, forms a nucleus for sophisticated, compact field service "packages."

CHARACTERISTICS

VERTICAL DEFLECTION

**Bandwidth at -3 dB points** — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

**Risetime** — 5 mV to 20 V/div, 23 ns or less.

**Ac Low-Frequency Response (Lower -3 dB points)** — Without probe, 10 Hz; with probe (10X), 1 Hz.

**Deflection Factors** — Calibrated range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0° to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (variable) range. At least 2.5:1 range. Continuously variable between calibrated steps. Extends maximum attenuator step to at least 50 V/div.

**Modes** — CH 1, CH 2, ALT, CHOP, CH 1 MINUS CH 2. Chop rate at least 250 kHz. Triggering waveform is displayed instead of selected display when desired.

**Input Impedance** — 1 MΩ within 1% paralleled by ≈47 pF.

**Maximum Input Voltage** — 350 V (dc + peak ac), 700 V p-p at ac 1 kHz or less.

**Common-Mode Rejection Ratio (CH 1 minus CH 2 mode)** — At least 50:1 at 1 MHz when using same attenuator setting.

**Channel Isolation** — 2% or less display related crosstalk to 15 MHz.

**Displayed Noise** — ≤0.2 mV p-p at 1 mV/div.

**Position Range** — ±6 div.

**Calibrator** — Voltage, 0.6 V ±1%. Frequency, twice the power line frequency.

HORIZONTAL DEFLECTION

**Sweep Generator** — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (variable) Range: the CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

**Sweep Rate Accuracy** — Within 3% unmagnified, 4% magnified, +15°C to +35°C. Derated by an additional 1% for 0°C to +15°C and +35°C to +50°C.

**Trigger Holdoff** — CAL (variable) control, if selected by an internal jumper, increases trigger holdoff time by a factor of at least 20.

**External Horizontal Amplifier** — Bandwidth: dc coupled, dc to at least 2 MHz; ac coupled <50 Hz to at least 2 MHz. Deflection Factor, 50 mV/div within 5%. X and Y Amplifier Phase Difference: <3° at 50 kHz or less. Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

TRIGGER

**Enhanced Automatic Triggering** — In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

**Trigger Modes** — Auto (enhanced), Normal (auto button out), Single Sweep.

**Trigger Sources** — CH 1, CH 2, Line Ext.

**Trigger Coupling** — Dc, ac, ac LF Rej.

**Trigger Sensitivity** — Minimum p-p signal required.

Source	dc to 5 MHz	5 MHz to 15 MHz
CH 1, CH 2	0.4 div	1.0 div
External	60 mV	150 mV

With ac coupling requirements increase below ≈50 Hz. Ac LF Rej coupling requirements increase below ≈5 kHz.

**Triggering Level Range** — Internal: at least ±8 div. External: at least ±1.2 V.

**External Triggering Input** — Input Impedance: 1 MΩ within 2% paralleled by ≈47 pF. Maximum Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

**Auto Mode** — Sweep free-runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approximately the p-p range of the triggering signal.

**Single Sweep** — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. AUTO pushbutton must be in the OUT position for operation and for setting triggering controls.

CRT

**Phosphor** — P31.

**Deflection** — Electrostatic.

**Acceleration Potential** — ≈12 kV.

**Graticule** — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

ENVIRONMENTAL CAPABILITIES

**Temperature** — Operating: 0°C to +45°C (to +50°C in mainframes equipped with fan). Nonoperating: -55°C to +75°C.

**Altitude** — Operating: Sea level to 4500 m (15,000 ft). Nonoperating: Sea level to 15 200 m (50,000 ft).

**Order SC 502 15 MHz Oscilloscope .. \$2,210**

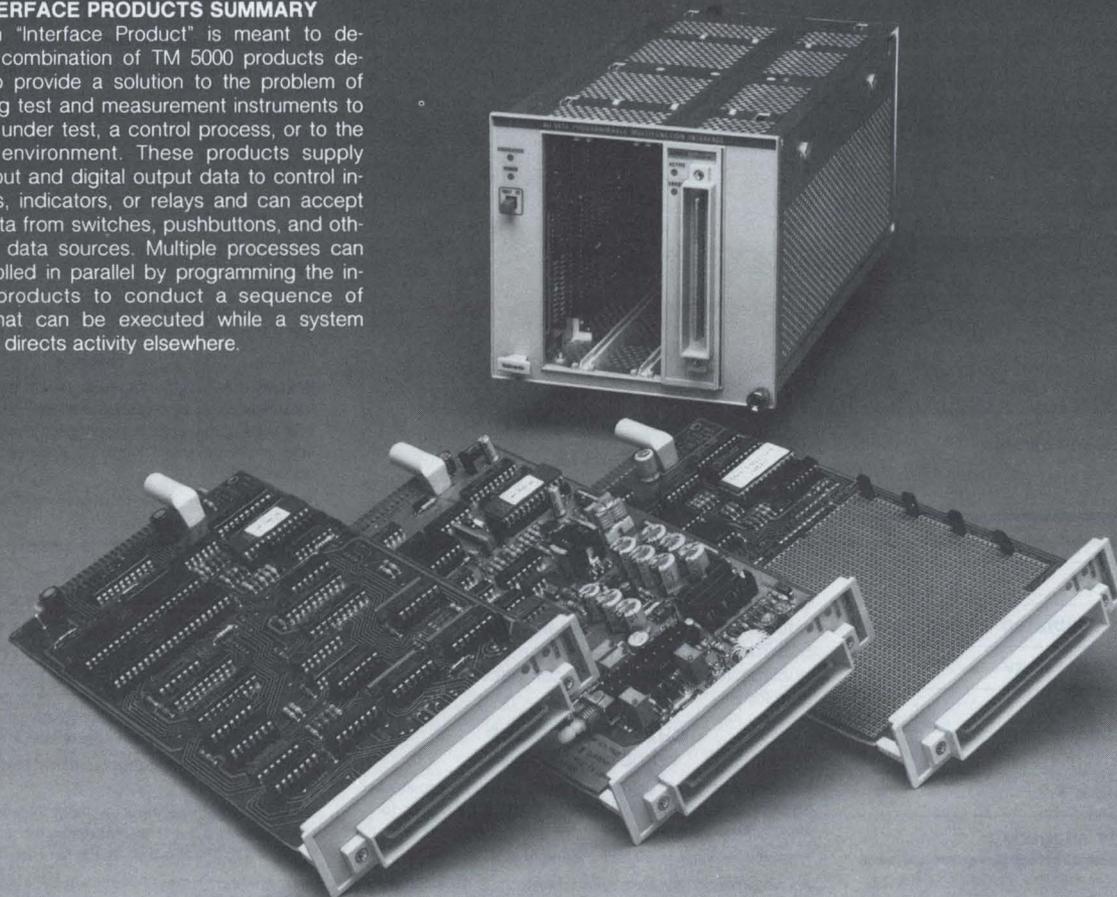
RECOMMENDED PROBES

P6101 1X, P6108 10X, P6062B 1X or 10X. See pages 438, 441.

Compatible accessories begin on page 410.

**INTERFACE PRODUCTS SUMMARY**

The term "Interface Product" is meant to describe a combination of TM 5000 products designed to provide a solution to the problem of interfacing test and measurement instruments to a device under test, a control process, or to the external environment. These products supply digital input and digital output data to control instruments, indicators, or relays and can accept digital data from switches, pushbuttons, and other digital data sources. Multiple processes can be controlled in parallel by programming the interface products to conduct a sequence of events that can be executed while a system controller directs activity elsewhere.



**MI 5010**  
Programmable Multifunction Interface



The MI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

- **Customer Configured**

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- **Automatic Self-Test**

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- **Triggered Externally or on Command**

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- **Built in Real-Time Clock**

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- **Mnemonic Instructions**

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- **Instruction Buffer for Unattended Operation**

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- **UL 1244 Listed**

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The MI 5010 Programmable Multifunction Interface is a two-wide, TM 5000 Series plug-in capable of accepting a total of three function cards.

The MI 5010, with appropriate function cards installed, is a GPIB compatible system capable of:

— Producing, on command from a GPIB controller, either analog or digital output signals to control the events or conditions in an external system.

— Receiving, on request from a GPIB controller, input signals (analog or digital) from external sensor points that represent events or conditions in an external system.

The MI 5010 has its own intelligence and a built in buffer capable of storing from 80 to 300 commands (depending on command length). The buffered commands are sequenced in order and can be paced with a time-of-day clock, built-in wait timer, external trigger or software trigger from the system controller.

One, two, or three function cards plug into the front of the MI 5010 and communicate with a microprocessor control card in the MI 5010 via the backplane connectors of the MI 5010.

Each function card in the MI 5010 or MX 5010 Multifunction Interface Extender contains its own ROM with the specific firmware required for that function. Each function can be programmed with its own, unique set of software commands.

**Order MI 5010 Multifunction Interface .. \$1,550**

**MX 5010**  
Multifunction Interface Extender

The Multifunction Interface Extender is a two-wide, TM 5000 plug-in which, when used, mechanically attaches to the MI 5010 and provides the capability of accepting three extra function cards into the system. The multifunction interface extender is electrically identical to the MI 5010 with the microprocessor control card removed. The combination of the MI 5010 and the MX 5010 allows a total of six function cards to be controlled by the microprocessor control card in the MI 5010 via commands from the GPIB. Digital control signals between the MX 5010 and the MI 5010 are connected via a flat ribbon cable at the backplane connector.

**Order MX 5010 Interface Extender ..... \$650**

**NEW**

**50M20**  
Programmable D/A Converter

- 12-Bit Resolution
- Voltage or Current Mode
- 20  $\mu$ s (maximum) Conversion Time
- 250 V RMS Isolation
- Mnemonic Instructions
- Self-Test and Error Indicators
- UL 1244 Listed

The Programmable Digital-to-Analog converter is a function card used in either the MI 5010 or MX 5010. The 50M20 contains its own ROM with the specific firmware required for the card, and is programmed with its own set of software commands.

The 50M20 converts digital data to either analog voltage or current. The voltage or current mode is selectable manually via an on-board switch.

Data format is 12 bits, sent in two sequential 7-bit words. Data may be sent via the IEEE Standard 488 (GPIB) using the MI 5010 as the interface, or from an external (front connector) bus for high speed data transfer (with appropriate handshake lines). On-board firmware will convert commands and data to the proper format to perform the required digital-to-analog conversion. Two lines at the front panel connector are provided to handshake data into the 50M20 from the user's external system.

Programming of the 50M20 is via the IEEE-488 (GPIB) bus. System commands sent to the MI 5010 microprocessor, along with specialized programming commands unique to the 50M20, control the source and the format of the digital data. The 50M20 may be programmed to respond to either external or internal system triggers.

**50M20 CHARACTERISTICS**

- Voltage Mode**
- Range** — -10.240 V to +10.235 V.
- Accuracy** —  $\pm 10.0$  mV (20 to 30°C)  $\pm 15$  mV (0 to 50°C).
- Resolution (1 LSB)** — 5 mV.
- Total Conversion Time (Maximum)** — 20  $\mu$ s.
- Output Ripple and Noise** —  $< 5$  mV, p-p, at 5 MHz BW.
- Output Current Range** — 0 to  $\pm 5$  mA.
- Current Mode**
- Range** — -20.48 mA to +20.47 mA.
- Accuracy** —  $\pm 20$   $\mu$ A (20 to 30°C)  $\pm 40$   $\mu$ A (0 to 50°C).
- Resolution (1 LSB)** — 10  $\mu$ A.
- Total Conversion Time (Maximum)** — 20  $\mu$ s.
- Output Ripple and Noise** —  $< 15$   $\mu$ A, p-p, at 5 MHz BW.
- Compliance Voltage** —  $\pm 11$  V.
- Isolation** — 250 V RMS maximum to ground.

**Order 50M20 Digital-to-Analog Converter Card ..... \$800**

**50M30**  
Programmable Digital Input/Output Card

- 16 Digital Input and 16 Digital Output Lines
- Data Entry/Output Formats in Decimal, Binary, or Hex
- Triggered Externally or on Command
- Mnemonic Instructions
- Self-Test and Error Indicator
- UL 1244 Listed

The Programmable Digital Input/Output Card is a function card used in either the MI 5010 or the MX 5010. The 50M30 contains its own ROM with the firmware specified for the card, and is programmed with its own set of software commands.

The 50M30 provides 16 digital input and 16 digital output lines. The digital inputs accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. The digital outputs provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The digital outputs can be configured for open-collector outputs by positioning internal jumpers and using power supplied by the user.

Programming of the 50M30 is via the IEEE-488 (GPIB) bus. System commands sent to the MI 5010 Microprocessor, along with specialized programming commands unique to the 50M30, control the selection of the data input/output channels and the arming/trigger functions of the card.

Four lines at the front panel connector operate as input/output pairs to handshake data with the user's external system. One handshake pair allows the user's data source to be synchronized with the 50M30 data input register and the other handshake pair allows the user's data storage device to be synchronized with the 50M30 data output register.

**50M30 CHARACTERISTICS**

- Data Outputs Using Internal Supply** — 16 open-collector TTL with 2 k $\Omega$  pullup resistors. Logical "1": +5 V  $\pm 2\%$  (open circuit). Source current -2.5 mA  $\pm 7\%$  maximum. Logical "0": 0.2 V. Sink current -40 mA maximum.
- Data Outputs Using External (User) Supply** — Maximum Voltage: +15 V. Pull-up Resistors; 2 k $\Omega$ . Logical "1" Equal to external supply voltage (open circuit). Source current = 7.5 mA  $\pm 5\%$  plus external supply tolerance. Logical "0": 0.2 V. Sink current 40 mA maximum.
- Data Inputs** — Input Buffers; 16 Schmitt triggers. Logical "1" (+V threshold); +1.6 V  $\pm 25\%$ . Source current = -0.14 mA nominal, -0.16 mA maximum. Logical "0" (-V threshold); +0.8 V  $\pm 40\%$ . Source current = -0.18 mA nominal, -0.21 mA maximum.

**Order 50M30 Digital Input/Output Card \$425**

**50M40**  
Programmable Relay Scanner Card

- 16 Mercury Wetted Relay Contacts
- User Configurable
 

1	1 of 16
2	1 of 8
4	1 or 4
- Triggered Externally or on Command
- Mnemonic Instructions
- Self-Test and Error Indicators
- UL 1244 Listed

The Programmable Relay Scanner Card is a function card used in either the MI 5010 or MX 5010. The 50M40 contains its own ROM with the firmware specified for the card, and is programmed with its own set of software commands.

The 50M40 provides 16 independent, normally-open relay contacts. The relay contacts may be used as switch closures to supply power to several external points from one source, or scan several sources and supply various inputs to a single measurement device.

The desired relay switch pattern is configured by the user with internal jumpers. When the configuration has been established, the relay scanning sequence, open and close operations, and triggering events are programmed over the IEEE-488 GPIB bus.

Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (READY) to indicate to the user when the relays have settled, and the other as an input (EXT TRIG) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close. Three possible configurations are:

- 4 groups of 4 individual relays
- 2 groups of 8 individual relays
- 1 group of 16 individual relays

Scanning sequence and relay closure is accomplished under program control. Two logic signal lines on the front panel connector are provided for externally controlling the 50M40—one as an output (Ready) to indicate to the user when the relays have settled, and the other as an input (Ext Trig) to tell the MI 5010 Microprocessor that the user is ready for the relay switch configuration to close.

**50M40 CHARACTERISTICS**

- Type of Relays** — Mercury wetted reed.
- Possible Configurations (Jumper Selectable)** — 1 of 4, 4 each. 1 of 8, 2 each. 1 of 16, 1 each. 1 of 12 and 1 of 4, 1 each. Pull In Time; 3 ms, nominal. 30 V connected to common port through 30 k $\Omega$ . Release Time; 3 ms, nominal. Sequence through all relays. Contact Resistance; 0.5  $\Omega$  nominal (end of life). Peak Applied Voltage; 40 V, maximum. Peak Contact Current; 1A, maximum. Breakdown Voltage; 100 V dc plus peak ac. Frequency Range; Dc to 1 MHz.

**Order 50M40 Relay Scanner Card ..... \$600**

**50M70 Programmable Development Card**

32 Data I/O Ports

Interrupt and Trigger Lines

Vector Board Development Region

Mnemonic Instructions

Self-Test and Error Indicator

UL 1244 Listed

The Programmable Development Card is a function card used in either the MI 5010 or the MX 5010. The 50M70 contains its own ROM with the firmware necessary for IEEE Standard 488 operation of a user's specialized circuit.

The 50M70 contains two interface logic registers, address and data buffers, a breadboard area for user development, and (as previously mentioned) its own firmware.

**Possible applications are:**

- Specialized DAC/ADC functions
- Timing functions
- Special communication interface functions
- Keyboard/Display functions, etc.

**Special features of the 50M70 include:**

- Programmable data direction registers (input/output)
- Programmable trigger conditions
- Programmable data transfer, register configuration, status, and interrupts
- Front panel edge connector configured by the user

**50M70 CHARACTERISTICS**

**I/O through I/O 7** — Open-circuit voltage on Pins 1 through 8 on J1200, J1202, J1210, and J1214. Output High Level; +2.4 V minimum, +5.5 V maximum. Output Low Level; 0 V minimum, +0.4 V maximum. Load current = 1.6 mA nominal. Maximum Load (Sink) Current (Any Output); 3.2 mA at 0.4 V dc. Input Low Current; 1.3 mA nominal, 2.4 mA maximum.  $V_{in}$  = 0.4 V dc. User Ground Points; Analog Ground; TP1201, TP1202. Digital Ground; TP1211, TP1212.

**Active Indicator Voltage** — Output High Level; +2.4 V minimum, +5.5 V maximum. J1216, Pin 1 pulsed for 20 ms or greater.

**Ready Lines** — Pin 10 on J1200 and J1210. Output High Level; +2.4 V minimum, +5.5 V maximum.  $I_{Lr}$  = -200  $\mu$ A. Output Low Level; 0 V minimum, 0.4 V maximum.  $I_L$  = 3.2 mA maximum.

**Trig Lines** — Inputs on Pin 9 of J1200, J1202, J1210, and J1214; Input leakage current = 1.0  $\mu$ A minimum, 2.5  $\mu$ A maximum. Minimum Hold Time; 3  $\mu$ s.

**Accept/Error Lines** — Pin 10 of J1214 and Pin 10 of J1202. Output High Level; +4.5 V minimum, +5.5 V maximum.  $I_L$  = 10  $\mu$ A. Output Low Level; 0 V minimum, +0.4 maximum.  $I_L$  = 3.2 mA maximum.

**Error Line States** — High during self-test, goes low if no error. J1201, Pin 1; +26 V dc,  $\pm$ 9%. 100 mA maximum. J1201, Pin 2; -26 V dc,  $\pm$ 9%. 100 mA maximum. J1212, Pin 1; +8 V dc,  $\pm$ 5%. 600 mA maximum. J1212, Pin 2; +5 V dc,  $\pm$ 5%. 1.5 A maximum.

**Total Combined Power Limit** — Not to exceed 7.5 W.

**INCLUDED ACCESSORIES**

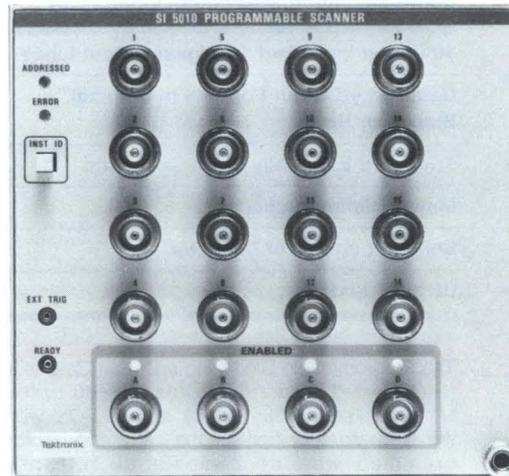
Function Card Extender Cable (015-0430-00).

**Order 50M70 Development Card ..... \$350**

**OPTIONAL ACCESSORIES**

Function Card Extender Cable Order 015-0430-00 ..... \$50

**SI 5010**



**Programmable Scanner**

**SI 5010**



The SI 5010 complies with IEEE Standard 488-1978, and with Tektronix *Standard Codes and Formats*.

Software Configured

Mnemonic Instructions

Triggered Externally or on Command

Built in Real-Time Clock

Instruction Buffer for Unattended Operation

350 MHz Bandwidth (1 ns Risetime)

UL 1244 Listed

The SI 5010 Scanner is a two-wide, TM 5000 plug-in capable of scanning and switching 16 different signal channels, or a combination of signal channels, under program control. Optimum frequency response is 350 MHz.

Of the 20 front panel BNC connectors used for channel switching, 16 are connected internally to 16 R.F. reed relays and four are connected to common points. The common points act as output connectors to an external system. The 16 relays can be programmed to connect to the common points in various combinations. Three possible combinations are:

- 4 groups of 4 channels
- 2 groups of 8 channels
- 1 group of 16 channels

For scanning, channel grouping is always done in groups of four with each individual channel exhibiting a characteristic impedance of 50 ohms and providing minimum signal degradation when configured for one or more groups of four individual channels. Channel risetime for groups of four channels is approximately 1 ns and degrades to about 4.0 ns for 1 group of 16.

Under program control it is possible to build a matrix using any or all 16 input channels while leaving the normal output channels disconnected. The possible number of combinations precludes characterization, and it is recommended that any such matrix established be characterized if degradation of signal quality is a consideration.

The SI 5010 has its own intelligence and a built in buffer capable of storing from 80 to 300 commands (depending on command length). The buffered commands are sequenced in order and can be paced with a built-in real time clock, built-in wait timer, external trigger or software trigger from the system controller.

**SI 5010 CHARACTERISTICS**

**RF Connectors** — Twenty BNC connectors, 16 channels and four commons.

**Control Input (Ext Trig)** — External Trigger; TTL compatible  
**Control Output Data Accepted (READY)** — TTL compatible. Output goes high when relays have settled.

**Channel Configuration (Software Selectable)** — 1, 2, 3, or 4 groups of 4 channels. 2 groups of 8 channels. 1 group of 16 channels.

**Frequency Response** — Any 1 group of 4; -3 dB at 350 MHz, decreasing to -6 dB at 500 MHz or greater. Any 1 group of 8; -3 dB at 175 MHz or greater. Any 1 group of 16; -3 dB at 80 MHz or greater.

**Port (Channel) Isolation** — 40 dB at 100 MHz.

**Characteristic Impedance (Each Channel)** — 50  $\Omega$ . See VSWR specification.

**Risetime (Each Channel)** — <1 ns.

**Voltage Standing Wave Ratio (VSWR)** — Any 4 channel group; 1.25:1 at 100 MHz, increasing to 1.8:1 at 350 MHz. Any other combination; 1.5:1 at 100 MHz. 2:1 at 225 MHz.

**Insertion Loss** — <1 dB at 100 MHz.

**Channel Delay Matching** — Any group of 4; 50 picoseconds. Any group of 8; 110 picoseconds. Group of 16; 310 picoseconds.

**Type of Relays** — 16 Form A, EAC 05Y21A1 40 BAB, or equivalent. 4 Form "C", TO-5, Teledyne 712-6, or equivalent. Pull In Time; 3 milliseconds. Release Time; 3 milliseconds. Breakdown Voltage; 350 V (dc + peak ac). Series Path Resistance (End of Life); 0.5  $\Omega$ .

**Peak Carry Voltage** — Unterminated; 40 V maximum. 50  $\Omega$  terminated; 12.5 V maximum.

**Peak Contact Current** — 0.25 A maximum.

**Peak Switching Voltages** — Unterminated; 15 V maximum. 50  $\Omega$ ; 3.73 V Maximum.

**Peak Switching Current** — 0.01 A maximum.

**Order SI 5010 Scanner ..... \$1,850**



## 4041 System Controller

**GPIB**  
IEEE-488

The 4041 complies with IEEE Standard 488-1978 and with Tektronix *Standard Codes and Formats*.

**Optimized for Instrumentation Control**

**Modular Design – Rackmount or Portable**

**Efficient, Easy to use BASIC Language with Extensions**

**Expandable Capability Through Memory (to 160 kBytes) and Other Options**

The 4041 Controller is a powerful, flexible, expandable IEEE Standard 488 systems controller designed to work with Tektronix and other vendor's IEEE Standard 488 instruments. While the basic unit is intended principally for low user-skill environments such as production line testing, a

variety of options and peripherals to equip the 4041 for full interactive flexibility in research lab applications Tektronix full line of terminals (graphics or alphanumeric, storage or raster, and color) are fully compatible to create an optimum programmer interface in the more sophisticated areas. Software features similarly span the range from the occasional programmer to the sophisticated programming team tackling complex products. The basic 4041 compactness, coupled with TM 5000 IEEE Standard 488 instruments, permits very compact system configurations that go into applications impractical for earlier generations of systems.

### Operator Skill Spectrum

In test and measurement systems applications the computer skills of the operator typically range from moderately high to zero. Laboratory applications are frequently interactive, where the engineer/programmer/operator are all the same person. On a production test station, operator computer skills are often low. Unattended testing has no operator by definition. The 4041 controller was designed, with options and peripherals, to fit these differing needs. The standard 4041 is an "execute only" controller; it can run only previously developed programs. The operator cannot

tamper with programs, or even list them. The standard 4041 is non-intimidating, with operator interaction limited to reading prompts from the alphanumeric display, inserting a DC 100 tape cassette, and pressing a small number of keys. Extensive error handling and trapping capabilities can keep the system from "crashing" in almost all situations. Hard copy, perhaps for applications such as failure tags to be attached to a defective unit under test, can be automatically generated on the built-in printer. Up to four ports, two IEEE Standard 488 and two RS-232, permit networking to host computers, up to 28 IEEE Standard 488 instruments, or even segregation of fast and slow instruments onto two busses to maximize throughput.

At the sophisticated end of the operator spectrum, an RS-232 CRT terminal attached to a 4041 with program development ROM packs (Option 30) provides a flexible interactive workstation for the sophisticated programmer. Peripherals such as printers, plotters, and mass storage add further power. This configuration would be typical in research labs, or for the test engineer to develop programs that will then be run by lower-skilled operators on the production line with execute-only 4041s.

## Programmer Skill Spectrum

Most test programs are written by "electronics types", not computer science majors. Many test engineers write programs only occasionally, and subsequent modifications and maintenance are frequently done by a second party since "the guy who wrote the program doesn't work here anymore".

At the other end of the spectrum, however, are complex requirements demanding a team approach to writing the program and sophisticated and powerful techniques to maximize memory utilization and minimize run time.

BASIC is an excellent language for the occasional programmer, and was chosen for the 4041. Its English-like commands, simple syntax, and line-by-line interpreter implementation combine for friendly, easy use. To improve the self-documenting characteristics and thus reduce maintenance costs, 4041 BASIC is enhanced by several features. Variable names may be up to eight characters, allowing the programmer to select meaningful names like RISETIME, VOLTAGE1, or DELAY. Subprograms and program lines may be named, with examples such as SRQHNDL or CALCRMS.

Simple BASIC leaves much to be desired for most sophisticated programmers. 4041 BASIC includes many enhancements such as FORTRAN-like subprograms. Variable passing from main to subprograms and the ability to declare any variables as local or global means that a team of programmers can work quite independently on a massive task, with the main program ultimately being not much more than a series of subprogram CALL statements. Other powerful features include optional data types (short and long floating point plus integer), a COMPRESS command to optimize memory use, a proceed mode which overlaps I/O and processing operations for maximum system speed, logical unit assignment capability, and up to 160k bytes of memory directly addressable without overlays or paging techniques.

## 4041 Architecture

The 4041 controller contains three microprocessors. The CPU is the powerful 16-bit 68000. Standard memory is 32k bytes (approximately 19k user-available), with optional 32k increments to 160k maximum. A 20-character alphanumeric LED display, 20 character thermal printer, DC 100 cassette drive, 18 function keys, an IEEE Standard 488 port are standard. A real time clock and calendar capability are standard on the 4041. Option 01 adds a second pair of ports (one IEEE Standard 488 and one RS-232). The Option 01 IEEE Standard 488 port has Direct Memory Access capability. Other options include an 8-bit parallel TTL port, (Option 02) the program development ROMs and carrier (Option 30), and a program development/debug keyboard (Option 31). Options 30 and 31 could thus let a test engineer easily and temporarily convert an installed execute-only 4041 into a debug/edit mode, make necessary program changes, and restore it to the tamper-proof condition. Extensive program development, however, would normally be accomplished at a programming station consisting of an Option 30 4041 plus a CRT terminal to permit multi-line viewing of program listings.

Option 30 4041 plus a CRT terminal to permit multi-line viewing of program listings.

The 4041 package is a compact monolithic unit of identical height and width to the TM 5003 Power Module. A 4041 and TM 5003 can be easily fastened together and used on the bench or rack-mounted as a single unit, leading to extremely compact system configurations suitable for crowded benches and racks or use in vans, ships and aircraft.

## Test and measurement Orientation

The 4041 Controller was developed simultaneously with the TM 5000 instrument family, and optimized as an instrument controller. Many of the IEEE Standard 488 functions are simple high level commands in 4041 BASIC. Examples include ATN, GET, LLO, and several others. In its power-up default condition, the 4041 implements Tektronix *Standard Codes and Formats* and thus can communicate instantly with Tektronix IEEE Standard 488 instruments without any programmer attention to formats, syntax, delimiters, number format, etc. However, the 4041 also has virtually complete, programmable control over every IEEE Standard 488 line and condition. When this ability is combined with the 4041's Logical Unit assignment and stream specification ability, virtually any IEEE Standard 488 instrument or device can be easily handled. The stream specification ability means that a particular device's format, syntax, end-of-message character, and other idiosyncrasies can be described one time in a Logical Unit assignment statement. Thereafter, the programmer can control or obtain data from that instrument as easily as from an instrument that fully complies with Tektronix *Standard Codes and Formats*.

The error trapping and handling capabilities of the 4041 are of particular importance in test and measurement systems. Virtually any category of error — in instruments, peripherals, on the bus or even within the 4041 — can be trapped and handled by software drivers. When coupled to the powerful self-diagnostics and error reporting features of TM 5000 instruments, very fault-tolerant systems can be configured which demand little or no operator skill.

## CHARACTERISTICS

### FRONT PANEL KEYBOARD SYSTEM KEYS

**AUTO-LOAD** — Causes the internal magnetic tape to rewind and find the "AUTOLD" program. This program is then loaded into memory and execution begins.

**ABORT** — Halts program execution if no user-specified handler routine is called by the program. If a handler routine is specified for the ABORT key, program control is passed to that routine.

**PROCEED** — Performs one of the following functions depending on equipment or program state:

1. Causes program execution to start at the next program line if a PAUSE was encountered.
2. Resumes execution after an ABORT. If a program is loaded from the tape, execution starts from the first program line.
3. Delimits user input when requested from an INPUT statement.

**CLEAR** — Clears the alphanumeric display. Does not clear user-defined prompts or the input cursor from an INPUT statement.

**EEX** — Causes the number requested by an INPUT statement to be entered in scientific notation. Numbers entered after pressing the EEX (Enter Exponent) key are considered part of the exponent.

**PAUSE** — Halts the program after executing the current line. If the current program line is an INPUT statement, the program stops before the execution of INPUT.

### USER-DEFINABLE FUNCTION KEYS

Numeric user-definable function keys, 0-9, can be assigned subroutines by the applications program. The keys may be re-defined by the program during execution to allow for unlimited user routines. The function keys can be enabled or disabled under the control of a program.

Numeric values are assigned to these keys for entering information requested by an INPUT statement. When input has been completed, user functions assigned to these keys are re-enabled.

The other two keys on the front-panel keyboard are the decimal key (".") and the minus ("—") key. The decimal key is provided for decimal point entry associated with numeric and the minus key is used to enter negative numbers associated with numeric.

Keyboard overlays may be used for labeling the function keys with a number or an abbreviation of the user routines.

### FRONT-PANEL DISPLAY

The front-panel display communicates test procedures and operator prompts and displays intermediate or final program results. The display is fully programmable.

### ALPHANUMERIC DISPLAY

Twenty character alphanumeric line.

Sixteen segment LED.

Size: Height: 3.8 mm (0.15 in), width: 2.8 mm (0.11 in).

Characters per cm: 1.6 character/cm (4 characters/in).

Sixty-four character symbols.

Message Viewing Time — programmable.

Scrolling Rate — programmable.

### SYSTEM INDICATORS

LEDs located on the display front panel indicate the status of the system.

**BUSY** —

Indicates that a program is running. A blinking BUSY light indicates that the system has PAUSED (temporarily halted).

**POWER** —

Indicates the machine is on.

**I/O** —

Indicates that an Input/Output operation is being performed.

**FN** —

Indicates that the user-definable function keys are enabled.

### MAGNETIC TAPE DRIVE

Magnetic tape drive is used to store user's programs and data. The tape is the primary means of loading programs, particularly for execute-only applications; in addition, the tape drive provides for long-term unattended data logging.

**File Structure** — 48 named files (maximum).

**Capacity (physical records)** — 650 typical (600 minimum).

**Physical Record** — 256 bytes.

**Average Transfer Rate** — 10.24 kbits/s.

**Search Speed** — 60 in/s 1520 mm/s.

**Tape Rewind** — 60 in/s 1520 mm/s.

**Tape Cartridge** — 100A Certified Data Cartridge from Tektronix.

**PRINTER**

The printer produces hard copies of the intermediate or final program results, operator prompts, and changes in variables or system status. Messages longer than twenty characters are printed on succeeding lines where the user can specify the appropriate indentation for better delineation and readability.

**Printing Method** — Thermal, fixed head.

**Capacity** — 20-character alphanumeric line.

**Font** — 5 x 7 dot matrix printed.

**Character Size** — 2.5 mm high x 1.8 mm wide (0.10 in high x 0.07 in wide).

**Line Spacing** — 6 ± 1/2 lines/in.

**Printing Speed** — 2.0 ± 0.24 lines/s.

**Feed Speed** — 8.46 mm/s (0.34 in/s).

**Character Set** — 26 Uppercase letters  
26 Lowercase letters  
10 Numeric digits  
34 Special characters  
32 Control characters

128 Total

**Paper Size** — 60 mm x 25 m (2.36 in x 82 ft).

**CONTROLLING THE BUS**

The 4041 automatically controls all bus management signals in the proper sequence for the desired interface task and instrument interaction.

A bus management function program that uses direct IEEE Standard 488 mnemonic commands accommodates differences in implementation of GPIB on other equipment. Virtually all legal bus states can be programmed this way, which affords a high degree of flexibility for addressing various system applications.

**BUS INTERRUPTS**

The 4041 has the ability to detect and respond to various types of interrupt conditions that can be generated in the GPIB. User-specified software handlers can be written to perform various tasks when these conditions occur. Interrupts can be programmably ENABLED or DISABLED.

**Interrupt Conditions** —

Mnemonic	Message
SRQ	Service Request
EOI	End or Identify
IFC	Interface Clear
DCL	Device Clear
TCT	Take Control
MTA	My Talk Address
MLA	My Listen Address

**BUS COMMUNICATION**

Interface and bus device addressing are programmable. This allows the user to direct message and data flow to and/or from the appropriate interface and GPIB peripheral. Information such as primary and secondary addressing, along with pertinent device-dependent information, can be attached to a specific Logical Unit number. Subsequent communication with that GPIB device can be directed to the Logical Unit, eliminating the need for redundant or repetitious statement programming.

**TRANSFER RATES (IEEE STANDARD 488)**

Transfer rates for the standard interface:

	Input	Output
Normal Mode	Exceeds 5k Bytes/s	Exceeds 5k Bytes/s
Fast Mode	Exceeds 16.5k Bytes/s	Exceeds 19.5k Bytes/s

**SERIAL INTERFACE**

The 4041 comes with a standard serial asynchronous RS-232C interface. The 4041 can support applications requiring terminals, modem/host communication, or instrumentation with this interface protocol.

In addition to standard transmission rates from 75 to 9600 baud transmission rates are programmable to any integer ranging from 2 to 9600 baud.

**Full Duplex** — Full Capability (half duplex not supported).

**Transmit/Receive** — Matched rate only.

**Bits Per Character** — 5, 6, 7, or 8 bits.

**Stop Bits** — 1 or 2.

**Parity** — Even, Odd, High, Low, None.

**ERROR AND INTERRUPTS**

Conditions such as parity, framing and overrun errors receipt of data or data available, and BREAK can all be programmably captured. User routines or handlers can then direct what action should be taken, depending on the particular condition.

The end of message delimiter (EOM) can be programmable to any one or two character ASCII string. This enables the 4041 to communicate with most hosts or peripherals via the serial interface.

**CLOCK/TIMER**

One clock provides date and time of day which is programmably set. The timer clock returns the time in seconds since power up. The timer has 10 millisecond resolution.

**SELF-TEST**

An integral part of the 4041 is the self-test feature, which assures the user of reliable operation. Self-test is executed automatically on power-up and performs extensive hardware and operating system tests.

**SYSTEM VERIFICATION**

The system verification tape is a standard accessory that tests 4041 components not covered by the self-test. These include front panel controls and indicators, and the optional program development keyboard interface line drivers can be tested. If necessary, by connecting loopback connectors.

**DYNAMIC RANGE**

**Short Floating Point** — Maximum +/- 3.40282 E+38; Minimum +/- 2.93874 E-39.

**Long Floating Point** — Maximum +/- 1.7976931348623 E+308; Minimum +/- 5.562684646269 E-309.

**Integer** — -32768 to +32767.

**Character String Length (maximum)** — 32767.

**Array Elements (real, integer or character arrays)** — 32767 elements maximum per row (or column); limited by total memory installed.

**AC POWER REQUIREMENTS**

**Line Voltage** — 90 to 132 V ac and 180 to 250 V ac.

**Line Frequency** — 48 to 66 Hz.

**Power Consumption** — 120 W (maximum).

**ENVIRONMENTAL CHARACTERISTICS**

**Operating Temperature** — Without data cartridge or printer paper: 0°C to +55°C without data cartridge or printer paper. 0°C to +45°C.

**Storage Temperature** — Without data cartridge or printer paper: -40°C to +75°C.

**Humidity** — Without data cartridge or printer paper: 95%. With data cartridge or printer paper: 85%. Nonoperating: 95%.

**Altitude** — Operating: Sea level to 4,500 m (15,200 ft). Nonoperating: Sea level to 15,000 m (50,000 ft).

**EMI** — Meets FCC Part 15, Subpart J, Class A and VDE 0871 Class B.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	215.9	8.5
Height	180	7.2
Depth	527	20.8
Weights	kg	lb
Net	7.8	17.5
Net (with options)	8.8	19.5

**INCLUDED ACCESSORIES**

Power cord (161-0066-00); Blank overlays for FP keyboard (334-4074-00); System verification tape (062-5828-00); DC 100 Tape Cartridge, Blank, (119-1350-00); Loop back connector. RS-232 male, (013-0198-00); Roll of printer paper (006-3557-00).

**ORDERING INFORMATION**

**4041 System Controller** ..... **\$4,995**  
**Option 01** — Second GPIB and RS-232C ..... +\$1,600  
**Option 02** — TTL Interface 8 bit parallel interface ..... +\$800  
**Option 20** — Added memory 64k byte total ..... +\$1,300  
**Option 21** — Added memory 96k byte total ..... +\$1,800  
**Option 22** — Added memory 128k byte total ..... +\$2,250  
**Option 23** — Added memory 160k byte total ..... \$2,650  
**Option 30** — Program Development ROMs and ROM Carrier ..... +\$995  
**Option 31** — Program Development Keyboard ..... +\$550

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC  
**Option A2** — UK 240 V/13A, 50 Hz ..... NC  
**Option A3** — Australian 240 V/10A, 50 Hz ..... NC  
**Option A4** — North American 240 V/15A, 60 Hz ..... NC

**FIELD INSTALLED MODIFICATIONS**

**4041F01** ..... \$1,800  
**4041F02** ..... \$1,000  
**4041F30** ..... \$995  
**4041F31** ..... \$550  
**First Expansion** from standard configuration (32k bytes for total of 64k bytes). Order 040-1021-00 ..... \$1,500  
**Memory Expansion** of 32k byte increments above 64k byte total. Order 040-1022-00 ..... \$800

**4051**

**GPIB**  
IEEE-488

System Controller

11 Inch DVST Display

Graphic Enhanced BASIC

GPIB Compatible

Built-in Tape Drive

Expandable Memory (to 32k)

Optional RS-232C with Terminal Mode



**4052A** **NEW**

**GPIB**  
IEEE-488

System Controller

11 Inch DVST Display

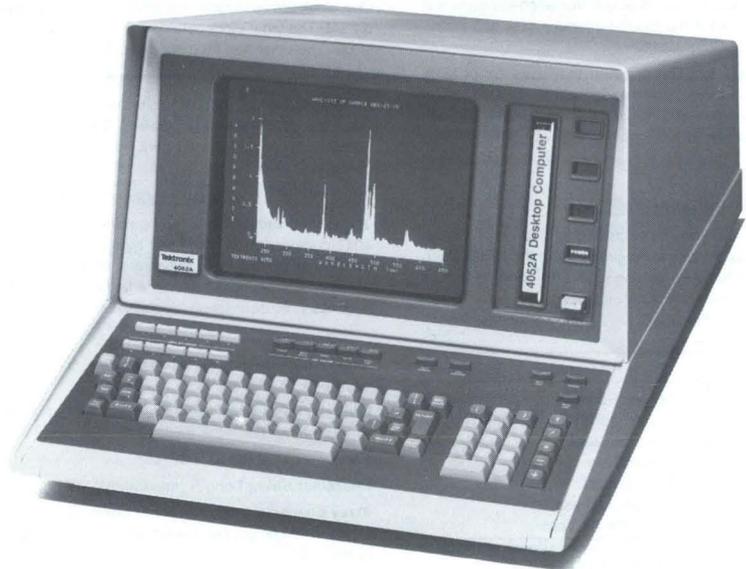
Graphic Enhanced BASIC

GPIB Compatible

Expandable Memory (to 64k)

RS-232 and Terminal Mode Option

High Speed 16-bit, Bit-sliced Processor



**4054A** **NEW**

**GPIB**  
IEEE-488

System Controller

19 Inch DVST Display

Enhanced High Resolution Graphics

Dynamic Graphics Option

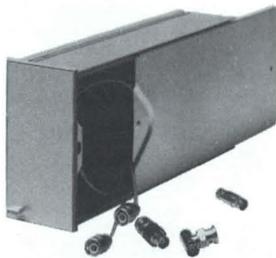
Thumbwheel Controlled Crosshair Cursor

Expandable Memory (to 64k)

GPIB and RS-232C Compatible



**PLUG-IN STORAGE COMPARTMENT**



An electronic engineer or technician away from their bench seldom has enough storage space for probes, cables, "tees", accessories, and small tools. The plug-in storage compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler Mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 Mainframes, 5000 Series Oscilloscope Mainframes, and 203 and 204 SCOPE-MOBILE® Cart plug-in storage bins; inside dimensions 250 mm L x 51 mm W x 106 mm H, (9 7/8 in L x 2 in W x 4 1/4 in H).

**Plug-in Storage Compartment**  
Order 016-0362-01 ..... \$125

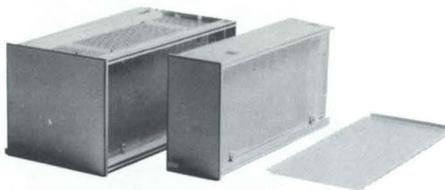
**TM 500/5000 BLANK PANEL**



When operating TM 500/5000 Instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

**Blank Plug-in Panel** Order 016-0195-03 .... \$25

**TM 500 CUSTOM PLUG-IN KITS**



**Single and double compartment sizes**

A complete test and measurement set-up for many typical jobs requires at least one nonstandard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceeds the cost of the functional elements. This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards that allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator ICs can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with other TM 500 Instrumentation.

**Single Compartment with Power Supply**

A blank plug-in kit complete with power supply parts and circuit board layout is now available. A single-wide compartment, this plug-in kit saves set up and build time as the power supply circuitry is designed and kitted for you.

Specifically, the supplies parts are:

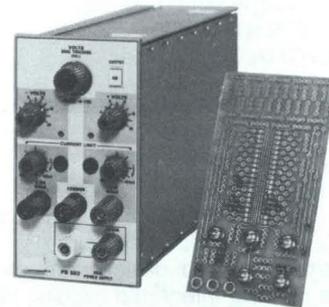
- (1) A ground-referenced positive supply, capable of +7 V to +20 V at up to 400 mA. (Adjustment is centered at 15 V; change of resistor values required for total 7-20 V range).
- (2) A ground-referenced negative supply, identical to supply No. 1 except for polarity.
- (3) A ground-referenced supply nominally 5 V, not adjustable, with current capability up to 1 ampere.

A series of TM 500 Construction Notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits and Thermal True RMS Converter.

**ORDERING INFORMATION**

Custom Plug-in Kit with Power Supply (single compartment) Order 040-0803-02	\$115
Custom Plug-in Kit (single compartment) Order 040-0652-05	\$95
Custom Plug-in Kit (double compartment) Order 040-0754-07	\$125
Single Compartment without ECB Order 040-0821-03	\$60

**FRONT-PANEL CIRCUIT BOARD ADAPTOR KIT PS 501-1 or PS 503A**



The front-panel circuit-board kit is a convenient way to mount small experimental circuits or fixtures right on the front of a TM 500 Power Supply.

Typical applications for the adaptor are as a device tester (test fixture), educational demonstrator (especially ICs), and in temporary systems functions, e.g., OR'ing and AND'ing two signals. This adaptor will supplement the blank plug-in kit for simple or temporary applications.

The adaptor kit provides a convenient platform for building up circuits; its pin holes are pre-solder-flowed and some are interconnected. Discrete devices can be readily attached to the adaptor kit board, stored, and easily reattached to the "banana jack" plugs on the face of the power supply. Circuit clips for interconnected pin holes are available from Tektronix. The adaptor kit is 2.5 inches wide.

**Adaptor Kit** Order 013-0152-00 ..... \$22

# CURVE TRACERS

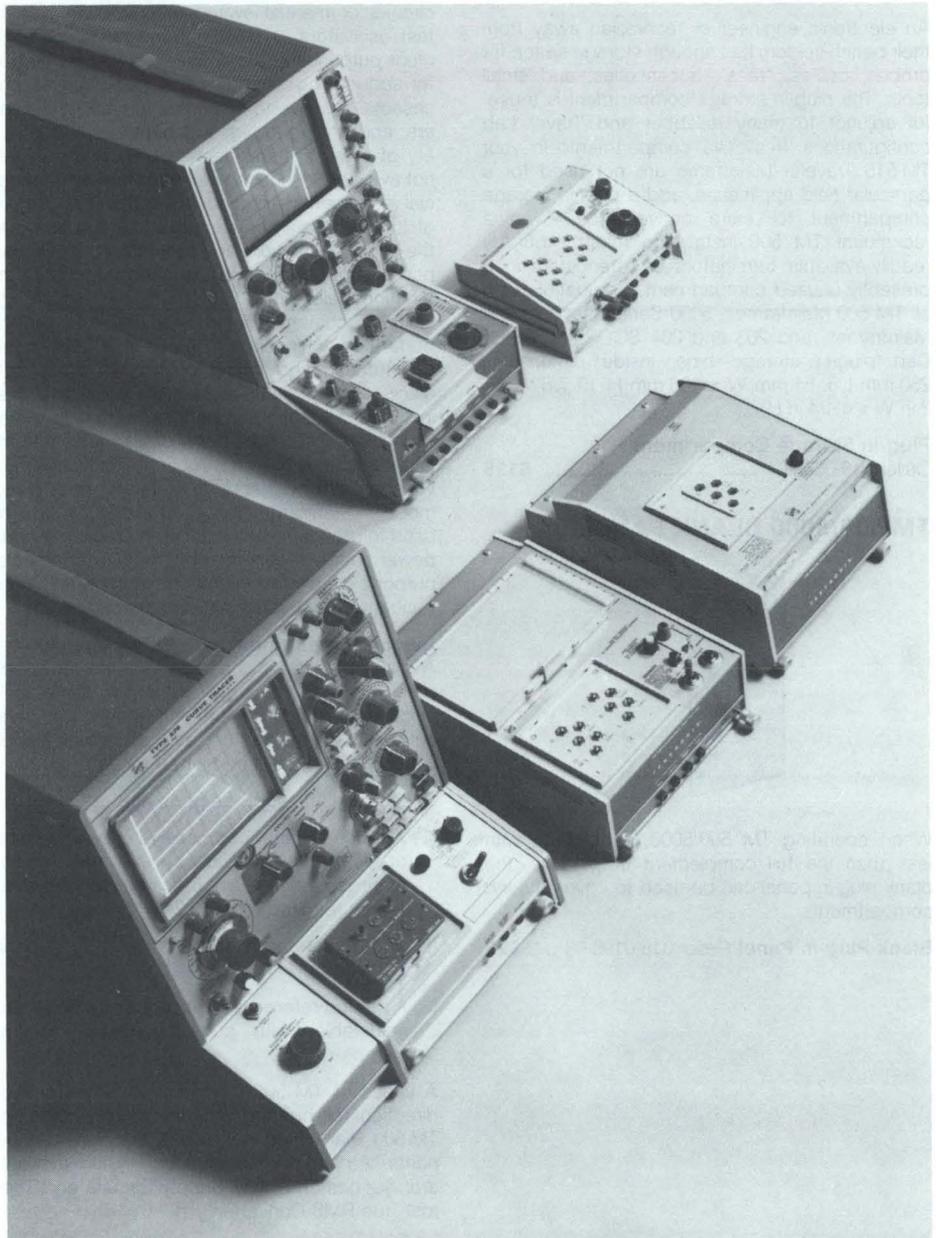
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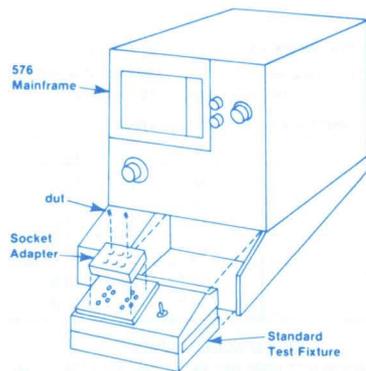
576 Curve Tracer System .....	397
172 Programmable Test Fixture .....	399
176 Pulsed High-Current Fixture .....	400
577 Curve Tracer System .....	401
178 Linear IC Test Fixture .....	403
5CT1N & 7CT1N Curve Tracer Plug-Ins .....	404

Curve Tracers can deliver comprehensive information about a multitude of semiconductor devices and integrated circuits, from two- and three-terminal devices through the full range of linear integrated circuits, from transistors and diodes to optoisolators, thyristors, and operational amplifiers.

These versatile measurement tools give you more than pinpointed parameters. A curve tracer can show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions in this section helpful in choosing the system that best meets your requirements. If you would like to receive a brochure, application notes, and other materials to learn more about Curve Tracers and their measurement capabilities, please use the reply card; or, for faster action, contact a Tektronix Sales Engineer at the Sales Office nearest you.





**576**

**Tests Two- and Three-Terminal Discrete Semiconductors**

**Power Capability up to 220 W**

**Convenient Scale Factor Readout**

**Other Test Fixtures for Testing Power Devices and Semi-Automated Testing**

The Tektronix 576 Curve Tracer System continues to hold the title "standard of the industry." The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (see Alphanumeric Index), and the 176 Pulsed High-Current Fixture (see Alphanumeric Index). The 576 is an excellent general purpose curve tracer system that performs well in applications where high-current testing is required.

With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the device under test. The step generator can deliver up to 2 amps in both its current and voltage modes of operation. With the 176 High-Current Fixture, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the Tektronix 577 Curve Tracer System is the display area adjacent to the 576's CRT. These alphanumeric indicators provide vertical and horizontal deflection factors, step amplitude, and Beta/div or  $g_m$ /div. The Beta or  $g_m$  readout saves the operator from the arithmetic usually necessary to arrive at these parameters. These indicators also provide a permanent record of major knob settings in 576 CRT photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer include: adjustable current limiting in the step generator, either 300  $\mu$ s or 80  $\mu$ s pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and an illuminated graticule.

**CHARACTERISTICS**  
COLLECTOR SUPPLY

**Modes**

**NORM** — Positive or negative full-wave rectified ac (line frequency); dc positive or negative.

**LEAKAGE** — Emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

**Voltages** — Peak open circuit voltages within +35% and -5% of indicated range.

Range	15 V	75 V	350 V	1500 V
Max Continuous Peak Current	10 A	2 A	0.5 A	0.1 A
Peak Pulse Mode Current	≥20 A	≥4 A	≥1 A	≥0.2 A

**Series Resistance** — From 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak power limit setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

**Safety Interlock** — Protects operator from 75 V, 350 V, and 1500 V collector voltages.

**STEP GENERATOR**

**Current Mode** — Step/offset amplitude range is 5 nA/mV/step (with X0.1 MULT) to 2 V/step, 1-2-5 sequence. Maximum current (steps and aiding offset) is X20 AMPLITUDE setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Maximum voltage (steps and aiding offset) is at least 10 V. Max opposing offset current is X10 AMPLITUDE switch setting or 10 mA, whichever is less. Maximum opposing voltage is limited at 1 V to 3 V.

**Voltage Mode** — Step/offset amplitude range is 5 mV/step (with X0.1 MULT) to 2 V/step, 1-2-5 sequence. Maximum voltage (steps and aiding offset) is X20 AMPLITUDE switch setting, 40 V max. Maximum current (steps and aiding offset) is at least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short circuit current limiting is 20 mA, 100 mA, 500 mA +100%, -0%; 2 A +50%, -0%. Maximum opposing offset voltage; X10 AMPLITUDE switch setting. Maximum opposing current; limited at 5 mA to 20 mA.

**Accuracy**

**Incremental** — Within 5%, between steps, within 10% with X1.0 MULT.

**Absolute** — Within 2% of total output including offset, or 1% of AMPLITUDE setting, whichever is greater.

**Offset Multiplier** — 0 to X10 the AMPLITUDE setting, continuously variable. Polarity AID(s) or OPPOSE(s) the step polarity.

**Step Rates** — X0.5, X1 (NORM), and X2 the collector supply rate. The collector supply rate is twice line frequency.

**Pulsed Steps** — ≈80 μs or 300 μs width, at NORM or X0.5 rates.

**Offset Step/Offset Polarity** — The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity, and positive in the ac position. Step polarity may be inverted by actuating the INVERT pushbutton.

**Step Family** — REPETITIVE or SINGLE FAMILY (manually actuated).

**Number of Steps** — Digitally selectable between one and ten.

**DEFLECTION CONTROLS**

**Display Accuracies (With Standard Test Fixture)** — As a percentage of highest on-screen value.

NORM and Dc MODES	Normal	OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
		100-40 div	35-15 div	10-0 div
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
<b>LEAKAGE MODE</b>		NOT APPLICABLE		
Vert Emitter Current/div:		NOT APPLICABLE		
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (Magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:		NOT APPLICABLE		
≥ 1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20, or 2 nA	3% plus 50 mV/vert div	NOT APPLICABLE		
500, 50, or 5 nA	3% plus 125 mV/vert div	NOT APPLICABLE		
<b>Vert Step Gen Position</b>	4%	3%	4%	5%
<b>Horiz Step Gen Position</b>	4%	3%	4%	5%

**Vertical Deflection Factor** — Collector current is 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter current is 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step generator is 1 step/div.

**Horizontal Deflection Factor**

**Collector Volts** — 50 mV/div to 200 V/div 12 steps (5 mV/div with X10 magnification).

**Base Volts** — 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification).

**Step Generator** — 1 step/div.

**Displayed Noise** — 1% or less or:

Range	15 V	75 V	350 V	1500 V
Vertical — Collector	1 μA	1 μA	2 μA	5 μA
Vertical — Emitter	1 nA	1 nA	1 nA	5 nA
Horizontal — Base	5 mV	5 mV	5 mV	5 mV
Horizontal — Collector	5 mV	5 mV	20 mV	200 mV

**Calibrator (CAL)** — Dc voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

**Position Controls** — Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

**Display Offset** — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 MAGNIFIER.

**CRT AND READOUT**

**CRT** — 165 mm (6.5 in) rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 Phosphor normally supplied.

**Readout** — The readouts, adjacent to CRT, are digital indicators of the following parameters: PER VERT DIV from 1 nA/div to 2 A/div; PER HORIZ DIV from 5 mV/div to 200 V/div; PER STEP from 5 nA/step to 2 A/step, 5 mA/step to 2 V/step; β (BETA) or 9m, PER DIV from 1 μ to 500k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and X0.1 MULT.

**STANDARD TEST FIXTURE**

**Description** — A plug-in fixture with two sets of five pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input and the OPERATOR PROTECTION BOX. The test terminals accept either the six pin universal adaptors, three pin adaptors, or the high-power transistor adaptors with KELVIN contacts.

**POWER REQUIREMENTS**

**Power Source** — Operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral.

**Voltage Ranges** — The quick-change line-voltage range selector accommodates 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions), at 48 Hz to 66 Hz line frequency. Maximum power consumption with or without adaptors is 305 W; stand by power is ≈60 W.

**ENVIRONMENTAL CHARACTERISTICS**

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of 10 to 40°C.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	mm	in	mm	in
Width	292	11.5		
Height	381	15.0		
Depth	584	23.0		
Weights	kg		lb	
	Net	32.0	70.5	
	Shipping ≈	48.5	107.0	

**INCLUDED ACCESSORIES**

Transistor adaptor (013-0098-02); FET Adaptor (013-0099-02); TO3 Adaptor (013-0100-01); TO66 Adaptor (013-0101-00); Axial Lead Diode Adaptor (013-0111-00); Stud Diode Adaptor (013-0110-00); Kelvin sensors for large and small plastic transistors (013-0138-01); protective cover (337-1194-00).

**ORDERING INFORMATION**

**576 Curve Tracer with Standard Test Fixture** ..... **\$9,995**  
**The 576 Option 01** deletes the parameter readout module but maintains provisions for insertion of the module (020-0031-00) at any time.  
**Option 01** ..... **-\$650**  
**Auto Scale-Factor Readout Module** 020-0031-00 ..... **\$1,500**

**INTERNATIONAL POWER CORD AND PLUG OPTIONS**

**Option A1** — Universal Euro 220 V/16A ..... **NC**  
**Option A2** — UK 240 V/13A ..... **NC**  
**Option A3** — Australian 240 V/10A ..... **NC**  
**Option A4** — North American 240 V/15A ..... **NC**

**OPTIONAL ACCESSORIES**

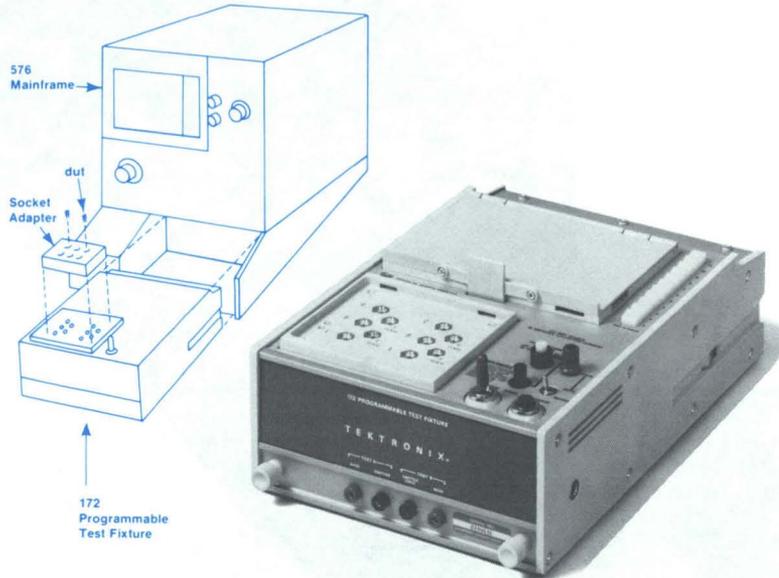
**Camera** — (See Oscilloscope/Camera Adaptor chart in Camera section of this catalog.)  
**Test Set-up Chart** (Pkg of 250.)  
 Order 070-0970-01 ..... **\$10**  
**172 Test Fixture** (See Alphanumeric Index.)  
**176 Test Fixture** (See Alphanumeric Index.)  
 Socket adaptors (See last page of this section.)

172

Semi-Automated Test Fixture

Tests up to 11 Parameters

Reduces Total Test Time



The 172 Programmable Test Fixture, when used with the Tektronix 576 Curve Tracer, permits the operator to program a sequence of tests of J FETs, transistors, and diodes.

The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172, all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable rate control is provided to set the test sequence at a

rate which is best for the operator. New operators require more time per test, but with experience they will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

**Display Accuracies** — The same as the 576 Curve Tracer with its included Standard Test Fixture.

**Vertical Deflection Factor** — Tests 1 and 2 (Collector or Emitter Current): 1 1  $\mu$ A to 2 A/div in 20 steps. Tests 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1  $\mu$ A to 0.5 A/div in 18 steps. Tests 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1-2-5 sequence.

**Horizontal Deflection Factor** — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for Test 2, at least 100 MHz at 100 mV/div and 200 mV/div. 1 M $\Omega$  (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Tests 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1-2-5 sequence.

**Collector Sweep Voltage** — At least 2 V open circuit, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

**Current Supply Accuracy** — 0.1  $\mu$ A to 11 mA, accurate within 2%  $\pm$  30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2%  $\pm$  30 nA with up to 50 V compliance. Increments of current are: 0.1  $\mu$ A (from 0.1  $\mu$ A to 11  $\mu$ A), 1  $\mu$ A (from 10  $\mu$ A to 110  $\mu$ A), 10  $\mu$ A (from 100  $\mu$ A to 1.1 mA), 100  $\mu$ A (from 1 mA to 11 mA) and 1 mA (from 10 mA to 110 mA).

**Voltage Supply Accuracy** — 1 V to 500 V, accurate within 3%  $\pm$  300 mV with at least 0.5 mA compliance.

**Test Display Time Range (Automatic)** — 300 ms or less to at least 2 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	198	7.8
Height w/cover	165	6.5
Depth	315	12.4
Weights	kg	lb
Net	5.2	11.5
Shipping $\approx$	8.2	18.0

INCLUDED ACCESSORIES

One protective cover (337-1194-00); five programming cards (016-0198-00); 250 programming card pins (214-1633-00); five CRT overlay limit cards (016-0510-00).

Order 172 Programmable Test Fixture \$4,195

TESTS THAT CAN BE PERFORMED ON:				PROGRAMMABLE CAPABILITIES
Test	Xstr	J FETs	Diodes	
1*	H <sub>FE</sub> V <sub>CE(sat)</sub>	V <sub>P</sub>	V <sub>F</sub>	PEAK CURRENT up to 10 A PEAK VOLTS up to 350 V.
2	V <sub>BE</sub>			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).
3	H <sub>FE</sub> , V <sub>CE(sat)</sub>	I <sub>DSS</sub> , R <sub>DS(on)</sub>		Base Drive: 100 nA to 110 mA. When testing J FETs the base terminal is shorted to the emitter terminal. Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively.
4	Same as #3			
5	I <sub>CEO</sub> or I <sub>CES</sub> , I <sub>CER</sub> with external short or resistor			Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is 1 nA/div.
6	I <sub>CBO</sub>	I <sub>GSS</sub>		Same as #5
7	I <sub>EBO</sub>		I <sub>R</sub>	Same as #5
8	V <sub>(BR)CEO</sub> or V <sub>(BR)CES</sub> with external resistor		V <sub>F</sub>	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 100 mA dc for breakdown voltage measurements to 50 V.
9	V <sub>(BR)CES</sub>	BV <sub>GSS</sub>		Same as #8.
10	V <sub>(BR)CBO</sub>	BV <sub>GSS</sub>		Same as #8.
11	V <sub>(BR)EBO</sub>		V <sub>R</sub>	Same as #8.

\* All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.

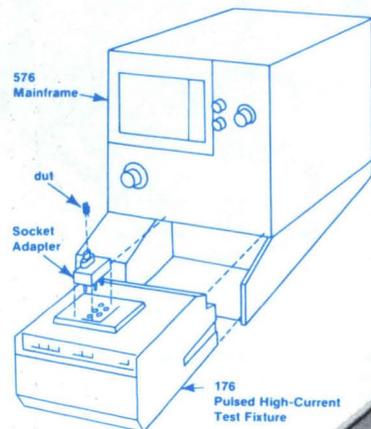
For the remaining test the only 576 controls that are functional are the Polarity and CRT controls such as INTENSITY, FOCUS, DISPLAY OFFSET.

## 176

### Tests Power Transistors

### Tests up to 200 Amps in Pulsed Mode

### 1000 Watt Capability



The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. When selected, the step offset is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without overdissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the 576 in regard to width and repetition rate.

The pulse width is selected by pressing the 300  $\mu$ s or 80  $\mu$ s pushbutton on the 576 Mainframe (usually, 300  $\mu$ s should be selected). The repetition rate is automatically set when the 176 is inserted in the mainframe. Repetition rate is also dependent on power-line frequency. The five highest VERTICAL CURRENT/DIV settings (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 VERT pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest STEP GENERATOR AMPLITUDE base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 STEP pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 VERT and X10 STEP pushbuttons provide inputs to the fiberoptic readout to display actual values.

### CHARACTERISTICS

#### COLLECTOR SUPPLY (PULSED)

- Width** — 300  $\mu$ s or 80  $\mu$ s determined by 576.
- Repetition Rate** — Power-line frequency.
- Polarity** — + or - determined by 576 polarity control.
- Amplitude** — Ranges are 15, 75, 350 V nominal, controlled by MAX PEAK VOLTS switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.
- Maximum Peak Watts** — Three illuminated pushbuttons select 10, 100, 1000 W maximum peak power.

#### STEP GENERATOR

- Current Ranges (X10 STEP selected)** — Step-Offset Amplitude Range is 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Maximum Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Maximum Voltage (Steps and Aiding Offset) is at least 5 V up to 10 A and 2 V up to 20 A.
- 576 Offset Multiplier** — 0 to X100 576 AMPLITUDE switch setting.
- Step Rate** — Power-line frequency.
- Pulsed Steps** — 300  $\mu$ s or 80  $\mu$ s wide.
- Step/Offset Polarity** — The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity. Step polarity may be inverted by actuating the INVERT pushbutton.
- Accuracy (Current steps including offset)** — Incremental is within 5% between any two steps; within 10% with X0.1 STEP MULT. Absolute is within 3% of total output  $\pm$  1% of one step or within 3% of one step, whichever is greater.

#### VERTICAL AMPLIFIER

- Deflection Factor (X10 VERT selected)** — 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Performance characteristics are valid over a temperature range of 0°C to +40°C.

### PHYSICAL CHARACTERISTICS

Dimensions	mm		in	
	mm	in	mm	in
Width	201	7.9		
Height	117	4.6		
Depth	290	11.4		
Weights	kg		lb	
	kg	lb	kg	lb
Net	5.8	12.8		
Shipping $\approx$	8.2	18.0		

### INCLUDED ACCESSORIES

TO36 Adaptor (013-0112-00); Stud Diode Adaptor (013-0110-00); protective shield (337-1194-00).

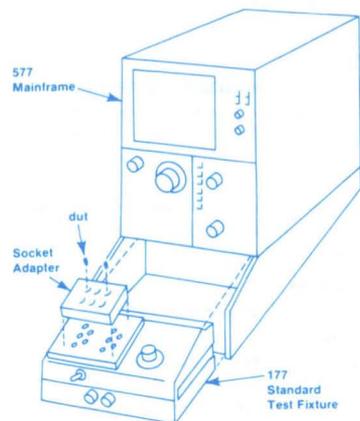
**Order 176 Pulsed High-Current Fixture** ..... **\$4,745**

577

Test Two- and Three-Terminal  
Discrete Semiconductors

Storage Capability

Power Capability up to 100 Watts



The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are a storage CRT and the emphasis on low current measurements with the 577.

The 577's storage CRT may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the CRT while in the storage mode. A good example of a dot display occurs in op amp testing because the open-loop, 3 dB bandwidth of many op amps is so low that the curves must be plotted slowly. Linear ICs such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see Alphanumeric Index).

In the 577/177 Curve Tracer System, several features facilitate low current measurements. They include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three-terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available; 10 amps continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both CRT axes, and a beam finder.

## CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

### COLLECTOR SUPPLY

**Modes** — Five modes of collector supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc, or negative dc.

**Voltage** — The voltage is variable to the maximum peak volts selected.

Max Peak Volts Open Circuit	6.5 V	25 V	100 V	400 V	1600 V
Continuous Current, Peak	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

**Series Resistance** — 14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains maximum peak power to the device under test when changing voltage ranges.

**Safety Interlock** — Protects operator from 100, 400, and 1600 V ranges. Momentary button provides for overriding interlock.

### STEP GENERATOR

**Current Mode** — Step amplitude range is 5 nA/step (with STEP X0.1) to 200 mA/step, in a 1-2-5 sequence. Available current is at least 2 A on the highest amplitude setting with 5 V or more compliance. For opposing offset, available current is at least 10 mA with voltage limited between 1 V and 5 V.

**Voltage Mode** — Step amplitude range is 5 mV/step (with STEP X0.1) to 2 V/step, in a 1-2-5 sequence. Current is limited between 100 mA and 200 mA. For opposing offset, available current is at least 10 mA (at 0 V) derating to 0 mA at 20 V.

**Accuracy** — Incremental; within 2% between steps. Absolute; within 3% of total output or AMPLITUDE setting, whichever is greater. When STEP X0.1 is actuated the absolute step accuracy is 4%.

**Step Rate** — Selectable at X1 (SLOW), X2 (NORM), or X4 (FAST) line frequency.

**Pulsed Steps** — Steps can be gated for a duration of ≈300 μs for testing at low duty cycle.

**Step/Offset Polarity** — With NORM POLARITY selected, the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with STEP/OFFSET POLARITY control or from the test fixture.

**Offset** — The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either AID or OPPOSE steps. Maximum range of offset is 10 full-amplitude steps.

**Step Family** — Repetitive or single family.

**Number of Steps** — Selectable from 1 to 10 full-amplitude steps. Selectable up to ≈95 steps when using STEP X0.1 multiplier.

### DEFLECTION CONTROLS

**Display Accuracies** — As a percentage of highest on-screen value.

Display Mode	Normal	Magnified
Vert Collector Current	3% ± 1 nA	4% ± 1 nA
Horiz Collector Volts	3%	4%
Horiz Base Volts	3%	4%
Horiz Step Gen	4%	5%

**Vertical Deflection Factor** — Collector current is 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

### Horizontal Deflection Factor

**Collector Volts** — 50 mV/div to 200 V/div, 12 steps in a 1-2-5 sequence (5 mV/div to 20 V/div with X10 magnification).

**Base Volts** — -50 mV/div to 2 V/div, 6 steps in a 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification).

**Step Generator** — 1 step/div (0.1 step/div with X10 magnification).

**Automatic Scale Factor Readout** — Change in deflection factor is indicated by lights behind the knob skirt when using X10 MAG.

**Automatic Positioning** — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

**Display Invert** — Single control inverts display and repositions trace.

**Display Filter** — Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

### CRT

**CRT** — Rectangular 165 mm (6.5 in) with an 8 x 10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage CRT with phosphor similar to P1. The D2 display unit has a nonstorage CRT with P31 Phosphor. Accelerating potential is 3.5 kV.

**Beam Finder** — Compresses off-screen trace to within graticule area.

**Ambient Temperature Range** — Performance characteristics are valid over an ambient temperature range of 10 to 40°C.

### PHYSICAL CHARACTERISTICS

Dimensions	mm		in	
	mm	in	mm	in
Width	224	8.8	201	7.9
Height	503	19.8	102	4.0
Depth	584	23.0	152	6.0
Weights	kg		lb	
	kg	lb	kg	lb
Net	18.1	40.0	1.1	2.5
Shipping ≈	22.7	50.0	2.7	6.0

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≈24 kg or ≈53 lb.



177 Standard Test Fixture

### CHARACTERISTICS

**Device Lead Selection** — Switch provides six different lead configurations. Three positions for EMITTER GROUNDED measurements provide STEP GEN, OPEN (OR EXT), and SHORT base terminal connections. Two positions for BASE GROUNDED measurements provide STEP GEN and OPEN (OR EXT) emitter terminal connections. One position provides for EMITTER BASE BREAKDOWN or leakage measurements up to 25 Vs.

**Left-Right Switch** — Selects left or right test connections. Off in center position. Test connection area accepts all Tektronix Curve Tracer adaptors and protective cover. Kelvin connections are provided for emitter and collector terminals.

**Looping Compensation** — Reduces display loops due to test adaptor capacitance and some device capacitance.

**Variable Voltage Supply** — Continuously variable bias supply from -12 V to +12 V. Source resistance is 10 kΩ or less.

### POWER REQUIREMENTS

**Line Voltage Ranges (±10%)** — 100, 110, 120 V ac or 200, 220, 240 V ac.

**Line Frequency** — 50 to 60 Hz.

**Power** — 155 W max at 110 V ac, 60 Hz.

### INCLUDED ACCESSORIES

Transistor adaptor for most bipolar transistors and some MOS FETs (013-0098-02); axial lead diode adaptor with Kelvin sensing terminals (013-0111-00); protective shield for test connection area (337-1194-00).

### ORDERING INFORMATION

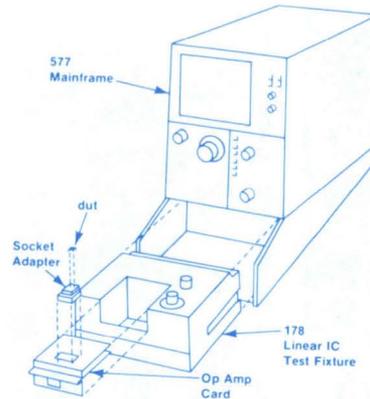
<b>577/D1 Storage Curve Tracer</b>	
Mainframe .....	\$5,560
<b>577/D2 Nonstorage Curve Tracer</b>	
Mainframe .....	\$4,800
Option 10, 10 x 10 cm Graticule; available with either storage or nonstorage mainframe .....	+\$60
<b>177 Standard Test Fixture .....</b>	<b>\$1,145</b>

### OPTIONAL ACCESSORIES

<b>178 Linear Test Fixture</b> (See following page for complete description.) .....	\$2,860
<b>C-5C Camera</b> (See Functional Index.) .....	\$525
<b>Tek Lab Cart, Model 3</b> (See Functional Index.) .....	\$525
Order Model 3 .....	\$525
<b>Test Set-up Chart</b> (pkg of 250). .....	\$7.50
Order 070-1639-00 .....	\$7.50
<b>Device Adaptor Sockets</b> (See the last page in this section for complete description.) .....	

## 178

**Tests Single, Dual, or Quad:  
Operational Amplifiers, Comparators  
Differential Amplifiers, Regulators and more**



Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary and accurate low-current measurement capability. Test cards set up the measurement function, and the 577's storage CRT allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the CRT while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 Mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adaptor that interfaces the system to the device under test.

Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

### OP AMP CARDS

The STANDARD OP AMP CARD is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, CMRR, gain, positive and negative psrr, positive and negative supply current, and collector supply current.

The HARDWIRE CARD is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device under test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The MULTIPLE OP AMP CARD allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

### Socket Adaptors for Op Amp Cards

The device under test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adaptors using the Amphenol-Barnes Adaptor System. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on the last page of this section.

### REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

### Socket Adaptors for Regulator Cards

Socket adaptors for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adaptors used on the standard curve tracer. (See the last page of this section.)

### CHARACTERISTICS

Vertical Deflection (1-2-5 Sequence)	Normal	Magnified
Input Voltage or $\Delta$ Input Voltage	10 $\mu$ V/div to 50 mV/div	1 $\mu$ V/div to 5 mV/div
Accuracy	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 $\mu$ A/div
Accuracy	3% $\pm$ 50 pA	4% $\pm$ 50 pA
Power Supply Current	0.1 $\mu$ A/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy	3% $\pm$ 0.1 $\mu$ A	4% $\pm$ 0.1 $\mu$ A
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy	3% $\pm$ 1 nA	4% $\pm$ 1 nA

Accuracies are a percentage of highest on-screen values.

**Power Supplies** — Positive and negative supplies are adjustable from 0 to 30 V; available current is at least 150 mA with adjustable current limiting. The voltage of both supplies can be adjusted from a single calibrated control; accuracy is within 2%  $\pm$  100 mV. Negative supply can be independently adjusted by an uncalibrated control.

**Sweep Generator** — A sinusoidal signal controls the output, common-mode input, or the power supply voltages of the device under test. The frequency is adjustable from 0.01 Hz to 1 kHz. Amplitude is adjustable up to 30 V peak.

**Source Resistance** — For input resistor pairs, selectable 50  $\Omega$ , 10 k $\Omega$ , 20 k $\Omega$ , and 50 k $\Omega$ , or external resistors may be used. When the vertical deflection factor is in one of the less sensitive positions, 1 mV through 50 mV/div, the input resistance values are 550  $\Omega$  greater.

**Load Resistance** — Six selectable load resistors, 100  $\Omega$ , 1 k $\Omega$ , 2 k $\Omega$ , 5 k $\Omega$ , 10 k $\Omega$ , 20 k $\Omega$ , and 50 k $\Omega$ , or external resistors may be used.

**Collector Supply** — The 25 V and 100 V ranges of the collector supply (located on 577 Mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for collector supply performance.)

**Step Generator** — All the capabilities of the step generator (located on 577 Mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for step generator performance.)

**DUT Supplies Disconnect** — A single switch disconnects all power to the device under test; both plus and minus power supplies, collector supply, and step generator.

**Function Switch** — Selects vertical and horizontal deflection signals and connection of the test signal to the device under test.

**Zero** — Single pushbutton provides a zero reference to the CRT display and in certain functions, nulls out offset voltage in order to measure  $\Delta$ input V on the vertical display axis.

### THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

#### Device Under Test Input Supply

**Input Voltage** — Two ranges 0-30 V and 0-60 V. 0-30 V is within  $\pm$ 2%  $\pm$ 200 mV of dial setting, and 0-60 is within  $\pm$ 2.5%  $\pm$ 300 mV of dial setting.

**Regulation** — Within 200 mV.

**Input Sweep Frequency** — Dc to 1 kHz.

**300  $\mu$ s Pulsed Current** — 5 mA to 2 A.

**Short Duration Dc Current (One minute)**

Supply Voltage	Current
0 - 10	700 mA
10 - 20	350 mA
20 - 40	350 mA
40 - 60	120 mA

**Device Under Test Current Load** — 5 mA to 2 A within  $\pm$ 3% of 0 to 1.25 mA.

**Device Under Test Comparison Output Dc Voltage Accuracy** — 0-10 V range within  $\pm$ 1%  $\pm$ 20 mV; 0-100 V range within  $\pm$ 1%  $\pm$ 150 mV.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	201	7.9
Height	114	4.5
Depth	198	7.8
Weights	kg	lb
Net	1.5	3.3
Shipping $\approx$	3.6	8.0

### INCLUDED ACCESSORIES

IC Socket, 16 DIP (136-0442-00); Standard Op Amp Card with cover and ten patch cords (013-0149-02); interchangeable nomenclature panel for function switch (333-1770-00).

**Order 178 Linear IC Test Fixture ..... \$2,860**

### OPTIONAL ACCESSORIES

**Standard Op Amp Card (One included with 178)**  
Order 013-0149-02 ..... \$130

**Hardwire Card**  
Order 013-0150-02 ..... \$85

**Multiple Op Amp Card**  
Order 013-0155-01 ..... \$475

**Positive Regulator Card**  
Order 013-0147-00 ..... \$795

**Negative Regulator Card**  
Order 013-0148-00 ..... \$795



Standard Op Amp Card



Positive Regulator Card

## 5CT1N/7CT1N

Tests Semiconductor Devices to 0.5 W

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

Easy to Operate

5CT1N



Curve Tracer

7CT1N



Curve Tracer

The 7CT1N Curve Tracer is a plug-in unit for use in Tektronix 7000 Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in Tektronix 5000 Series Oscilloscope Systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000 Series Oscilloscope Systems.

### CHARACTERISTICS COLLECTOR/DRAIN SUPPLY

	X1		X10	
	0.5	2	5	20
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

**Max Open Circuit Voltage** — Within  $\pm 20\%$ . Max short circuit current within 30%.

**Series Resistance** — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less depending upon control settings.

**High Voltage Warning** — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

### STEP GENERATOR

**Transistor Mode** — Step amplitude range is 1  $\mu\text{A}/\text{step}$  to 1 mA/step, 1-2-5 sequence. Max current (steps plus aiding offset) is X15 amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least X5 amplitude setting.

**FET Mode** — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V max. Source impedance is 1 k $\Omega$   $\pm$  1%.

### Accuracy

Incremental — Within 3% between steps.

Absolute — Within  $\pm(3\% + X0.3$  amplitude setting).

**Step Polarity** — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

**Number of Steps** — Selectable in one-step increments between 0 and 10.

**Offset** — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

**Vertical Deflection Factors** — 10 nA/div to 20  $\mu\text{A}/\text{div}$  with the  $\div 1000$  control activated. 10  $\mu\text{A}/\text{div}$  to 20 mA/div in the X1 mode.

**Vertical Display Accuracy** — Within 5% in the X1 mode. Within 5%  $\pm 0.2$  nA per displayed horizontal V when in the  $\div 1000$  mode.

**Horizontal Deflection Factors** — Selectable, 0.5 V, 2 V, 5 V, or 20 V.

**5CT1N Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 5000 Series Plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 k $\Omega$  and would be used in the horizontal compartment of the 5000 Series Oscilloscope Mainframe.

**7CT1N Horizontal Display Accuracy** — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the Tektronix 7000 Series Plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 k $\Omega$  and would be used in the horizontal compartment of the 7000 Series Oscilloscope Mainframe.

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Performance characteristics are valid from 0 to 50°C.

### PHYSICAL CHARACTERISTICS

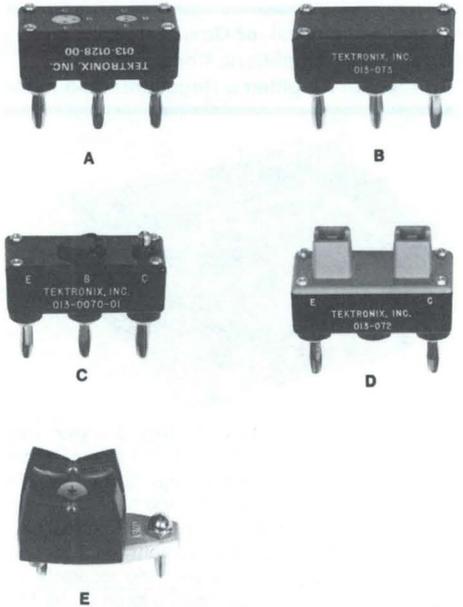
	5CT1N		7CT1N	
	mm	in	mm	in
<b>Dimensions</b>				
Width	66	2.6	71	2.8
Height	127	5.0	127	5.0
Depth	305	12.0	368	14.5
<b>Weights</b>				
Net	0.8	1.8	1.1	2.5
Shipping $\approx$	1.8	4.0	2.7	6.0

### INCLUDED ACCESSORIES

Test Adaptor with two sets of test terminals, one with TO5 basing and the other with TO18 basing (013-0128-00).

### ORDERING INFORMATION

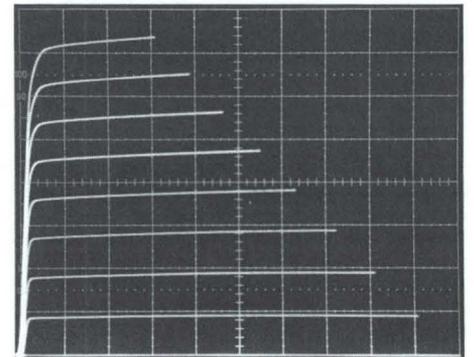
5CT1N Curve Tracer .....	\$855
7CT1N Curve Tracer .....	\$1,385



### 3-PIN ADAPTORS

The following 3-pin adaptors may be used with any of the Tektronix Curve Tracer products. They do not have Kelvin sensing contacts.

<b>A. TO5 or TO18 Transistor Adaptor</b> — Order 013-0128-00 .....	\$30
<b>B. Blank Adaptor</b> — For mounting special sockets. Order 013-0073-00 .....	\$18
<b>C. TO3 or TO66 Transistor Adaptor</b> — Order 013-0070-01 .....	\$40
<b>D. Diode Test Adaptor</b> — Holds axial-lead diodes. Order 013-0072-00 .....	\$70
<b>E. Diode Test Adaptor</b> — Magnetically holds steel axial-lead diodes. Order 013-0079-00 .....	\$175



2N3904 transistor characteristic generated by the 7CT1N. Control Settings are indicated on front panel of 7CT1N. Vertical: 2 mA/division Horizontal: 0.5 V/division Base Current: 10  $\mu\text{A}/\text{step}$



A B



C D



E



A



B



C



D



E



F



G



H



I

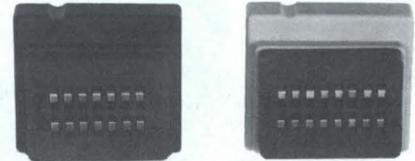
**KELVIN SENSING ADAPTORS**

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

- A. Transistor Adaptor** — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations. Order 013-0127-01 ..... \$80
- B. In-Line Adaptor** — Accepts large and small transistors with in-line leads. The adaptor will accept devices with approx spacing between terminals of 0.06 in up to 0.18 in. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration. Order 013-0138-01 ..... \$95
- C. TO36 Adaptor** — Order 013-0112-00 ..... \$95
- D. TO3 Adaptor** — Can be rewired to accommodate nonstandard configurations. Order 013-0100-01 ..... \$110
- E. TO66 Adaptor** — Order 013-0101-00 ..... \$110
- F. Axial Lead Diode Adaptor** — Order 013-0111-00 ..... \$95
- G. Stud Diode Adaptor** — Order 013-0110-00 ..... \$95
- H. Blank Adaptor** — For mounting special sockets. Order 013-0104-00 ..... \$55
- I. Power Transistor Adaptor** — Order 013-0163-00 ..... \$110



A B



C D

**MULTILEAD SOCKETS**

These sockets are used with the Integrated Circuit Adaptor (013-0124-01) listed under Dual Width Adaptors, and with the 178 Test Fixture.

- A. 8 Lead TO Package** — Order 136-0444-00 ..... \$35
- B. 10 Lead TO Package** — Order 136-0441-00 ..... \$40
- C. 14 Lead Dual-in-line Package** — Order 136-0443-00 ..... \$40
- D. 16 Lead Dual-in-line Package** — Order 136-0442-00 ..... \$45

These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.

(The sockets you will receive have the same electrical characteristics as those shown A-D above, and will be similar in appearance.)

- DUAL WIDTH ADAPTORS**
- The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.
- A. Transistor Adaptor** — Useful for most single and dual bipolar transistors and some MOS FETs. Order 013-0098-02 ..... \$195
  - B. FET Adaptor** — Useful for most single and dual FETs. Order 013-0099-02 ..... \$195
  - C. Long Lead Transistor Adaptor** — Accepts dual or single transistors with untrimmed leads. Order 013-0102-00 ..... \$190
  - D. Long Lead FET Adaptor** — Accepts dual or single FETs with untrimmed leads. Order 013-0103-00 ..... \$215
  - E. Integrated Circuit Adaptor** — Allows connection to multipin device packages. The appropriate multilead socket is plugged into the integrated circuits adaptor. The pins are then connected to the collector, base, or emitter terminals by means of the patch cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Order the appropriate multilead socket listed separately. Order 013-0124-03 Includes 10 each 4 inch test leads ..... \$350

# DIGITAL PHOTOMETER/ RADIOMETER



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### J16 Photometer/Radiometer

#### Digital LED Readout

#### Freedom from Saturation Effects over Entire Range

#### Metric and US Versions Available

#### Accurate Spectral and Cosine Corrections

#### Internal Rechargeable Batteries

#### Environmentalized

#### Eight Silicon Sensor Probes Quickly Interchanged without Recalibration

### CHARACTERISTICS

**Display** — 3½-digit LED readout and three LEDs automatically indicating correct units for probe in use.

**Stability** — Within 2% per year.

**Linearity** — Within 2% over the entire range, enabling single point calibration.

**Integration Time** — ≈ 100 ms.

**Calibration** — Electrical calibration of the J16 is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

**Power Requirements** — Internal rechargeable NiCd batteries only need recharging weekly in normal usage. Two hours of continuous operation is provided.

The Tektronix J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory or in the field.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are interchanged. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 3½-digit LED display can be easily read under low ambient conditions. All probes use silicon photo-diodes and multi-element glass filters for maximum stability and accuracy. The excellent stability eliminates the need for routine zero adjustments.

Integrated circuits are used extensively in the J16 to achieve stable operation, low power requirements, small size, and low weight.

Under normal usage, internal rechargeable nickel cadmium batteries will only need recharging weekly. A battery charger is supplied. An ac power supply is available that replaces and is interchangeable with the battery pack for continuous operation.

A shoulder strap provides carrying ease. The cabinet and probes have a standard threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.



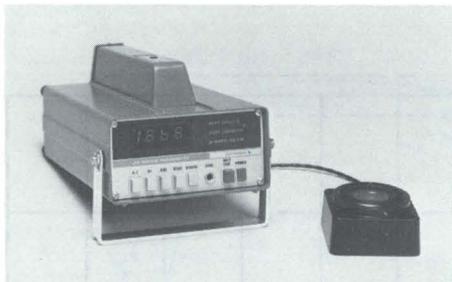
**J6511 and J6501 Illuminance Probes**

The J6511 is an illuminance probe with readout in footcandles (lumens/m<sup>2</sup> (lux) for the J6511 Option 02). A multi-element glass filter and silicon photo-diode insure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe and J16 allows the user to be out of the field of view while making measurements. Typical applications include measurement of roadway illumination, office lighting, and illumination of work surfaces.

Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction and units as the J6511.



A low-profile version of the probe (J6512), physically similar (without cosine correction) to the J6511, is available for use where space is restricted.

**J6502 and J6512 Irradiance Probes**

The J6502 measures irradiance in microwatts/cm<sup>2</sup> (milliwatts/m<sup>2</sup> for the J6502 Option 02). The spectral response is flat from 450 to 950 nanometers,  $\pm 7\%$ . The response is typically down 50% at 400 and 1030 nm. Typical applications include laser research experiments and measurements of radiant efficiency.

An optional filter holder is available to mount standard 1-inch diameter customer-supplied filters of up to  $\frac{3}{8}$  inch thickness. Where high intensity sources are used (over 1990  $\mu$ Watts/cm<sup>2</sup>), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.). These filters may be held with optional filter holders.

Where the 1 sq cm sensor is not completely filled by the source for example with a laser beam, the reading obtained represents  $\mu$ Watt instead of  $\mu$ Watts/cm<sup>2</sup> (J6502), or milliwatts  $\times 10^{-4}$  instead of milliwatts/m<sup>2</sup> (J6502 Option 02). Small variations in sensor uniformity may add  $\pm 5\%$  uncertainty to this measurement.

**J6503 8° Luminance Probe**

The J6503 measures luminance in footlamberts (candelas/m<sup>2</sup> (nit) for the J6503 Option 02) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface. Typical applications include measuring brightness of television screens and street signs, and light reflected from work surfaces and movie screens.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 21 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m<sup>2</sup> (nit) (J6503 Option 02) indicator automatically lights when the J6503 is connected.



Measuring Luminance with the Tektronix J16/J6523.

**J6523 1° Luminance Probe**

The J6523 will measure the luminance in footlamberts (candelas/m<sup>2</sup> for the J6523 Option 02) of a spot as small as 0.32 inches in diameter (0.035 inches with a standard +10 diopter, 55 mm photographic close-up lens). The 1° angle represents 0.21 inches per foot of distance from the probe to the source. Thus at 10 feet, the J6523 measures a 2.1-inch diameter spot. Typical applications include measuring highway lighting, television displays and photographic equipment.

The probe includes an optical sighting system with a 9° viewing field. The focusing range is 18 inches to infinity, closer with commercially available close-up lenses. The spectral response is closely matched to the CIE photopic curve (color-corrected) for accurately measuring all commonly used light sources.

The J6523 may be attached to the J16 or used with an optional probe extension cable. A standard  $\frac{1}{4}$ -20 threaded socket allows it to be used on a tripod or an optical bench.

**J6504 Uncorrected Probe**

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters. The J6504 is useful for checking light sources used in photo-resist or photoprocessing applications and comparisons of ultraviolet light sources.

A HOLD switch allows the reading to be stored at any time. No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

**J6505 LED Test Probe**

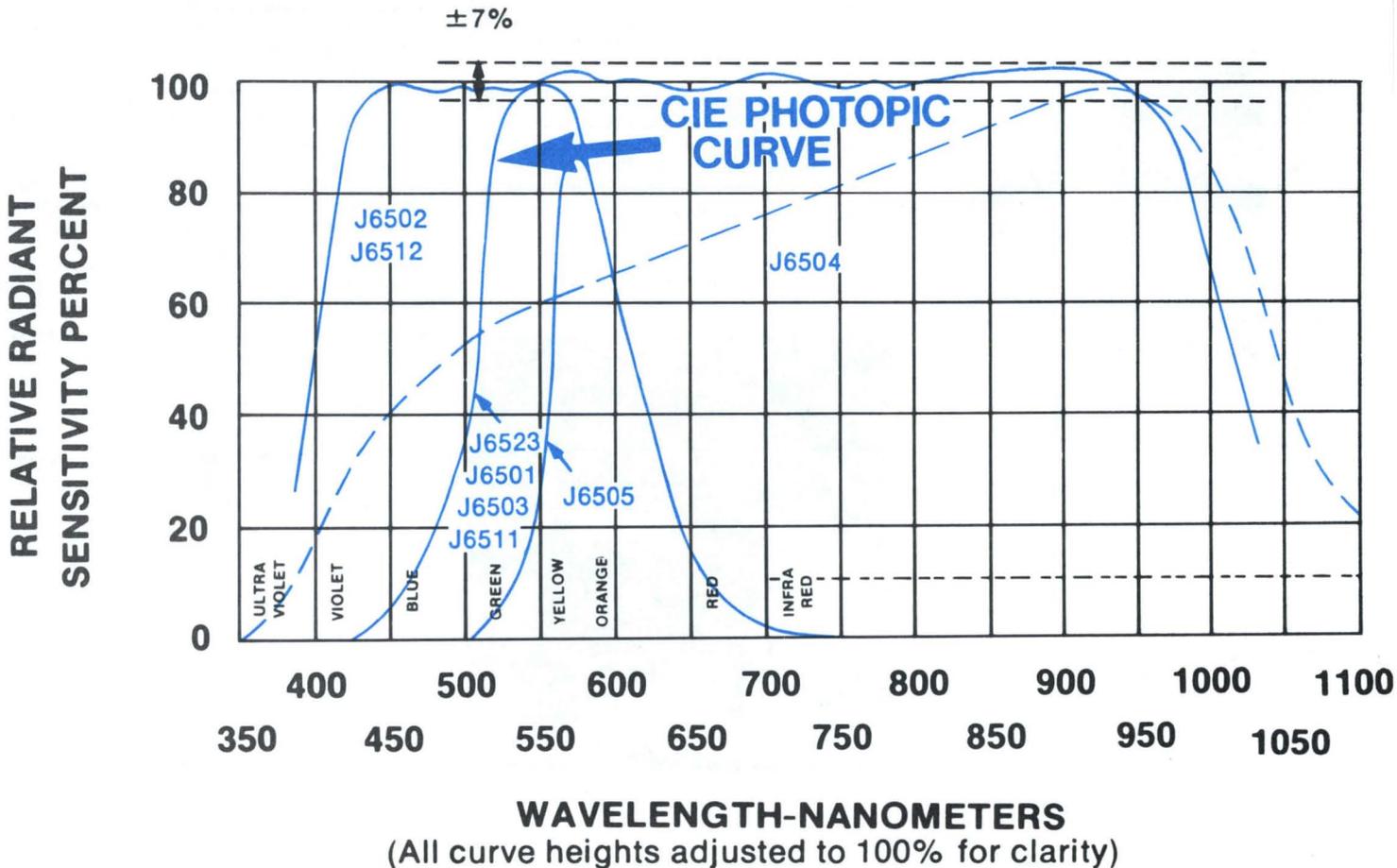
The principal application of the J6505 is measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 to 710 nm). The J6505 measures illuminance in footcandles (lumens/m<sup>2</sup> (lux) for the J6505 Option 02), which can easily be converted into luminous intensity in candelas.

An adaptor supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adaptor excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adaptor to fit common sizes of LED's (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adaptor in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (Option 02), 1 lumen/m<sup>2</sup> represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 to 710 nm. This close match requires compromising in the 380 to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the adaptor must be used with the J6501 and the same conversion factor for luminous intensity applies.

**TYPICAL PROBE SPECTRAL CHARACTERISTICS**



### PROBE CHARACTERISTICS

Application	Illuminance		Irradiance	Luminance		Uncorrected	Red LED	
	J6501	J6511	J6502/J6512	J6503	J6523	J6504	J6505	
Probe	US	0.001 to 1999 footcandles*†	0.001 to 1999 footcandles*†	0.001 to 1999 microwatts/cm <sup>2</sup>	0.1 to 199,900 footlamberts*	0.1 to 19,990 footlamberts*	Relative response only	0.001 to 1999 footcandles*†
	Metric (Opt. 02)	0.01 to 19,990 lumens/m <sup>2</sup> (lux)*†	0.01 to 19,990 lumens/m <sup>2</sup> (lux)	0.01 to 19.990 milliwatts/m <sup>2</sup> *	1 to 1,999,000 candelas/m <sup>2</sup> (Nits)*	1 to 199,900 candelas/m <sup>2</sup> (Nits)*	Relative response only	0.01 to 19,990 lumens/m <sup>2</sup> (lux)*†
Accuracy (Including J16)	Within 5% of NBS standards and ± 1 digit in last place. Calibrated with a 3100° K tungsten halogen light source traceable to NBS		Same, except calibrated with a 762 nm filter	Within 5% of NBS standards and ± 1 digit in last place. Calibrated with a 3100° K tungsten halogen light source traceable to NBS		Probe-to-Probe accuracy ± 5% with tungsten light source	Same as J6501, except calibrated with a 656 nm filter	
Spectral Response	Within 2% (integrated) of CIE photopic curve		Flat within ± 7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve		UV enhanced silicon spectral curve (250 to 1200 nm)	Within 2% (integrated) of CIE photopic curve from 600 to 710 nm	
Acceptance Angle	50% sensitivity at 48° off axis	Cosine Corrected (180°)	50% sensitivity at 48° off axis	8°	1°	50% sensitivity at 48° off axis		
Stability and Repeatability	Within 2% per year							
Linearity	Within 2% over entire range enabling single point calibration							

\*An additional decade of sensitivity is included and is usable if the J16 is carefully zeroed and used at a relatively stable temperature.  
 †0.00001 to 199.9 candelas when used with 014-0047-00 LED adaptor or at 3.8 inches source-to-sensor spacing. Luminous intensity readings of higher intensity light sources may be easily made at correspondingly greater distances using the formula: Footcandles x d<sup>2</sup> = candelas where d is the distance from the source to the sensor in feet. (For metric readings use lux x d<sup>2</sup> = ccandelas where d is distance from the source to the sensor in meters.)

### ENVIRONMENTAL CHARACTERISTICS

**Ambient Temperature** — Nonoperating: -50°C to +75°C. Operating: -15°C to +40°C.  
**Altitude** — Nonoperating: to 15 200 m (50,000 ft). Operating: to 4500 m (15,000 ft).  
**Humidity** — Operating and storage, 5 cycles (120 hour) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.  
**Vibration** — Operating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 in p-p (4 g's) from 10 to 55 to 10 Hz in 1 minute cycles. Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.

### PHYSICAL CHARACTERISTICS WITH PROBE AND BATTERY PACK INSTALLED

Dimensions	mm	in
	Width	123
Height	60	2.4
Depth	203	8.0
Weights ≈	kg	lb
	Net	1.5
Domestic Shipping	2.3	5.0
Export-packed	4.5	10.0

### INCLUDED ACCESSORIES

**For Battery Operated J16** — Battery charger (119-0375-02); shoulder strap (346-0104-00).  
**For Ac Operated J16 (Options 03 or 04)** — Ac power pack (119-0404-00 or 119-0404-01) shoulder strap (346-0104-00).

### ORDERING INFORMATION

**J16 Photometer/Radiometer (without Probes)** ..... **\$1,180**  
**Option 01** — 230 V ac, 50 Hz Battery Charger ..... **NC**  
**Option 02** — Probe for Metric Readout ..... **NC**  
**Option 03** — 115 V ac, 60 Hz ..... **NC**  
**Option 04** — 230 V ac, 50 Hz ..... **NC**  
 †For a J16 with metric readout, specify Option 02 in addition to above ordering information. No additional charge. Option 02 probes are required for Option 02 J16's.  
**J16-TV Package** — For TV color monitor set-up. The package includes J16 Battery-Operated Photometer, J6502 Irradiance Probe, Light Occluder, Probe Extension Cable.  
**Order J16-TV** for 115 V ac, 60 Hz Battery Charger ... **\$1,770**  
 \*Refer to Readout Units of Probe Characteristics chart.  
**Order J16-TV Option 01** For 230 V ac, 50 Hz battery charger ..... **\$1,770**

### PROBES

**J6501** Illuminance Probe ..... **\$545**  
**J6502** Irradiance Probe ..... **\$545**  
**J6503** 8° Luminance Probe ..... **\$545**  
**J6504** Uncorrected Probe ..... **\$515**  
**J6505** LED Probe, includes LED adaptor ..... **\$610**  
**J6511** Illuminance Probe cosine corrected ..... **\$540**  
**J6512** Irradiance Probe ..... **\$545**  
**J6523** 1° Luminance Probe ..... **\$1,575**  
**Actual Spectral Curve** of any probe is available on initial order at additional cost.  
**Order Option 05** ..... **+\$90**

### OPTIONAL ACCESSORIES

**42 in Probe Extender Cable** Connects J16 and probe.  
**Order 012-0414-02** ..... **\$104**  
**Spare Battery Pack** Order 016-0539-01 ..... **\$137**  
**Cables up to 30 ft in Length** Available on special order.  
**Analog and BCD Output** Available on special order.  
**Light Occluder** For TV color monitor balancing.  
**Order 016-0305-00** ..... **\$22**  
**Filter Holder** Mounts one-inch diameter filters, of up to 3/8 inch thickness, to probes (except J6511, J6512, J6514, J6523).  
**Order 016-0527-00** ..... **\$23**  
**LED Adaptor** included with J6505.  
**Order 014-0047-00** ..... **\$83**  
**Ac Power Supply** Allows J16 to be used without batteries.  
**Order 119-0404-00** 115 V ac, 60 Hz ..... **\$205**  
**Order 119-0404-01** 230 V ac, 50 Hz ..... **\$220**  
 When ordering a battery pack for your ac-powered J16, also order one of the following chargers.  
**Battery Charger** 115 V ac, 60 Hz.  
**Order 119-0375-02** ..... **\$50**  
**Battery Charger** 230 V ac, 50 Hz.  
**Order 119-0375-03** ..... **\$50**

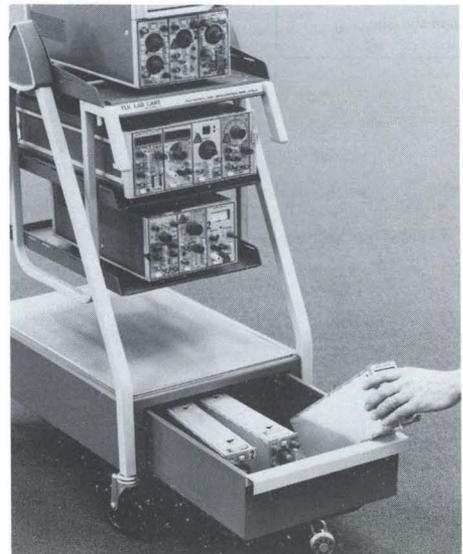
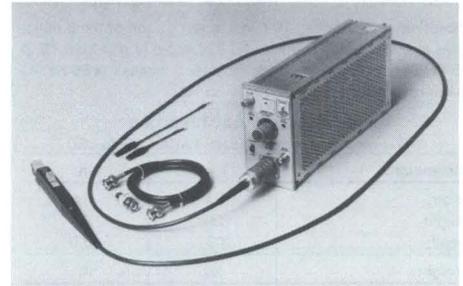
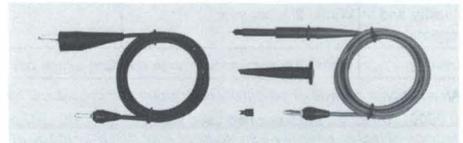
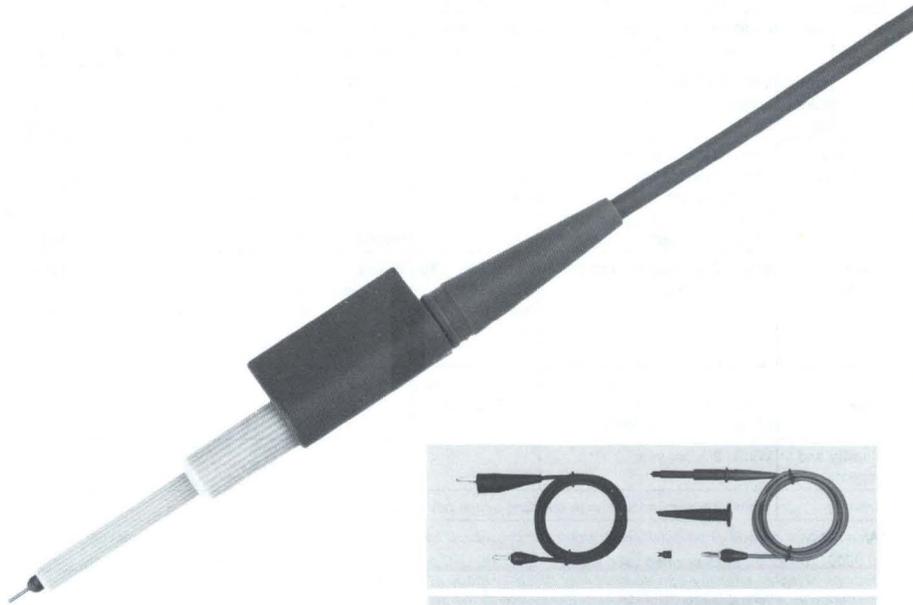
Within the basic limitations of the silicon sensors and the J16 design, a number of modifications are possible. Contact your local Tektronix Sales Office or Representative regarding special application requirements.

Please use the return card to request data sheet and application notes describing the use of the J16.

# ACCESSORIES

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For accessory products, you can order direct by calling 800-426-2200 extension 99. In Oregon call collect (503) 627-9000 extension 99.

# Choosing a Tektronix Camera . . .

## an overview of Tektronix Camera Families

A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

### MOUNTING

The table on page 413 indicates the camera adaptors required for most Tektronix Instruments and a few by other manufacturers. In some cases, adaptors are available from Hewlett-Packard or others to mount Tektronix cameras to their instruments.

### POWER

The C-51 and C-53 electric shutters require +15 volts, normally supplied by a 7000 Series oscilloscope. An optional battery pack is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-28 Camera requires +15 volts at 750 mA for operation. The shutter may be actuated with either a switch closure or TTL logic.

### GRATICULE LIGHTING

Some oscilloscopes do not have illuminated grati- cules. An image of the graticule may be obtained by using the flash on the C-5C Camera or storage background (flood guns).

### LENSES

Tektronix camera lenses differ mainly in light gathering ability, magnification, and field of view.

### Speed

The f-number of a lens inversely signifies its aperture area and light gathering ability. For example: the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in Tektronix cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type used in the C-5C Camera is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31B and C-51 Cameras.

### Field of View

The description for each camera includes a statement of its field of view; this signifies how large a CRT display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adaptor, camera body, film holder, and the image area of the film.

### Magnification

Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most Tektronix cameras are designed for use at one lens magnification. One exception is the C-30B Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 x 6.3 cm to 8 x 10 cm.

The rated magnification of a lens signifies its image-to-object ratio. Note in the table below that only an image-to-object ratio of less than 7:1 can record the trace of a 6 1/2 inch CRT.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 107 pack film which has an image area of 73 x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film.

### SHUTTERS

Of the two available types of shutters, mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism. Electrical shutters permit remote, automatic, or manual release and offer higher reliability. They may be actuated by an insulated switch closure.

### VIEWING

Except for the C-30 Series, all Tektronix cameras have a viewing port which provides a binocular view of the CRT. All Tektronix cameras, except the C-5C, are hinge mounted and can be swung aside to allow a wide-angle view of the CRT. The light-weight C-5C can easily be slipped off the CRT bezel to view the CRT. The C-28 and C-50 Series cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the CRT display while excluding ambient light.

### FILMS

The three types of backs used on Tektronix cameras accommodate most of the films that are used for CRT trace recording. These include sheet films, roll films, and pack films.

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in CRT recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types.

Many different types of Polaroid film are available in rolls, packs, and 4 x 5 inch single-sheet packets. The types most used in oscilloscope and monitor photography are types 107, 612, 47, 57, 084 and 667. Wet process film can be used with 4 x 5 Graflok with adaptors page 417.

Technical assistance with Polaroid film and back questions or problems is available directly from The Polaroid Corporation. **Call (800) 225-1618 toll free within U.S.**

Manufacture of Polaroid 410 ROLL film, ASA 10,000, has been discontinued. Polaroid 612 PACK film, ASA 20,000, is now available for most high speed applications.

### BLACK BODY COLOR STANDARD

All Tektronix cameras are supplied with a standard black body finish.

### MAXIMUM MAGNIFICATION TO RECORD ENTIRE SCREEN

Screen Size	5 x 6.3 cm	7.2 x 9 cm	8 x 10 cm	9.76 x 12.2 cm
Polaroid pack and roll film	1.0	1.0	0.85	0.67
4 x 5 sheet film	1.0	1.0	1.0	0.85 or less
6 x 7 cm format roll film (70 mm, 120, 220, etc.)	1.0	0.67	0.67	not recommended

**PHOTOGRAPHIC WRITING SPEED**

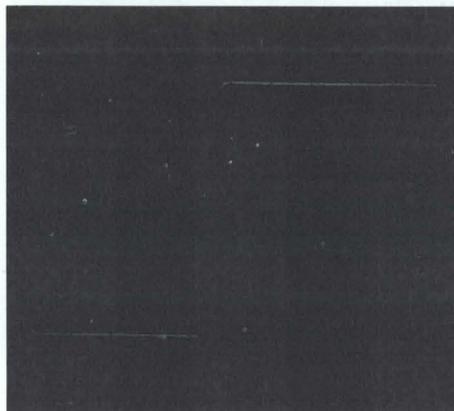
Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/ $\mu$ s or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the CRT phosphor and film used, and the definition of a readable trace image.

**Increasing Writing Speed**

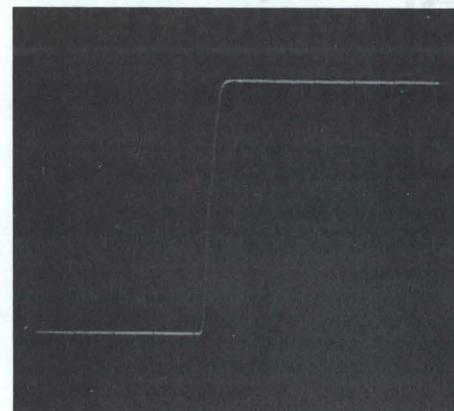
Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The Tektronix Writing Speed Enhancer is designed to fill this need.

The Enhancer installs in minutes, and can be triggered in three ways; by a pushbutton on the control box; remotely, with a switch closure to ground (such as provided by the camera-shutter x-sync switch); or by the oscilloscope-sweep + gate.

Thus, the film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, postfogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the Enhancer with the oscilloscope-sweep + gate.



*Polaroid Type 107, 3000 speed pack film was exposed to the single-trace display of a pulse waveform with a fast rising leading edge too dim to produce a developable image.*



*Film from the same pack was exposed to the same single-trace waveform and simultaneously to light from a Writing Speed Enhancer. The Enhancer light supplied the additional photons needed at the weak film development centers formed by the dim leading edge, to produce a visible image of the entire waveform.*

POLAROID FILM		RELATIVE FILM WRITING SPEED	
ASA Equivalent Speed	Type	Unfogged	Fogged
3,000	667 107 084 47	1 (Reference)	3
20,000	612* <sup>1</sup>	>2	≈ 2

<sup>1</sup> Polaroid 612 PACK film, ASA 20,000, is now available with faster writing rate than previous 410. ROLL film. Writing rate specifications are not complete at this time.

The more commonly used films for each type of camera back are listed below.

**POLAROID FILMS**

Film Type	ASA Equivalent Speed	Development Time (Seconds at 75°F)	Format	Resolution (Line Pairs/mm)	Characteristics	CRT Recording Uses				
						Repetitive	Stored	TV Type (Gray Scale)	Scintillation Type Medical	Graphics Alpha-Numeric
<b>PACK FILMS — Actual image size 7.3 cm x 9.5 cm (2<sup>7</sup>/<sub>8</sub> x 3<sup>3</sup>/<sub>4</sub> in)</b>										
611* <sup>1</sup>	200	45	Positive Print	20	Low Contrast, wide gray scale			X		
612* <sup>2</sup>	20,000	30	Positive Print	20 to 25	High Contrast					X
665	75	30	Positive Print Negative	160 to 180	Medium Contrast, wide gray scale	X	X	X		
107	3000	15	Positive Print	20	Medium Contrast	X	X			X
084* <sup>2</sup>	3000	15	Positive Print	16	Medium Contrast	X	X	X	X	
667* <sup>1,2</sup>	3000	30	Positive Print	16	Medium Contrast	X	X	X	X	
<b>ROLL FILM — Actual image size 7.3 x 9.5 cm (2<sup>7</sup>/<sub>8</sub> x 3<sup>3</sup>/<sub>4</sub> in) (46L and 146L are 6.2 x 8.3 cm)</b>										
47	3000	15	Positive Print	20 to 22	Medium Contrast	X	X			X
46L	800	130	Positive Trans	35 to 40	Medium Contrast	X	X	X		
146L	200* <sup>3</sup> 100	30	Positive Trans	40 to 50	High Contrast, Blue Sensitive	X				X
<b>SHEET FILMS — Actual image size 8.9 x 11.4 cm (4 x 5 in)</b>										
55			Positive Print	22 to 25						
55 P/N	50	20	Negative	160	Medium Contrast, wide gray scale	X	X	X		
57	3000	15	Positive Print	20	Medium Contrast	X	X			X

\*<sup>1</sup> No coating required.

\*<sup>2</sup> Preferred for oscilloscope photography.

\*<sup>3</sup> Daylight rating.

A limited quantity of ROLL film camera backs is available for customers who wish to use roll films listed above. Contact your Tektronix Representative for information.

SELECTION GUIDE FOR CAMERAS AND MOUNTING ADAPTORS

OSCILLOSCOPE OR DISPLAY DEVICE	RECOMMENDED CAMERAS			ADAPTOR PART NUMBERS*10		
	HIGH WRITING RATE	GENERAL PURPOSE	LOW COST	C-5C	C-51, C-53 C-59, C-28, C-27	C-30 C-31
<b>5000 Series</b>						
5100 Series Nonstore**1*2*3 includes; 5110, 5112, D10, D12, 577/D1		C-59A	C-5C	016-0357-01	016-0249-04	Not Recommended
5100 Series Storage**1*2*4 includes; 5111, 5111A, 5113, 5115 D11, D13, D15, 5577/D2		C-59A	C-5C	016-0357-01	016-0249-04	Not Recommended
5400 Series Nonstore**1*2 includes; 5403/D40, 5440, 5444, D40		C-59A	C-5C	016-0357-01	016-0249-04	Not Recommended
5400 Series Storage**2*4 includes; 5403/D41, 5441, D41	C-51	C-53	C-5C	016-0357-01	016-0249-04	016-0248-01
5233*1		C-59A	C-5C	016-0357-01	016-0249-04	Not Recommended
<b>7000 Series</b>						
8 x 10 cm Display includes; 7104, 7503, 7504, 7514, 7603N 7613, 7623, 7633, 7704, 7834 7844, 7854, 7903R, 7904, T922R*2 Large Screen Display includes;*1 7403, 7603	C-51	C-53	C-5C Opt 01	016-0357-01	016-0249-04	016-0248-01
		C-59A	C-5C	016-0357-01	016-0249-04	Not Recommended
<b>Display Monitors</b>						
8 x 10 cm**2*3 includes; 601, 602, 605, 606, 607		C-28	C-5C	016-0357-01	016-0249-04	016-0248-01
Large Screen 10 x 12 cm includes;*1 603, 604, 608, 620, 624, 634		C-28	C-5C	016-0357-01	016-0249-04	Not Recommended
<b>Older 5 Inch Round*2</b>						
502, 503, 504, 515, 516, 519, 530 & 540 Series, 550 Series, 580 Series, 575	C-51	C-53	C-59A	No adaptor	016-0225-04	016-0243-00
<b>Older 5 Inch Rectangular</b>						
560 Series includes;*2 561, 564, 567, 568		C-53	C-59A	No adaptor	016-0224-01	016-0244-00
<b>TV Products</b>						
380, 381		C-30B		No Adaptor	No Adaptor	016-0327-01
520, 521, 522A*1*2		C-59A		No adaptor	016-0295-01	No adaptor
1480*2		C-53	C-59A	No adaptor	016-0342-00*9	No adaptor
528A*2, 1420*1*2		C-59A	C-5C	016-0357-01	016-0249-04	016-0248-01
529*1		C-53		No adaptor	016-0224-01	016-0244-00
<b>Portables*5</b>						
Older with 0.8 cm Graticule includes; 422, 453, 454, 485, 491	C-31	C-30 Std		No adaptor	No adaptor	016-0306-01
Newer with 1 cm Graticule includes;*7 455, 464, 465, 466, 468, 475 432, 434, 442, 1 cm nonilluminated graticule 2213, 2215 ¼ In Graticule includes; 305, 314, 326, 335, 1502	C-31 Opt 01	C-30 Opt 01	C-5C Opt 02	016-0359-01	No adaptor	016-0269-03
			C-5C Opt 04	016-0359-01	No adaptor	016-0269-03
TM 500 includes; SC 502, SC 503, SC 504	C-30			No adaptor	No adaptor	016-0327-01
	C-30			No adaptor	No adaptor	016-0327-01
<b>Spectrum Analyzers</b>						
491*5	C-30/C-31			No adaptor	No adaptor	016-0306-01
492, 496*2		C-59A	C-5C	016-0357-01	016-0249-04	016-0248-01
<b>Others*6</b>						
576, 5030, 5031 T900 includes; T912, T921, T922, T932, T932, T935 (not included; T922R see 7000 Series) 308, 2300 Series*8		Only C-59A	C-5C Opt 03	No adaptor 016-0358-01	016-0288-01 No adaptor	No adaptor No adaptor

\*1 Only cameras with <0.7 magnification can record the entire screen area of a 10 x 12 cm display.  
\*2 These scopes do not have camera power. The C-51 and C-53 may be used only if powered with 016-0270-02 battery pack.  
\*3 These scopes do not have illuminated graticules w/o mod.  
\*4 Though these scopes do not have illuminated graticules the graticule may be photographed using storage flood guns.  
\*5 Due to physical configuration the C-50 Family cannot be mounted.  
\*6 Adaptors for HP and other scope manufacturers are available from those manufacturers.

\*7 A corrector lens is required to increase cameras field of view so that the full 8 x 10 cm CRT display area can be recorded. The camera should be changed from standard to Option 01, to do this order 016-0301-01 for the standard C-30 or 016-0269-04 for the standard C-31. These adaptors include the adaptor and corrector lens.  
\*8 These scopes have no camera bezel, therefore a camera cannot be mounted. A hand held C-5C can obtain a record.  
\*9 The C-59A may be used with 016-0224-01, however the image size is reduced.  
\*10 See page 414 for mounting adaptor pricing.

**OSCILLOSCOPE CAMERA COMPARISON CHART**

Camera	C-51	C-53	C-59A	C-30B	C-31B	C-28	C-5C
Features	Adjustable film & shutter speed Built-in viewer Single sweep mode Remote control Fastest writing speed	Adjustable film & shutter speed Built-in viewer Single sweep mode Remote control General purpose camera for 7000 Series scopes	Adjustable film & shutter speed Built-in viewer General purpose camera for CRTs up to 6½ inch Low cost	Variable magnification for 400 Series scopes, adaptable to 8 x 10 cm CRT or smaller	Maximum writing speed for 400 Series scopes, adaptable to 8 x 10 cm CRT or smaller	For XY, XT, gray scale photos, precision accuracy for 600 Series monitors Variable magnification Power supply required OEM Applications	Low cost General purpose Graticule illuminator Viewing door Variable magnification OEM Applications
Lens speed	f/1.2	f/1.9	f/2.8	f/1.9	f/1.3	f/2.8	f/16
Magnification	0.5	0.85	0.67	Variable: 0.7 to 1.5	0.5	0.67 or 0.85	0.67 or 0.85
Relative light gathering ability	3.0	1.0	0.65	1.0	2.7	0.65 or 0.5	0.02
Field of view	8x10 cm with Polaroid pack		10.2 x 12.7 cm with Polaroid pack	8 x 10 cm w/Opt 01 7 x 9 cm std	8 x 10 w/Opt 01 7 x 9 cm std	10.2x 12.7 cm or 8 x 10 cm	9.8 x 12.2 cm or 8 x 10 cm
Shutter	Electrical, 1/60 to 4 s (bulb, time, single sweep), remote shutter actuation, X-sync, scope + gate		Mechanical, 1/50 to 1 s (bulb and time) X-sync	Mechanical, 1/125 to 1 s (bulb and time) X-sync		Electrical, 1/50 to 2 s (bulb, time open shutter)	Electrical 1/10 to 5 s (bulb)
Film backs	Polaroid pack or Graflok back	Polaroid pack or Graflok back	Polaroid pack or Graflok back	Polaroid pack	Polaroid pack	Polaroid-Graflok combination	Polaroid pack
Options			Adaptor frame/corrector lens for CRT to 6½ inch, reduces magnification to 0.5 (for 576 & 5030)	01 Lens Adaptor has fixed magnification of 0.8; relative light gathering ability of 0.9; 8 x 10 cm field of view. A bezel to accommodate 400 Series scopes with 8 x 10 cm CRTs		01 Focus lights 02 Graflok focus screen & hood 03 No Polaroid back 04 0.8 magnification 05 0.9 magnification 06 1.0 magnification 08 Mounting Adaptor	01 02 03 04 See page 413 for specific selections
Optional Accessories	Mounting adaptors, battery pack (for C-51, C-53), writing speed enhancer (one for each model). Polaroid pack film back. Graflok 4 x 5 inch back and adaptors. X-sync connector, carrying case			Mounting adaptors, writing speed enhancer, Polaroid pack film back, Polaroid roll film back, Graflok 4 x 5 inch back, carrying case, X-sync cable, porta lens, (for C-30B only)		View Hood	Mounting adaptors, flash unit, viewing door

**CAMERA MOUNTING ADAPTOR PART NUMBERS AND PRICES**

016-0217-00	\$72	016-0269-03	\$83
016-0223-01	\$60	016-0269-04 <sup>**</sup>	\$90
016-0224-01	\$58	016-0295-01	\$58
016-0225-04	\$58	016-0299-00	\$72
016-0226-01	\$72	016-0301-01 <sup>***</sup>	\$105
016-0228-01	\$95	016-0306-01 <sup>***</sup>	\$83
016-0243-00	\$72	016-0327-01	\$169
016-0244-00	\$72	016-0342-00	\$230
016-0248-01	\$80	016-0357-01 <sup>***</sup>	\$19
016-0249-04 <sup>***</sup>	\$83	016-0358-01 <sup>***</sup>	\$19
016-0263-00	\$72	016-0359-01 <sup>***</sup>	\$19

- <sup>\*\*</sup> Included with C-50 Series cameras.
- <sup>\*\*</sup> Adaptor with lens included with C-31 B Option 01 cameras.
- <sup>\*\*\*</sup> Adaptor with lenses included with C-30B Option 01 cameras.
- <sup>\*\*\*</sup> Included with C-30B, C-31B Cameras.
- <sup>\*\*\*</sup> Included with C-5C and C-5C Option 01 Cameras.
- <sup>\*\*\*</sup> Included with C-5C Option 03 Cameras.
- <sup>\*\*\*</sup> Included with C-5C Option 02 and Option 04 Cameras.

**ORDERING INFORMATION**

**Polaroid Pack Film Back For Older Cameras C-12, C-19, C-13, C-27**

These cameras are no longer produced by Tektronix. However due to customer need for a Pack Film Back these are now available. The Pack Film Back accepts the Polaroid pack film.  
Order 122-0671-01 ..... **\$235**

**Mounting Adaptors**

C-12 to 7000 Series and 5000 Series  
Order 016-0299-00 ..... **\$72**  
C-12 to 530, 540, 550 Series  
Order 016-0226-01 ..... **\$72**  
C-12 to 560 Series rectangular CRTs  
Order 016-0217-00 ..... **\$72**

**C-51P**



**C-53P**



## C-50 Series

**Electronic-Actuated Shutter**

**Photometer Exposure Aid**

**Range-Finder Focusing**

**Automatic Single-Sweep Control**

### The top of the line

The three C-50 Series cameras are designed for use with all Tektronix 7000 Series oscilloscopes, and can be adapted to fit most 5000 Series oscilloscopes. Full selection of film backs, and adjustable film and shutter speeds give you the flexibility you need to best record your measurements. The photometer exposure aid, similar to light meters used in conventional photography, provides an easy way to approximate the correct exposure for repetitive or stored traces. X-sync connectors allow the camera shutter to trigger the event. And each camera's built-in viewing tunnel lets you see what's on the display when the camera is in place.

The electronic actuated shutter allows the shutter to be operated with a contact closure or TTL logic level.

The single sweep mode, available only on the C-51 and C-53 cameras, automatically closes the shutter after the trace sweeps the screen.

Range-finder focusing, a feature the C-53 shares with the C-51 and the C-59A, results in sharp, focused pictures every time.

## C-51

**Fastest Writing Speed**

This camera offers the fastest writing speed of any Tektronix oscilloscope camera. The f/1.2 lens shoots images at 0.5 magnification, clearly capturing fast transients or single sweeps, although at some expense to image size. The C-51's electric shutter can operate at speeds ranging from 1/60 to 4 seconds, and offers bulb, time, and single sweep modes by manual or remote control.

### CHARACTERISTICS

**Aperture** — Variable from f/1.2 to f/16.

**Lens Speeds** — f/1.2.

**Magnification** — 0.5.

**Relative Light-Gathering Ability** — 3.0.

**Shutter** — Electric; 1/60 to 4 s bulb, time, and single sweep modes, manual or remote control. Scope + gate input for shutter actuation.

**Power Requirement** — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

**Synchronization** — X-sync switch closure.

**Field of View** — 8 x 10 cm.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	248	9.8
Height	292	11.5
Depth	273	10.8
Weights ≈	kg	lb
Net	4.3	9.5
Shipping	6.8	15.0

### INCLUDED ACCESSORIES

(C-51 and C-53)

Mounting adaptor for all 7000, 5000, and small 600 Series (016-0249-04); \*P\* Models include - focus plate (387-0893-00). \*G\* models have an integral focusing screen.

## C-53

**General Purpose Medium Speed**

**Is the Fastest Camera without Image Reduction**

**8 x 10 cm Field of View**

The C-53, like the C-51, provides an 8 x 10 cm field of view when used with Polaroid pack film. Its f/1.9 lens and 0.85 magnification, however, offer somewhat slower writing speed. This camera's electric shutter also offers speeds ranging from 1/60 to 4 seconds, and can be operated manually or remotely in bulb, time, or single sweep mode.

### CHARACTERISTICS

**Aperture** — Variable from f/1.9 to f/16.

**Lens Speed** — f/1.9.

**Magnification** — 0.85.

**Relative Light-Gathering Ability** — 1.0.

**Shutter** — Electric; 1/60 to 4 s; bulb, time, and single sweep modes, manual or remote control scope + gate input for shutter actuation.

**Power Requirement** — +15 V from 7000 Series oscilloscopes, or an optional battery pack for non-7000 Series instruments (see next page).

**Synchronization** — X-sync switch closure.

**Field of View** — 8 x 10 cm.

### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	191	7.5
Height	292	11.5
Depth	273	10.8
Weights ≈	kg	lb
Net	2.4	7.5
Shipping	5.4	12.0

For Ordering Information see next page.

**C-59AP**



**C-59A**

- Low-Cost**
- Photometer Exposure Aid**
- Range-Finder Focusing**
- Internal Battery Power**
- For Larger CRT'S**

This camera is designed for CRTs up to 6½ inches, and has a 10.2 x 12.7 cm field of view with Polaroid pack film. It is the only camera for the 576 Curve Tracer, and the only C-50 Series camera for the 7603 Oscilloscope. The f/2.8 lens means slower writing speed, but it also means economy. The C-59A's mechanical shutter operating between 1/50 and 1 second also contributes to a low cost. Still, many of the features of the high-priced C-50 Series cameras are standard on the C-59A: photometer exposure aid, range-finder focusing, bulb and time operating modes, X-sync contacts, and film back interchangeability.

**CHARACTERISTICS**

- Aperture** — Variable from f/2.8 to 1/16.
- Lens Speed** — f/2.8.
- Magnification** — 0.67.
- Relative Light-Gathering Ability** — 0.65.
- Shutter** — Mechanical; 1/50 to 1 s; bulb and time.
- Synchronization** — X-sync switch closure.
- Field of View** — 10.s x 12.7 cm (6.5 in with optional Adaptor Frame/Corrector Lens).
- Power Requirement** — Receives power (+15 V from a 7000 Series oscilloscope, or from an internal battery pack, 8 AA size alkalines, (12 V) if used on a non-7000 Series scope.

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	mm	in	kg	lb
Width	193	7.7		
Height	292	11.5		
Depth	273	10.8		
<b>Weights ≈</b>				
Net	3.2	7.0		
Shipping	5.0	11.0		

**INCLUDED ACCESSORIES (C-59)**

Focus Plate for Polaroid pack film (387-0893-02); or focusing screen integral with Graflok type back; mounting adaptor for all 7000, 5000, and small 600 Series (016-0249-04).  
C-59 does not include 8 AA size alkaline batteries.

**ORDERING INFORMATION**

- "P" Models accept only Polaroid pack film.**
- "G" Models have a Graflok type back that requires A film holder (see next column)**
- C-51 CAMERA**
- C-51G ..... **\$2,060**
- C-51P ..... **\$2,060**
- C-53 CAMERA**
- C-53P ..... **\$1,695**
- C-59A CAMERA**
- C-59AG ..... **\$1,260**
- C-59AP ..... **\$1,260**

**ADAPTOR FRAME/CORRECTOR LENS  
C-59 CAMERAS**

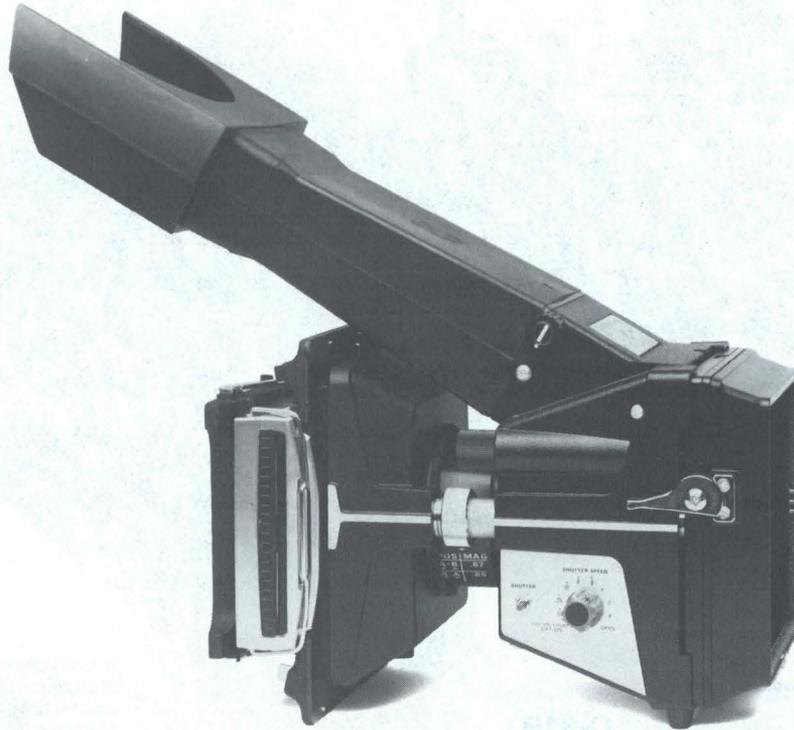
Optional Adaptor Frame Corrector Lens expands the field of view to fully cover the 6½ inch CRT and adjacent scale readout characters of the 576 Curve Tracer and 5030 Series oscilloscopes. The corrector lens reduces the effective magnification of the C-59 from 0.67 to 0.5 so it can record the entire display on Polaroid 3¼ x 4¼ inch film (for the C-59A camera only). Adapts camera to 576, 5030, and 5031.  
**Order 016-0288-01 ..... \$125**

**C-51 and C-53 OPTIONAL CAMERA ACCESSORIES**

- Mounting Adaptors** — See table on page 413.
- Battery Pack** — Provides auxiliary +15 V power source for using the C-51, C-53 Cameras with oscilloscopes without camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000 Series oscilloscope or an external +15 V source. Net weight, including batteries, is 1.2 lb. Requires 12 AA size alkaline batteries (not included).  
Order 016-0270-02 ..... **\$280**
- Writing Speed Enhancer** — Provides controlled film fogging to increase writing speed by three times for 3000 ASA film and about two times for 10,000 ASA film. Installs in minutes.  
For C-51 Order 016-0279-02 ..... **\$270**  
For C-53 Order 016-0300-02 ..... **\$300**  
For C-59A Order 016-0290-02 ..... **\$300**
- X-Sync Connector Plug** — Not shown.  
Order 134-0079-00 ..... **\$1.30**
- Carrying Case** — Hold a complete C-50 Series camera with extra film backs and accessories.  
Order 016-0177-00 ..... **\$270**
- Polaroid Pack Film Back** — Included with "P" models.  
Order 122-0926-01 ..... **\$163**
- Focus Plate** — Included with "P" models.  
Order 387-0893-02 ..... **\$3.60**
- Graflok Type Film Back** — Included with "G" models, accepts Polaroid 4 x 5 inch film holder, standard cut-film holders, film-pack adaptors, roll-film holders\* (except heavy motorized models).  
Order 122-0931-01 ..... **\$220**
- Focusing Screen** — For Graflok film back, included with "G" models.  
Order 016-0249-04 ..... **\$83**

**OPTIONAL FILM HOLDERS FOR  
GRAFLOK TYPE BACKS  
("G" MODELS ONLY)**

- Cameras with Graflok type backs must have a film holder in order to be functional.
- Here are several holders\*1 that allow the use of roll film, or 4 x 5 inch Polaroid films. Order these holders from Tek, the manufacturer, or from your local camera store.
- Polaroid Land #545 4 x 5 Film Holder** — For Polaroid 4 x 5 inch Single Exposure Film Packets.  
Order 016-0201-01 ..... **\$310**
- RH/10 120 Roll-Film Holder** — 10 exposures 2¼ x 2¾ inch for 4 x 5 inch Graflok Backs  
Order 122-0736-01 ..... **\$345**
- RH/50 70 mm Holder** — 50 exposure, 2¼ x 2¼ inch for 4 x 5 inch Graflok Backs only.  
Order 122-0967-00 ..... **\$275**
- Roll film holders are also manufactured by several other companies.
- \*1 Other film holders and adaptors (4 x 5 cm cut film, pack film, or roll film) are available at local camera store.



**C-28**

**Used with UL Approved Medical and Dental Equipment**

**Rangefinder Focusing**

**Rigid Body Design Eliminates Distortion Errors**

**OEM Pricing Available**

**When Measurement Accuracy is Critical**

The C-28 camera is a high quality recording device for systems displaying XY, XT, or gray scale images. It is recommended for use with 600 Series display monitors, and offers broad interface capability with many oscilloscopes. And its UL Component Recognition allows the C-28 to interface with UL approved medical and dental equipment.

The accurate reproduction quality of C-28 photographs results from a special rigid body design that eliminates focus errors and trapezoidal distortion, even with heavy motorized roll film backs.

The C-28 f/2.8 lenses has interchangeable 0.67 and 0.85 magnification which you can easily change to fully record from 102 x 127 mm or 80 x 100 mm CRTs. Lens mounts with fixed magnifications of 0.8, 0.9, and 1.0 are available as options. A reliable electric shutter with a wide choice of speeds from 1/50 to 2 seconds can be operated manually or remotely in bulb or time mode. Optional rangefinder focus lights allow easy, accurate focusing without necessitating film removal.

This camera's versatility extends to its standard combination Graflok/Polaroid film back. The Polaroid back, which takes 3 1/4 x 4 1/4 inch photos horizontally or vertically, is easily removed to allow the use of Graflok-compatible accessories, such as 70 mm or 90 mm roll film backs.

**OEM Quantities**

Both the highly accurate C-28 and the low cost C-5C, page 419, Oscilloscope Cameras are available in OEM quantities with special pricing, terms, and conditions.

**CHARACTERISTICS**

**Aperture** — Variable from f/2.8 to f/16.

**Lens Speed** — f/2.8

**Magnification** — 0.67 and 0.85 (0.8, 0.9, and 1.0 optional).

**Shutter** — Electric: 1/50 to 2 seconds bulb and time.

**Synchronization** — Switch closure coincident with shutter opening. 28 V 750 mA rating.

**Field of View** — 80 x 100 mm (0.85 magnification) and 102 x 127 mm (0.67 magnification).

**PHYSICAL CHARACTERISTICS**

PHYSICAL CHARACTERISTICS		
Dimensions	mm	in
Width	185	7.3
Height	205	8.1
Depth	246	9.7
Weights ≈	kg	lb
Net	3.8	8.5
Shipping	5.9	13.0

**Voltage Input** — +15 V dc ±0.5 V.

**Current Drain** — ≈260 mA with focus lights on; ≈250 mA with shutter open; ≈25 mA idle.

**Power Consumption** — ≤12 W.

*Note: Power supplied by user — Camera supplied with power cord and connector.*

**Temperature Range to Assure Specified Performance** — 0°C to +50°C (+32°F to +122°F).

**Altitude**

Operating — Sea level to 4500 m (15,200 ft).

Nonoperating — Sea level to 15 000 m (50,000 ft).

**Maximum Input** — -1 to +10 V (dc or peak transient).

**Input Requirement for Shutter Actuation** — TTL: Transition from ≥2.5 V dc to ≤0.9 V dc in 10 μs or less, and remaining low for at least 50 μs. Bulb requires a continuous low while the shutter is open. Switch closure: Transition from ≥7.5 kΩ to ≤1 kΩ in 10 μs or less, and remaining low for at least 50 μs. Minimum time interval between shutter operations is not <500 ms.

**INCLUDED ACCESSORIES**

Six-pin connector and 18-inch power and control cable assembly (131-1794-00); viewing tunnel and hood (122-0719-01); Polaroid pack film holder (352-0505-01).

**ORDERING INFORMATION**

**C-28 Camera with Graflok Back ..... \$1,565**

**Graflok Film Back** — Accepts 4 x 5 inch film holders, standard cut film holders, film pack adaptors (Polaroid back comes standard), and roll film holders (including heavy motorized models).

**Option 01** — With Focus Lights ..... +\$55

**Option 02** — With Graflok focus screen and hood. (122-0510-00 and 122-0944-00) ..... +\$110

**Option 03** — Without Polaroid pack film holder (deletes 352-0505-01) ..... -\$50

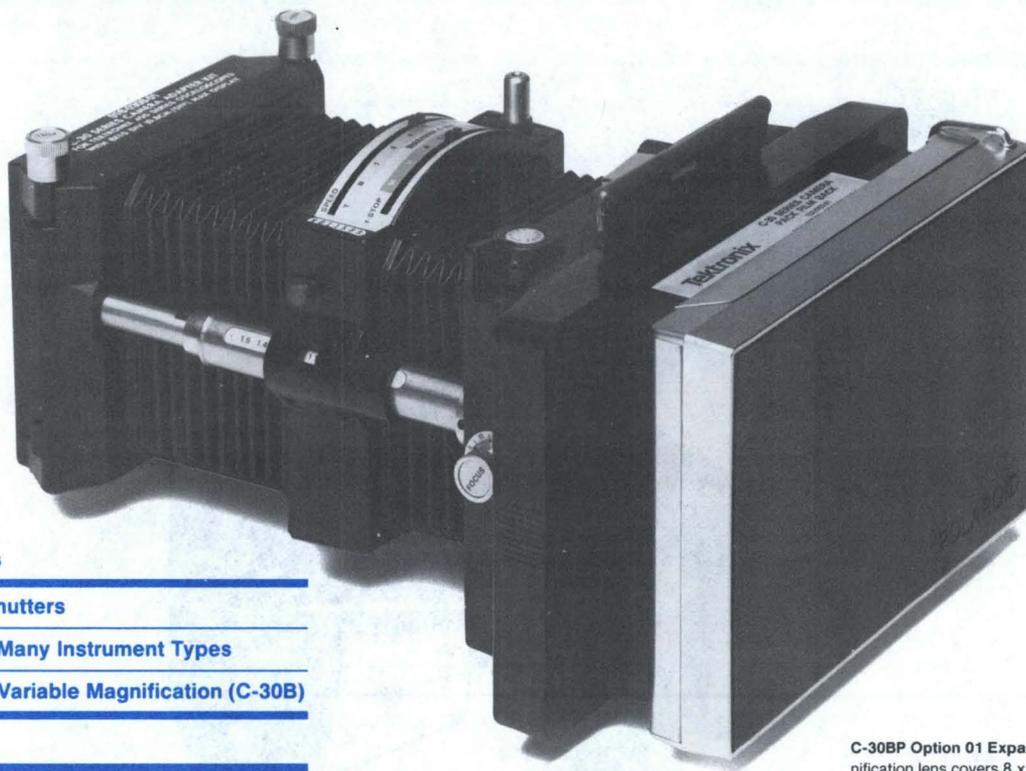
**Option 04** — 0.8 magnification only ..... +\$45

**Option 05** — 0.9 magnification only ..... +\$45

**Option 06** — 1.0 magnification only ..... +\$45

**Option 08** — With Mounting Adaptor for 600, 5000, and 7000 Series (016-0249-04) ..... +\$65

Special pricing, terms and conditions are available to qualified OEM's. Contact your local Tektronix representative for complete information.



## C-30 Series

### Mechanical Shutters

### Adaptable to Many Instrument Types

### Continuously Variable Magnification (C-30B)

#### Option 01

#### Is Optimized for 8 x 10 cm

#### 400 Series Portables

The C-30B and C-31B Cameras are primarily designed for use with the 400 Series portable oscilloscopes, but are also adaptable to 80 x 100 mm or smaller 7000, 5000, and 600 Series instruments, and to others as shown on Camera Adaptor Selection Guide. The C-30 Series cameras feature mechanical shutters with bulb and time operating modes. X-sync contacts, and choice of speeds between 1/125 and 1 second. Polaroid pack film backs are interchangeable on both C-30 Series cameras.

## C-30B

The C-30 B is a versatile, general purpose camera that offers a highly reliable mechanical shutter and an f/1.9 lens. It is the only Tektronix oscilloscope camera that features continuously variable magnification (from 0.7 to 1.5) giving you greater photographing flexibility. This camera was designed for the 453, 454, 485C and 491.

## C-30B Option 01

An optional adaptor lens with fixed 0.8 magnification photographs an 80 x 100 mm CRT screen without darkening the edges of a print. This lens is designed especially to fit the 455, 464, 465, 465B, 466, 468, 475, and 475A oscilloscopes.

### CHARACTERISTICS

**Aperture** — Variable from f/1.9 to f/16.  
**Lens Speed** — f/1.9.  
**Magnifications** — Variable from 0.7 to 1.5.  
**Relative Light-Gathering Ability** — 1.0 (0.9 on Option 01).  
**Shutter** — Mechanical, 1/125 to 1 second; bulb and time.  
**Synchronization** — X-sync contact closure.  
**Field of View** — 70 x 90 mm (80 x 100 mm on Option 01).

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	191	7.5
Height	130	5.1
Depth	254	10.4
Weights ≈	kg	lb
Net	2.2	4.8
Shipping	4.1	9.0

## C-31B

This camera's f/1.3, 0.5 magnification lens offers the fastest writing speed for 400 Series oscilloscopes. The C-31B Option 01 covers an 8 x 9 cm CRT.

## C-31B Option 01

This option includes an adaptor/corrector lens that accommodates the same oscilloscopes as the C-30B Option 01.

### CHARACTERISTICS

**Aperture** — Variable from f/1.3 to f/16.  
**Lens Speed** — f/1.3  
**Magnification** — 0.5  
**Relative Light-Gathering Ability** — 2.7 (2.9 on Option 01).  
**Shutter** — Mechanical; 1/125 to 1 second; bulb and time.  
**Synchronization** — X-sync contact closure.  
**Field of View** — 7 x 9 cm (8 x 10 cm on Option 01).

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	231	9.1
Height	140	5.5
Depth	269	10.6
Weights ≈	kg	lb
Net	3.1	6.8
Shipping	5.4	11.0

#### INCLUDED ACCESSORIES

Polaroid pack film back (122-0752-02); split-image focus plate (387-0893-02); mounting adaptor (016-0306-01).

### ORDERING INFORMATION

C-30BP Camera .....	\$1,360
C-31BP Camera .....	\$1,570
Both models include Polaroid pack films back.	

### OPTIONS

**C-30BP Option 01 Expanded Field of View** — f/1.9, 0.8 magnification lens covers 8 x 10 cm CRT screen without vignetting. Relative light-gathering ability is 0.9. Includes 016-0269-03 adaptor for 465 size CRT bezel and corrector lens and holder. Recommended for — 455, 464, 465, 465B, 466, 475, 475A.

**Specify Option 01** ..... \$42

**C-31BP Option 01, Expanded Field of View** — f/1.2, 0.5 magnification lens with relative light gathering ability of 2.9 covers CRT screens up to 8 x 10 cm. Includes 016-0269-03 adaptor for 465 size CRT bezel and corrector lens and holder. Recommended for — 455, 464, 465, 465B, 466, 475, 475A.

**Specify Option 01** ..... \$42

### CONVERTING OPTION 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30B and C-31B Cameras can be converted to standard models by simply slipping off the Corrector Lens, removing the Adaptor Frame, and adding an 016-0306-01 Adaptor. Please refer to page 414 for prices and compatibility.

### CONVERTING STANDARD MODEL TO OPTION 01 MODEL

A standard-model C-30B or C-31B can be converted to an Option 01 model by means of the appropriate Adaptor Frame/Corrector Lens. 016-0301-01 for C-30B; 016-0269-04 for the C-31B. Please refer to page 414 for prices and compatibility.

### OPTIONAL ACCESSORIES

**Mounting Adaptors** — See page 414.

**Writing Speed Enhancer** — Increases effective film speed about three times for 3000 speed film. Installs in minutes.  
 Order 016-0284-01 ..... \$270

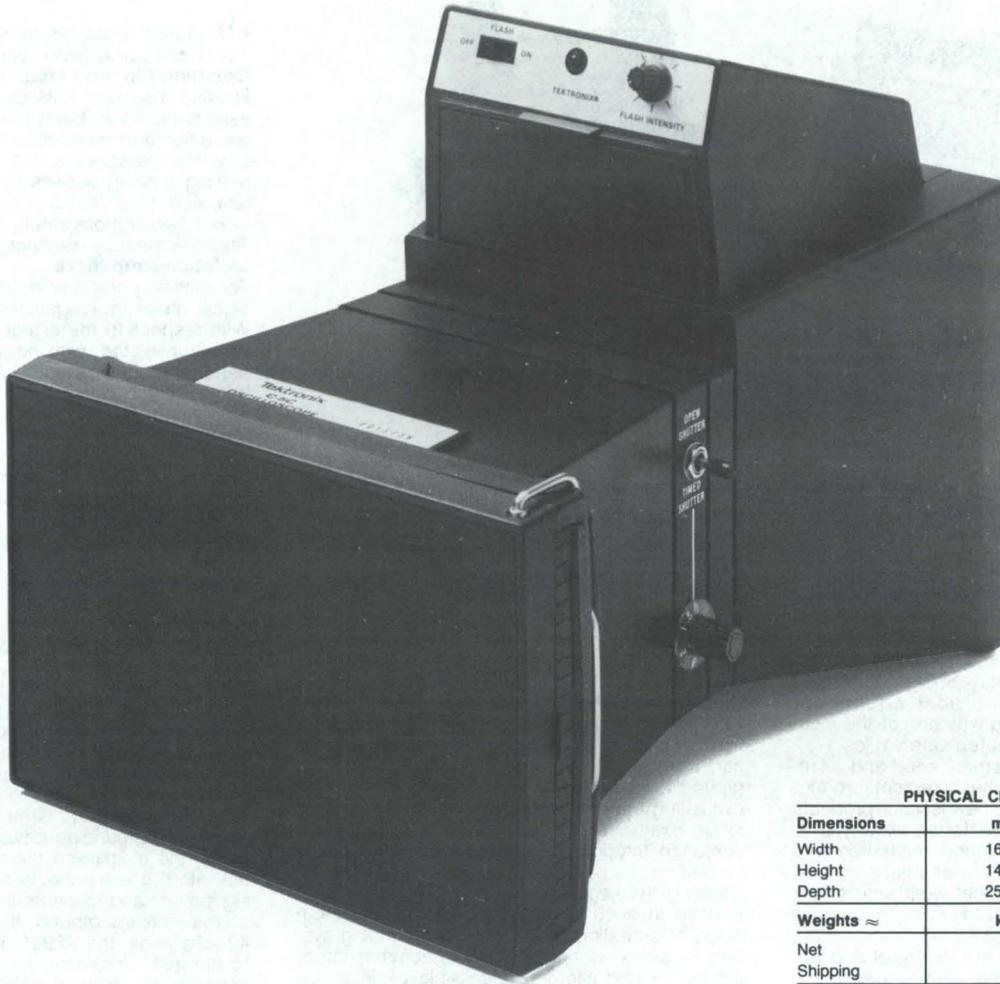
**Polaroid Pack Film Back** — Accepts Polaroid pack film. Included with "P" models.  
 Order 122-0752-02 ..... \$185

**Graflok Type 4 x 5 in Back** — Accepts Polaroid Land 4 x 5 in film holders, standard cut film holders, filmpack adaptors, roll film holders (except heavy motorized roll film holders).  
 Order 016-0487-00 ..... \$235

**Carrying Case** — Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 x 14.5 x 8 in.  
 Order 016-0587-00 ..... \$108

**X-Sync Cable**  
 Order 012-0364-01 ..... \$21

**Portra Lens** — A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a distance of 21 inches the camera covers 19 x 21 inches. Usable with either the C-30B or C-30B Option 01.  
 Order 016-0246-02 ..... \$33



**C-5C**

**Low Cost**

**Easy to Use**

**Lightweight**

**1/10 to 5 s Timing Speeds**

**OEM Pricing Available**

**Maximum Performance at Minimum Cost**

If your application does not require specialized photographic techniques, such as the capability to record single sweeps, this general purpose camera may fill your needs at exceptionally low cost. The C-5C is lightweight and modular, with a reliable electric shutter offering timed speeds from 1/10 to 5 seconds. The three-element f/16 lens offers both 0.67 and 0.85 magnifications, either of which you can easily change, for 98 x 122 mm or 80 x 100 mm fields of view.

This camera's optional features include a variable-intensity xenon flash that evenly lights CRTs with nonilluminated graticules. A viewing door allows screen viewing while the camera is in place, and fits any of the three optional mounting adaptors which slide onto many oscilloscopes and small monitors.

**OEM Quantities**

Both the highly accurate C-28, page 413, and the low-cost C-5C Oscilloscope Cameras are available in OEM quantities.

Special pricing, terms and conditions are available to qualified OEMs. Contact your local Tektronix representative for complete information.

**CHARACTERISTICS**

**Aperture** — Fixed at f/16.

**Lens speed** — f/16.

**Magnification** — 0.67 and 0.85.

**Relative Light-Gathering Ability** — 0.02.

**Shutter** — Electric; 1/10 to 5 seconds; time.

**Field of View** — 98 x 122 mm (0.67 magnification) and 80 x 100 mm (0.85 magnification).

**Power** — The C-5C requires (4) AA alkaline batteries (not included).

**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	168	6.6
Height	140	5.5
Depth	257	10.1
Weights ≈	kg	lb
Net	1.4	3.0
Shipping	1.9	4.1

**OPTIONAL ACCESSORIES**

**Viewing Door** — Fits all three mounting adaptor hoods. Included with C-5C Options 01 and 02.

Order 016-0630-00 ..... **\$7.00**

**Graticule Flash Unit** — Fits all three mounting adaptor hoods. Included with C-5C and C-5C Options 03 and 04.

Order 016-0642-00 ..... **\$140**

**Additional Mounting Adaptor Hoods** — (Requires assembly with viewing door or flash unit.)

For C-5C and C-5C Option 01

Order 016-0357-01 ..... **\$19**

For C-5C Options 02 and 04

Order 016-0359-01 ..... **\$19**

For C-5C Option 03

Order 016-0358-01 ..... **\$19**

**ORDERING INFORMATION**

Order	For Use With	Adaptor Hood (Included) Part Number	Mounting Flash Unit (Included)	Price
C-5C	577, 600 Series with unilluminated graticule 1420 Series, 5100 Series	016-0357-01	Yes	\$525
C-5C Option 01	528, 600 Series without graticule, or with illuminated graticule, 5400 Series, 7000 Series, T922R TELEQUIPMENT D83	016-0357-01	No	-\$20
C-5C Option 02	432, 434, 455, 464, 465B, 465M, 466, 475, 475A	016-0359-01	No	-\$20
C-5C Option 03	T900 Series except T922R	016-0358-01	Yes	NC
C-5C Option 04	2200 Series with unilluminated graticule	016-0359-01	Yes	NC



## ISOLATION ACCESSORIES FOR FLOATING MEASUREMENTS

In the world of oscilloscope use, the problem of floating measurements is a pressing need that often causes users to employ questionable and often unsafe practices to allow the oscilloscope chassis to float at some potential other than ground. Such practices are parts of a larger problem concerning equipment grounding. In a recent study of computer data, OSHA found that faulty grounding of electrical equipment connected by cord and plug was one of the most common violations of accepted safety rules.

Recognition of the measurement need and a firm commitment to test and measurement product safety have resulted in two new isolator products from Tektronix. These products will allow you to make those necessary floating measurements with minimum risk of operator injury or test equipment damage. Both meet worldwide safety standards; including UL 1244, CSA Electronics Bulletin 556B, IEC 348 and BS 4743.

But, before we delve into the technical and applications aspects of these new accessories, perhaps some background information would be appropriate. Just what are floating measurements and why are such measurements necessary?

### A Need Met

Users of oscilloscopes often must make measurements in which neither point of the measurement is at ground potential. The signal common may be at times hundreds of volts from ground. Also, many such measurements require rejection of high amplitude common-mode signals in order to examine low-level signals. Unwanted ground currents may add bothersome hum and ground loops to displays.

### Ground Loops

The potential difference between two green wire grounds on separate mains circuits may be as great as 5 volts RMS at 60 Hz. An oscilloscope plugged into one main circuit would thus measure a signal on a system plugged into another mains circuit equal to the sum of the signal plus the difference between the green wire grounds. A logic signal typically swings 1.8 volts. With this logic signal imposed on that 5 volts 60 Hz signal, making measurements becomes difficult if not impossible. Traditional oscilloscope designs cannot effectively cope with these problems alone. All too often, the problems almost force users into employing dangerous measurement techniques. But why is this?

Most oscilloscopes have a "signal common" terminal that is connected to the protective grounding system. This is because all signals applied to or from an oscilloscope must have a common connection point. This is ordinarily the oscilloscope chassis, which is usually at zero volt. To

prevent one input from becoming live when another is connected to a signal, the common connection point is connected to the protective grounding system of the oscilloscope.

While this arrangement usually works well and is safe for the user, it also provides that, with few exceptions, all measurements must be made with respect to ground. This constrains the oscilloscope (at least in a single measurement) from being used to measure potential differences between points where neither is at ground potential. Also, measurements can be exceedingly difficult to perform because probes and connectors can introduce unwanted circulating currents, ground loops, into the circuit under test. Such circulating currents impose noise on the signals to be examined and can interfere with system operation through the connection of the probe ground.

"Floating the scope" is the usual technique that is used in such measurements. It is the technique of defeating the protective grounding system — disconnecting the "signal common" from ground — and allowing accessible oscilloscope parts, such as the chassis, enclosure, connectors, and controls to assume the potential of the point at which the ground lead is connected. And it is dangerous, for two reasons. First, and most obvious, is the possibly high voltages on exposed metal parts of the oscilloscope that present a shock hazard to the operator. Second, and not so obvious, is the cumulative stresses on the oscilloscope power transformer insulation. Such stresses can cause future failure, with attendant shock and fire hazard, even after the oscilloscope is returned to properly grounded operation. From a measurement standpoint the "floated scope" has the problem of imposing a filtering action on the point the "signal common" is connected. This filtering is caused by capacitance between the floating scope chassis and the power line which may be considered at ac ground.

### Safety Principles

Tektronix has over the years adopted many safety principles in the design of its products. Of particular concern to those making electrical and electronic measurements are these principles:

- Accessible parts shall not be live, even in the event of the single worst-case fault.
- Electronic devices (those devices that employ conduction in a vacuum, gas, or semiconductor) shall not be relied upon to protect the operator from electric shock.
- Products shall not develop insidious hazards during proper operation. (An insidious hazard is one that develops so gradually as to be well established before becoming apparent.)
- An operator shall not have to defeat a protective system to perform a measurement.

- No switch shall be placed in series with the protective grounding conductor.

### Common Floating Measurement Techniques

Floating measurements can be performed using various methods. Each has limitations and some are safer and more reliable than others. In the following paragraphs, ten common methods of making floating oscilloscope measurements are reviewed. Note that four of these methods each violate two or more safety engineering principles. Tektronix strongly discourages such methods.

### Isolation Amplifiers

The isolating amplifier is connected between the signal under investigation and the oscilloscope. With respect to the signal, the amplifier is completely insulated, with no accessible conductive parts. The signal is coupled across an insulating barrier to the oscilloscope. Use of the isolation amplifier maintains the usability of all scope functions.

The Tektronix A6902 Isolator is an isolation amplifier consisting of two identical amplifiers, isolated from each other, from accessible parts, from the mains, and from ground. It enables an oscilloscope to measure potentials from  $\pm 20$  mV to  $\pm 1500$  volts. Each signal common lead can be independently connected to separate voltages up to + or - 1500 volts. The A6902 can measure two such signals simultaneously, in combination with any dual trace oscilloscope.

### Indirect Grounding

Safety standards specify indirect grounding as an alternative to direct grounding. All of the grounding requirements apply, except that the grounding circuit need not be completed until the available voltage or current exceeds a prescribed amount.

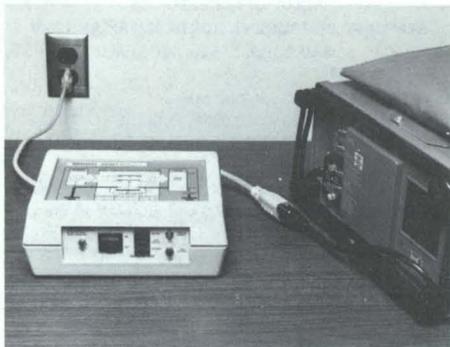
The Tektronix A6901 Ground Isolation Monitor is an indirect grounding device. It is connected between the mains and the test instrument. When activated, it disconnects the protective grounding system and monitors the voltage and current of the isolated ground. If this voltage exceeds 40 volts peak, the A6901 disconnects the power to the test instrument, sounds an alarm, and re-connects the protective grounding conductor.

The A6901 can be used with any grounded test instrument. It also tests ground continuity of the mains and will not activate if the mains ground is inadequate. It solves the problems of defeating the protective ground and provides the means for valid measurements.

### Differential Techniques

The most popular solution to the need for a floating measurement is the A minus B quasi-differential technique. Most general-purpose dual-trace oscilloscopes (such as the Tektronix 465B) have an ADD Mode in which the two channels (invert CH 2) can be electrically subtracted, giving a display of the difference signal. This can be a problem when attempting to examine low-level control signals in the presence of high common-mode voltages. Also, the common-mode dynamic range is severely limited ( $\pm 6$  divisions beyond screen height) and CMRR is low — approximately 100:1.

True differential solutions are amplifiers specifically designed to have good rejection of the common-mode signal and display only the difference signal. Because these amplifiers are basically two ground-referenced amplifiers, limited floating or common-mode capability is provided. Further, the ability to display a small signal in the presence of a large common-mode signal changes as a function of the absolute magnitude of the common-mode signal, as well as the ratio of the common-mode signal to the difference signal. Also, there are bandwidth limitations. The Tektronix 7A13 provides 500 volts of common-mode dynamic range at 0.1 V/div with a CMRR of at least 1000:1 and a bandwidth up to 105 MHz.



### All-Insulated Oscilloscopes

The all-insulated oscilloscope has no accessible conductive parts. All accessible parts are made of insulating material. No protective system is defeated to make the measurement.

The completely insulated oscilloscope provides true isolation from both the mains and the signal common. It is not grounded but does not suffer the problems of being floated. It is not a differential amplifier and therefore does not suffer previously mentioned performance problems. But, it cannot be interconnected with other equipment because its internal common is at the elevated potential of the probe ground lead connection.

The Tektronix 200 Series oscilloscopes are all-insulated, and are rated to 250 V with respect to mains insulation and 700 V peak with respect to the signal being measured (when operated on internal batteries). The 200 Series Oscilloscopes offer 3 x 5 cm display and bandwidths up to 5 MHz, with sweep speeds to 100 ns/div. These instruments are especially suitable for power supply and mechanical measurement applications.

### Grounded Oscilloscopes

A grounded oscilloscope is capable of making floating measurements by making two separate measurements, recording the results, and subtracting the common-mode signal. This requires an oscilloscope system capable of waveform processing such as the Tektronix 7854. The 7854 is capable of digitizing and storing the two waveforms and subtracting the common-mode signal mathematically. It is a highly sophisticated oscilloscope system with microprocessor-based waveform processing capability. The 7854 is especially suitable for those floating measurement applications that justify a substantial instrumentation investment.

### Integrated Circuit Amplifiers

Some products purported to be isolators are nothing more than limited-performance IC differential amplifiers. Such units not only suffer from the problems of all differential amplifiers (limited dynamic range and ability to display small difference signals in the presence of large common-mode signals), but also suffer from lack of control and versatility. Impressive performance specifications disappear when probes, attenuators, power supply, and display connections are considered.

### Isolation Transformers

Isolation transformers sometimes are employed between the mains and the test instrument to enable floating. To do this, the protective grounding system is defeated, resulting in violation of one safety principle: accessible parts are live due to the potential to which the signal common lead is connected.

The isolation transformer can provide some degree of protection in the event of a test instrument mains insulation failure — if the isolated mains does not have ground reference. If the

transformer does not have a secondary ground reference, then a single insulation failure in the test instrument will not result in a hazard, even though it is insidious. If the isolated main is ground-referenced (grounded neutral or grounded center-tap), then no protection is provided.

Also, during floating, the insulations of both the isolation transformer and the test instrument mains transformers are subjected to a voltage stress that is the sum of the mains voltage plus the signal common or floating voltage. This is because the two primary windings form a capacitive voltage divider among the floating chassis, the test instrument primary, and the isolation transformer primary. This voltage is extra — above the mains rating. Thus, if the mains insulation does break down, the test instrument is not grounded and a hazard exists. In this instance, the chassis will be live and the operator will have no indication of a problem. If grounded, smoke and fire may be the result. Using an isolating transformer to make a test instrument "safe" to float is a futile gesture and provides a false sense of security.

### Double Insulated Mains

Some measuring equipment safety standards allow double insulation of the mains circuits instead of grounding (2-wire mains instead of 2-wire mains with earth connection). Ordinarily, double insulation provides protection equivalent to grounding. This is not true for measuring equipment, since measuring equipment has a second source of hazardous potentials — the circuit under test. Equal protection must be provided from all hazardous circuits, not just the mains circuits.

Ungrounded oscilloscopes are available in which protection from the mains is provided by double insulation, but where the signal common remains connected to the chassis enclosure and connectors. With respect to the signal being measured, these designs are the equivalent of defeating the protective grounding system.

Incidentally, unlike indirect grounding solutions that complete the protective grounding circuit when excessive voltage or currents are applied, this solution gives no warning to the operator that dangerous voltages and currents are present on the chassis.

### Isolating Circuits

Some users, and at least one oscilloscope manufacturer, have placed semiconductor devices (back-to-back parallel rectifiers or zener diodes) in series with the protective grounding conductor. The purpose is to limit the excursion of voltage on accessible parts to a "safe" level. One oscilloscope has a switch in parallel with the semiconductors to restore the ground when isolation is not required.

Unfortunately, these techniques violate two safety principles and lead to another insidious hazard. Most safety standards assume failure of semiconductors. Should a diode fail, there is no indication to the operator and an insidious hazard exists.

Also, safety standards commonly specify no switch in the protective grounding conductor; a switch defeats the protective grounding system just as cutting off the ground prong of the mains plug.

### Defeating Grounds

Operators often defeat a test instrument protective grounding system by cutting off the ground prong or by using a 3-to-2 wire adapter. This technique allows the scope chassis, enclosure, and connectors to assume the potential of the probe ground lead connection.

The only protection for both the operator and nearby persons is to maintain distance and avoid simultaneously touching the test instrument and ground. Some safety officers require the work area to be roped off, a warning to be posted, and an observer to maintain surveillance on the operator. Some enforcement agencies accept these precautions under the heading of "reasonable caution" and choose not to cite violators. Although these precautions are laudable, we have described earlier the dangers inherent in floating oscilloscopes by defeating the protective grounding systems.

### Summary

The following table provides a summary of the ten most common methods of performing floating measurements and highlights four as being unsafe.

**METHODS OF MAKING FLOATING SCOPE MEASUREMENTS**

	Meets Safety Principles	Dynamic Range/Bandwidth	Flexibility	Ease of Operation	Isolation Voltage	Cost
Isolation Amplifiers	✓	High	High	High	A6902 11500 V	Moderate
Indirect Grounding	✓	High	High(-)	High	A6901 140 V	Low
Differential Techniques	✓	Medium(+)	Medium(-)	Medium(-)	7A13 1500 V	Moderate
All Insulated Oscilloscopes	✓	Medium(-)	Medium(-)	Medium(+)	221 1250 V/1750 V	Moderate
Grounded Oscilloscope	✓	High	High	High	7854 1250 V	High
IC Isolation Amplifiers	✓	Low(-)	Low(-)	High	12000 V	Low
Isolation Transformers	No		Not Recommended			
Double Insulated Mains	No		Not Recommended			
Isolating Circuits	No		Not Recommended			
Defeating Grounds	No		Not Recommended			



## A6901

Isolates Test Instrument from Ground

Continuous Voltage Monitoring

Activities Ground Connection with Over-Voltage Detection

Certified by Worldwide Safety Agencies

Compact, Portable

Placed in the circuit between an oscilloscope or other piece of test equipment and its power source, the A6901, acting as an indirect grounding device, allows floating measurements to be made with operator protection. It permits the elevation of the test instrument chassis to voltage levels other than ground to aid in logic circuit analysis or to circumvent the effects of ground loop noise problems.

In operation, the A6901 isolates the protective grounding system of a test instrument, monitors the voltage on that isolated system, and, when the voltage exceeds predetermined levels, interrupts the voltage supply to the instrument, sounds an alarm, and connects the isolated grounding system to the supply circuit grounding system. Also, the A6901 tests the power source for a functional ground before activating to the isolated mode.

Once in the isolated mode, the A6901 continuously monitors voltage between the test instrument and earth ground. If a 40 volt peak level is exceeded the unit protection circuit activates and disconnects power from the test instrument, re-establishes the earth ground connection, and sounds an alarm.

Applications for the A6901 include elevating a test instrument chassis to logic reference voltages for more accurate logic level measurements, and isolating a test instrument chassis from common-mode voltages present on ground systems to eliminate undesirable noise from signal measurements.



### CHARACTERISTICS

#### ELECTRICAL CHARACTERISTICS

**Trip Voltage (Dc)** — 40 V peak (28 RMS) or + and - 40 V (within 5%).

**Trip Current** — 0.5 mA, 3.5 mA to 5 mA selectable.

**Neutral-to-Ground Continuity** — Between 3 and 10 V RMS (8.5 and 28.3 V p-p), 50 Hz.

**Dc Voltage Trip Delay** — <20 ms.

**Line Voltage Ranges** — 90 to 128 V RMS, 180 to 250 V RMS.

**Line Frequency Range** — 48 to 66 Hz.

**Maximum Power Consumption (No External Load)** — 12 W at 115 V, 60 Hz.

**Load Power** — 500 W maximum

#### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating: -15°C to +55°C (+5°F to +131°F). Nonoperating: -62°C to +85°C (-80°F to +185°F). Meets MIL-T-28800B, Class 3.

**Altitude** — Operating: to 4500 m (15,000 ft). Nonoperating: to 15 000 m (50,000 ft). Exceeds MIL-T-28800B, Class 3.

**Humidity** — Exceeds MIL-T-28800B, Class 3.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	87	3.4
Width	206	8.1
Depth	153	6.0
Weights	kg	lb
Net (without accessories)	1.4	3.0
Shipping	2.3	5.0

### INCLUDED ACCESSORIES

#### STANDARD INSTRUMENT, NORTH AMERICAN 120 V

161-0150-00 1 **LOAD CORD**, 17.5 cm, IEC Male to NA Female, 120 V

159-0190-00 1 **FUSE**, 3 AF, DIN, Metric

159-0051-00 1 **FUSE**, 3 AG, 0.062A, SLO

161-0066-00 1 **POWER CORD**, 3 m, North American Male to IEC Female

#### UNIVERSAL EURO, OPTION A1

161-0157-00 1 **LOAD CORD**, 17.5 cm, IEC Male to Euro Female, 240 V

159-0202-00 1 **FUSE**, 6.3 A, DIN, Metric

159-0074-00 1 **FUSE**, 0.1 A, DIN, Metric

161-0066-09 1 **POWER CORD**, 3 m, Euro Male to IEC Female

#### UNITED KINGDOM OPTION A2

161-0159-00 1 **LOAD CORD**, 17.5 cm, IEC Male to UK Female, 240 V

159-0202-00 1 **FUSE**, 6.3 A, DIN Metric

159-0074-00 1 **FUSE**, 0.1 A, DIN, Metric

161-0066-10 1 **POWER CORD**, 3 m, UK Male to IEC Female

#### AUSTRALIA, OPTION A3

161-0158-00 1 **LOAD CORD**, 17.5 cm, IEC Male to Australian Female, 240 V

159-0202-00 1 **FUSE**, 6.3 A, DIN, Metric

159-0074-00 1 **FUSE**, 0.1 A, DIN, Metric

161-0066-11 1 **POWER CORD**, 3 m, Australia Male to IEC Female

#### SWITZERLAND, OPTION A5

161-0160-00 1 **LOAD CORD**, 17.5 cm, IEC Male to Swiss Female, 240 V

159-0202-00 1 **FUSE**, 6.3 A, DIN, Metric

159-0074-00 1 **FUSE**, 0.1 A, DIN, Metric

161-0154-00 1 **POWER CORD**, 3 m, Swiss Male to IEC Female.

### ORDERING INFORMATION

**A6901 Ground Isolation Monitor** ..... \$440

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... NC

**Option A2** — UK 240 V/13A, 50 Hz ..... NC

**Option A3** — Australian 240 V/10A, 50 Hz ..... NC

**Option A5** — Switzerland 220 V/10A, 60 Hz ..... NC

(North American 240 V not available. Neutral not grounded in 240 V N.A. Systems)



## A6902

Dc to 15 MHz Bandwidth

Completely Insulated for User Protection

Two Probe Sizes and Ratings (1500 and 500 V)

Two Isolated Channels That can be Used Simultaneously

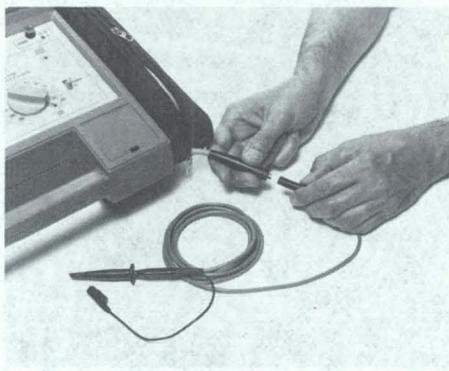
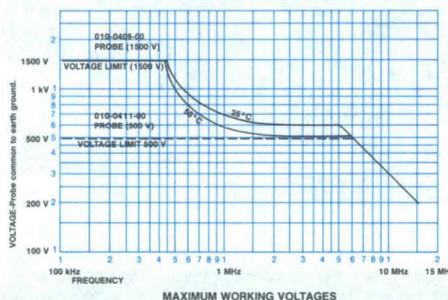
Compact, Portable

Meets Worldwide Safety Specifications

In recognition of the requirement to perform floating measurements and low-level signal measurements in the presence of high-amplitude common-mode voltages, Tektronix offers the A6902 Isolator. It is a dual-channel, optical- and transformer-coupled voltage isolator that allows safely grounded test instruments to make floating measurements at high sensitivity levels in the presence of large common-mode signals.

The A6902 acts as a buffer between the test instrument and the system under test and extends the range of the test instrument to 1500 V (dc plus peak ac) with the larger industrial probe and to 500 V (dc plus peak ac) with the smaller signal probe. Using a combination of optical and transformer coupling, the unit isolates signals from and allows the test instrument to be safely grounded.

Designed for use with any dual-channel oscilloscope, the A6902 permits simultaneous observation of signals at two points in the same circuit or of signals in two different circuits. Separate, calibrated controls for volts per division on each channel provide for precise floating measurements. The larger, 1500-volt probes are used in high-voltage industrial applications and can grip studs as large as one-half inch; the smaller, 500-volt probes are used in signal applications in which access to crowded spaces is important and voltages are lower. Both probes are quickly interchangeable at the cable connectors inside the side pouch. The two pairs of probes and output cables are stored in the two side pouches for availability and convenience.



Operator safety is achieved through design. The all-plastic case and external controls protect the user during control settings and other operators. Other than probe tip connections, the user is never in close proximity to hazardous voltages. The A6902 is certified by worldwide safety agencies. These include: UL 1244, IEC 348, BS 4743, and CSA Bulletin 556B. A high degree of operator protection is thus afforded, when making non-grounded measurements of voltages as high as 1500 volts.

### CHARACTERISTICS

#### ELECTRICAL CHARACTERISTICS

**Deflection Factor** — Probe Tip Sensitivity: 20 mV/div to 200 V/div in 1-2-5 sequence with oscilloscope set to 10 mV/div. Accuracy:  $\leq \pm 3\%$  of indicated VOLTS/DIV switch setting.

#### Maximum Working Voltage

**Large Probe** — Probe Center Tip to Earth Ground: 1500 V (dc + peak ac) Pulse Tested to 4.4 kV for 1 s. Probe Center Tip to Probe Common: 1500 V (dc + peak ac) to 900 kHz, derated to 105 V (dc + peak ac) at 15 MHz. Probe Common to Earth Ground: 1500 V (dc + peak ac) to 440 kHz, derated to 520 V (dc + peak ac) at 5.8 MHz then to 200 V (dc + peak ac) at 15 MHz.

**Small Probe** — Probe Center Tip to Earth Ground: 500 V (dc + peak ac). Probe Center Tip to Probe Common: 500 V (dc + peak ac) to 3 MHz, derated to 105 V (dc + peak ac) at 15 MHz. Probe Common to Earth Ground: 500 V (dc + peak ac), derated to 200 V (dc + peak ac) at 15 MHz.

**Frequency Response** — Bandwidth (dc coupled):  $\geq 15$  MHz (to  $-3$  dB points). Bandwidth (ac coupled):  $\leq 1$  Hz (to lower  $-3$  dB points).

**Transient Response** — 23 ns or less risetime.

**Input Impedance** — Resistance:  $10\text{ M}\Omega \pm 3\%$ .

**Probe Tip Capacitance** — Large Probe Tip to Common:  $\approx 21$  pF.

**Small Probe Tip to Common** —  $\approx 17.4$  pF.

**Common Mode Capacitance** —  $\approx 150$  pF from probe common to earth ground.

**Output Impedance** —  $\approx 50$   $\Omega$ .

**Tangential Noise** — 2.0 mV.

**Dc Drift With Temperature** —  $\leq 1$  mV/ $^{\circ}\text{C}$  or 0.1 div/ $^{\circ}\text{C}$  at output.

**Channel Isolation Voltage** — Two 1500 V probes: 1500 V (dc to peak ac). Two 500 V probes: 1000 V (dc + peak ac).

**Delay** — Either Probe:  $48 \pm 3$  ns from probe tip to output BNC.

**Common Lead Signal Feedthrough** —  $-110$  dB from probe input to output BNC (with oscilloscope having 1 M $\Omega$  input resistance and up to 47 pF input capacitance, derated to  $-80$  dB at 10 kHz and to  $-50$  dB at 3.3 MHz).

#### POWER SOURCE CHARACTERISTICS

**Line Voltage Ranges** — Low: 90 to 132 V RMS. High: 180 to 250 V RMS.

**Line Frequency Range** — 48 to 440 Hz.

**Power Consumption** — 15 W at 115 V, 60 Hz.

#### ENVIRONMENTAL CHARACTERISTICS

**Temperature** — Operating:  $0^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  ( $+32^{\circ}\text{F}$  to  $+122^{\circ}\text{F}$ ). Nonoperating:  $-62^{\circ}\text{C}$  to  $+75^{\circ}\text{C}$  ( $-21.6^{\circ}\text{F}$  to  $+167^{\circ}\text{F}$ ).

**Altitude** — Operating: to 4500 m (15,000 ft). Nonoperating: to 15 000 m (50,000 ft).

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Height	13.6	5.4
Width	39.4	15.5
Depth	34.4	13.5
Weight	kg	lb
Net	5.7	12.6
Shipping	7.5	16.6

#### INCLUDED ACCESSORIES

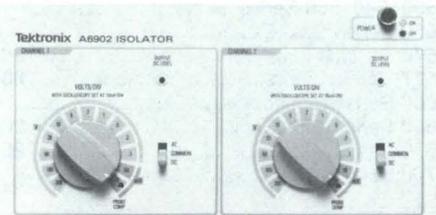
2 probe, isolation, 500 V (010-0411-01); 2 probe, isolation, 1500 V (010-0409-00); 1 Fuse, 4.1 A, 250 V (159-0171-00); power cord, right angle, (161-0117-00); 2 output cable, 50  $\Omega$ , 2 m (012-0204-00).

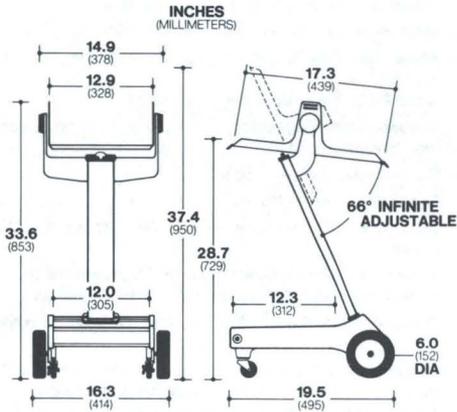
#### ORDERING INFORMATION

**A6902 Isolator** ..... **\$2,345**  
**Option 01** — (Delete 2 500-V probes) ..... **-\$100**  
**Option 02** — (Delete 2 1500-V probes) ..... **-\$200**

#### INTERNATIONAL POWER CORD AND PLUG OPTIONS

**Option A1** — Universal Euro 220 V/16A, 50 Hz ..... **NC**  
**Option A2** — UK 240 V/13A, 50 Hz ..... **NC**  
**Option A3** — Australian 240 V/10A, 50 Hz ..... **NC**  
**Option A4** — North American 240 V/15A, 60 Hz ..... **NC**  
**Option A5** — Switzerland 220 V/10A, 50 Hz ..... **NC**





**MODEL 200C/200D**

**Recommended For:**  
All 400 Series Portable Scopes.

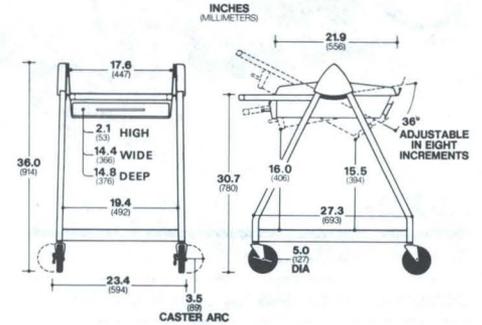
**MODEL 200C** includes brakes on front casters, safety belt to secure instrument on top tray. Net weight is 7.3 kg, (16 lb). Shipping weight is 12.2 kg, (27 lb).

**ORDERING INFORMATION**

- Model 200C** Blue Vinyl Finish ..... **\$295**
- Model 200D** Brown Vinyl Finish ..... **\$295**



Model 200C



**MODEL 205/205D**

**Recommended For:**  
All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray. Maximum top surface weight 80 lb.

**MODEL 205** includes brakes on front casters, storage drawer, power distribution module (three outlets, 15 ft cord). Net weight is 19.5 kg (43 lb). Shipping weight is 25.8 kg (57 lb).

**ORDERING INFORMATION**

- Model 205** Blue Vinyl Finish ..... **\$435**
- Model 205D** Brown Vinyl Finish ..... **\$435**

**OPTIONAL SAFETY BELT** recommended to secure instruments on top tray. Net weight is 0.23 kg (0.5 lb). Shipping weight is 0.45 kg (1 lb).  
**Order 346-0070-01** ..... **\$48**



Model 205

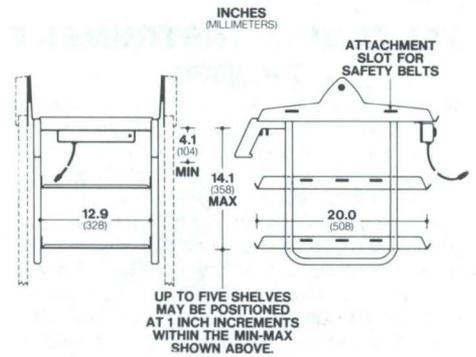
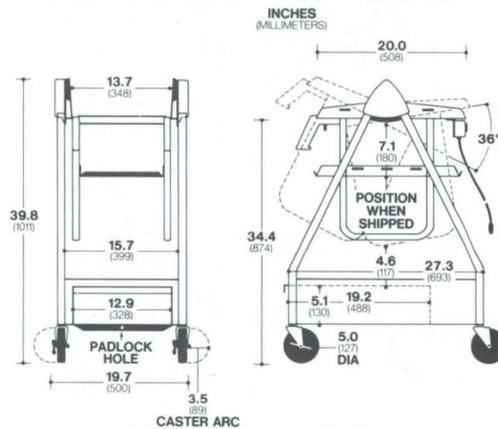
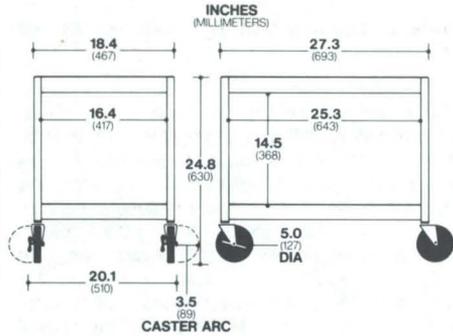
**CARTS**  
**QUICK REFERENCE**

Product	Cart Model
DAS9100 Series .....	205D
TM 5003 .....	Model 3
TM 5006 .....	205
TM 503 .....	3
TM 504 .....	3
TM 506 .....	205
1420 Series .....	*
2200 Series .....	200C
2300 Series .....	200C

400 Series Portables .....	200C
4000 Desktop Series .....	206
4600 Plotters and Hard Copy System .....	206
4900 File Managers .....	206
5000 Series .....	3
520A, 521A, 522A .....	205
528 .....	*

530, 540, 550 Series .....	3
560 Series .....	3
576 .....	206
577 .....	206
600 Series Monitors .....	*
650 Series .....	205
670 Series .....	205
7000 Series .....	3

\*These products are applicable to several carts — see dimensions and features for your specific needs.



UP TO FIVE SHELVES  
MAY BE POSITIONED  
AT 1 INCH INCREMENTS  
WITHIN THE MIN-MAX  
SHOWN ABOVE.

**MODEL 206/206D**

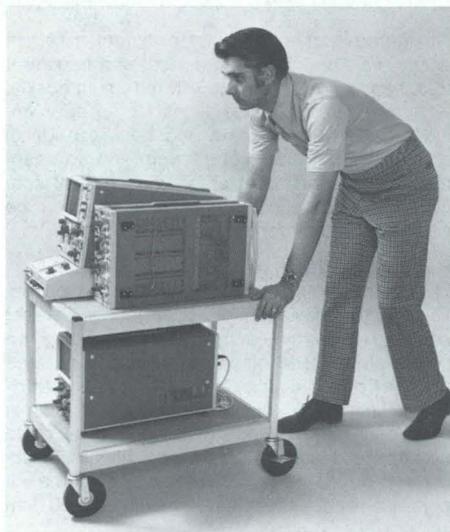
**Recommended For:**

Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment. Maximum top surface weight is 100 lb.

**MODEL 206** includes brakes on caster at one end of cart. Plastic laminate on top tray and base. Net weight is 13.6 kg, (30 lb). Shipping weight is 17.2 kg (38 lb).

**ORDERING INFORMATION**

- Model 206** Light Gray Vinyl Finish ..... **\$210**
- Model 206D** Brown Vinyl Finish ..... **\$210**



**TEK LAB CART MODEL 3/3D**

**Recommended For:**

Maximum recommended weight 65 lbs on tray top. 5100, 5400, and 7000 Series three and four plug-in oscilloscopes, TM 503, and TM 504 mounted on top tray.

TM 503, TM 504 mounted on shelves.

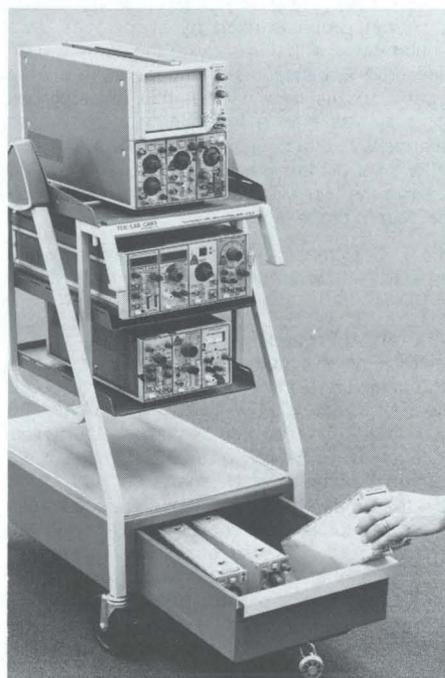
**MODEL 3** includes drawer in base with provision for padlock, brakes on all casters, power distribution module (four outlets and 15 ft cord), removable scope lock-down bar on top tray, one shelf, one safety belt, UL listed. Net weight is 25.8 kg, (57 lb). Shipping weight is 34 kg, (75 lb).

**ORDERING INFORMATION**

- Model 3** Blue Vinyl Finish ..... **\$525**
- Model 3D** Brown Vinyl Finish ..... **\$525**

**INTERNATIONAL VERSION** deletes power module for shipment outside U.S.A.

**Order Option 01** ..... **NC**



The Model 3 is shown with the 436-0132-01 Optional Shelf.

**OPTIONAL ACCESSORIES**

Extra shelf with four mounting screws. Net weight is 0.4 kg (0.9 lb). Shipping weight is 1.4 kg (3 lb).

Order 436-0132-01 ..... **\$37**

**SAFETY BELT** to secure instruments on top tray, shelves, or base 42 inch. (Not needed for 5000 or 7000 Series scopes on top tray.) Net weight is 0.23 kg (0.5 lb). Shipping weight is 0.45 kg (1 lb).

Order 346-0136-01 ..... **\$24**

For 7000 or 5000 Plug-in Storage on shelves contact Modified Products.



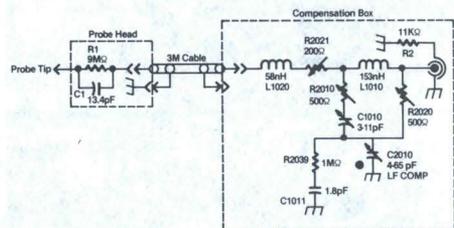
## TEKTRONIX INSTRUMENT PROBES

A probe can be any conductor used to establish a connection between the circuit under test and the measuring instrument. This conductor could be a piece of bare wire, a multimeter lead, or a piece of unterminated coaxial cable. However, these "simple probes" do not fulfill the basic purpose of a probe; that is to extract minimal energy and transmit it faithfully. The barewire can load the input amplifier with a short circuit; multimeter leads are unshielded and are often susceptible to stray pickup; and unterminated coax will severely capacitively load the circuit under test (100 pF per meter typical). Also, the unterminated coax is usually resonant at frequencies related to the electrical length of the cable and will not faithfully transfer signals to the test instrument.

In an effort to minimize the reflection problem associated with unterminated coaxial cable and to reduce the effect of cable capacitance, Tektronix has been designing and manufacturing instrument probes for more than 30 years.

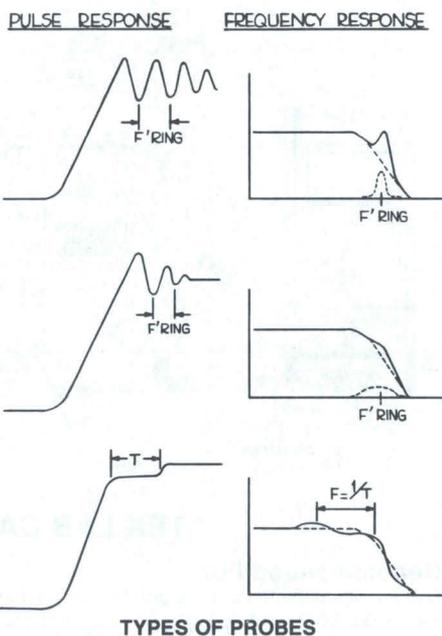
Many years ago Tektronix obtained a patent for a resistive-wire, center-conductor probe cable that minimized reflections. By extending this technology, present probe cable manufactured by Tektronix can faithfully transfer a signal frequency that exceeds 300 MHz and presents only 30 pF per meter to a circuit. When employed in a 10X passive probe.

This resistive center-conductor probe/cable, and its inherent distributed capacity tends to limit the frequency response of an associated probe, but good bandwidth characteristics are obtained by careful termination.



To reduce capacitive loading, most modern probes use a 10X compensated voltage divider. This divider is adjusted to be "flat" (to have the same attenuation at all frequencies across the frequency band of use). This type of compensated voltage divider decreases both the resistive loading and capacitive loading by a factor of 10.

Because of the basic laws of reciprocity between time and frequency domains, the bandwidth roll-off of a probe must be smooth. A sharp cut-off in the frequency domain will cause ringing in the time domain. And, since a sharp discontinuity in the time domain can cause ringing in the frequency domain, time domain reflections also must be minimized. Sharply peaking a probe to extend its frequency response will cause the probe to be underdamped and it will exhibit ringing when used to view an input step function.



TYPES OF PROBES

Tektronix probe products include active voltage probes and active and passive current probes, high voltage probes, low impedance/high frequency probes and differential probes.

### Current Probes

Current probes provide a method to measure the current flowing in a circuit. For instance, their use can eliminate the calculations that would be required to determine the current from the voltage drop across a current sampling resistor.

Two types of current probes are available, the traditional ac only probe and the "Hall effect" type. Ac only current probes use a transformer to convert current flux into ac signals and have a frequency response from a few hundred hertz to 100 MHz. Hall effect current probes use semiconductors to provide a frequency response from dc to 50 MHz.

A current probe is used by clipping its jaws around the wire that is carrying the current to be measured. Because it is "non-invasive", a current probe imposes less loading than other probes (typically less than a few nanohenrys in series with the wire at a capacitance of less than 1 pF). Differential current measurements are made by passing the two wires (in correct phase) through the current probe jaws.

The CT5 increases the high-current measuring capability of most current probes by either 20:1 or 1000:1.

### Differential Probes

Tektronix oscilloscope plug-ins are available with high common rejection ratio (7A13 with 10,000:1, the 5A13 with 100,000:1, and the 5A22 with 1,000,000:1). The normal 10X probe has a typical accuracy of  $\pm 1\%$  and gives a differential measurement accuracy of two parts per 100. Using this 10X probe, the common mode rejection ratio of a scope/probe combination would be no better than 50:1. The use of a matched pair of P6055 differential probes allows the user to adjust the attenuation of the probes for compatibility with the various Tektronix plug-ins. This attenuation adjustment includes probe compensation

so the probes match at high frequency as well as low frequencies.

### FET Probes

FET probes include active components (field effect transistors) rather than passive components. This FET results in a higher impedance without loss of signal. Also due to an offset control, the dynamic range of the system is substantially increased. Since FET probes have a selectable 50-ohm output impedance, the FET probe can drive a 50-ohm cable. This capability allows the distance from the probe tip to the instrument to be limited only by the bandwidth limit of the coaxial cable.

### Z<sub>0</sub> Probes

probes provide the lowest input capacitance (typically 1 pF for high frequency signals) and are used with high frequency, 50-ohm-input scopes. Z<sub>0</sub> probes provide the most consistent probe loading because they exhibit a frequency response that is essentially flat.

### High Voltage Probes

Several high voltage probes are available from Tektronix that provide 100X or 1000X compensated dividers. Because these probes are primarily designed for high voltage applications, input capacitance is reduced to approximately 3 pF by the high division ratio.

### PROBE SELECTION CRITERIA

Since proper probe selection will extend and enhance instrument performance while imprudent probe selection often reduces performance, thoughtful consideration of probe characteristics will help ensure that the performance of your instrument meets your application requirements.

The purpose of a probe is to extract minimum energy from the circuit under test and transfer it to a measuring instrument with maximum fidelity. While the major considerations for an appropriate probe are its loading and fidelity, physical parameters such as probe length and tip adaptors are required to establish the physical connection to the circuit under test and can be equally important considerations.

### Bandwidth/Risetime

The bandwidth/risetime of a probe can be defined as the maximum  $-3$  dB frequency a user can expect with a scope/probe system. The bandwidth is rolled off to ensure minimum pulse aberrations. In most probes, the bandwidth/risetime product is close to 0.35 and in most cases the bandwidth is verified by pulse risetime to ensure minimum aberrations. To accurately define these parameters, the source impedance is specified as a terminated 50-ohm system (i.e., 25 ohm).

### Aberrations

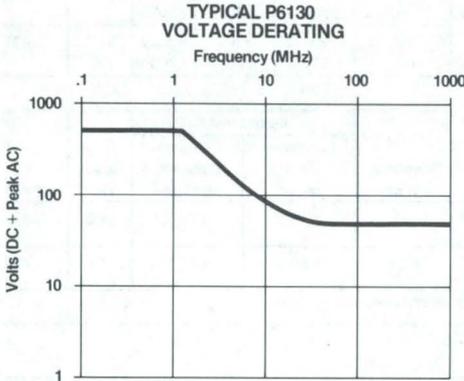
A high frequency probe that is specified without limiting aberrations can be very misleading. Existing aberrations can indicate a severely distorted bandwidth/roll-off characteristic.

### Maximum Voltage

The maximum voltage (dc + peak ac) should be specified to ensure a usable, upper voltage range. At Tektronix, probes are tested to two times the rated voltage plus 1000 V RMS in accordance with standard safety procedures.

**Voltage Derating with Frequency**

This specification is applicable for all high frequency probes. Either the termination elements or the resistive center conductor in the probe cable limit the maximum voltage that may be applied to a probe at a specific frequency. This derating applies at frequencies above 100 kHz.



**Compensation Range**

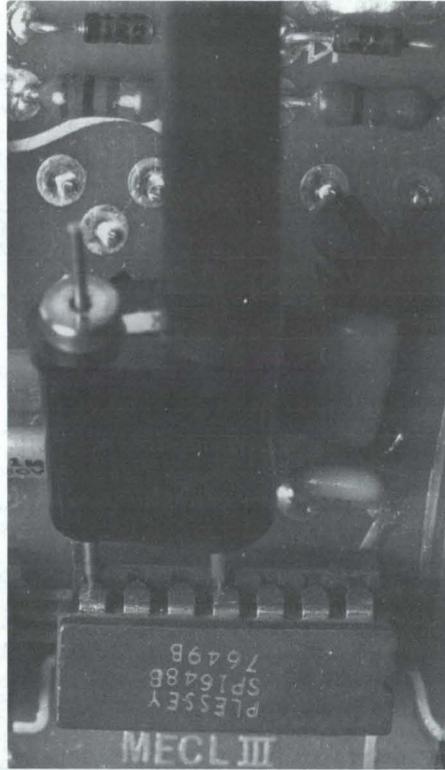
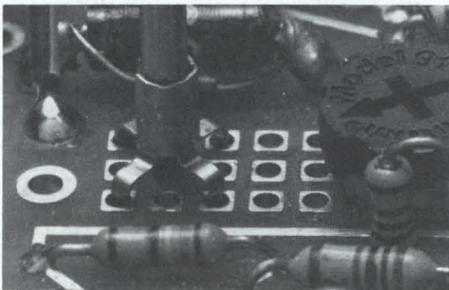
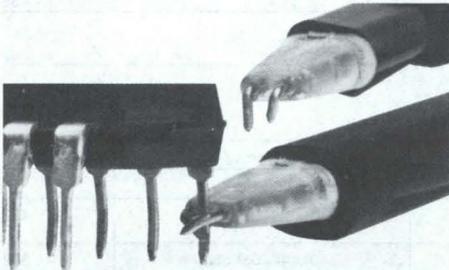
The range of a scope's input capacitance over which a specific probe will compensate to provide a flat frequency/attenuation ratio.

**Probe Length**

Most Tektronix probes are available with cable lengths of 1, 2, or 3 meters. Probe cable lengths should be kept as short as possible because extra length decreases the bandwidth and increases the loading capacitance of the probe. A longer probe cable also has a greater propagation delay (typical 4 ns/meter).

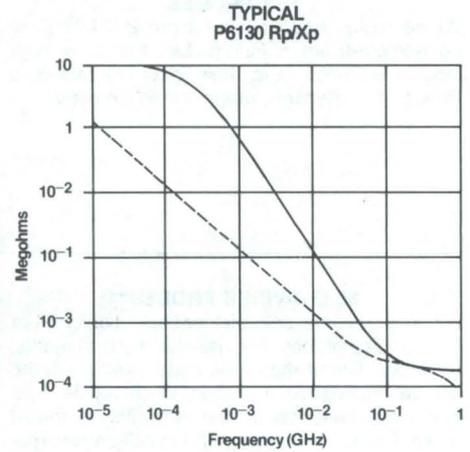
**Probe Tip Accessories**

A wide variety of adaptors are available to mechanically connect the probe to the circuit under test (see catalog page 442). Since the probe tip conducts very little current many materials that are considered good conductors have high resistance at low current levels. The Tektronix probe tip has an alloy coating to minimize current conduction problems.



**Probe Loading**

Input resistance and capacitance are used to determine the loading effect of a probe. But, these low frequency parameters are erroneous miss loading at high frequency. Curves showing typical values of the in-phase ( $R_p$ ) and out-of-phase ( $X_p$ ) reactance over the probe's frequency range are included in the users manual for each Tektronix probe.



**Maximum Current (CW)**

The maximum current probe sinewave current that can be measured with the probe without distortion.

**Maximum Current (pulse)**

The maximum pulse current that can be measured with the probe without distortion limited by Amp-Second (A-S) product.

**Amp-Second Product**

The maximum integral of the current pulse waveform that may be measured without distortion.

**Maximum Dc**

At levels lower than the RMS current, dc will saturate some of the current probes causing distortion insertion impedance. The impedance reflected into the circuit being measured is normally in the form of resistance and inductance.

**Attenuator Ratio**

When correctly terminated, a probe should have a flat attenuation ratio with frequency gradually decreasing to 3 dB below the attenuator ratio at the rated bandwidth.

**Probe Coding**

Probe coding provides the user with an indication of the actual probe tip sensitivity. This coding eliminates the need to divide by the attenuation ratio or remember which probe is being used.

**Modularity**

The Tektronix modular probe concept provides users with an economic design. Portions of a damaged probe are easily replaceable. Modular probe parts snap together and can be assembled without tools so maintenance and repair are less expensive.

**FET PROBES**

Where higher frequencies (above 250 MHz) are encountered, active FET probes that have high input resistance and low input capacitance through their dynamic range should be used.

Type	Attn	Length* <sup>2</sup>	Package Number	Loading		Risettime in ns	Input Limits			Read-Out	Page
							Maximum dc + pk ac	Linear Dynamic Range	Dc Offset Range		
<b>P6046</b> Diff/Amp	1X	6.0	010-0232-00 Std	1 MΩ	10 pF	3.5	± 25 V	± 5 V		NO	432
	10X		Inc PS & Amp	10 MΩ	3 pF		± 250 V	± 50 V			
<b>P6201</b> FET	1X	6.0	010-6201-01 Std Inc PS & Amp	100 kΩ	3 pF	0.4	± 100 V	± 0.6 V	± 5.6 V	YES	435
	10X			1 MΩ	1.5 pF		± 200 V	± 6 V	± 56 V		
	100X			1 MΩ	1.5 pF		± 200 V	± 60 V	± 200 V		
<b>P6202A</b> FET	10X	2 m	010-6202-03 Std W/010-0384-00 Atn	10 MΩ	2 pF	0.7	± 200 V	± 6 V	± 55 V	YES	431
	100X			10 MΩ	2 pF		± 200 V	± 60 V	± 200 V		

**50 Ω DIVIDER PROBES\*<sup>1</sup>**

For 50 Ω systems, see adjacent selection chart of 50 Ω divider probes. For risetime measurements, the interaction of the probe capacitance with the source impedance is important (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

Type	Attn	Length* <sup>2</sup>	Package Number	Loading		Risettime in ns	Input Limits		Read-Out	Page
							Maximum dc + pk ac	Linear Dynamic Range		
<b>P6056</b>	10X	6.0 9.0	010-6056-03 Std 010-6056-05	500 Ω	1 pF	0.1	± 16 V	± 16 V	YES	432
<b>P6057</b>	100X	6.0 9.0	010-6057-03 Std 010-6057-05	5 kΩ	1 pF		± 50 V	± 50 V	YES	432

<sup>1</sup> For use with 50 Ω input amplifiers <sup>2</sup> Length in feet except where specified.

**CURRENT PROBES**

To measure currents from dc to 1000 A, see the adjacent selection chart of current probes.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the milliohm to low ohm range. Current probes can be used for differential measurements; where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. A measurement of the current waveform is necessary to obtain the total picture.

Type	Bandwidth Hz to MHz		Current/Div Scope at		Saturation		Maximum Current			Peak Pulse Amp	Page	
			10 mV/div	mA/mV	Dc Amps	Pulse Amp-S Product	dc + pk ac Amp	ac p-p Amp	Derate			
									Below			Above
<b>A6302/AM 503</b>	dc	50	1 mA to 5A		20	100 x 10 <sup>-6</sup>	20	40		1 MHz	50	434 375
	0.5	20	20 mA to 5 kA* <sup>1</sup>			0.1	40 k	20 Hz	1.2 kHz	50 k		
<b>A6303/AM 503</b>	dc	15	10 mA to 50 A		100	10,000 x 10 <sup>-6</sup>	100	200		20 kHz	500	434, 375
<b>P6021</b> Passive Term	120	60		2 or 10	0.5	0.5 x 10 <sup>-3</sup>	15	300 Hz	5 MHz	250	435	
	134	12 38	1 mA to 1A* <sup>2</sup>		0.5	0.5 x 10 <sup>-3</sup>	15	230 Hz	5 MHz	15		
<b>CT/5</b> Passive Term	120	20		40 or 10 kA	20	0.5	2000	300 Hz	1.2 kHz	50 k	436	
	134	12 20	20 mA to 1 kA* <sup>2</sup>		20	0.5	2000	230 Hz	1.2 kHz	15 k		
<b>P6022</b> Passive Term	8.5 k	200		1 or 10	0.2	9 x 10 <sup>-6</sup>	6	3 kHz	10 MHz	100	435	
	134	100 65	1 mA to 1A* <sup>2</sup>		0.2	9 x 10 <sup>-6</sup>	6	1.3 kHz	10 MHz	15		
<b>CT-1</b>	30 k	1000		5 mV/mA	0.2	1 x 10 <sup>-6</sup>	1.4			100	436	
<b>CT-2</b>	1.2 k	100		1 mV/mA	0.2	50 x 10 <sup>-6</sup>	7			100	436	

<sup>1</sup> Scope at 10 mV/div  
<sup>2</sup> Scope at 50 mV/div

**OTHER PROBES**

Recommended Probes—For 7000 Series see page 230, for 5000 Series see page 291, for 400 Series see the individual instrument description.

Probe	Package Number	Function	Use	Page
<b>P6048</b>	010-0215-00	Low Capacitance 1 pF, 1 kΩ	400 Series	
<b>P6058A</b>	010-0260-00 010-6058-01	Temperature and Voltage Probe	DM 501, 7D13A	432
<b>P6430</b>	010-6430-00	Temperature Probe	DM 44, DM 502	352
<b>P6104</b>	010-6104-00	Voltage Probe	465M	430
<b>40 kV</b>	010-0277-00	High Voltage Dc Probe	2337, DM 501A, DM 502A	300
<b>P6451</b>	010-6451-03	Data Acquisition Probe	7D01	77,430
<b>P6401</b>	010-6401-01	Logic Probe	TTL Logic	77,430,433
<b>P6406</b>	010-6406-01	Word Recognizer	308	77
<b>P6420</b>	010-6420-03	RF Probe for DMM's	2337, DM 501A, DM 502A, DM 44	433,354
<b>P6601</b>	010-6601-01	Temperature Probe	DM 501A, DM 502A, 7D13A	354
<b>P6125</b>	010-6125-01	Digital Counter/Timer Probe, 5X Attenuation	DC 503A, DC 504, DC 505A, DC 508, DC 509	362

**PASSIVE PROBES**

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source imped-

ance. For higher frequencies (greater than about 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, passive voltage probes offer a wide probe selection for a variety of applications for 1 MΩ inputs.

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6107, P6108, P6120 and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes).

**VOLTAGE PROBES FOR 1 MΩ INPUTS**

**MODULAR**

TYPE	ATTEN	LENGTH*1 (m)	PACKAGE NUMBER	LOADING		USEFUL BW MHz*3*6	DC MAXIMUM	SCOPE C IN pF	READOUT	PAGE	
P6101	1X	1.0	010-6101-01	1 MΩ	32.0 pF	34.0	500 V	ANY	—	438	
		2.0	010-6101-03		54.0 pF						15.5
		3.0	010-6101-05		78.0 pF						8.0
P6105	10X	1.0	010-6105-01	10 MΩ	10.5 pF	100.0	500 V	15 to 47	YES	438	
		2.0	010-6105-03		13.0 pF						100.0
		3.0	010-6105-05		15.5 pF						95.0
P6106	10X	1.0	010-6106-01	10 MΩ	10.5 pF	300.0*7	500 V	15 to 24	YES	438	
		2.0	010-6106-03		13.0 pF						250.0
		3.0	010-6106-05		15.5 pF						150.0
P6107	10X	2.0	010-6107-03	10 MΩ	13.0 pF	100.0*7	500 V	15 to 47	YES	439	
P6108	10X	1.0	010-6108-01	10 MΩ	10.5 pF	100.0	500 V	15 to 47	NO	438	
		2.0	010-6108-03		13.0 pF						100.0
		3.0	010-6108-05		15.5 pF						95.0
P6120	10X	1.5	010-6120-01	10 MΩ	14.0 pF	60.0	500 V	23 to 51	NO	437	
		3.0	010-6120-05	10 MΩ	17.0 pF	60.0	500 V	23 to 43			
P6125	5X	1.5	010-6125-01	5 MΩ	20.0 pF	200.0	250 V	15 to 33	NO	357, 359, 362	
P6130	10X	1.5	010-6130-01	10 MΩ	10.0 pF	250.0	500 V	15 to 47	YES	437	
		2.0	010-6130-03								
		3.0	010-6130-05								
P6149	10X	2.0	010-6149-03	10 MΩ	15.5 pF	50.0	500 V	20 to 62	NO	439	

**MONOLITHIC**

TYPE	ATTEN	LENGTH*1 (m)	PACKAGE NUMBER	LOADING		USEFUL BW MHz*3*6	DC MAXIMUM	SCOPE C IN pF	READOUT	PAGE	
P6006	10X	3.5	010-0127-00	10 MΩ	7.5 pF*3	35.0	600 V	15 to 55	NO		
		6.0	010-0160-00		8.5 pF						25.0
		9.0	010-0146-00		11.0 pF						25.0
		12.0	010-0148-00		15.0 pF						12.0
P6007	100X	3.5	010-0150-00	10 MΩ	2.0 pF*3	25.0	1.5 kV	15 to 55	NO	440	
		6.0	010-0165-00		2.2 pF						20.0
		9.0	010-0152-00		2.4 pF						15.0
		12.0	010-0154-00		2.6 pF						13.0
P6008	10X	3.5	010-0129-00	10 MΩ	7.5 pF	100.0	600 V	12 to 47	NO	433	
P6008 (Environmentalized)	10X	6.0	010-0129-01	10 MΩ	7.5 pF	100.0	600 V	12 to 47	NO	433	
			Environmentalized -50°C to +150°C								
P6009	100X	9.0	010-0170-00	10 MΩ	2.5 pF	120.0	1.5 kV	12 to 47	NO	440	
		9.0	010-0264-01		2.5 pF						100.0
P6010	10X	3.5	Furnished with S-5. For other uses see P6105 or P6106.								
P6015	1000X	10.0	010-0172-00	100 MΩ	3.0 pF	75.0	20 kV	12 to 47	NO	440	
P6028	1X	3.5	010-0074-00	1 MΩ	50.0 pF	17.0	600 V	ANY	YES		
		6.0	010-0075-00		67.0 pF						10.0
		9.0	010-0076-00		90.0 pF						7.0
		12.0	010-0077-00		112.0 pF						4.0
P6048	10X	6.0	010-0215-00	1 kΩ	1.0 pF	100.0	20 V	15 to 20	NO	432	
P6053B	10X	3.5	010-6053-11	10 MΩ	9.5 pF	200.0	500 V	15 to 24	YES*8	441	
		6.0	010-6053-13		12.5 pF						200.0
		9.0	010-6053-15		13.5 pF						115.0
P6055*4	10X	3.5	010-6055-01	1 MΩ	10.0 pF	60.0	500 V	20 to 47	YES	441	
P6060*3	10X	3.5	010-6060-01	1 MΩ	7.5 pF*3	35.0	500 V	15 to 55	YES*5		
		6.0	010-6060-03		8.5 pF						25.0
P6062B	10X or 1X	3.5	010-6062-11	10 MΩ	13.5 pF	100.0	500 V	15 to 47	YES		
			1 MΩ	100.0 pF	8.0						
	10X or 1X	6.0	010-6062-13	10 MΩ	14.0 pF	100.0					
			1 MΩ	105.0 pF	6.0						
P6062B	10X or 1X	9.0	010-6062-15	10 MΩ	17.0 pF	95.0	500 V	15 to 24	YES	441	
				1 MΩ	135.0 pF	4.5					
P6063B	10X or 1X	3.5	010-6063-11	10 MΩ	11.0 pF	200.0	500 V	15 to 24	YES	441	
			1 MΩ	80.0 pF	12.0						
	10X or 1X	6.0	010-6063-13	10 MΩ	14.0 pF	200.0					
			1 MΩ	105.0 pF	6.0						

\*1 Length in feet except where specified.

\*2 To convert to uhf connectors, use adapter 103-0015-00.

\*3 Rating varies with scopes having other than 20 pF inputs.

\*4 Designed for use with scopes having differential inputs.

\*5 Not compatible with CRT readout.

\*6 25 Ω source.

\*7 Typically 300 MHz at probe tip with scope bandwidth at least 325 MHz.

\*8 Trace identification button.

**PROBE/INSTRUMENT COMPATIBILITY**

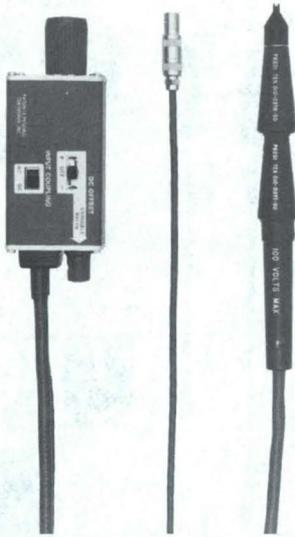
For quick reference only, identify correct probe types (X1, X10, X100 etc.) from this chart and preceding charts, or call your Tektronix Sales Representative or the Tek National Marketing Center for assistance.

INSTRUMENT	PROBES		
	PASSIVE	ACTIVE	CURRENT
<b>7000 SERIES</b>			
7A11	Built in FET Probe		A6302/AM 503 A6303/AM 503
7A13	P6055 P6101 P6062B	P6015 P6009 P6105	P6021 P6022
7A15A	P6101 P6105 P6062B	P6015 P6009	P6021 P6022
7A16A	P6106 P6101 P6063B	P6015 P6009 P6130	P6201 P6202A P6021 P6022 A6302/AM 503
7A18	P6101 P6105 P6062B	P6015 P6009	P6202 P6021 A6302/AM 503
7A19	P6056 P6057		P6201 P6202A A6302/AM 503 A6303/AM503
7A22	P6101 P6062B	P6055	P6021 A6302/AM 503
7A24	P6056 P6057		P6201 P6202A A6302/AM 503 A6303/AM 503
7A26	P6063B P6048	P6015 P6009	P6201 P6202A P6022 A6302/AM 503 A6303/AM 503
7A29	P6056 P6057		P6201 P6202A A6302/AM 503 A6303/AM 503
7D20	P6053B		
<b>5000 SERIES</b>			
5A14N	P6101 P6108 P6062B	P6015 P6007	A6302/AM 503 P6021
5A15N	P6101 P6108 P6062B	P6015 P6007	A6302/AM 503 P6021
5A18N	P6101 P6108 P6062B	P6015 P6007	P6021 A6302/AM 503
5A21N	P6101	P6055	P6021
5A22N	P6101	P6055	
5A26	P6101	P6055	P6021
5A38	P6101 P6105 P6062B	P6015 P6009	P6021 P6022 A6302/AM 503
5A45	P6101 P6105 P6062B	P6015 P6009	P6021 P6022 A6302/AM 503
5A48	P6101 P6105 P6062B	P6015 P6009	P6021 P6022 A6320/AM 503
5D10	P6101 P6007 P6062B	P6105 P6015	P6021
<b>TM 500 SERIES</b>			
AM 502	P6055	P6101	P6021
AM 503			A6302 A6303
DM 501A DM 502A DM 505	P6420 40 kV(010-0277-00)		
DC 503A DC 504 DC 505A DC 509	P6125 P6108		

INSTRUMENT	PROBES		
	PASSIVE	ACTIVE	CURRENT
<b>TM 500 SERIES</b>			
DC 508A	P6125 P6108	P6056	
SC 501 SC 502 SC 503	P6101 P6028 P6108 P6060	P6062B P6007 P6013A P6015	P6021
SC 504	P6101 P6108	P6062 P6009	P6021 P6022
<b>400 SERIES</b>			
485	P6101 P6106 P6056 P6057 P6063B	P6015 P6009 P6048 P6130	P6201 P6202 P6021 A6302/AM 503 A6303/AM 503
475A 475	P6101 P6106 P6063B P6130	P6015 P6009 P6048	P6201 P6202 P6021 A6302/AM 503 A6303/AM 503
465B 465 468	P6101 P6105 P062B	P6015 P6009 P6048	P6201 P6202 P6021 A6302/AM 503 A6303/AM 503
465M	P6101 P6104	P6015 P6009	P6201 P6202 P6021 P6022 A6302/AM 503 A6303/AM 503
455	P6101 P6105 P6062B	P6015 P6009	P6202 P6021 P6022 A6302/AM 503 A6303/AM 503
466 464	P6101 P6105 P6062B	P6015 P6009	P6202 P6201 P6021 A6302/AM 503 A6303/AM 503
434	P6101 P6108 P6009 P6015	P6120	P6021 P6022 A6302/AM 503 A6303/AM 503
<b>300 SERIES</b>			
308	P6107		P6404 P6451-05
305, 314, 323 326, 335	P6101 P6149		P6021, P6022 A6302/AM 503 A6303/AM 503
390AD	P6101 P6062B	P6105 P6015	P6021 P6022
<b>T900 SERIES</b>			
T935A, T932A T922R, T921 T912	P6101 P6108 P6009*1 P6015	P6120 P6062B P6007*2	P6021 A6302/AM 503 A6303/AM 503
<b>2200 SERIES</b>			
2213/2215 2335/2336/2337	P6120 P6101 P6009 P6062B	P6108 P6015	P6021, P6022 P6021 P6022

\*1 For T935A and T932A only  
\*2 For T922R, T921 and T912 only

**P6201 Dc to 900 MHz**



**Unity Gain**

**Two Plug-on Attenuator Heads that Maintain Scope Readout Factor**

**Low Input Capacitance**

**Dc Offset**

**Ac-Dc Coupling Switch**

The P6201 is an active (FET) probe providing unity gain and dc to 900 MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. Very low input capacitance permits acquisition of high frequency signals with minimum loading of circuits under test while high input resistance minimizes low frequency and dc

loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The probe derives its power from the probe power jack on many Tek scopes or an 1101 FET Power Supply.

**CHARACTERISTICS**

	P6201	P6202
Risetime	<0.4 ns	<0.7 ns
Bandwidth (verified by risetime)	>900 MHz	>500 MHz
Attenuation	X1	X10
Attenuation Accuracy	±3%	±4%
Input Resistance	100 kΩ	10 M
Input Capacitance	3 pF	2 pF
Input R with Attenuator	1 MΩ	10 M*
Input C with Attenuator	1.5 pF	2 pF*
Dynamic Range	±0.6 V	±6.0 V
Dynamic Range with Attenuator	±6 V or ±60 V	±60 V*
Dc Offset Range	±5.6 V	±55 V
Noise	300 μV	150 μV
Maximum Input Probe Only	±100 V peak	±200 V peak
Derated above	60 MHz	2 MHz
Derated to — at Frequency	5 V at 500 MHz	20 V at 300 MHz
Maximum Input With Attenuator	200 V peak	200 V peak*
Derated above	50 MHz	150 MHz*
Derate to — at Frequency	5 V at 500 MHz	70 V at 400 MHz*
Ac Coupling—3 dB Low Frequency	10 Hz	16 Hz

\*Optional accessory

**P6201 INCLUDED ACCESSORIES**

Tip, probe, retractable (CG, 013-0135-00); attenuator head 10X (010-0376-00); attenuator head 100X (010-0377-00); 3 tips, probe (CO, 206-0200-00); lead, ground, 30 cm (12 inch) (DB, 175-0848-02); contact, ground (CM 131-1302-00); tip, probe (CJ, 103-0164-00); clip, alligator (AS, 344-0046-00); insulating sleeve, electrical (CK, 166-0557-00); insulator, ground contact (CL, 342-0180-00); carrying case (016-0156-02).

**ORDERING INFORMATION**

**P6201 FET Probe Order 010-6201-01 \$1,090**

**1101 FET Power Supply**



The 110 Accessory Power Supply provides power for active probes such as the Tektronix P6201, and P6202A when they are used with oscilloscopes that do not have a probe power supply.

The 1101 will provide power for up to four probes. Output power features short-circuit protection. A platform base provides storage for the power cord.

**CHARACTERISTICS**

**Output Voltages** — +15 V dc ±0.75%; -15 V dc ±1.5%; +5 V dc ±2.0%.

**Output Currents** — 400 mA each supply (short-circuit protected).

**Ripple** — ≤1 mV with 400 mA load (each supply).

**Ac Input Voltages** — Selectable, 90 to 136 V ac or 180 to 272 V ac.

**Line Frequency** — 50 to 400 Hz.

**Power** — High Range: 39 W (390 mA) maximum at 115 V ac, 60 Hz. Low Range: 47 W (455 mA) maximum at 115 V ac, 60 Hz.

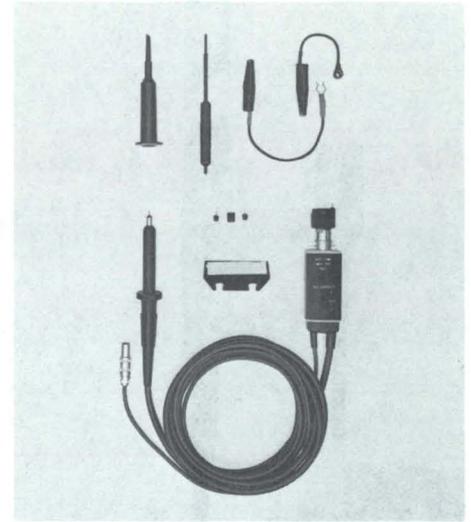
**PHYSICAL CHARACTERISTICS**

Dimensions	mm	in
Width	132	5.3
Height	79	3.1
Depth	209	8.3
Weight	kg	lb
Net	1.6	3.5

**ORDERING INFORMATION**

**1101 Accessory Power Supply,**  
Powers to four P6201 or P6202A Probes ..... **\$535**

**P6202A Dc to 500 MHz**



**Dc Offset**

**High Input Impedance through Freq Range**

**Small Probe Size**

With its standard Tektronix power connector the P6202A can be used on any instrument that has standard probe power. The very low input capacitance of the probe permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading.

The probe has a dc offset feature to offset any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The P6202A derives its power from the probe power jack on many of Tek scopes or an 1101 Power Supply.

**INCLUDED ACCESSORIES**

Tip, probe, retractable (CB, 013-0097-01); two clips, alligator (AS, 344-0046-00); holder, probe (352-0351-00); lead, ground, 7.5 cm (3 inch) (DC, 175-0849-00); adjustment tool, probe (CP, 003-0675-01); carrying case (016-0378-00); lead, ground, 13 cm (6 inch) (DE, 175-1017-00); two tips, probe, replaceable\*; insulating sleeve, electrical (BP, 166-0404-01).

\*Available in package of 10 only, Order 206-0230-03 (CF).

**ORDERING INFORMATION**

**P6202A FET Probe, 2 Meter Cable,**  
Order 010-6202-03 ..... **\$583**

**OPTIONAL ACCESSORIES**

**P6202A 10X Attenuator.**  
Order 010-0384-00 ..... **\$65**  
**P6202A Ac Coupling Cap.**  
Order 010-0360-00 ..... **\$32**

**P6046** Dc to 100 MHz Differential



1000:1 CMRR at 50 MHz

±250 V Maximum Voltage with 10X Attenuator

Dual Probe Tips for Greater CMRR at High Frequencies

The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities with all Tektronix oscilloscopes. The differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

**CHARACTERISTICS**

**CMRR** — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz. **Common-mode Linear Dynamic Range** — ±5 V, ±50 V with 10X attenuator. **Bandwidth** — Dc to 100 MHz (–3 dB). **Risetime** — 3.5 ns or less. **Deflection Factor Range** — 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). **Input RC** — 1 MΩ paralleled by 10 pF or less. **Input Coupling** — Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is –3 dB at 20 Hz, 2 Hz with 10X attenuator. **Displayed Noise** — 280 μV or less (tangentially measured). **Maximum Input Voltage** — ±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency. **Output Impedance** — 50 Ω through a BNC-connector. 50 Ω termination supplied with amplifier for use with 1 MΩ systems. **Probe Cable** — 6 ft long, terminated with special nine-pin connector.

**INCLUDED ACCESSORIES**

Termination, 50 Ω (BR, 011-0049-01); coaxial cable, (RF, 012-0076-00); hanger assembly (014-0029-00); carrying case (016-0111-01); 10X attenuator (010-0361-00); amp and power supply (015-0106-00); dual attenuator head (010-0361-00); probe tip, swivel; spring ground contact; connector test point jack.

**ORDERING INFORMATION**

**P6046** FET Differential Probe, Amplifier, and Power Supply Order 010-0232-00 . \$1,640  
 Without Amplifier and Power Supply, Order 010-0213-00 ..... \$853  
 Power Supply with Amplifier Order 015-0106-00 ..... \$806

**P6056** Dc to 3.5 GHz 10X 500 Ω  
**P6057** Dc to 1.4 GHz 100X 5000 Ω



Low Capacitive Loading, 1 pF or Less

For 50 Ω Wide Band Scopes

<70 ps Probe to Probe Variation

The P6056 is a miniature low-capacitance probe for use with 50 Ω wide-band oscilloscopes. Bandwidth is dc to 3.5 GHz. This probe can also be used with 50 Ω sampling systems, with an appropriate BNC adaptor. The P6056 is equipped with a special BNC connector that provides trace identification and CRT Readout information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

**CHARACTERISTICS**

	P6056	P6057
Risetime	<100 ps	<250 ps
Input Z @ Dc	500 Ω	5 kΩ
Input Z @ 1 GHz	300 Ω	1500 Ω
Maximum Dc + Peak Ac	16 V	50 V
Derated Above	800 MHz	500 MHz
Maximum Peak @ 1 GHz	9 V	21 V
Maximum Peak Pulse	500 V <1 ms	500 V <1 ms

**INCLUDED ACCESSORIES**

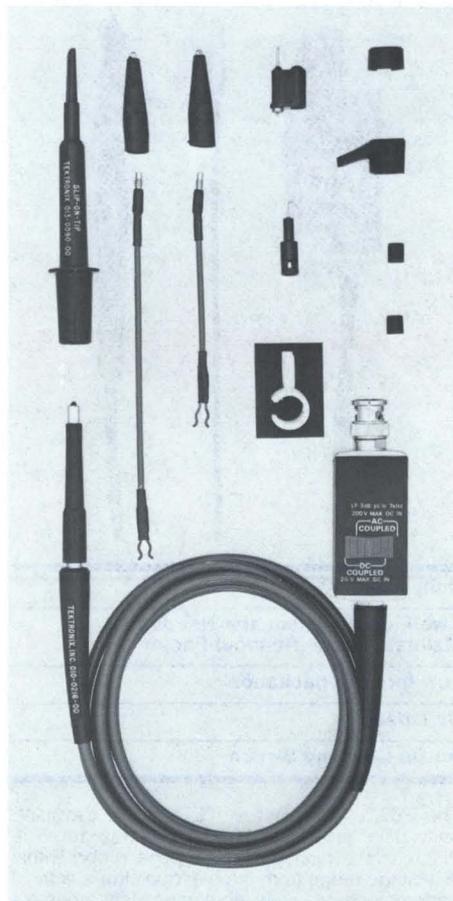
Clip, alligator (AS, 344-0046-00); lead, ground, 75 mm (3 inch) (DA 175-0249-00); tip, hook probe (BU, 206-0114-00); tip, probe bayonet (BM, 013-0085-00); contact, electrical (BQ 214-0283-00).

**ORDERING INFORMATION**

**P6056** 10X, 50 Ω Probe,  
 6 ft, Order 010-6056-03 ..... \$154  
 9 ft, Order 010-6056-05 ..... \$154  
**P6057** 100X, 50 Ω Probe,  
 6 ft, Order 010-6057-03 ..... \$159  
 9 ft, Order 010-6057-05 ..... \$159

Included Accessories with double alpha codes are pictured on pages 442 and 443.

**P6048** Dc to 200 MHz 10X



Minimum Loading 1 pF to 1 kΩ

Ac/dc Switch

The P6048 is a miniature low capacitance probe for use with 1 MΩ 20 pF oscilloscopes. The probe input impedance of 1 kΩ paralleled by 1 pF is intended for applications where capacitor loading may distort the circuit waveforms. Ac or dc coupling switch is available to extend the measurement range.

**CHARACTERISTICS**

**Attenuation** — 10X.  
**Input Resistance** — 1 kΩ.  
**Input Capacitance** — 1 pF or less.  
**Maximum Input** — Dc 20 V; ac 200 V.  
**Ac Low Frequency** — 7 kHz or less.  
**Bandwidth** — (With 250 MHz oscilloscope with 1 MΩ/20 pF input) 175 MHz.  
**Typical Probe Risetime** — 1.95 ns.

**INCLUDED ACCESSORIES**

Tip, probe, bayonet (BM, 013-0085-00); tip, probe retractable hook (CA, 013-0090-00); two insulating sleeve, electrical (BP, 166-0404-01); two clips, alligator (AS, 344-0046-00); lead, ground, 13 cm (5 inch) (175-0124-01); insulating sleeve, ground lead (CN, 166-0433-00); tip, hook probe (BU, 206-0114-00); lead, ground, 7.5 cm (3 inch) (DD, 175-0263-01); holder, probe (352-0090-00).  
**P6048** 10X Probe, 6 ft,  
 Order 010-0215-00 ..... \$196

## P6401 Logic Probe



### Illuminated Probe Tip Indicates Logic Level

The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 volt supply.

Two bright lights in the probe tip indicate condition of the logic signal.

### CHARACTERISTICS

#### POWER SUPPLY

**Low State Input Voltage Range** — 0 V to +0.7 V  $\pm$  0.125 V.  
**High State Input Voltage Range** — 2.175 V  $\pm$  0.125 V to V cc.

**Minimum Recognizable Pulse Width** — 10 ns.

**Impedance** —  $\approx$  7.5 k $\Omega$  paralleled by  $\approx$  6 pF.

**Minimum Circuit Resistance for Open Circuit Indication** — 10 k $\Omega$ .

**Maximum Safe Input** —  $\pm$  150 V (dc or RMS).

**Minimum Recognizable Strobe Pulse Width** — 20 ns.

**Maximum Safe Strobe Input** —  $\pm$  30 V (dc or RMS).

**Strobe Input Impedance** — 5.6 k $\Omega$  within 20%.

**Cable Length** — 1.5 m (5 ft).

#### INCLUDED ACCESSORIES

Hook tip, (BU, 206-0114-00); strobe lead (175-0958-01); strobe lead (175-0958-00); probe tip to 0.025 inch square pin adaptor (AH, 206-0137-01); white plug (348-0023-00); two alligator clips (AS, 344-0046-00); accessory pouch (016-0537-00).

### P6401 Logic Probe

Order (010-6401-01) ..... \$148

## P6420 RF Probe



### 10 kHz to 1 GHz Bandwidth

### Dc V output/RMS of Sine Input

The P6420 RF probe measures high frequency ac voltage from 10 kHz to 1 GHz. It provides a dc output voltage proportional to the RMS value of a sinewave input compatible with any DMM with an input resistance of 10 M $\Omega$ .

### CHARACTERISTICS

**Voltage Range** — 0.5 V to 25 V RMS (70.7 V p-p).

**Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V RMS  $\pm$  10% (+15°C to +35°C). 5.0 V to 25 V RMS  $\pm$  5% (+15°C to +35°C).

**Frequency Response** — 100 kHz to 300 MHz ( $\pm$  0.5 dB). 50 kHz to 500 MHz ( $\pm$  1.5 dB), 10 kHz to 1 GHz ( $\pm$  3.0 dB).

**Input Capacitance** —  $\approx$  3.7 pF.

**Maximum Input Voltage** — 42.4 V (peak ac + dc).

**Temperature Range** — Nonoperating: -55°C to +75°C.

Operating: +15°C to +35°C.

**Length** — Probe only: 96 mm. Cable only: 2 m.

### INCLUDED ACCESSORIES

Tip, probe, retractable (CB, 013-0097-01); two clips, alligator (AS, 344-0046-00); two tips, probe, replaceable\*; insulating sleeve, electrical (BP, 166-0404-01); lead, ground, 75 mm (3 inch) (DC, 175-0849-00); lead, ground, 130 mm (6 inch) (DE, 175-1017-00); holder, probe (352-0351-00); adaptor, BNC female to dual banana (103-0090-00).

\*Available in package of 10 only, Order 206-0230-04 (CF).

### ORDERING INFORMATION

#### P6420 RF Probe (with 2 m Cable)

Order 010-6420-03 ..... \$131

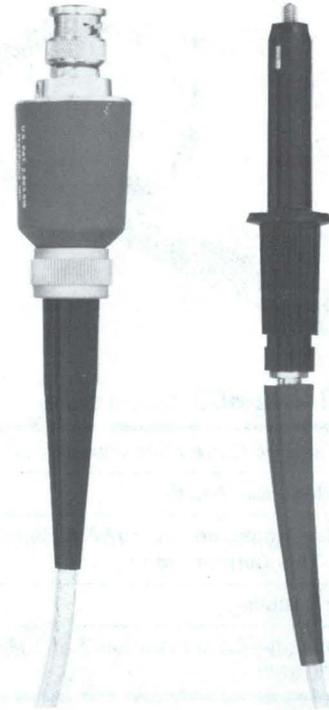
For a 1 meter length cable only (does not change specifications)

Order 175-1661-00 ..... \$27

For a 3 meter length cable only (does not change specifications)

Order 175-1661-02 ..... \$27

## P6008 (Environmental) 10X 100 MHz



### -50°C to +150°C Temperature Range

The P6008 Environmental Probe is designed to operate over -50°C to +150°C for the probe body and cable; the compensation box operates from -15°C to +55°C. It is designed for use with Tektronix dc to 100 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance to 1 M $\Omega$ .

### CHARACTERISTICS

**Attenuation** — 10X.

**Input Resistance** — 10 M $\Omega$ .

**Input Capacitance** —  $\approx$  7.5 pF when used with an instrument having a 20 pF input capacitance.

**Bandwidth** — Dc to 100 MHz.

**Voltage Rating** — 600 V dc, ac peak, or dc and ac peak combined. P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

**Cable Length** — 1.8 m (6 ft).

### INCLUDED ACCESSORIES

Plug, tip, banana (AK, 134-0013-00); lead, ground, 300 mm (12 inch) (BD, 175-0125-01); clip, alligator (AR, 344-0045-00); tip, probe, retractable hook (AP, 013-0071-00).

### P6008 Environmental 10X Probe

Order 010-0129-01 ..... \$210



**A6302/AM 503** Current Probe

20 A Ac and Dc Current Measurements

Dc to 50 MHz Bandwidth

Peak Pulse Measurements to 50 A, 50,000 A with the CT-5 Current Probe

Ac or Dc Coupling

Small Loading—0.1  $\Omega$  Insertion Z at 1 MHz, 0.5  $\Omega$  at 50 MHz

The Tektronix A6302 and A6303 Current Probes are designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope. Both probes are used to make SCR, power supply, industrial control and motor start-up current measurements. The A6303 is especially recommended for measuring current in x-ray tubes to ensure compliance with PL 90-602, the Radiation Control for Health and Safety Act of 1968.

The A6302 and A6303 are valuable measurement tools when low loading is important, as when testing high impedance points or with current dependent devices.

Both probes make ac or dc coupled current measurements by the simple act of opening their sliding jaws and placing them around the conductor to be measured. For differential or sum measurements just place properly phased conductors in the probe jaw.

Suggested measurements for the A6302 and A6303 Current Probes include:

- X-ray tube currents
- SCR currents
- Power supply currents
- Motor start-up currents
- Industrial control currents
- Relay currents
- Common-mode rejection of dc and ac currents



**A6303/AM 503** Current Probe

100 A Ac and Dc Current Measurements

Peak Pulse Measurement to 500 A

Ac or Dc Coupling

25 x 21 mm (1 x 0.83 inch) Jaw Opening

Minimal Loading—0.02  $\Omega$  Insertion at 1 MHz, 0.15  $\Omega$  at 15 MHz

**CHARACTERISTICS**

	A6302 and AM503	A6303 and AM 503
Sensitivity Scope @ 10 mV/div	1 mA/div to 5 A/div	10 mA/div to 50 A/div
Accuracy 3%		
Bandwidth	Dc to 50 MHz	Dc to 15 MHz
Risetime	7 ns	23 ns
Max Current CW	20 A peak	100 A peak
Derated above	20 kHz	20 kHz
	2.5 A @ 10 MHz	12 A @ 10 MHz
Maximum Current Peak Not to Exceed A-S product	50 A	500 A
A-S Product	100 A to $\mu$ s	10,000 A to $\mu$ s
Insertion Z	0.1 $\Omega$ @ 5 MHz	0.02 $\Omega$ @ 1 MHz
Insertion Z	0.5 $\Omega$ @ 50 MHz	0.15 $\Omega$ @ 15 MHz
Max Hardware Volts	500 V	700 V
Max Conductor Diameter	0.15 inch	0.83 inch
System Prop Delay	$\approx$ 30 ns	$\approx$ 40 ns
Cable Length	2 m	2 m
Noise	0.3 mA	3 mA
Aberrations	$\pm$ 3%	$\pm$ 5%
Magnetic Sweepability	250 $\mu$ A/Gauss	25 mA/Gauss

**INCLUDED ACCESSORIES**

Carrying case A6303 only (016-0622-00); probe ground lead, 130 mm (5 in) A6302 only, (DD, 175-0124-01); probe ground lead, 75 mm (3 in) A6302 only, (DD, 175-0263-01); miniature alligator clips A6302 only, (AS, 344-0046-00).

**ORDERING INFORMATION**

**A6303** Current Probe ..... **\$930**  
**A6302** Current Probe ..... **\$490**



**AM 503** Current Probe Amplifier

The AM 503 Current Probe Amplifier operates in any one of the TM 500 power modules and is connected to either the A6302 or A6303 probes through a multi-pin connector.

It is calibrated in 12 steps; the knob skirt is illuminated to indicate current per division. Bandwidth can be limited to 5 MHz to eliminate unwanted transients. Both ac and dc coupling are provided. Ac coupling allows the measurement of low amplitude signals on a high-level dc current. A front-panel light warns of input currents above 100 A dc with the A6303 or 20 A dc with the A6302. A push button allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the A6303/AM 503 can be displayed on any oscilloscope that has at least a 50 MHz bandwidth and a 10 mV sensitivity. The A6302/AM 503 can be used on a 75 MHz oscilloscope with 10 mV sensitivity to display the probe's full bandpass. The AM 503 output can be plugged directly into a 50  $\Omega$  recording instrument, or a 50  $\Omega$  termination which is supplied.

**INCLUDED ACCESSORIES**

Cable BNC, 50  $\Omega$  (012-0057-01); termination 50  $\Omega$  BNC (BR, 011-0049-01).

**ORDERING INFORMATION**

**AM 503** Current Probe Amplifier ..... **\$980**

The AM 503 Current Probe Amplifier requires one of the TM 500 Series power modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel of the power module. See page 375.

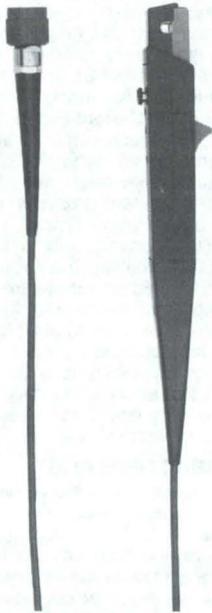
**TM 501** Power Module

Option 02 — Interface ..... **+\$60**

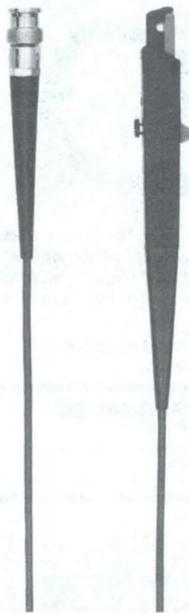
**TM 503** Power Module

Option 02 — Interface ..... **+\$80**

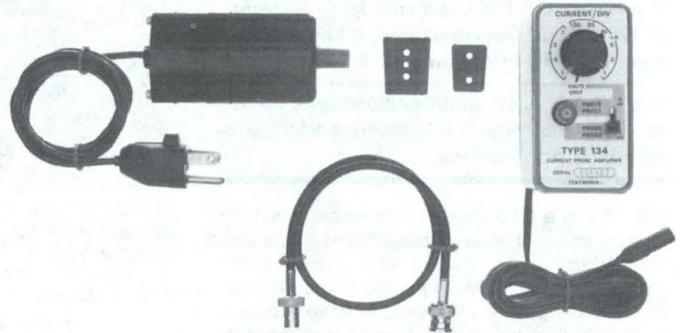
**P6021 w/Term**



**P6022 w/Term**



**134 Current Probe Amplifier**



**Clip-on Capability**

**Shielded Probe Heads**

The P6021 and P6022 Current Probes and 134 Current Probe Amplifier provide versatility in a user-assembled ac current measurement system. Both probes provide accurate current measurements over a wide range of frequencies and are used with real-time oscilloscopes. Together with the 134 Amplifier or with passive termination, both of these probes can be used with scopes that have 1 MΩ or greater input impedance. Both the P6021 and P6022 avoid breaking a circuit by clipping on to a conductor. Just open the spring-loaded slide, place the conductor into the

slot and release the slide. No electrical connection is required.

Shielded probe heads are not grounded when the slides are in their open positions, eliminating accidental grounding of the current under test.

**P6021 Current Probe**

For general purpose applications the P6021 Current Probe provides wide-band performance with excellent low-frequency characteristics. P6021 bandwidth is 120 Hz to 60 MHz.

**P6022 Current Probe**

The extra small size of the P6022 Current Probe makes it ideally suited to measure current in compact semiconductor circuits. P6022 bandwidth is 935 Hz to 200 MHz.

The 134 is used to extend the measurement capabilities and sensitivity of the P6021 or P6022 Current Probe. A Current/Div switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). A passive termination is not required when using a 134 with a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the Current/Div switch in the Volts position.

**INCLUDED ACCESSORIES (134)**

Hanger assembly (014-0029-00); power supply, 110 V (015-0058-01); cable assembly (012-0104-00); 230 V power supply (015-0059-01).

**INCLUDED ACCESSORIES (P6021 and P6022)**

Lead, ground, 13 cm (5 inch) (DD, 175-0125-01); two clips, alligator (AS, 344-0046-00); lead, ground, 7.5 cm (3 inch) (DD, 175-0263-01).

**ORDERING INFORMATION**

**P6021**

- P6021 Current Probe, Term and 5 ft Cable**  
Order 015-0140-02 ..... **\$323**
- 9 ft Cable and Term**  
Order 015-0140-03 ..... **\$323**
- 5 ft Cable w/o Term**  
Order 010-0237-02 ..... **\$276**
- 9 ft Cable w/o Term**  
Order 010-0244-02 ..... **\$276**

**P6022**

- P6022 Current Probe, Term, and 5 ft Cable**  
Order 015-0135-00 ..... **\$360**
- 9 ft Cable and Term**  
Order 015-0135-01 ..... **\$360**
- 5 ft Cable w/o Term**  
Order 010-0238-00 ..... **\$281**
- 9 ft Cable w/o Term**  
Order 010-0238-02 ..... **\$281**

**134**

- 134 Current Probe Amplifier**  
Order 015-0057-02 ..... **\$594**
- Option 04 — 230 V ac**  
Order 015-0057-03 ..... **\$594**

**OPTIONAL ACCESSORIES  
(for P6021, P6022, and 134)**

- Calibrator Adaptor — BNC**  
Order 013-0092-00 ..... **\$33**
- Carrying Case — P6021 or P6022, and a 134 Amplifier**  
Order 016-0087-01 ..... **\$24**
- Passive Termination — P6021**  
Order 011-0105-00 ..... **\$110**
- Passive Termination — P6022**  
Order 011-0106-00 ..... **\$120**

**PERFORMANCE CHARACTERISTICS**

	P6021 with Passive Termination		P6022 with Passive Termination		Probe with 134 Amplifier		
					P6021	P6022	
Accuracy 3% Sensitivity	2 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	1 mA to 1 A/div @ 50 mV/div		
Bandwidth	Low -3 dB	450 Hz	120 Hz	8.5 kHz	935 Hz	12 Hz	100 Hz
	High -3 dB	60 MHz	60 MHz	130 MHz	200 MHz	38 MHz	65 MHz
Risetime	5.8 ns	5.8 ns	2.7 ns	1.7 ns	9.2 ns	5.4 ns	
Droop TC	0.35 ms	1.3 ms	18.7 μs	0.17 ms	13 ms	1.6 ms	
Maximum Ac CW	From	7.5 A peak	7.5 A peak	6.0 A peak	6.0 A peak	6.0 A peak	6.0 A peak
	To	1.2 kHz	300 Hz	10 kHz	3 kHz	230 Hz	1.3 kHz
Maximum Peak Current	250 A	250 A	100 A	100 A	250 A	100 A	
Amp/Second Product	500 A/μs	500 A/μs	9 A/μs	9 A/μs	500 A/μs	9 A/μs	
Maximum Dc	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A	0.5 A	
Insertion Z (Ω)	0.03 @ 1 MHz		0.03 @ 1 MHz		0.03	0.03	
Insertion Z (Ω)	1.0 @ 60 MHz		0.2 @ 120 MHz		1.0	0.2	
Propagation Delay (ns)	5 ft	9	9	9	9	9	
	9 ft	15	15	15	15	15	
Maximum Voltage Barewire	600 V	600 V	600 V	600 V	600 V	600 V	
Net Weight	≈ 1 lb		≈ 1 lb		≈ 5 lb		
Conductor Size	Up to 0.15 in dia		Up to 0.1 in dia		0.15 in dia	0.1 in dia	

For accessory products, you can order direct by calling 800-426-2200 extension 99. In Oregon call collect (503) 627-9000 extension 99.

**CT-1/CT-2 Current Probes**

The 1 GHz CT-1 is used with 50 Ω Systems, or Wide Band Oscilloscopes, it has a Minimum Loading Effect on a 50 Ω Environment

The CT-2 is used with Oscilloscopes up to 100 MHz Bandwidth, it is Insulated for Limited space Applications

The CT-1 and CT-2 Current Probes are designed for permanent or semi-permanent in-circuit installation. Each probe consists of a current transformer, an interconnecting cable and a termination. The current transformers are traversed by a small hole through which a current carrying conductor is passed during circuit assembly.

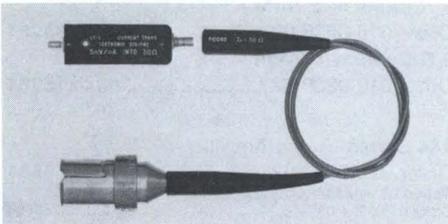
One probe cable can be used to monitor several current transformers that have been wired into a circuit.

**CHARACTERISTICS**

	CT 1	CT 2
Sensitivity	5 mV/mA	1 mV/mA
Accuracy	3%	3%
Risetime	350 ps	500 ps
Frequency Response		
Low: -3 dB	25 kHz	1.2 kHz
High: -3 dB	1 GHz	200 MHz
Decay Time Constant: L/R	6.35 μs	160 μs
Insertion Impedance:		
at 10 MHz	≈ 1 Ω	0.1 Ω
at 100 MHz	2 Ω	0.5 Ω
Capacitive Loading		
Barewire	1.5 pF for #14	1.8 pF for #16
Maximum Barewire Voltage	1000 V	1000 V
Dc Saturation Current:		
Current to Reduce L/R by X2	75 mA	175 mA
Pulse Current Rating Not to Exceed:		
Amp Sec Product	*1 A to μs	*50 A to μs
Maximum CW Current	*450 mA	*2.5 A
Cable Length	18 inch	42 inch
Prop Delay	3.25 ns	6.1 ns
Cable Connector	GR874	BNC

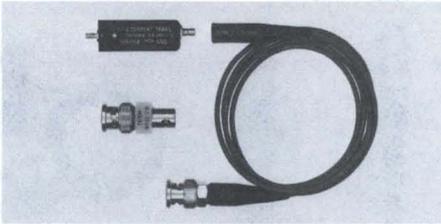
\*With 50 Ω termination. Values are reduced by a factor of 2 if unterminated.

**CT-1 with Probe Cable**



The CT-1 Probe Cable (010-0133-00) provides the connection between the CT-1 current transformer and a scope input. This cable can also be used with other test point connectors such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF connectors.

**CT-2 with Probe Cable**



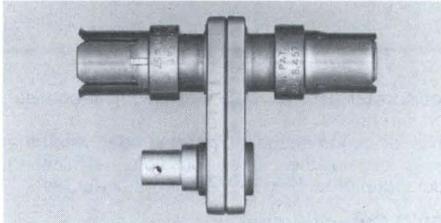
The CT-2 Probe Cable (010-0164-00) is used to connect the CT-2 current transformer with an oscilloscope input. A 50 Ω termination is used to terminate the cable at the high impedance input of an oscilloscope.

**INCLUDED ACCESSORIES (CT-2)**  
Termination, 50 Ω (BR, 011-0049-01).

**ORDERING INFORMATION**

CT-1 Current Transformer and Probe Order 015-0041-00 ..... \$143  
CT-2 Current Transformer, Probe, and Termination Order 015-0047-00 ..... \$154

**CT-3 Signal Pickoff**

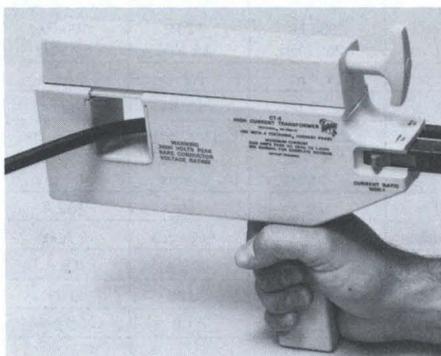


Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50 Ω system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

**Sensitivity** — 10% of the voltage under test, into a 50 Ω load.  
**Decay Time Constant** — 4.5 μs at 0 dc current.  
**Risetime** — <0.4 ns.  
**Frequency Response** — 50 kHz to 875 MHz at 0 dc current.  
**Insertion Impedance** — With 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 M termination.  
**V<sub>swr</sub>** — <1.2 at 1.5 GHz.  
**Voltage Rating** — At 0 V dc is 25 V RMS, 1 kV pulse peak. The V's product is 100 Vμs. If exceeded, the L/R decay will decay rapidly toward zero.

CT-3 Signal Pickoff Order 017-0061-00 ..... \$143

**CT-5 Pulsed Currents to 50,000 A**



**1.5 Inch Diameter Conductors**

Measurements on Bare Conductors to 3000 V Nullifies Dc Effects to 300 A

The CT-5 is a clip-on high-current transformer that extends the measurement capability of Tektronix clip-on current probes. Maximum low-frequency performance is obtained using the A6302/AM 503 Dc Current Probe. Pulse current to 50,000 amps may be measured using the P6021 and passive termination, provided the 0.5 A-s rating is not exceeded. The P6021 and 134 Current Probe Amplifier may also be used for measurements at normal line frequency and above. (The P6022 and CT-5 are not compatible with each other.) The CT-5 has receptacles for current probes in either 20:1 or 1000:1 step-down ratios. The 1.5 inch square opening makes it possible to clip onto large conductors without breaking the circuit under test. The core and shield assembly are insulated from the windings and the handle. This allows measurements on bare wires to 3000 V, and to 10 kV RMS with a high voltage bushing. A dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading measurements. This is very useful for measuring ac signals on top of a dc voltage level.

**CT-5 CHARACTERISTICS**

The following are characteristics of the CT-5 using either the A6302/AM 503 or P6021/134 combinations.

**Risetime** — 17.5 ns or less.  
**Insertion Impedance** — ≤20 μΩ at 60 Hz; 20 mΩ at 1 MHz.  
**Current Range** — 20 mA/div to 100 A/div with A6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with A6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio).  
**Accuracy** — ±4%. Maximum Current is 1000 A peak cw.\*  
**Amp-Sec product** — 8 A-s.  
**Maximum Voltage** — Of circuit test is 3000 V (barewire).  
**Maximum Dc Bucking Current** — 300 mA to buck out 300 A dc (using dc bucking coil).  
\*Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.

**CT-5 CURRENT MEASUREMENT COMBINATIONS**

Product	Band-width	A-s Product	Maximum Current	
			RMS	Peak Pulse
CT-5/A6302/AM 503	0.5 Hz to 20 MHz	0.1	700 A	50 kA
CT-5/P6021/134	12 Hz to 20 MHz	0.5	700 A	15 kA
CT-5/P6021/Term	120 Hz to 20 MHz	0.5	700 A	50 kA

**PHYSICAL CHARACTERISTICS**

Dimensions	mm		in	
	Width	Height	Width	Height
Width	57	241	2.3	9.5
Height	241	266	9.5	10.5
Depth	266		10.5	
Weight	kg		lb	
	Net	1.8		4.0

**INCLUDED ACCESSORIES**

Carrying case (016-0191-03); high voltage bushing 12 inch (015-0194-00).

**ORDERING INFORMATION**

CT-3 Signal Pickoff Order 017-0061-00 ..... \$143  
CT-5 Current Probe (Includes dc Bucking Coil) Order 015-0189-01 ..... \$1,080  
Without dc Bucking Coil, Order 015-0189-00 ..... \$885

**OPTIONAL ACCESSORIES**

Dc Bucking Coil Order 015-0190-00 ..... \$255  
High-Voltage Bushing — 4 ft long, inside diameter 1 inch. Order 015-0194-01 ..... \$43

**NEW**

**P6130 Dc to 250 MHz 10X with readout**



**Lightweight Tip**

**Flex Lightweight Cable**

**250 MHz Bandwidth**

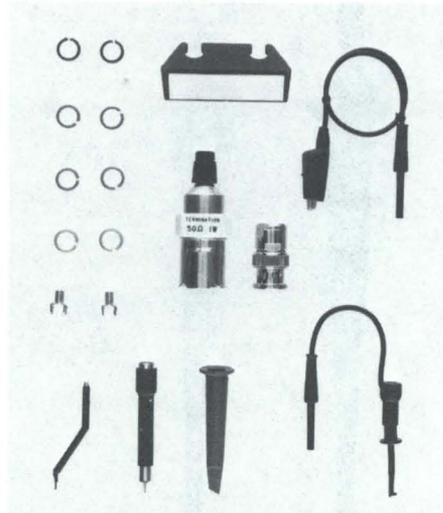
The P6130 probe accommodates oscilloscopes with bandwidth's up to 250 MHz. The small size and lightweight probe tip coupled with an extremely flexible probe cable provide a low bending moment avoids breakage when probing small fragile components.

The unique reversible ground lead system provides flexible grounding methods from the short swivel ground lead for high frequency probing through the 3-inch ground with micro hook tip to the 6-inch ground with insulated alligator clip for lower frequencies, are tailored for a wide range of applications.

The hybrid probe tip circuitry not only provides a small, rugged, lightweight probe tip; it also provides more uniform probe tip compensation for better high frequency response with less aberrations. Any of the modular probe tip accessories may be used with the optional miniature probe tip adaptor, (see page 442). This selection also allows the probe to be tailored to a wide range of applications.

The P6130's modular construction allows snap-on replacement without tools. (P6130 modules are not interchangeable with larger modules.) Three cable lengths are available 1.5, 2.0 and 3.0 meters.

**P6130 Accessories**



**CHARACTERISTICS**

**Bandwidth** (–3 dB) — 1.5 and 2.0 m: Dc to 250 MHz. 3.0 m: Dc to 60 MHz.

**Risetime (System)** — 1.5 and 2.0 m: <1.4 ns. 3.0 m: <2.0 ns.

**Attenuation (System)** — 10X ±3% (with scope Z of 1 MΩ).

**Input Resistance (Probe)** — 9 MΩ ±0.7%.

**Input Resistance (System)** — 10 MΩ ±1%.

**Input Capacitance** — 1.5 m: <14 pF. 2.0 m: <14.5 pF. 3.0 m: <15.8 pF.

**Maximum Input Voltage** — 500 V dc + peak ac.

**Compensation Range** — 15 to 35 pF.

**INCLUDED ACCESSORIES**

Probe-to-circuit connector (131-2766-03); low inductance lead (195-4240-00); sub miniature hook tip (013-0208-00); lead with alligator clip (195-1870-00); test prod holder (352-0687-00); lead with micro hook (195-4104-00); 2 green band markers (334-2794-07); 2 red band markers (334-2794-06); 2 gray band markers (334-2794-03); 2 white band markers (334-2794-01); carrying pouch (016-0708-00).

**ORDERING INFORMATION**

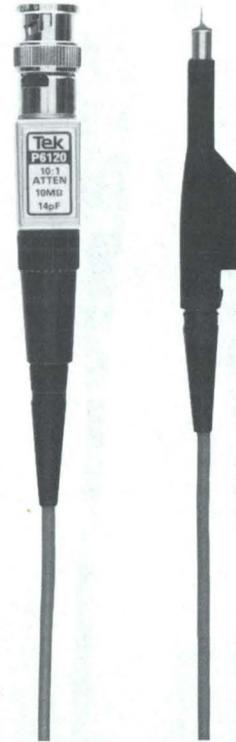
**P6130 10X High Impedance Probe 1.5 meter cable and accessories,**  
Order 010-6130-01

**P6130 with 2 meter cable and accessories,**  
Order 010-6130-03

**P6130 with 3 meter cable, and accessories,**  
Order 010-6130-05

Contact your Sales Offices for prices.

**P6120 Dc to 60 MHz**



**500 V Maximum Voltage**

**Modular, Snap-Together Parts**

**Low Cost**

The P6120 miniature 10X passive probe, a continuation of the modular design concept, offers good performance at a very attractive price. It performs particularly well in combination with 2200 Series oscilloscopes. The probe is designed to be repairable and employs a replaceable compensation box, cable, and probe head, with the ground attached by a shielded-pin receptacle in the probe head. User comfort and safety are enhanced by the probe head shape. Two cable lengths are available: 1.5 and 3.0 meters.

The probe allows use of the optional push on/pull off IC Grabber Tip that greatly facilitates attachment in congested circuit areas such as DIP leads and multipin connectors.

**CHARACTERISTICS**

**Bandwidth** — Dc to 60 MHz (–3 dB).

**Risetime** — <5.9 ns.

**Attenuation (System)** — 10X ±2% (with oscilloscope resistance of 1 MΩ ±1%).

**Input Resistance (Probe)** — 9.0 MΩ ±1% series resistor.

**Input Resistance (System)** — 10 MΩ ±1%.

**Input Capacitance** — 14 pF with 1.5 meter cable, 17 pF with 3.0 meter cable.

**Maximum Input Voltage (Ac/Dc Coupled)** — 500 V (dc + peak ac) to 3 MHz, derated to 70 V (dc + peak ac) at 50 MHz.

**Compensation Range** — 23 pF to 51 pF.

**INCLUDED ACCESSORIES**

Pouch, accessory (016-0521-00); two band, marker (silver-gray) (334-2794-02); tip, retractable (BB, 013-0107-04); sleeve, insulating (BP, 166-0404-01); ground lead, 25 cm (10 inch) (195-1870-00).

**ORDERING INFORMATION**

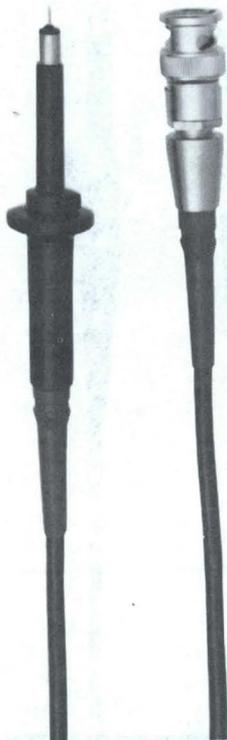
**P6120 10X Voltage Probe and Accessories**

1.5-Meter Cable Order 010-6120-01 ..... \$77

P6120 with 3 Meter Cable and accessories, Order 010-6120-05 ..... \$77

Optional Tip, Probe with Actuator (IC Grabber) Order 013-0191-00 ..... \$10.50

## P6101 Dc to 34 MHz 1X



## P6105 Dc to 100 MHz 10X with Readout P6108 Dc to 100 MHz 10X



## P6106 Dc to 300 MHz 10X with readout



**Simplified, Faster Maintenance and Repairs**

**High Fidelity Signal Acquisition at Low Cost**

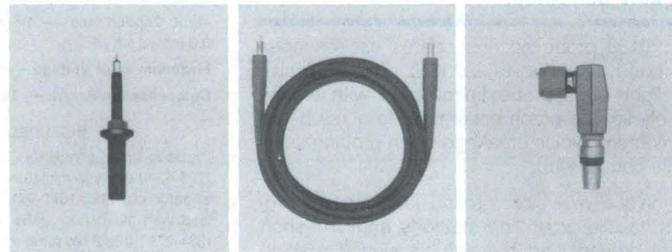
**Rugged for Greater Reliability**

**Available in Three Lengths**

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6107, P6108, and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap together making maintenance and repair less expensive, faster, and much easier. Snap-on replacement modules eliminate soldering irons and tools, and modular probes do not have to be sent in to be repaired because spare modules can be ordered and stocked. Strain relief and modular component design make these probes rugged for greater reliability.

The P6101, P6105, P6106, and P6108 are available in three color-coded lengths — blue for one meter, yellow for two meters, and red for three meters. (The P6149 and P6107 are two meters long.) These probes may be used to acquire high fidelity signal from low source-impedance circuits.

### Modular Probe Replacement Parts

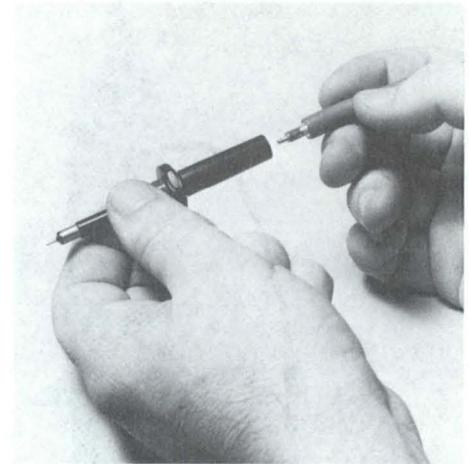
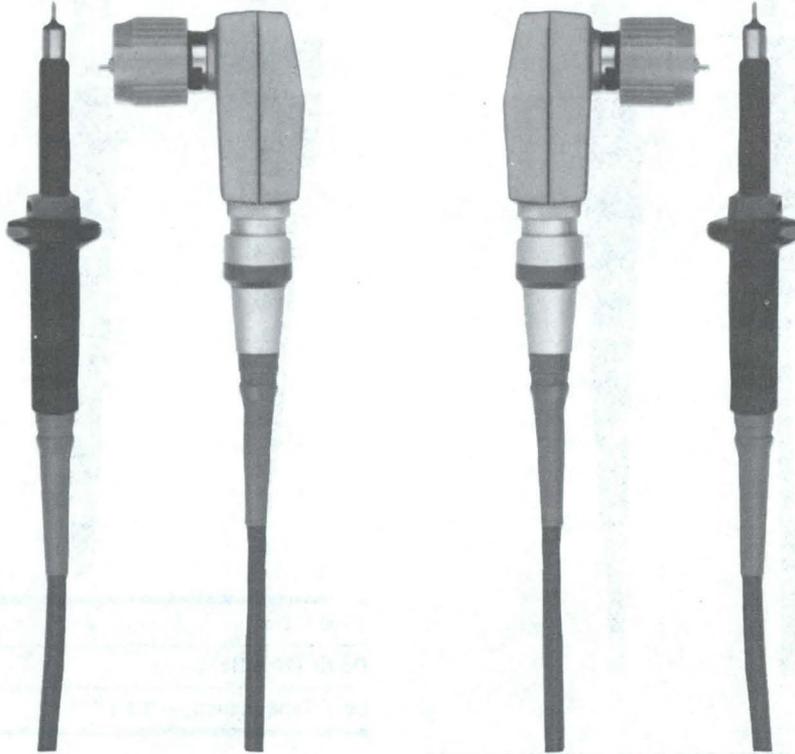


Probe	Length	Probe Head		Probe Cable		Compensator/Connector	
P6101	1 Meter	206-0223-00	\$19	175-1661-00	\$27	103-0189-00	\$18.50
	2 Meter	206-0223-00	\$19	175-1661-01	\$27	103-0189-00	\$18.50
	3 Meter	206-0223-00	\$19	175-1661-02	\$27	103-0189-00	\$18.50
P6105	1 Meter	206-0216-00	\$45	175-1661-00	\$27	206-0219-00	\$44
	2 Meter	206-0217-00	\$45	175-1661-01	\$27	206-0220-00	\$44
	3 Meter	206-0218-00	\$45	175-1661-02	\$27	206-0221-00	\$44
P6106	1 Meter	206-0216-00	\$45	175-1661-00	\$27	206-0237-00	\$65
	2 Meter	206-0217-00	\$45	175-1661-01	\$27	206-0238-00	\$70
	3 Meter	206-0218-00	\$45	175-1661-02	\$27	206-0239-00	\$70
P6107	2 Meter	206-0217-00	\$45	175-1661-00	\$27	206-0247-00	\$40
P6108	1 Meter	206-0224-00	\$39	175-1661-00	\$27	206-0227-00	\$41
	2 Meter	206-0225-00	\$39	175-1661-01	\$27	206-0228-00	\$44
	3 Meter	206-0226-00	\$39	175-1661-02	\$27	206-0229-00	\$44
P6149	2 Meter	206-0234-00	\$36	175-1661-01	\$27	206-0255-00	\$26

## P6107 Dc to 100 MHz 10X with readout

## P6149 Dc to 50 MHz 10X

## Modular Parts Snap Together



### INCLUDED ACCESSORIES

Retractable tip hook (BB, 013-0107-03); insulating sleeve (BP, 166-0404-01); probe tips (2) available in packages of 10 only (BO, 206-0191-03); probe holder (352-0351-00); ground lead, 75 mm P6106 only (DD, 175-0263-01); ground lead, 130 mm (DD, 175-0124-01) for P6101, P6105, P6108 and P6149 only, 300 mm (DD, 175-0125-01); marker bands, 3 pair, black, white and silver gray for all probes except P6149, available in packages of 9 sets of different colors (016-0633-00); marker bands, 2 pair, gray and silver gray for P6149, available in packages of 9 sets of different color (016-0633-00); miniature alligator clips (2) (AS, 344-0046-00); accessory pouch (016-0521-00).

### ORDERING INFORMATION

<b>P6101, 1X Probe, 2 m.</b>	
Order 010-6101-03 .....	\$67
Option 01 — 1 m Order 010-6101-01 .....	\$67
Option 02 — 3 m Order 010-6101-05 .....	\$67
<b>P6105, 10X Probe 2 m.</b>	
Order 010-6105-03 .....	\$111
Option 01 — 1 m Order 010-6105-01 .....	\$111
Option 02 — 3 m Order 010-6105-05 .....	\$111
<b>P6106, 10X Probe 2 m.</b>	
Order 010-6106-03 .....	\$131
Option 01 — 1 m Order 010-6106-01 .....	\$131
Option 02 — 3 m Order 010-6106-05 .....	\$131
<b>P6107, 10X Probe 2 m.</b>	
Order 010-6107-03 .....	\$117
<b>P6108, 10X Probe 2 m.</b>	
Order 010-6108-03 .....	\$101
Option 01 — 1 m, Order 010-6108-01 .....	\$101
Option 02 — 3 m, Order 010-6108-05 .....	\$101
<b>P6149, 10X Probe, 2 m.</b>	
Order 010-6149-03 .....	\$106

Tektronix Modular Probes are designed for specific Tektronix Instruments, but may be purchased as options for all Tektronix oscilloscopes with 1 M $\Omega$  and appropriate pF inputs as indicated in the chart. The P6106 is standard with the 475A and 475 Oscilloscopes.

The P6105 is standard with the Tektronix 434, 455, 465B, and rackmount oscilloscopes. The P6101 is a 1X, 1 M $\Omega$  probe. The P6105, P6106, P6107, and P6108 are 10X, 10 M $\Omega$  probes.

With oscilloscopes that are equipped with vertical scale or CRT readout, the P6105 and P6106 will automatically scale the readout by a factor of 10. This makes mental calculations unnecessary. Also ground level can be determined on the display by actuating a button on the probe head, without having to return to the oscilloscope.

The P6149 and P6107 feature a right angle BNC connector. This can be useful when bench space is limited.

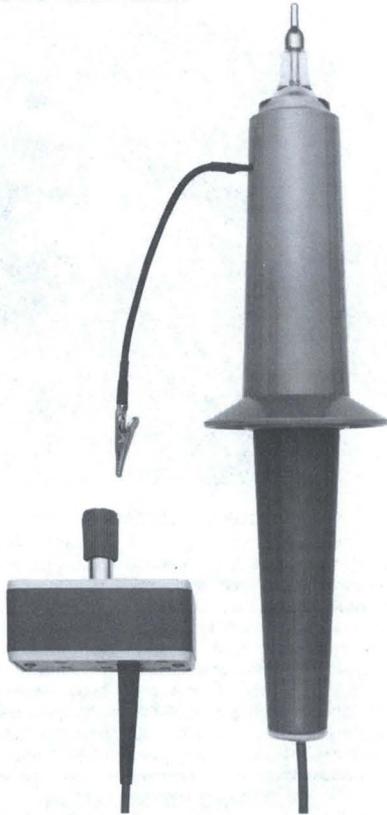
### CHARACTERISTICS

Type	Attenuation	Length	Package Number	Loading	Useful BW MHz	Dc Maximum	Scope in pF	Readout	
P6101	1X	1 m	010-6101-01	1 M $\Omega$	32 pF	500 V <sup>*1</sup>	ANY	—	
		2 m	010-6101-03		54 pF				15.5
		3 m	010-6101-05		78 pF				8
P6105	10X	1 m	010-6105-01	10 M $\Omega$	10.5 pF	500 V <sup>*3</sup>	15 to 47	YES	
		2 m	010-6105-03		13.0 pF				100
		3 m	010-6105-05		15.5 pF				95
P6106	10X	1 m	010-6106-01	10 M $\Omega$	10.5 pF	500 V <sup>*4</sup>	15 to 24	YES	
		2 m	010-6106-03		13.0 pF				300 <sup>*5</sup>
		3 m	010-6106-05		15.5 pF				250
P6107	10X	2 m	010-6107-03	10 M $\Omega$	13.0 pF	500 V <sup>*3</sup>	14 to 47	YES	
P6108	10X	1 m	010-6108-01	10 M $\Omega$	10.5 pF	500 V <sup>*3</sup>	15 to 47	NO	
		2 m	010-6108-03		13.0 pF				100
		3 m	010-6108-05		15.5 pF				95
P6149	10X	2 m	010-6149-03	10 M $\Omega$	15.5 pF	500 V <sup>*3</sup>	20 to 62	NO	

<sup>\*1</sup> Maximum Input Voltage is 500 V dc + peak ac to 300 kHz derated to 20 V at 30 MHz.  
<sup>\*2</sup> Maximum Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 27 V at 10 MHz.  
<sup>\*3</sup> Maximum Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 30 V at 50 MHz.  
<sup>\*4</sup> Maximum Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 70 V at 100 MHz.  
<sup>\*5</sup> Scope bandwidth must be 325 MHz.

Included Accessories with double alpha codes are pictured on pages 442 and 443.

## P6015 40 kV 1000X



Measure up to 40 kV Peak Pulse

High Voltage Probe

Up to 20 kV Dc + Peak AC

75 MHz Useful Bandwidth

For 1 MΩ Inputs

The P6015 Provides 1000X attenuation for oscilloscope measurements up to 40 kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in temperatures above 25°C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF.

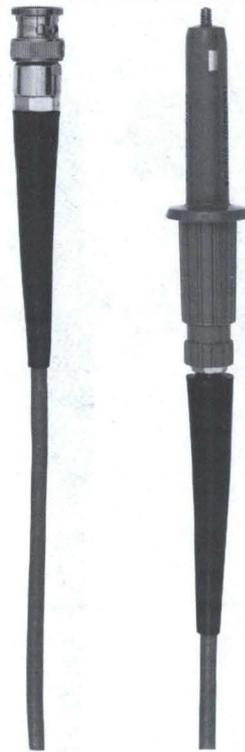
### INCLUDED ACCESSORIES

Compensating box, BNC (015-0049-00); high-voltage dielectric fluid can (AU, 252-0120-00); alligator clip (AQ, 344-0005-00); carrying case (016-0128-020); probe holder (352-0056-00).

**P6015 1000X Probe, 10 ft Cable**

Order 010-0172-00 ..... **\$615**

## P6007 Dc to 25 MHz 100X



1500 V Dc

Low Capacitance Loading

The P6007 is a low input capacitance, high-voltage (1.5 kV) probe. It can be compensated to match all Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ. The P6007 is similar to the photo of the P6006.

### INCLUDED ACCESSORIES

Tip, probe, retractable hook (AN, 013-0071-00); plug, tip, banana (AK, 134-0013-00); tip, probe (0.055 inch diameter) (AA, 206-0015-00); lead ground, 13 cm (5 inch) (175-0124-01); lead, ground, 30 cm (12 inch) (175-0125-01); tip, probe, hook (AG, 206-0105-00); holder, probe (352-0090-00); two clips, alligator (AS, 344-0046-00).

### ORDERING INFORMATION

**P6007 100X Probe**

6 ft Order 010-0165-00 ..... **\$106**

3.5 ft Order 010-0150-00 ..... **\$106**

9 ft Order 010-0152-00 ..... **\$106**

12 ft Order 010-0154-00 ..... **\$106**

## P6009 Dc to 120 MHz 100X



1500 V Dc

Dc to 120 MHz

Low Capacitance — 2.5 pF

The P6009 is a low input capacitance, high-voltage (1.5 kV) probe designed for use with Tektronix dc to 150 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides CRT Readout information when used with plug-in units and mainframes that have these features. The readout connector is not compatible with most standard non-readout BNC connectors.

### INCLUDED ACCESSORIES

Lead, ground, 30 cm (12 inch) (175-0125-01); lead, ground, 13 cm (5 inch) (175-0124-01); lead, ground, 7.5 cm (3 inch) (DD, 175-0263-01); holder, probe (352-0090-00); tip, probe, (0.080 inch diameter) (AB, 206-0060-00); tip, probe, retractable hook (AN, 013-0071-00); tip, probe, hook (AG, 206-0105-00); bayonet ground assembly (AJ, 013-0052-00); two clips, alligator (AS, 344-0046-00); probe tip, banana (AK, 134-0013-00); tip, probe (0.055 inch diameter) (AA, 206-0015-00).

### ORDERING INFORMATION

**P6009 100X Probe, 9 ft, w/Readout**

Order 010-0264-01 ..... **\$165**

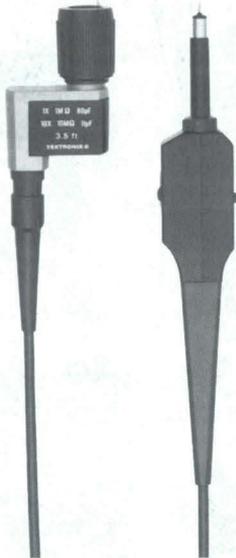
w/o Readout Order 010-0170-00 ..... **\$164**

### CHARACTERISTICS

	Attenuation	Accuracy	Input Resistance	Input Capacitance			Probe Rise-time	Aberrations	Bandwidth	Cable Length (ft)	Maximum Voltage	Derated Above	Derated to — @ Frequency	Compensation Range (pF)
				3 1/2 ft	6 ft	9 ft								
P6007	100X	3%	10 MΩ	2 pF	2.2 pF	2.4 pF	14.0 ns	±3	25 MHz	3 1/2, 6, 9, 12	1.5 kV	200 kHz	20 kV @ 5 MHz	15 to 55
P6009	100X	3%	10 MΩ		2.5 pF		2.9 ns	±3	120 MHz	9	1.5 kV	200 kHz	450 V @ 40 MHz	15 to 47
P6015	1000X	Adjustable	100 MΩ	3 pF (10 ft only)			1.4 ns	±5	250 MHz	10	20.0 kV	100 kHz	2 kV @ 20 MHz	12 to 47

Included Accessories with double alpha codes are pictured on pages 442 and 443.

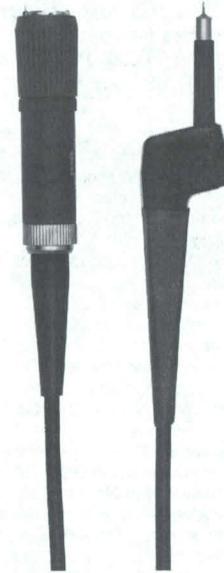
**P6062B** Dc to 100 MHz with Readout  
**P6063B** Dc to 200 MHz with Readout



**P6053B** 1X to 10X with Readout



**P6055** 20,000:1 CMRR 10X with Readout



**1X - 10X Selectable Attenuation**

**Switch on Probe Body**

The P6062B and P6063B are passive dual attenuation probes designed for Tektronix oscilloscopes with bandwidths to 100 and 200 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multitrace display. The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

The P6063B is a fast-rise dual attenuation, passive probe designed for Tektronix oscilloscopes with bandwidths greater than 100 MHz.

**COMMON CHARACTERISTICS**

	Probe Length	P6062A		P6063A	
		1X	10X	1X	10X
Attenuation		1X	10X	1X	10X
Accuracy		Same as Scope	3%*	Same as Scope	3%*
Input Resistance		Same as Scope	10 MΩ*	Same as Scope	10 MΩ*
Input Capacitance	3½ ft 6 ft 9 ft	100 pF 105 pF 135 pF	13.5 pF 14 pF 17 pF	80 pF 105 pF NA	11 pF 14 pF NA
Bandwidth	3½ ft 6 ft 9 ft	8 MHz 6.7 MHz 4.5 MHz	100 mHz 100 MHz 100 MHz	12 MHz 6 MHz NA	200 MHz 200 MHz NA
Maximum Voltage		100 V peak	500 V peak	100 V	500 V
Derated Above		450 kHz	3.5 MHz	450 kHz	4.5 MHz
Derated to Frequency		35 V @ 10 MHz	35 V @ 50 MHz	35 V @ 10 MHz	30 V @ 50 MHz
Aberrations		±3%	<5% p-p	±3%	<5% p-p
Risetime			3.5 ns		1.7 ns
Compensation Range		15 pF to 47 pF		15 pF to 24 pF	

\*In 10X position the input R = 10 MΩ ± 0.5% with an oscilloscope input R = 1 MΩ ± 2%.

**Miniature**

**Fast Risetime**

The P6053B is a miniature fast-rise 10X probe designed for Tektronix instruments having a nominal input capacitance of 15 to 24 pF. The probe has a pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

**Attenuation** — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 9.5 pF with 3.5 ft probe. 12.5 pF with 6 ft version, 13.5 pF with 9 ft version. **Bandwidth** (with 225 MHz or greater oscilloscope) — ≈200 MHz for 3.5 and 6 ft versions, ≈115 MHz for the 9 ft version. **Voltage Rating** — 500 V (dc + peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz; 18 V at 150 MHz.

**INCLUDED ACCESSORIES**

Holder, probe (352-0351-00); insulating sleeve, electrical (BP, 166-0404-01); tip, probe, retractable (BB, 013-0107-03); tip, hook probe (BU, 206-0114-00); lead, ground, 13 cm (5 inch) (175-0124-01); two clips, alligator (AS, 344-0046-00); lead, ground, 30 cm (12 inch) (DD, 175-0125-01); pouch, accessory (016-0521-00). For P6053B only, tip, probe bayonet (BM, 013-0085-00); lead, ground, 7.5 cm, 3 inch, (DD, 175-0263-01).

**ORDERING INFORMATION**

- P6062B** Switchable Attenuation Probe  
 6 ft, Order 010-6062-13 ..... **\$164**  
 3.5 ft, Order 010-6062-11 ..... **\$164**  
 9 ft, Order 010-6062-15 ..... **\$164**
- P6063B** Switchable Attenuation Probe  
 6 ft, Order 010-6063-13 ..... **\$201**  
 3.5 ft, Order 010-6063-11 ..... **\$201**
- P6053B** Miniature 10X Probe,  
 6 ft, Order 010-6053-13 ..... **\$154**  
 3.5 ft, Order 010-6053-11 ..... **\$154**  
 9 ft, Order 010-6053-15 ..... **\$154**

**High CMRR**

**Compact Size**

**Low Capacitance**

**Dc—60 MHz**

The P6055 is a miniature, low-capacitance, 10X probe designed for use with Tektronix differential amplifiers with nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. The use of a matched pair of P6055 differential probes allows the user to adjust the attenuation of the probes for compatibility with the various Tektronix plug-ins.

**CHARACTERISTICS**

**CMRR** — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz.

**Attenuation** — Adjustable to 10X.

**Input Resistance** — 1 MΩ ± 0.5%.

**Input Capacitance** — ≈10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance.

**Maximum Useful Bandwidth** — 60 MHz.

**Typical Probe Risetime** — 5.8 ns.

**Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. P-p voltage derates to 100 V at 70 MHz.

**INCLUDED ACCESSORIES**

Tip, probe, retractable (BB, 013-0107-03); lead, ground, 13 cm (5 inch) (175-0124-01); two insulating sleeves, electrical (BP, 166-0404-01); adjustable tool, probe (CP, 003-0675-01); tip, hook probe (BU, 206-0114-00); lead, electrical, 13 cm (5 inch) (DF, 175-1256-00); holder, probe (352-0090-00); two clips, alligator (AS, 344-0046-00); lead, ground, 30 cm (12 inch) (175-0125-01).

**ORDERING INFORMATION**

- P6055** 10X Differential Probe 3.5 ft.  
 Order 010-6055-01 ..... **\$244**  
**Matched Pair of P6055**  
 Order 015-0437-00 ..... **\$420**

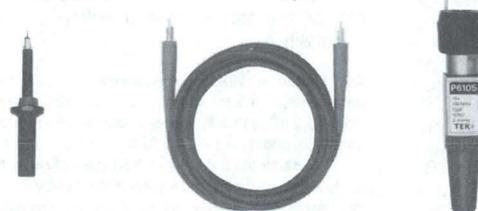
## #6-32 Probe Tips and Accessories

The following tips and adaptors can be used on all Tektronix Probes that accept a #6-32 screw-on tip, including the P6006, P6007, P6008, P6009, P6028, and P6060 Probes and others with 6-32 adaptor.

CODE	DESCRIPTION	PART NUMBER	PRICE
AA	Probe straight tip (0.055 in dia)	206-0015-00	\$ 1.00
AB	Probe spring tip (0.080 in dia)	206-0060-00	\$ 1.75
AC	Probe spring tip (accepts 0.065 in dia pin)	206-0061-00	\$ 1.25
AD	Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	\$ 2.50
AE	IC test tip	206-0203-00	\$ 1.40
AF	Probe long straight tip (0.032 in dia)	206-0104-00	\$ 1.10
AG	Probe hook up	206-0105-00	\$ 1.10
AH	Probe ground lead adaptor (#6-32 to 0.025 in square pin closing)	206-0137-01	\$ 2.00
AI	Probe right angle hook tip	206-0185-00	\$ 1.50
AJ	Bayonet ground assembly	013-0052-00	\$ 7.00
AK	Probe banana tip	134-0013-00	\$ 1.00
AL	Probe ground cover (for P6009)	166-0428-00	\$ 1.35
AM	Probe calibration tip (0.063 in dia)	206-0100-00	\$10.50
AN	Probe retractable hook tip	013-0071-00	\$ 3.25
AP	Probe retractable hook tip (for P6008E)	013-0071-01	\$ 3.00
AQ	Alligator clip	344-0005-00	\$ 3.75
AR	Alligator clip	344-0045-00	\$ 1.40
AS	Miniature alligator clip	344-0046-00	\$ 1.40
AT	Probe tip to BNC adaptor	013-0054-00	\$17.00
AU	High-voltage dielectric fluid 3 oz.	252-0120-00	\$ 5.00
AV	Probe pin tip (accepts 0.025 in IBM SLT in)	206-0134-03	\$ 4.25
AW	Probe tip to BNC adaptor (for P6028)	013-0056-00	\$18.00



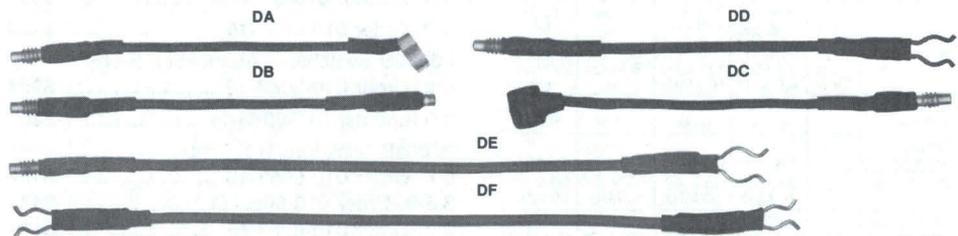
## Modular Probe Replacement Parts



Probe	Length	Probe Head		Probe Cable		Compensator/Connector	
P6101	1 Meter	206-0223-00	\$19	175-1661-00	\$27	103-0189-00	\$18.50
	2 Meter	206-0223-00	\$19	175-1661-01	\$27	103-0189-00	\$18.50
	3 Meter	206-0223-00	\$19	175-1661-02	\$27	103-0189-00	\$18.50
P6105*	1 Meter	206-0216-00	\$45	175-1661-00	\$27	206-0219-00	\$44.00
	2 Meter	206-0217-00	\$45	175-1661-01	\$27	206-0220-00	\$44.00
	3 Meter	206-0218-00	\$45	175-1661-02	\$27	206-0221-00	\$44.00
P6106*	1 Meter	206-0216-00	\$45	175-1661-00	\$27	206-0237-00	\$65.00
	2 Meter	206-0217-00	\$45	175-1661-01	\$27	206-0238-00	\$70.00
	3 Meter	206-0218-00	\$45	175-1661-02	\$27	206-0239-00	\$70.00
P6107	2 Meter	206-0217-00	\$45	175-1661-00	\$27	206-0247-00	\$40.00
P6108	1 Meter	206-0224-00	\$39	175-1661-00	\$27	206-0227-00	\$41.00
	2 Meter	206-0225-00	\$39	175-1661-01	\$27	206-0228-00	\$44.00
	3 Meter	206-0226-00	\$39	175-1661-02	\$27	206-0229-00	\$44.00
P6149	2 Meter	206-0234-00	\$36	175-1661-01	\$27	206-0255-00	\$26.00

\*The BNC Connector with readout may be replaced with 131-1799-01

CODE	DESCRIPTION	LENGTH (in)	PART NUMBER	PRICE
DA	Ground lead for S-3A, P6056, P6057	3	175-0249-00	\$5.00
DB	Ground leads for P6054, P6075, 7A11, and P6201	3	175-0848-00	\$1.60
		5	175-0848-01	\$1.75
		12	175-0848-02	\$1.75
DC	Ground leads for P6202 and P6420	3	175-0849-00	\$6.00
		6	175-0849-01	\$6.00
DD	Ground lead*	3	175-0263-01	\$2.15
		5	175-0124-01	\$2.15
		12	175-0125-01	\$2.15
DE	Ground leads for S-3A, P6202, P6420	6	175-1017-00	\$3.50
		6	175-1256-00	\$5.00
DF	Ground lead for P6055	6	175-1256-00	\$5.00



CABLE MARKER SETS (Not Pictured)		
DESCRIPTION	PART NUMBER	PRICE
For 1/8 in dia cable	016-0130-00	\$6.00
For 3/16 in dia cable	016-0127-00	6.00
For modular cable	016-0633-00	\$4.00

## MODULAR/MINIATURE ADAPTORS



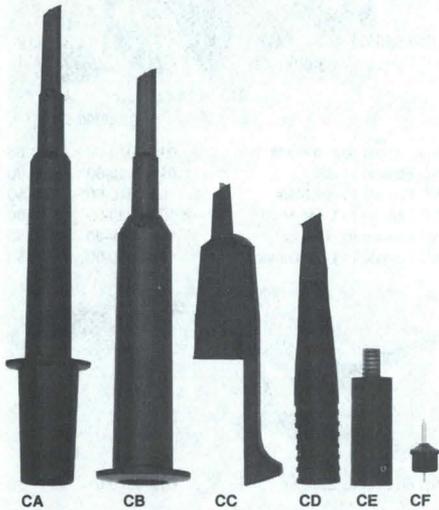
CODE	DESCRIPTION	PART NUMBER	PRICE
BA	Retractable hook tip (for all modular probes)	013-0105-00	\$ 7.00
BC	Probe tip, IC Grabber	013-0191-00	\$10.50
BB	Retractable hook tip (for P6053B, P6055, P6062B, P6063B, P6101, P6105, P6106, P6108, and P6149)	013-0107-03	\$ 3.25
BD	Miniature retractable hook tip	206-0222-00	\$ 3.25
BE	Probe tip flexible, adapts miniature probe to retractable hook tip (BD)	103-0177-01	\$ 6.50
BF	Probe tip flexible for 0.025 square pin	206-0193-00	\$ 7.75
BG	Miniature probe to #6-32 adaptor (for all miniature probes except P6045, P6202, includes all modular probes)	103-0051-01	\$ 4.00
BH	Miniature probe to #6-32 adaptor with ground connection	103-0131-00	\$ 5.25

CODE	DESCRIPTION	PART NUMBER	PRICE
BI	Probe pin tip (accepts 0.025 in IBM SLT pin)	206-0209-00	\$ 3.50
BJ	Miniature probe tip to GR adaptor	017-0076-00	\$42.00
BK	Miniature probe tip to GR 50 $\Omega$ termination adaptor	017-0088-00	\$50.00
BL	Chassis mount test jack (for miniature probes, including modular)	131-0258-00	\$ 4.25
BM	Bayonet ground assembly	013-0085-00	\$ 6.50
BN	Miniature probe tip cover, IC tester, Package of 10	015-0201-04	\$ 6.50
BO	Replaceable probe tip, pkg of 10. All miniature probes including modular except P6202 and P6420	015-0201-05	\$17.75
		206-0191-03	\$17.00

CODE	DESCRIPTION	PART NUMBER	PRICE
BP	Miniature probe tip ground cover, insulating sleeve (for all miniature probes, including modular)	166-0404-01	\$ 1.00
BQ	Electrical contact	214-0283-00	\$ 1.00
BR	Termination, 50 $\Omega$	011-0049-01	\$25.00
BS	Probe tip to BNC adaptor for all probes	013-0084-01	\$ 8.00
BT	Probe tip to BNC adaptor for all, except P6202	013-0084-02	\$10.00
BU	Probe tip hook (for all miniature probes, including modular)	206-0114-00	\$ 2.75
BV	Probe tip straight (for all miniature probes, including modular)	206-0114-01	\$ 2.75
BW	Dual lead adaptor for miniature probes	015-0325-00	\$13.00

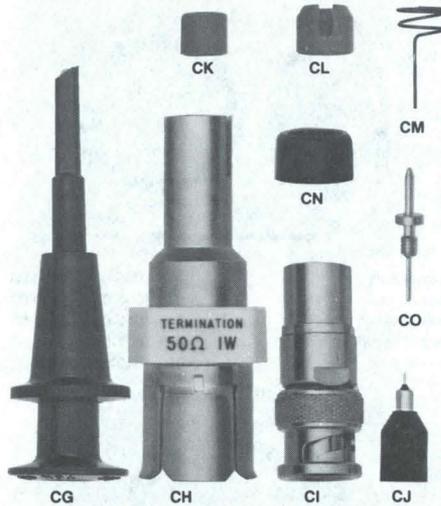
## OTHER ADAPTORS

The following tips and adaptors are designed for use with Tektronix Miniature Probes and accept a slip-on tip.



CODE	DESCRIPTION	PART NUMBER	PRICE
CA	Retractable hook tip (for P6010 and P6048)	013-0090-00	\$ 4.00
CB	Retractable hook tip (for S-3A, P6202, and P6420)	013-0097-01	\$ 7.00
CC	Retractable hook tip (for 7A11 and P6401)	013-0106-00	\$ 9.25
CD	Retractable hook tip (for 211, 212, 213, 214, 221)	013-0107-02	\$ 3.25
CE	Miniature probe to #6-32 adaptor (for P6045, P6046, P6202, 7A11, S-3A)	103-0051-00	\$ 4.00
CF	Replaceable probe tip for P6202 and P6420, pkg of 10	206-0230-03	\$15.75

## P6201 ACCESSORIES



CODE	DESCRIPTION	PART NUMBER	PRICE
CG	Retractable probe tip (for P6201 only)	013-0135-00	\$ 4.25
CH	P6201 probe tip to GR 50 $\Omega$ termination adaptor	017-0094-00	\$55.00
CI	Probe tip to BNC adaptor (for P6201 only)	013-0145-00	\$14.00
CJ	Probe tip to test point jack (for P6201 only)	103-0164-00	\$ 5.25
CK	Insulating sleeve, electrical (for P6201 only)	166-0557-00	\$ 1.00
CL	Ground contact insulator (for P6201 only)	342-0180-00	\$ 1.00
CM	Ground contact (for P6201 only)	131-1302-00	\$ 1.10
CN	Ground lead, insulating sleeve (for P6201 only)	166-0433-00	\$ 1.00
CO	Replaceable probe tip (for P6201 only)	206-0200-00	\$ 1.00

## PROBE TOOLS

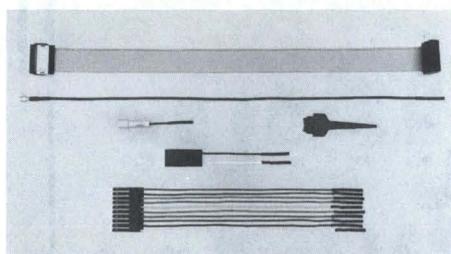


CODE	DESCRIPTION	PART NUMBER	PRICE
CP	Adjustment tool, probe	003-0675-01	\$ 2.35
CQ	Probe tip extractor	003-0825-00	\$ 2.10

## ITEMS NOT SHOWN

FB	Female to dual banana adaptor, BNC	103-0090-00	\$ 7.50
FC, FD, and FE	Coaxial cable — see page 444.		
FA	For LA Probe tip for tri-state logic (308) see page 67.	206-0252-01	\$16.00

## LOGIC PROBE TEST LEADS

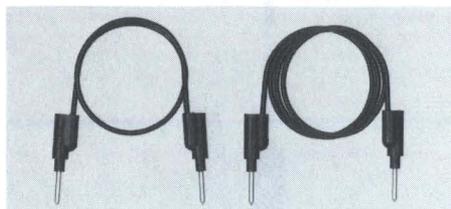


16 pin low profile dip clip (can be used with 14 or 16 pin ICs)	015-0330-00	\$ 35.00
10 wide comb set with grabber tips not included	012-0747-00	\$ 50.00
Miniature retractable hook tip	206-0222-00	\$ 3.25
Dual lead adaptor for miniature probes	015-0325-00	\$ 13.00
Flexible probe tip, P6006 type	103-0210-00	\$ 5.00
Ground lead, P6006 type	195-0234-00	\$ 4.50

## PATCH CORDS

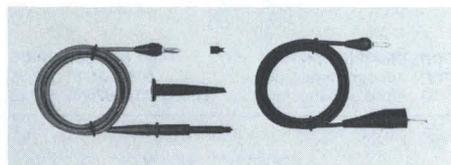


<b>BNC to BNC, 18 in</b>		
Red	012-0087-00	\$ 6.50
Black	012-0086-00	\$ 6.50
<b>BNC to banana plug-jack, 18 in</b>		
Red	012-0091-00	\$ 6.50
Black	012-0090-00	\$ 6.50
<b>Banana plug-jack to banana plug-jack, 18 in</b>		
Red	012-0031-00	\$ 6.50
Black	012-0039-00	\$ 6.25



<b>Pin-jack to pin-jack, 0.08 in dia pin</b>		
Red, 8 in	012-0179-00	\$ 3.75
Red, 18 in	012-0180-00	\$ 3.75
Black, 8 in	012-0181-00	\$ 3.75
Black, 18 in	012-0182-00	\$ 3.75

## TEST LEADS



Test Lead, Black, 4 ft	012-0425-00	\$ 12.00
Test Lead, Red, 4 ft	012-0426-00	\$ 17.50
Test Lead, Black, 4 ft	012-0426-01	\$ 17.50
Test Lead set includes 012-0425-00, 012-0426-00, and 013-0107-03	012-0427-00	\$ 29.00

## PERSONALITY MODULE TEST LEADS

40 Pin Dip Clip—10 cm cable (order M/F adaptor below)	015-0339-00	\$ 42.00
40 Pin Dip Clip—30 cm cable		
Male Adaptor for 40 Pin (order M/F adaptor below)	015-0339-02	\$ 42.00
Low Profile Dip Clip—for use with PM 101/7D02 General Purpose Personality Module (or with individual leads such as the 10-wide comb set 012-0747-00)	380-0560-05	\$ 15.00
Female Adaptor for 40 Pin Low Profile Dip Clip—for use with dedicated 7D02 personality modules	380-0647-01	\$ 30.00

## COAXIAL CABLES

### BNC Connectors

Coaxial, 50 $\Omega$ , 42 in	012-0057-01	\$ 17.00
Coaxial, 75 $\Omega$ , 42 in	012-0074-00	\$ 17.00
Coaxial, 93 $\Omega$ , 42 in	012-0075-00	\$ 25.00
Coaxial, 50 $\Omega$ , 18 in	012-0076-00	\$ 17.00
Coaxial, 50 $\Omega$ , 18 in, Male to Female	012-0104-00	\$ 24.00
Coaxial, 50 $\Omega$ Precision, 36 in	012-0482-00	\$ 25.00

### N Connectors 50 $\Omega$

Coaxial N connectors, 6 ft	012-0114-00	\$ 25.00
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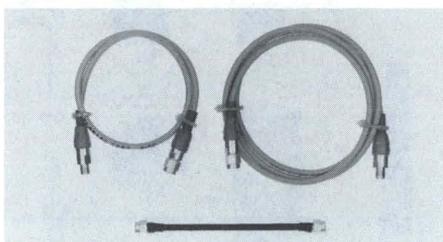
### GR Connectors 50 $\Omega$

Coaxial 10 ns RG58A/U	017-0501-00	\$ 85.00
Coaxial 5 ns RG213/U	017-0502-00	\$ 160.00
Coaxial 1 ns RG58A/U*	017-0503-00	\$ 100.00
Coaxial 20 ns RG213/U	017-0504-00	\$ 100.00
Coaxial 2 ns RG58A/U	017-0505-00	\$ 120.00
Coaxial 5 ns RG58A/U	017-0512-00	\$ 90.00
Coaxial 10 in RG213/U	017-0513-00	\$ 75.00
Coaxial 20 in RG213/U	017-0515-00	\$ 90.00

\*Connector on one end only.

## 50 $\Omega$ CABLES

### SMA (3 mm) Connectors 50 $\Omega$



Coaxial 2 ns	015-1005-00	\$ 80.00
Coaxial 5 ns	015-1006-00	\$ 130.00
Coaxial semirigid 500 ps	015-1015-00	\$ 40.00
Coaxial semirigid 750 ps	015-1017-00	\$ 35.00
Coaxial 1 ns	015-1019-00	\$ 105.00

### BNC to BSM Connectors 50 $\Omega$



Coaxial, 10 in, RG58		
BSM Female to BNC Male	012-0128-00	\$ 20.00
Coaxial, 18 in, RG58		
BSM Female to BNC Male	012-0127-00	\$ 20.00

## 50 $\Omega$ AIR LINE



The 20 cm 50  $\Omega$  air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50  $\Omega$   $\pm$  0.4%. Time delay is 0.6698 ns  $\pm$  0.4%.

50 $\Omega$ Air Line	017-0084-00	\$ 165.00
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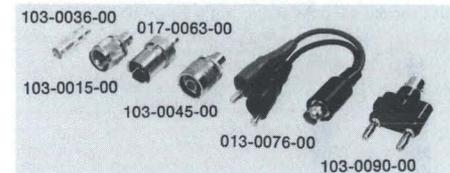
## ADAPTORS



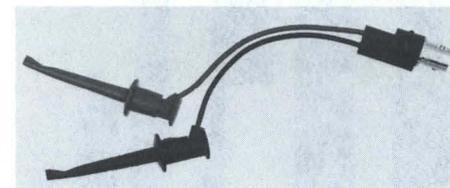
BNC Female to BNC Female	103-0028-00	\$ 5.00
BNC Male to BNC Male	103-0029-00	\$ 5.50
BNC T	103-0030-00	\$ 6.50
BNC Elbow Male to Female	103-0031-00	\$ 6.00



BNC Male to GR	017-0064-00	\$ 75.00
BNC Male to UHF Female	103-0032-00	\$ 4.75
BNC Male to Binding Post	103-0033-00	\$ 4.75
BNC Male to Dual Binding Post		
Post	103-0035-00	\$ 12.00
BNC Male to N Female	103-0058-00	\$ 7.00



BNC Female to clip leads	013-0076-00	\$ 21.00
BNC Female to GR	017-0063-00	\$ 43.00
BNC Female to uhf Male	103-0015-00	\$ 4.50
BNC Female to BSM Male	103-0036-00	\$ 15.00
BNC Female to N Male	103-0045-00	\$ 6.50
BNC Female to Dual Banana	103-0090-00	\$ 7.50



BNC Female to EZ Ball	013-0076-01	\$ 17.50
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GR to N Male	017-0021-00	\$ 35.00
GR to C Male	017-0027-00	\$ 55.00
GR to N Female	017-0062-00	\$ 43.00
GR to C Female	017-0065-00	\$ 80.00



GR to BNC Female	017-0063-00	\$ 43.00
GR to BNC Male	017-0064-00	\$ 75.00
50 Ω termination, thru-line *(GR to BNC Male)	017-0083-00	\$ 80.00

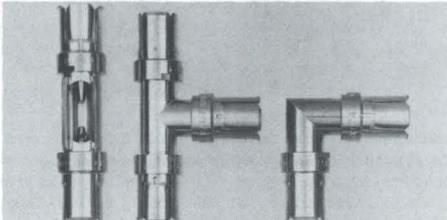
\*Upper frequency limit vswr not specified



N Male to GR	017-0021-00	\$ 35.00
N Female to GR	017-0062-00	\$ 43.00
N Male to BNC Female	103-0045-00	\$ 6.50
N Female to BNC Male	103-0058-00	\$ 7.00



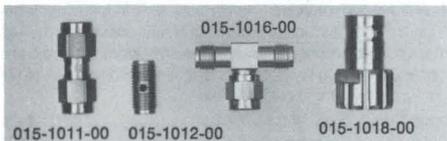
"F" Female to BNC Male	013-0126-00	\$ 15.00
"F" Female to GR874	017-0089-00	\$ 45.00
"F" Male to "F" Male	103-0157-00	\$ 7.50
"F" Male to BNC Female	103-0158-00	\$ 8.50
"F" Female to "F" Female	103-0159-00	\$ 7.50



GR Insertion Unit	017-0030-00	\$ 80.00
GR T	017-0069-00	\$100.00
GR Elbow	017-0070-00	\$100.00



SMA Male to GR	015-1007-00	\$ 90.00
SMA Female to GR	015-1008-00	\$ 90.00
SMA Male to N Female	015-1009-00	\$ 50.00
SMA Male to 7 mm APC	015-1010-00	\$175.00



SMA Male to Male	015-1011-00	\$ 20.00
SMA Female to Female	015-1012-00	\$ 16.00
SMA T	015-1016-00	\$ 30.00
SMA Male to BNC Female	015-1018-00	\$ 8.00

## ACCESSORY HOUSING



Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing	011-0081-00	\$ 30.00
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## ATTENUATORS—TERMINATIONS



50 Ω ±0.1% precision feedthrough termination (dc -100 kHz, 11 V RMS maximum)	011-0129-00	\$ 95.00
50 Ω feed through termination*1	011-0049-01	\$ 25.00
50 Ω 10X (20 dB) attenuator*2	011-0059-02	\$ 35.00
50 Ω 5X (14 dB) attenuator*2	011-0060-02	\$ 35.00
50 Ω (6 dB) attenuator*2	011-0069-02	\$ 35.00
50 Ω 2.5X (8 dB) attenuator*2	011-0076-02	\$ 35.00
50 Ω feedthrough termination (5 W)*3	011-0099-00	\$ 40.00

**Characteristics** — Dc resistance is 50 Ω ±1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

### vswr

\*1 <1.1 dc -250 MHz and <1.2 dc -500 MHz.

\*2 <1.1 dc -1.0 GHz and <1.2 dc -2.0 GHz.

\*3 1.1 dc -100 MHz.

75 Ω feedthrough termination	011-0055-00	\$ 25.00
93 Ω feedthrough termination	011-0056-00	\$ 25.00
50 Ω to 75 Ω minimum loss attenuator	011-0057-00	\$ 25.00
50 Ω to 93 Ω minimum loss attenuator	011-0058-00	\$ 25.00
75 Ω 10X attenuator	011-0061-00	\$ 30.00
93 Ω 10X attenuator	011-0062-00	\$ 28.00
600 Ω feedthrough termination (1 W, dc to 1 MHz)	011-0092-00	\$ 30.00
75 Ω to 50 Ω minimum loss attenuator (ac coupled)	011-0112-00	\$ 60.00

## CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at dc. Power rating of attenuators is 1/2 W and terminations 1 W. Voltage standing wave ratio (vswr) not specified.

## ATTENUATORS and TERMINATORS



Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

10 dB attenuator	011-0085-00	\$ 70.00
20 dB attenuator	011-0086-00	\$ 70.00
40 dB attenuator	011-0087-00	\$ 90.00

## GR

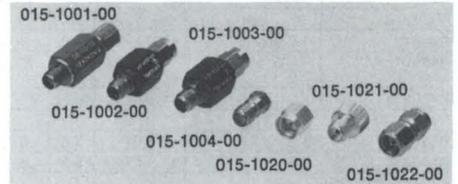


50 Ω 10X attenuator	017-0078-00	\$210.00
50 Ω 5X attenuator	017-0079-00	\$210.00
50 Ω 2X attenuator	017-0080-00	\$150.00
50 Ω termination, end-line	017-0081-00	\$135.00

## CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at dc, ±3% at 1 GHz. Voltage standing wave ratio (vswr) is <1.1 up to 1 GHz. Power rating is 1 W.

## 3 mm 50 Ω



50 Ω 2X attenuator	015-1001-00	\$120.00
50 Ω 5X attenuator	015-1002-00	\$120.00
50 Ω 10X attenuator	015-1003-00	\$120.00
50 Ω termination Female	015-1004-00	\$ 60.00
Short-Circuit termination Male	015-1020-00	\$ 17.50
Short-Circuit termination Female	015-1021-00	\$ 24.00
50 Ω termination Male	015-1022-00	\$ 32.00

## CHARACTERISTICS

	Dc— 12.40 GHz		12.41— 18.00 GHz		Power	
	Attenuation		Attenuation			Contin- uous
	Accuracy	Vswr	Accuracy	Vswr		
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W	
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W	
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W	
10X (20 db)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W	

## 50 Ω COUPLING CAPACITOR



The coupling capacitor is a short length of coaxial line with a disk capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150 ps tr system), is 0.03 maximum. Voltage rating is 200 V.

Coupling Capacitor SMA (3 mm)	015-1013-00	\$170.00
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The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

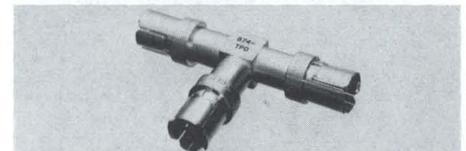
Coupling Capacitor GR	017-0028-00	\$ 90.00
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## 50 Ω POWER DIVIDERS



This coaxial tee is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Maximum vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

Power Divider SMA (3 mm)	015-1014-00	\$200.00
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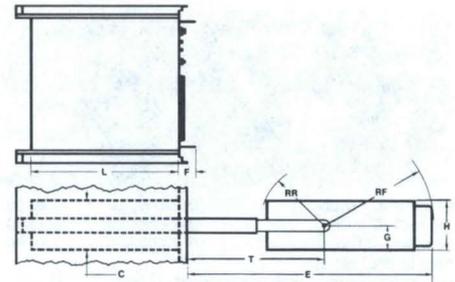
This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer setup where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Power Divider GR	017-0082-00	\$260.00
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## MOUNTING DIMENSIONS

PRODUCT	H		L		F		G		E		RF		RR		T		C	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
R434	5.3	13.5	18.0	45.7	1.6	4.0	—	—	—	—	—	—	—	—	—	—	5.3	13.5
R465B*, R475*, R-475A*	7.0	17.8	16.3	41.4	1.8	4.6	3.5	8.9	20.4	51.8	11.0	27.9	7.9	20.1	9.6	24.4	6.8	17.3
R485*	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	49.0	10.9	27.7	7.9	20.1	9.3	23.6	6.8	17.3
R491*	7.0	17.8	17.4	44.2	2.1	5.1	3.5	8.9	21.1	53.6	11.9	30.2	8.5	21.6	9.3	23.6	6.8	17.3
R5100N, R5400*	5.3	13.5	19.0	48.3	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
R7704*	7.0	17.8	22.4	56.9	2.3	5.8	1.8	4.6	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313*, R7603*, R7613*, R7623*	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	5.3	13.5
R7844*	7.0	17.8	24.8	56.6	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
R7903*	5.3	13.5	22.5	57.2	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	13.5
R7912*	5.3	13.5	26.9	68.3	1.8	4.6	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	—	—	30.7	78.0	—	—	—	—	—	—	6.9	17.5
RTM506	5.25	13.3	18.9	48.0	1.82	4.7	—	—	—	—	—	—	—	—	—	—	5.25	13.3
T922R	5.2	13.2	17.0	43.2	1.7	4.3	—	—	24.2	61.5	—	—	—	—	—	—	5.2	13.2
016-0115-02	5.3	13.5	16.3	41.4	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0551-01	14.0	35.6	22.4	56.9	0.6	1.5	—	—	30.9	78.5	—	—	—	—	—	—	—	—
040-0554-01	15.8	40.1	21.5	54.6	1.9	4.8	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
040-0601-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.25	13.3
040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
040-0624-01	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0126-03	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	6.6	16.8
016-0468-00	5.2	13.3	14.9	37.8	2.0	5.1	—	—	—	—	—	—	—	—	—	—	—	—

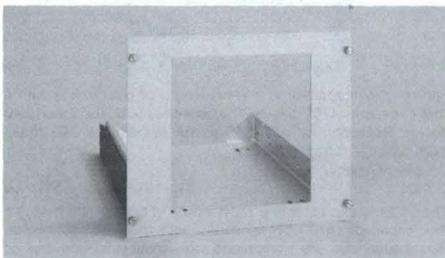
\*These instruments mount with sliding tracks to a standard 19-inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.



### DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

Symbol	Definition
H	Height of front panel
L	Rack front to rearmost permanent fixture excluding cables
F	Back of front panel to foremost protrusion
G	Bottom of front panel to horizontal plane of rotation
E	Maximum forward clearance with instrument out and horizontal
RF	Front radius of rotation
RR	Rear radius of rotation
T	Rack front to pivot point
C	Cabinet height

### RACK ADAPTORS



For rackmounting the 7000 Series oscilloscopes in a standard 19 in wide rack. Rack adaptor includes slide-out assemblies. 7000 Series mask finish is light gray.

For 7704A, 7104, 7834 and 7854, rack height is 15.75 in, rack depth is 21.38 in, shipping weight is ≈41 lb.

Order 040-0611-01 ..... \$700

For 7704 and 7904, rack height is 15.75 in, rack depth is 21.75 in shipping weight is ≈41 lb.

Order 040-0554-01 ..... \$800

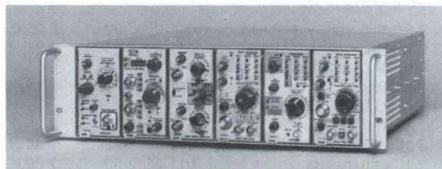
For 455 and 465M, includes cradle mount, rack height 7 in, rack depth 18.75 in.

Order 040-0825-01 ..... \$350



For 468, and DM versions of other 400 Series oscilloscopes. Order 016-0675-00 ..... \$325

### STORAGE CABINETS



For 7000 Series Plug-in Units — Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high.

Order 437-0126-03 ..... \$750

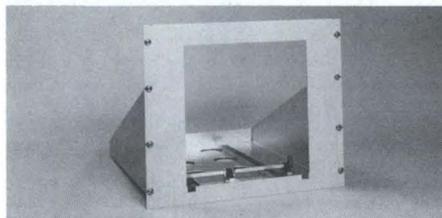
### REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19 in backless rack. Shipping weight is ≈3 lb.

For R561B, R564B, and R647A.

Order 040-0344-00 ..... \$60

### CRADLE MOUNTS

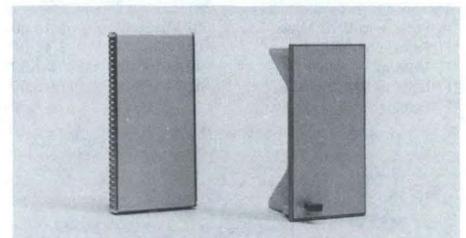


For rackmounting 7000 Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 7000 Series mask finish is light gray.

For 7704A, rack height is 15.75 in, rack depth is 22 in, shipping weight is ≈16 lb.

Order 040-0560-00 ..... \$445

### BLANK PANEL



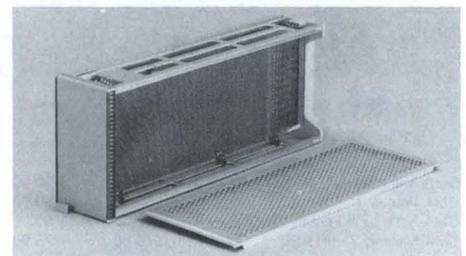
Blank Panel — When operating the 5000/7000 Series mainframes or the TM 500 or 2600 Series generators with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMC Shielding.

7000 Series, 2600 Series, Order 016-0155-00 ..... \$45

5000 Series, Order 016-0452-00 ..... \$18

TM 500 Series, Order 016-0195-03 ..... \$25

### BLANK PLUG-IN CHASSIS



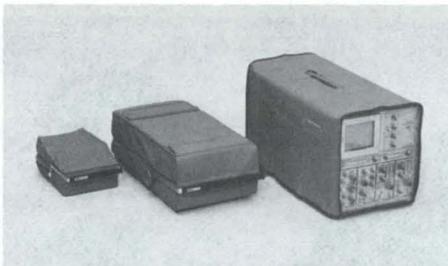
Blank Plug-in Chassis — Available for all Tektronix mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug, securing hardware and plug-in frame.

7000 Series Order 040-0553-01 ..... \$130

5000 Series Order 040-0818-03 ..... \$105

TM 500 Series Order 040-0652-05 ..... \$ 95

560 Series Order 040-0245-00 ..... \$125



**OSCILLOSCOPE PROTECTIVE COVERS**

The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000 Series laboratory oscilloscopes have clear vinyl frontal areas.

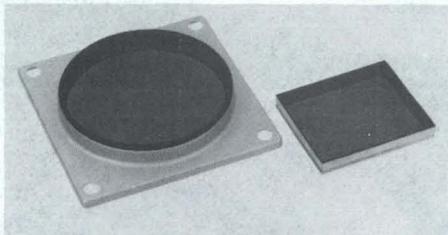
**PROTECTIVE COVERS**

INSTRUMENT	PART NUMBER	PRICE
200 Series	016-0512-00	\$15.00
323,324,1401A,1401A-1, 1501	016-0112-00	\$24.00
314,335	016-0612-00	\$115.00
326	016-0532-00	\$75.00
453A,454A,491	016-0074-01	\$18.00
455	016-0344-00	\$18.00
434,464,466	016-0365-00	\$21.00
465,465B,475,485	016-0554-00	\$17.00
560 Series (except 565,567, 568)	016-0067-00	\$17.00
565,567,568	016-0069-00	\$20.00
540 Series	016-0068-00	\$20.00
5000 Series	016-0544-00	\$25.00
7300,7400,7600 Series	016-0192-01	\$20.00
7704A,7900	016-0531-00	\$20.00

**PLUG-IN UNIT CARRYING CASES**

**3-wide Carrying Case** for 7L14, 7L5 Option 25, 7D20, 7L18.  
Order 016-0626-00 ..... \$220

**2-wide Carrying Case** for 7L12, 7L5.  
Order 016-0625-00 ..... \$220



**CRT MESH FILTERS**

The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

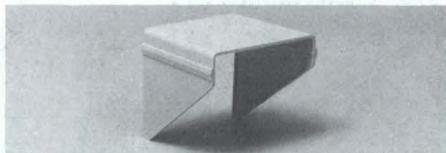
The mesh filter also serves as an EMC filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMC spectrum.

INSTRUMENT*	PART NUMBER	PRICE
314, 326, 335	378-0063-00	\$27.00
432, 434	378-0682-00	\$45.00
422, 491, 453A, 454A, 485	378-0648-00	\$24.00
465, 465B, 475, 464, 466, 434	378-0726-01	\$55.00
7400, 7603	378-0696-00	\$55.00
7500,7700,7800,7900 Series and 7613,7623 7633	378-0603-00	\$55.00

\*For both cabinet and rackmount instruments.

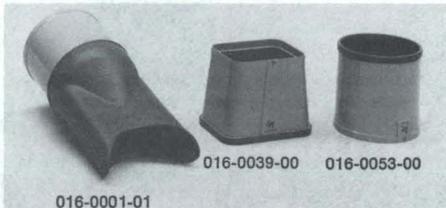
**VIEWING ACCESSORIES**

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Sales Engineer for bezel-viewer compatibility before ordering.



**View Hood (folding)** — 314, 326, 335, 400 Series, 576, 577, 5000, and 7000 Series oscilloscopes.

For 576, **Order 016-0259-00** ..... \$20  
For 577, 5000, and 7000 Series  
**Order 016-0260-00** ..... \$18  
For 326, 314, 335, SC 502, SC 504 (not pictured),  
**Order 016-0297-00** ..... \$ 6.50  
For 464, 466, 455 (not pictured),  
**Order 016-0592-00** ..... \$12

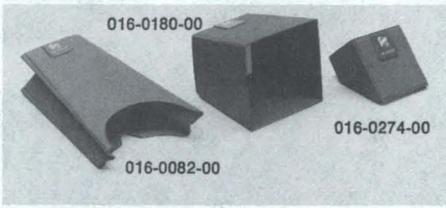


**Polarized Viewers** — For Tektronix older 5 inch oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

Rectangular Viewer, **Order 016-0039-00** ..... \$80  
Plastic Round Viewer, **Order 016-0053-00** ..... \$42

**Viewing Hood** — For Tektronix older 5 inch round oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.

**Order 016-0001-01** ..... \$125



**Collapsible Viewing Hood** — For oscilloscopes with rectangular CRTs. Blue vinyl material, folds flat for convenient storage.

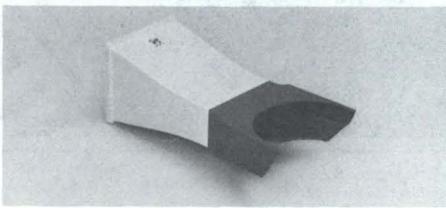
For 422, 453A, 454A, 485, 491,  
**Order 016-0082-00** ..... \$15

For 422, 453A, 454A, 485, 491,  
**Order 016-0274-00** ..... \$15

**Viewing Hood (folding binocular)** — For some 400 Series.  
For 434, 455, 464, 466, 465B, 475 and 475A.

**Order 016-0566-00** ..... \$15

**Polarized Collapsible Viewing Hood** — To reduce reflections and glare under high ambient light conditions for 432, 434, 455, 465, 465B, 475, 464, 466, **Order 016-0180-00** ..... \$40



**Viewing Hood** — For 576, 5000 and 7000 Series oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

For 576, **Order 016-0153-00** ..... \$40  
For 5000 and 700 Series, 601, 602, 603, 604, 528 and 577,  
**Order 016-0154-00** ..... \$28

**CATHODE-RAY TUBE LIGHT FILTERS**

INSTRUMENT*	COLOR	PART NUMBER	PRICE
314,335	Blue	378-2016-01	\$1.80
200 Series	Blue	378-0691-00	\$ 1.25
455	Blue	337-2122-00	\$ 5.25
465,465B,475, 464,466	Blue Clear Smoke-gray filter	337-1674-00 337-1674-01 337-1674-07	\$ 5.00 \$ 5.00 \$ 4.00
540,550 Series 565,575	Smoke-gray† Green Blue Amber	378-0567-00 378-0568-00 378-0569-00 378-0570-00	\$ 9.00 \$ 4.00 \$ 4.00 \$ 4.00
529,561B,567 568	Smoke-gray†	378-0560-00	\$ 4.00
576	Blue† Amber	378-0616-00 378-0616-01	\$ 5.00 \$ 5.00
603,604	Clear (603†) Green Amber Blue Gray Graticule (8x10 div)	337-1440-00 337-1440-01 337-1440-02 337-1440-03 337-1440-04 331-0303-00	\$ 3.00 \$ 3.00 \$ 3.50 \$ 3.50 \$ 4.50 \$10.00
605,606,607	Blue Amber Graticule Clear Shield Gray† Graticule (8x10 div)	337-1674-00 337-1674-05 337-1674-10 337-1674-13 337-1674-06 331-0391-00	\$ 5.00 \$ 5.00 \$ 5.00 \$ 5.00 \$ 5.00 \$ 5.00
608	Amber Green Graticule†	378-0704-00 378-0705-00 337-2126-02	\$ 5.00 \$ 5.00 \$ 5.25
7904,7844 7313,7700 Series,7613 7623	Blue† Amber Gray Green Gray Tv Graticule CCIR Gray Tv Graticule NTSC Clear Shield With Spectrum Analyzer Graticule	378-0625-00 378-0625-01 378-0625-02 378-0625-03 378-0625-05 378-0625-06 337-1159-02	\$ 5.00 \$ 5.00 \$ 5.00 \$ 5.00 \$ 9.50 \$ 9.50 \$ 8.00
7613,7623 7623A,7633	Spectrum Analyzer Green (UV) Tv Graticule CCIR Tv Graticule NTSC	378-0625-07 378-0625-08 378-0625-09 378-0625-09 378-0625-10	\$ 9.50 \$ 5.00 \$ 9.50 \$ 9.50 \$ 9.50
7403N,7603	Blue Amber Gray Green Gray Tv Graticule CCIR Gray Tv Graticule NTSC With Spectrum Analyzer Graticule Blue Implosion Shield† Clear Implosion Shield	378-0684-00 378-0684-01 378-0684-02 378-0684-03 378-0684-04 378-0684-04 378-0684-05 337-1439-01 337-1700-01 337-1700-04	\$ 7.00 \$ 7.00 \$ 7.00 \$ 7.00 \$ 12.00 \$ 12.00 \$ 8.00 \$ 6.50 \$ 6.50
5100 and 5400 Series (except 5441)	Clear Green Amber Blue Gray	337-1440-00 337-1440-01 337-1440-02 337-1440-03 337-1440-04	\$ 3.00 \$ 3.00 \$ 3.50 \$ 3.50 \$ 4.50
5441	Clear† Gray Graticule (8x10 div)	337-1674-01 337-1674-06 331-0391-00	\$ 5.00 \$ 5.00 \$ 5.00
434	Blue	378-0678-01	\$ 1.80

\*For both cabinet and rackmount instruments unless rackmount version is listed.

†Standard filter supplied with instrument.

*"HUMAN ENGINEERING"* — to enable maximum ease of use — is a major emphasis at Tektronix.



*INFUSION* of computer-aided design helps Tektronix engineers design in the features that fit your applications.

*THE KEY* to managing quality is a team effort beginning in the early steps of design and manufacturing.

# To set our standards for quality, we go to the ultimate judge . . . Our Customers.

## **Our Number One job is understanding your needs.**

To achieve the quality you need, we design in the qualities that fit your applications, your environment.

## **Performance. Reliability. Price.**

Our design engineers combine these qualities to equal one constant: unmatched value. The highest return for your investment.

## **Do we go to extremes to achieve reliability?**

Yes, we do. In our reliability and environmental labs, we life-cycle components and take prototypes and production models to the extremes of your environment.

Extremes in temperature and humidity. EM fields. Vibration. Bench drops. Salt fogs and sulfides.

We engineer for reliability at the initial stage of design using component derating, fewer parts and connectors, less power and lower operating temperatures.

To minimize your downtime risks, we track every warranty failure on every product right down to the component level. If reliability goals aren't met, changes are made. And not just to new products. Each time a product is calibrated by a Tektronix Service Technician, these modifications are made at no charge to products already in use.

We give you a solid specification of performance. Your Tektronix product will do what we say it will do.

## **Inside Tektronix, there's no substitute for materials that meet specifications.**

If incoming materials fall short of spec, the decision is easy. We don't use them.

To be that rigid in meeting specs, we work cooperatively with our suppliers to assure that their materials meet the same quality standards as our products.

## **We're tough on ourselves.**

Critical self-evaluation is often painful, but at Tektronix it's always deliberate. And deliberate steps to manage quality are what we take.

Team leadership. Training. If you have a problem, we have a problem. The loop isn't closed until you have a satisfactory answer.

## **At Tek, quality inspection is everybody's job, not just someone's job title.**

Our policy is to foster a spirit of pride among employees regarding the company's quality performance. Each person is responsible and accountable for the quality of their work, and the only acceptable performance standard is "doing it right the first time."

## **Quality service is our cornerstone of solid worldwide support.**

On any repair, our objective is an efficient "fix first time."

And, we will tailor Tektronix maintenance agreements to your response-time needs and budget.

*TEKTRONIX SERVICE TECHNICIANS are knowledgeable and skilled. They work exclusively on Tektronix products, with the best diagnostic equipment in the industry. And a parts inventory second to none.*



## **How do we know that quality is worth the effort?**

A simple handshake with you is our surest sign.

But we don't expect you to base your product selections on a lot of verbiage. Your applications have to be satisfied. You want a demonstration of performance. You want prices, a written agreement.

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Over 60,000 companies and organizations know the difference quality makes. Chances are you know Tektronix quality, too. And you know our commitment.

Sales Office Listing on pages 9-11  
Functional Index on pages 12-16  
Alphanumeric Index on pages 17-20

**Tektronix**<sup>®</sup>  
COMMITTED TO EXCELLENCE