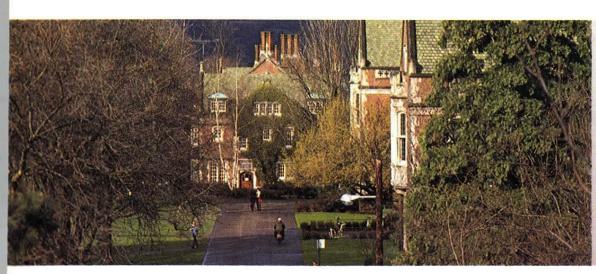


1978

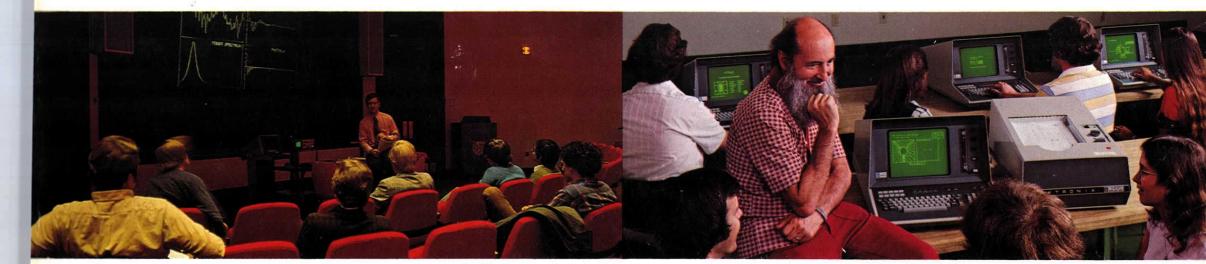




TM 500 compactness and versatility mean fast focus on the problem to be solved



Microprocessor Labs provide software and hardware development support for the design of microprocessor-based products



Computer graphics help provide special insight into abstract problems



The 851 Digital Tester can help cut soaring field service costs that sap profits

Cover photos courtesy of:

American Airlines, Inc. Ampex Corporation

Dartmouth College

NASA, Papago Indian Tribe, Indian Health Service, Lockheed Missiles and Space Co.

Reed College

University of California, Irvine

University of Oregon Graduate Center



The TM 500 mainframe/plug-in system has set a new standard for compactness, uniformity, portability, and utility of general-purpose instrumentation. TM 500 systems allow quicker exchange of instruments and make it feasible to use the same set of instrument plug-ins for rack, bench, or portable use. The idea of being able to mix and match almost 40 instruments without pulling plugs appeals to a lot of people. Especially where budget stretching is always a problem. Educators, for example, like being able to quickly rotate special-purpose and high-performance units from bench to bench or lab to lab, depending upon student needs. See pages 133 through 168.



Tektronix Microprocessor Labs represent a significant advance in the microprocessor-based product design field because they provide design teams with a single system to aid in everything from software development to software/hardware debugging and integration. A key feature is the support of major chips, including the Intel 8085A and 8080, Motorola 6800, Texas Instruments TMS9900, and Zilog Z80, with more to follow. That means flexibility, eliminating new equipment needs for changes in chip vendors. Equally important, you can count on Tektronix' worldwide service and customer-training programs. See pages 29 through 36.



Computer graphics is fast becoming a commonplace problem-solving tool in education, business, industry, and government. Besides being able to gain special insight into complex problems, users save time and money by being able to explore the effects of alternate solutions right on the screen. Typical applications range from the testing of design alternatives and modeling... to converting tangles of operational details to simple graphs and bar charts. Tektronix pioneered the development of high-quality, low-cost graphics with its proprietary storage crt technology. Today, we're the world's leading supplier of computer graphics products. See pages 13 and 14p.





Cutting service costs is the idea behind the new 851 Digital Tester. With this one portable tester, a first-line service engineer can make many of the same measurements that have required an oscilloscope, DMM, counter, timer, logic probe, thermometer, and special purpose test equipment. One knob allows you to dial 22 functions that perform a wide range of system measurements, signal analyses, and self tests. Being able to pinpoint the defective board or component the first time around should enable service organizations to reduce spare parts inventories, and increase company profits. See pages 129 through 132.

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NEW PRODUCTS SUMMARY

A brief discussion of new products introduced during the past year.

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REFERENCE INFORMATION

An overview of some of the important factors involved in selecting products to meet your needs. Includes charts.

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INFORMATION DISPLAY GROUP PRODUCTS

A look at our family of computer graphics products. Featured are the new 4020 Series of computer display terminals. Also highlighted are our popular 4006-1 low-cost graphics terminal, 4051 Graphic System and 4014-1 19-inch graphics terminal.

3

INSTRUMENTS FOR DIGITAL AND MICROPROCESSOR DEVELOPMENT

Logic Analyzers to speed your digital design, development and service include the versatile 7000-Series compatible 7D01 as well as the portable LA 501W which is compatible with the TM 500. Companion plug-ins to the 7D01 include the DF1 and DF2 Display Formatters (which allow you numerous ways to look at logic) and the DL2 and DL 502 Digital Latches which extend the measurement capabilities of the 7D01 by detecting narrow pulses in a data stream. The versatile DL 502 may be used with the LA 501W as well as the 7D01.

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7000-SERIES PLUG-IN OSCILLOSCOPES

4a

7000-SERIES NON-STORAGE MAINFRAMES

Conventional, dual-beam, and ruggedized.

4b

7000-SERIES STORAGE MAINFRAMES

Choice of multimode, variable persistence, or bistable storage.

4c

7000-SERIES PLUG-INS

Real-time, sampling, and digital measurement.

E

5000-SERIES PLUG-IN OSCILLOSCOPES

Versatile, low cost, easy-to-operate oscilloscope family with your choice of 2 MHz or 60 MHz mainframe, conventional or storage displays, and 23 diverse plug-ins.

6

PORTABLE OSCILLOSCOPES

22 models to choose from including: the labquality 400-Series Portables with bandwidths to 350 MHz, the lightweight SONY/ TEKTRONIX 300-Series, the battery-powered 200-Series Miniscopes, and the low-cost T900-Series Oscilloscopes. Designed for service, research, education, and production testing applications.

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The 851 Digital Tester is a first-line, multifunctional service instrument developed to meet the needs of the digital service industry.

8

TM 500 133 A complete family of test and measurement instruments.

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These TDR cable testers provide maintenance people with fast, accurate, portable tools for checking the internal condition of cables and locating faults.

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Compact, reliable physiological monitors. Portable and versatile for bedside, transport, intensive care, operating room or nursery. Options include hard copy and multiple digital readout.

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For both OEM and end-users, we offer a wide range of display monitors for direct viewing or photography; bistable or variable persistence storage; and X-Y, raster scan (video), random dot scan or vector displays. U.L. 544 Listing and Component Recognition is available on most instruments.

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OUR NEWEST PRODUCTS

INFORMATION DISPLAY PRODUCTS4020-Series Computer Display Terminal



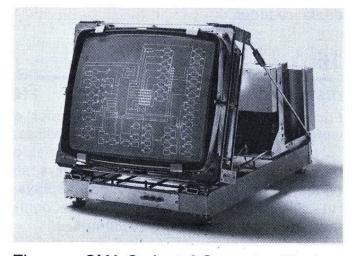
From alphanumerics to graphics. Now your terminals can keep pace with your needs. The 4020-Series makes easy-to-use graphics available to the alphanumeric user. With full alphanumerics capability, the 4020-Series can grow into forms ruling, then into graphics, all without one capability compromising the other.

4907 File Manager



The new 4907 File Manager is a flexible disc, mass storage device, designed to give the 4051 Graphic System random access file management capability. Available in single (shown above), double and triple disc drive configurations, the 4907 provides up to 1.89 megabytes of user available storage.

GMA Series Displays



The new GMA Series of Computer Displays are designed specifically for inclusion in computer data processing systems. This series of displays can show selected portions of on-screen graphics or alphanumerics in refresh mode, while the rest of the picture remains stored.

This merger of our storage tube technology with refresh functions enables high user interactivity without the relative high-cost core consumption and screen flicker normally associated with refresh display systems.

INSTRUMENTS FOR DIGITAL MICROPROCESSOR DEVELOPMENT



DL2 and DL 502 Digital Latches

The DL2 and DL 502 Digital Latches extend the measurement capabilities of the 7D01 and LA 501W Logic Analyzers 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 as 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 DL2 and DL 502 Digital Latches allow you to expand the time frame in which information can be stored by sampling at a slower rate. The Digital Latches capture the glitch (pulses which are narrower than one sample interval), hold it until the next clock edge, then expand it to one sample interval for display.

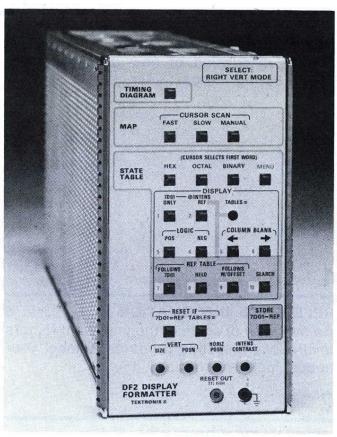
The DL2 is used in conjunction with the 7D01 Logic Analyzer and plugs into any compartment of a 7000-Series Mainframe. The flexibility of the DL 502 allows it to be used in a variety of configurations. It can be used with the LA 501W in all TM 500 Mainframes or as a companion to the 7D01 Logic Analyzer. Two 25-pin connectors connect the Digital Latches with their respective TEKTRONIX Logic Analyzers. Data is acquired via the P6451 Probes which plug into the Digital Latch front panel.

A two position switch allows you to select either the LATCH input mode or OFF. An asynchronous clock input is required from the Logic Analyzer to the Digital Latch.

DF2 Display Formatter

The DF2 is a companion plug-in to the 7D01 Logic Analyzer. It contains all the features of the DF1 with the addition of two new operating modes. These two new modes are a format for IEEE 488/GPIB (General Purpose Interface Bus) and ASCII (American Standard Code for Information Interchange).

In the GPIB mode, data is displayed in standard IEEE 488 message mnemonics familiar to the GPIB user. Data is acquired via a 24-pin standard GPIB connector. The states of the four GPIB management lines (ATN, EOI, SRQ and REN) are displayed in GPIB mnemonics and eight data lines are displayed



DF2 Display Formatter

in hexadecimal or decimal. Four additional lines of data are user definable to provide circuit information and are displayed in binary. This display enables you to monitor and display activity on the GPIB data bus, transfer bus (handshake lines) and management bus (control lines). The DF2 is useful in designing new GPIB compatible instruments as well as in mixing and matching different vendor equipment on the same bus.

In the ASCII mode, acquired data can be displayed in all 128 standard ASCII characters. Further decode of ASCII characters in octal, hexadecimal or binary can be displayed at the same time.

The versatility of the DF2 permits its use in a variety of applications. Through monitoring bus activity, the DF2 can be used in the design and debug of GPIB controls and "talker-listener" designs. The DF2 is also a powerful tool for troubleshooting systems. It allows the technician to observe bus activity in either a timing or state mode easing his task of solving system problems and keeping downtime to a minimum.

Other features offered by the DF2 include EXCLUSIVE OR and automatic data comparison. The EXCLUSIVE OR feature compares newly-acquired 7D01 data with reference data stored in the DF2 and intensifies the differences between the two tables on the crt. The two automatic data comparison features combine the EXCLUSIVE OR feature with an automatic RESET IF=feature and compare the entire 7D01 memory to the DF2 reference memory. Detected differences are intensified on the 7D01 display and the location and number of resets required to detect a difference are displayed on the crt.

The DF2 is a dedicated plug-in that attaches to the left side of the 7D01 forming a three-wide plug-in. This assembly operates in any 7000-Series Oscilloscope Mainframe to comprise a complete 16-channel logic timing-state analyzer system.

T900-SERIES OSCILLOSCOPES



T932A and T935A

The T932A and T935A are the two newest members of the T900 family. With these models we've added differential and full sensitivity X-Y capabilities, dc trigger coupling, a composite trigger, and selectable chop/alternate display modes to the Tektronix line of low-cost portable oscilloscopes.

The T932A offers a 35-MHz bandwidth at 2 mV/div with variable trigger holdoff. The T935A, identical in all these aspects to the T932A, also has delayed-sweep capabilities. See page 124.

DIGITAL SERVICE INSTRUMENTS



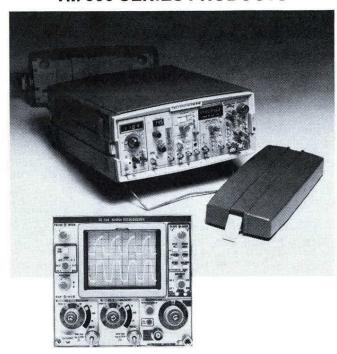
851 Digital Tester

The 851 Digital Tester simplifies digital servicing procedures by combining many of the functions of an oscilloscope, DMM, counter, timer, logic probe, thermometer and special purpose test equipment into one 13-pound package.

With the turn of one knob, you can dial 22 functions to perform a wide range of system measurements, signal analyses, and self tests. All the functions are completely autoranging and the indicator lights tell you exactly what range is being used. The interpretation is done for you. So a first-line service engineer can solve more problems, in less time, on the first call with the 851 Digital Tester.

See page 129 for further information.

TM 500 SERIES PRODUCTS



DC 508 1 GHz Frequency Counter

The new DC 508 expands the TM 500 family of counters to measurement capabilities up to 1 GHz. The DC 508 operates in any TM 500 Series Mainframe and is compatible with all existing TM 500 instruments.

A nine-digit LED display shows frequency or totalized events from 0 to 999,999,999. The prescaler input allows the DC 508 to measure frequency from 75 MHz to 1 GHz, and the direct input from 10 Hz to 100 MHz. An audio frequency resolution multiplier multiplies the resolution by 100 to 25 kHz. This allows resolution to .01 Hz in 1 second.

Option 01 includes a high-stability time base, and Option 07 also includes an interface for the TR 502 Tracking Generator/Spectrum Analyzer.

See page 138 for further information.

SC 504 80 MHz Oscilloscope

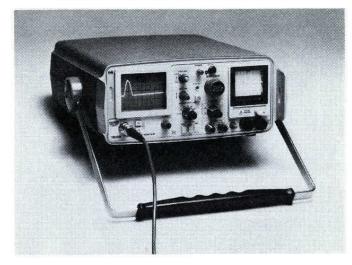
The SC 504 80 MHz Oscilloscope makes many new TM 500 configurations possible, especially for those applications demanding higher bandwidth capabilities. The doublewide SC 504 is compatible with all existing TM 500 Plug-ins and multi-compartment Mainframes.

The SC 504 is a general purpose, dual-trace, non-delayed sweep oscilloscope. The SC 504 features high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). Enhanced auto triggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use.

The SC 504 also 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).

See page 159 for further information.

CABLE TESTER PRODUCTS



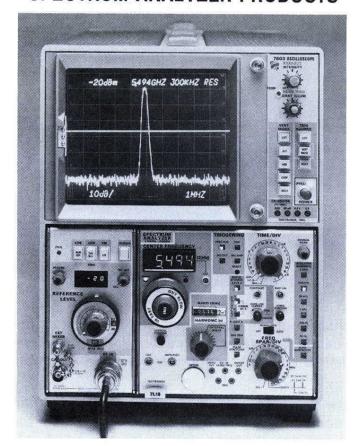
1503 Option 01 Cable Tester

This newest 1500 Series TDR Cable Tester has controls especially suited to fault location in a variety of cables. Other changes allow easier operation by craft level peop!e.

The 1503 Option 01 is used for testing twisted-pair cables in telephone and other communications applications, and can be used for locating faults in ground-check conductors in portable cables used to power surface mine equipment.

For more information see page 170.

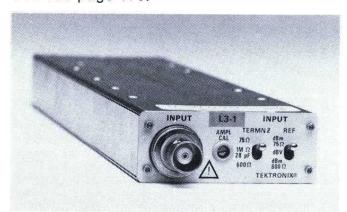
SPECTRUM ANALYZER PRODUCTS



7L18 1.5 GHz to 60 GHz Spectrum Analyzer

The 7L18 Spectrum Analyzer covers frequencies for satellite communications, ECM, radar, and microwave relay. It offers full calibration, freedom from spurious responses, and operator ease. With 30 Hz resolution to 12 GHz, it has microprocessor-aided front panel controls, and digital display and signal processing.

This new member of the high-performance plug-in spectrum analyzer family fits any 7000-Series Mainframe. For further information see page 176.



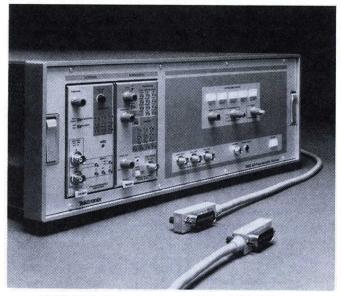
L3-1 Plug-in Module for 7L5 Spectrum Analyzer

The new L3-1 plug-in module features a selectable 75 Ω input impedance, 600 Ω , or 1 M Ω /28 pF probe-compatible input.

It is one of a series of modules used with the 7L5 to provide it with various front-end capabilities.

For further information see page 182.

SIGNAL PROCESSING SYSTEMS



7912AD Programmable Digitizer

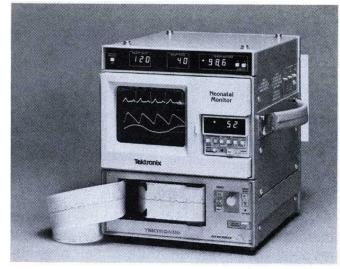
The new TEKTRONIX 7912AD Programmable Digitizer brings full programmability of operating parameters to the world's fastest waveform digitizer. This means that the 7912AD can be operated automatically and remotely.

Operation of the 7912AD is similar to that of an oscilloscope except that acquired waveforms are normally output as digital information for waveform processing rather than being presented as crt displays. A crt monitor can be added, however, if waveform display is desired.

To complete the 7912AD, the 7A16P Programmable Amplifier and the 7B90P Programmable Time Base are announced simultaneously. Other TEKTRONIX 7000-Series Plug-ins can be used in the 7912AD, but their operation is not programmable.

A built-in microprocessor makes it possible to direct the setting of scale factors and most other controls from a remote terminal or software program. The 7912AD is fully compatible with the IEEE 488 bus so that control can be exercised by a wide range of programmable calculators, microcomputers, and minicomputers. Greatest measurement potential is realized, however, when the 7912AD is used in conjunction with a TEKTRONIX CP4165 Instrument Controller programmed in TEK SPS BASIC.

MEDICAL MONITOR PRODUCTS



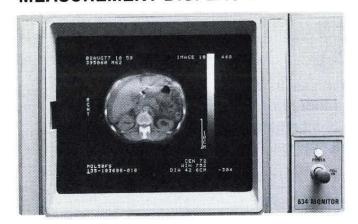
Additional Recorder and Readouts for Patient Monitors

Model 400, Option 04 is a new addition to the 400 Series recorders for TEKTRONIX Patient Monitors. Designed for 413 Series Monitors, the Option 04 provides thermal printout copies of ECG, blood pressure, peripheral pulse, or respiration waveform. The recorder also provides alphanumeric record of elapsed time, heart rate, temperatures A and B, systolic/diastolic and mean blood pressures, and respiration rate.

A new Digital Readout Module adds three dedicated LED readouts to TEKTRONIX 413 and 414 Series Monitors. Information displayed includes ECG, temperature and respiration or blood pressure depending on which monitor is used. Modules weigh only 21/4 lbs, are 13/6 in high, and are powered from the monitor.

Both recorder and Digital Readout Module can be ordered with monitors or added to monitors already in use. (See page 213.)

MEASUREMENT DISPLAY PRODUCTS

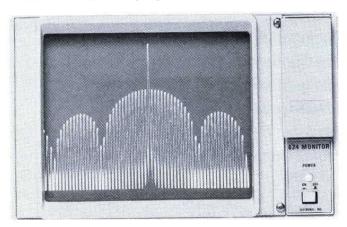


634 Raster Scan Display Monitor

The TEKTRONIX 634 is a very high resolution, low geometric distortion raster scan monitor, designed for high quality applications and superior performance. It offers: 1400-line nominal resolution—center screen at 100 cd/m² (30 fL); non-linearity \leq .5% within a 9 cm circle— \leq 1% at corners; \leq 20% phosphor non-uniformity; minimal corner defocus (\leq 25% with Option 18). In addition, there's modular construction for ease of installation, and U.L. 544 listing and component recognition.

System manufacturers requiring less than 1400-line resolution will want the TEKTRONIX 634 Option 01. It offers standard resolution of 800 lines nominal—center screen at 100 cd/m² (30 fL), while meeting other 634 specifications—including those for geometric distortion and phosphor uniformity.

OEM pricing is available for qualified original equipment manufacturers. For further information, see page 217.



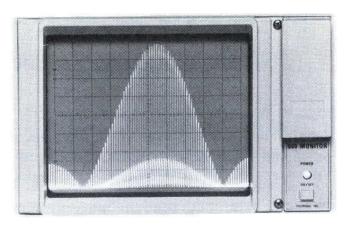
624 Display Monitor

The TEKTRONIX 624 combines large screen size $(9.8 \times 12.2 \text{ cm})$, brightness of 137.05 cd/m² (40 fL) ¹ and small spot size (12 mils). The result: sharply detailed displays for both high ambient light viewing as well as photography.

A broad selection of options, including U.L. 544 listing and component recognition, lets you adjust both capability and pricing to meet your system's needs and to make your product more cost-effective.

OEM pricing is available for qualified original equipment manufacturers. For further information, see page 218.

1. Measured with quality area flooded by a 60 Hz raster, 320 horizontal lines.



608 High Brightness Monitor

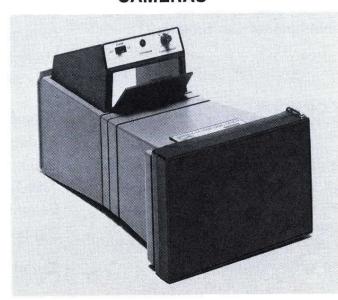
The 608 Display Monitor delivers a lot more than high brightness. It delivers more usable brightness—up to 239.84 cd/m² (70 footlamberts)—plus improved image contrast and enhanced detail in shadow areas. A special crt design suppresses the diffuse expansion mesh halo usually present in high intensity displays; the result is a more uniformly readable display that provides those subtle nuances of gray scale vital to accurate interpretation.

Ease of interpretation is also aided by large screen size (10x12 cm). Displays are viewed easily, even in high ambient light. Resultant photographs are sharp. And the TEKTRONIX 608 accurately displays fast signals at varying intensity levels.

A full range of options are provided for broad flexibility in both pricing and capability, including U.L. 544 listing and component recognition. And you can select from several phosphors—for high ambient light viewing, longer persistence, photography—depending on your requirements.

OEM pricing is available for qualified original equipment manufacturers. For further information, see page 219.

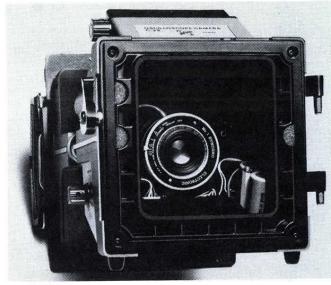
CAMERAS



C-5B Camera

The C-5B is an updated version of our popular C-5A low-cost camera. The C-5B now features an electric shutter with continuously variable speeds from .1 to 5 seconds and a three-element lens for improved focus.

The C-5B in its various mounting options is available for 7000, 5000, 400 and T900-Series Oscilloscopes. OEM prices are available for qualified original equipment manufacturers. See page 234.

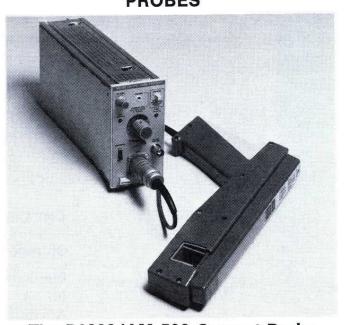


The High Performance C-28 Camera

The C-28 features changeable magnification (1:0.67 to 1:0.85), remotely controllable electric shutter, and rigid body design that eliminates trapezoidal distortion. F-stops from f/2.8 to f/16, and 8 shutter speeds (from 1/50 to 2 seconds, plus "bulb" and "open") handle a broad variety of exposure variables. Comes with a combination Graflok/Polaroid film back for 3¼" x 4¼" Polaroid film or the user's choice of Graflok-compatible accessories such as 70 or 90 mm roll film backs. Three optional fixed object-to-image ratio lens mounts are also available. U.L. component recognized.

The C-28 is especially suitable for 600 Series Display Monitors. OEM pricing is available for qualified original equipment manufacturers. For further information see page 233.

PROBES



The P6303/AM 503 Current Probe

The P6303 is the newest current probe designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope (with a bandwidth of at least 50 MHz to display the full bandpass of the probe).

The P6303 measures ac and dc currents to 100A and peak pulse currents to 500A in the frequency range of dc to 15 MHz. With its large 1 inch by 0.83 inch (2.5 x 2.1 cm) jaw opening, the P6303 can easily check currents in X-ray tubes, SCR motor controls, power supplies, and relays. The P6303 uses inductive coupling and thus requires no electrical contact or breaking of the circuit. See page 241.

Reference Information

USING THIS REFERENCE SECTION

The products in this catalog cover a range of capabilities in a number of areas. In many cases you'll have several products from which to choose. These introductory notes are intended to help you review some of the factors involved in making a selection.

Of course this reference section can only outline some of the major factors involved. If you need more information, contact your local Tektronix Field Office, Representative, or Distributor — we're ready and willing to help.

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istics of various techniques are presented. Accompanied by a chart of TEKTRONIX	Digital Time Displays				
products using crt storage.	Sampling				

CONFIGURATION

TWO BASIC APPROACHES

There are two basic configurations for test and measurement instruments. Modular instruments, more often called plug-in or laboratory models when referring to oscilloscopes, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments, such as monolithic oscilloscopes, are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all monolithic instruments meet all the objectives of portability. On the other hand, some modular systems, such as the TEKTRONIX TM 500 Modular Test and Measurement Line, are designed for easy transport right into the field—See the reference section on portability for more details.

Modular Design

Versatility is the primary advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit can be made available in separate plug-ins. You the user, can then choose the ones that serve you best.

Because a modular instrument is so versatile, it can also make use of advances in instrument design. New plug-ins or mainframes can be added that, within the basic limitations of the other units, add new functions or higher performance.

Modularity also allows plug-ins and mainframes to be shared between various uses. For example, with the TM 500 Line, the same general test and measurement plug-ins used in the lab for design work can be quickly inserted into a portable mainframe and easily carried to a service problem. Alternately, where demand warrants it, the identical model plug-ins can be supplied to both field service and laboratory personnel, assuring the repeatability of measurements and minimizing training time.

Plug-ins can also extend the original instrument range to other 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 oscilloscopes.

Oscilloscopes

There are two lines of TEKTRONIX modular oscilloscopes to choose from. The TEKTRONIX 5000 Series uses two amplifier plugins plus one time base. The TEKTRONIX 7000 Series, which offers higher performance in a number of areas, can accept up to two vertical-channel plug-ins and two time bases or other horizontal units simultaneously. In-depth coverage begins on page 37.

MODULAR NON-STORAGE OSCILLOSCOPES

Model Number	Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Maximum Sweep Rate	Delayed Sweep	Page	Price*
7904 R7903	500 MHz†	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	×	46	\$5250 4750
7844	400 MHz†	20 mV/div at BW 10 μ V/div 1 mA/div	up to 4 Dual-Beam	1 ns/div	Х	48	7650
7704A Opt 09	250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	х	50	+200
7704A	200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	х	50	3325
7603	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	х	52	2050
5440	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	5 ns/div	X	85	1550
5112	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 Dual-Beam	100 ns/div	Х	90	1300
5110	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns/div	х	90	775
7603N11S	Ruggedized oscilloscope system [meets or exceeds MIL-0-24311 (EC) (AN/USM 281 Specs)]		up to 2	5 ns/div	х	54	3875

^{*}Price does not include plug-ins.

Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

Test and Measurement Instruments

In the general test and measurement field the TEKTRONIX TM 500 Test and Measurement Line is our modular system. One, three, four, five, and six-compartment mainframes accept a broad selection of plug-in units. The mainframe unit provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as importantly, TM 500 Mainframes also provide a signal control and data interface between modules. This allows TM 500 units to work either individually or together as integrated measuring systems. The TEKTRONIX TM 500 Modular Test and Measurement Line is extensive: more than 30 units, including power supplies, signal sources, oscilloscope modules, a logic analyzer, digital multimeters, counter/timers, 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. In-depth coverage begins on page 133.

Other Modular Devices

Logic Analyzers	page 15
Digital Processing Oscilloscopes	page 193
Waveform Digitizing Instruments	page 193
Spectrum Analyzers	page 175
Curve Tracers	page 201

Integrated and Monolithic Devices

Taking the other design approach to instrument design, integrated instrument are optimized for a single range of functions. Onepiece instrument design provides reduction in weight, increased ease of use, smaller size, and usually lower power requirements when a definite function is required.

Many oscilloscopes of this type are particularly designed for portable use, with rugged cases, environmental protection, and internal or external battery power. In-depth coverage begins on page 97.

Tektronix also offers many other one-piece products designed to be used alone or as elements of larger systems. Each performs its specialized task economically yet fully because it is designed for a specific type of use:

Graphic Terminals page 13
Tv Products page 173
Display Monitors page 215

To sum up, modular instruments feature versatility, opportunities for tailor-made selection of functions, and a wide range of measurement capability. Integrated designs are strongest in economy for single functions, ruggedness, and portability.

^{†1} GHz with 7A21N direct-access plug-in.

^{**}Bandwidths are real time.

Reference Information

PORTABILITY

Any instrument not actually permanently bolted down is in some sense portable, but in most cases by "portable" we mean something more.

Portable Oscilloscopes

For oscilloscopes, a combination of factors must be considered. Small size and light weight are obviously important, but the degree depends on the application and the uses. Similarly, ruggedized cases or dust covers may be required. The TEKTRONIX 200-Series Oscilloscopes, for example, are less than 8 x 14 x 23 cm (3 x 6 x 9 in), weigh less than 2 kg (3½ lb) and are specifically designed and packaged for field use. The 300-Series all weigh less than 5 kg (11 lb). The high-performance TEKTRONIX 400-Series models, 10.5 to 11.8 kg (21 to 26 lb), are still very much designed to be portables, too.

For many applications, internal battery power is often essential. On the other hand, the weight of internal batteries can be a disadvantage if they are rarely needed. In some applications power is always available, since it must be provided to the equipment being tested. TEKTRONIX Portable Oscilloscopes cover the full range of power options. The 200-Series has internal batteries. Two 300-Series models have internal batteries and two are line operated. High performance portables, like the TEKTRONIX 400-Series, are line operated. However external battery packs are available as accessories for both the 300-Series and the 400-Series

Portable Test and Measurement Instruments

Many of these same factors apply to other instruments besides oscilloscopes. The TM 500 Modular Test and Measurement Line, for example, has several configurations designed for portability. The TM 515 Traveller Mainframe travels like luggage but works like a lab bench set-up. Although it is attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat in most airplanes), the TM 515 is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. Again, relatively light weight, rugged construction, and convenient size are the key to portability.

Plug-ins include: pulse generators, function generators, other signal generators, amplifiers and filters, oscilloscopes and monitors, lab power supplies, digital counter/timers, digital multimeters, logic analyzers, special plug-ins, and custom plug-ins.

All of the more than 30 TM 500 plug-ins are portable when used with portable TM 500 Mainframes: TM 515 5-compartment Traveller Mainframe, TM 503 3-compartment Mainframe with carrying case or protective cover, TM 504 4-compartment Mainframe with carrying case or protective cover.

In-depth coverage of TM 500 products begins on page 133.

PORTABLE NON-STORAGE OSCILLOSCOPES

Model Number	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	100	\$5225
475A	250 MHz	5 mV/div at BW	X	1 ns/div	X	102	3555
475	200 MHz	2 mV/div at BW	X	1 ns/div	X	102	3195
465	100 MHz	5 mV/div at BW	X	5 ns/div	X	102	2295
465M	100 MHz	5 mV/div at BW	X	5 ns/div	X	104	2345
455	50 MHz	5 mV/div at BW	X	5 ns/div	X	106	1850
335	35 MHz	10 mV/div at BW 1 mV/div	Х	20 ns/div	Х	112	1925
326	10 MHz	10 mV/div at BW 1 mV/div	Х	100 ns/div		114	2180
221	5 MHz	5 mV/div at BW	Х	100 ns/div		117	1025
323	4 MHz	10 mV/div at BW 1 mV/div	Х	500 ns/div		115	1445
213	1 MHz	20 mV/div at BW 5 mV/div		400 ns/div		118	1520
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		120	1080
T935A	35 MHz	2 mV/div at BW	Х	10 ns/div	Х	124	1435
T932A	35 MHz	2 mV/div at BW	Х	10 ns/div		124	1155
T922	15 MHz	2 mV/div at BW	X	20 ns/div		123	850
T921	15 MHz	2 mV/div at BW		20 ns/div		122	695

Our Other Portables

Still other TEKTRONIX portable instruments meet special requirements far above simple movability. The 1502 and 1503 TDR-Cable Testers, for example, are designed to work outdoors in any weather, including pouring rain.

TEKTRONIX Portable Patient Monitors provide hours of battery-powered operation so they can keep on providing data on vital functions not only during surgery but right through patient transport.

For movement within limited area, TEK-TRONIX SCOPE-MOBILE® Carts and Lab Carts are available in several configurations. A typical setup might include a 400-Series Oscilloscope on the top shelf with two TM 503 Mainframes underneath. These carts are particularly useful for in-plant servicing, school and research laboratories, and similar applications.

For more information, see the following pages:

Logic Analyzer	page 15
Cable Testers	page 170
Spectrum Analyzers	page 175
Portable Patient Monitors	page 213
SCOPE-MOBILE® Carts	page 256

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 physicial deterioration. 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 longterm 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.

POWER SOURCE CONSIDERATIONS

In general, instruments are factory wired for the nominal voltage of the country of manufacture. 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.

Most TEKTRONIX instruments are designed for operation from a power source with its neutral at or near ground (earth) potential. They are not intended for operation from two phases of a multiphase system or across the legs of a single-phase three-wire system (220 V).

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

STORAGE

Storage crts continue to display a waveform after the input signal ceases. The period of image retention runs from a few seconds to several hours depending on several factors mentioned below. The stored display may be erased to make way for storage of a later waveform. Storage tubes may also be operated as conventional (nonstorage) tubes. Storage oscilloscopes allow easy, accurate evaluations of slowly changing phenomena that would appear only as slow moving dots. They are also needed for viewing rapidly changing nonrepetitive waveforms whose images would otherwise flash across the crt too quickly to be evaluated. Storage can reduce the time to photograph scope traces by allowing you to "compose" the picture. Unwanted displays can be erased as many times as necessary before the photograph is taken.

Storage crts are used in other TEKTRONIX products, too. For terminals, crt storage provides an economical means of retaining graphic and alphanumeric display without requiring refresh circuitry. Curve tracers with a storage crt show a wider range of waveforms. And monitors with storage find a wide variety of applications.

TYPES OF STORAGE

TEKTRONIX products use three types of storage crts — the TEKTRONIX proprietary bistable phosphor storage tube, a variable persistence tube (sometimes called halftone storage), and a fast transfer tube. The last device can also provide operating modes similar to the simpler bistable and variable persistence types.

Although storage writing speeds are not quite as fast as conventional crt speeds yet, they are catching up: recent developments in transmission storage tubes at Tektronix have resulted in a fast stored writing speed of 2500 cm/ μ s.

BISTABLE

The bistable-phosphor crt utilizes a special phosphor with two stable states: written and unwritten.

The storage mode allows waveforms to be stored and displayed a minimum of several hours (in some cases much longer) or until erased by operator.

Bistable storage is often the easiest kind of storage to use. It is also usually the most inexpensive. Some principal applications include mechanical measurements, signal comparisons, and data recording. Most bistable phosphor crts have a split-screen viewing area which allows each half to be used independently for storage displays. The split-screen feature provides many unique advantages. With this system, a reference waveform can be stored on one half of the screen and the other half can be used to store the effect that calibration adjustments or the insertion of filters, etc, have on circuit operation. If desired, this technique can be used where the reference portion operates in the stored mode and the other half of the display, operating in the nonstored mode, monitors an external input.

CRT STORAGE OSCILLOSCOPES (in order of Stored Writing Rate)

			(in oi	der of Sto	ored Writing Rate)				
Model Number	Stored Writing Speed	View Time	Type of Storage	Band- width**	Minimum Deflection Factor	Number of Trace Operations	Delayed Sweep	Plug-in	Page	Price
7834	5500 div/μs	30 s ††	Fast Variable Persistence	400 MHz	20 mV/div at BW 10 mV/div at 325 MHz	up to 4	Х	Х	56	\$7100
	776 div/μs	30 min minimum	Fast Bistable							
	12 div/μs	30 s ††	Variable Persistence							
	0.2 div/μs	30 min minimum	Bistable							
466	3000 div/μs	15 s ††	Fast variable persistence	100 MHz	5 mV/div at BW	up to 2	Х		108	4895
	3 div/μs	15 s ††	Variable persistence							
7633	2200 div/μs	30 s ††	Fast variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	Х	X	58	5200
	400 div/μs	30 min minimum	Fast bistable							
	3 div/μs	30 s ††	Variable persistence							
	2 div/μs	30 min minimum	Bistable							
7623A	150 div/μs	30 s ††	Fast variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	х	X	58	3975
	50 div/μs	30 min minimum	Fast bistable							
	0.5 div/μs	30 s ††	Variable persistence							
	0.03 div/μs	30 min minimum	Bistable							
464	110 div/μs 0.5 div/μs	15 s †† 15 s ††	Fast variable persistence	100 MHz	5 mV/div at BW	up to 2	Х		108	4120
7613	5 div/μs	1 hr	Variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	Х	60	3150
5441	5 div/μs	1 hr	Variable persistence	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	Х	86	2650
7313	5 div/μs	30 min minimum	Bistable split screen	25 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	Х	61	3125
434	5 div/μs	4 hrs	Bistable split screen	25 MHz	10 mV/div at BW 1 mV/div	up to 2			110	3245
5115	0.8 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	х	Х	90	1475
5113	0.2 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 dual-beam	х	Х	90	1925
5111	0.02 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	Х	Х	90	1400
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW 1 mV/div	up to 2			120	1520
314	0.25 div/μs	4 hrs	Bistable	10 MHz	2 mV/div at BW	up to 2			116	2385

**Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.
††View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.

An example of the usefulness of the splitscreen feature is in speech therapy. The normal speech pattern is recorded on the upper half of the storage screen and the patient's attempts to match this pattern are recorded on the lower half. With split-screen operation, the lower half showing the trial waveform can be erased as many times as desired without affecting the stored information on the upper screen.

VARIABLE PERSISTENCE

Variable persistence storage allows a continuous gradation between the bright written level and the dark reference.

The variable persistence mode also allows for the selection of the time a stored image will be retained. The storage persistence can be adjusted so the entire waveform can be viewed, yet the stored trace fades from view just as the new waveform is being plotted. With the save feature, an entire display can be stored for further analysis if desired.

Applications for variable persistence stor-

age include real time, spectrum analysis, time-domain reflectometry, sampling, and other measurements which require slow sweep displays. For fast repetitive sweeps, the storage persistence can be set so multiple traces are displayed before the first trace fades from view. Then you can view changes in signal response with changes in circuit conditions, time, or adjustments. This method can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Any aberration or jitter not common to all repetitive traces will not be stored or displayed. Low-repetition rate, fast-rise-time signals that are not discernible on conventional crts can be easily viewed.

This type of storage provides the best display when storing displays with varying intensities, such as delayed sweep or with Z-axis intensity modulation. Variable persistence storage provides very good displays for photographs due to the high contrast between dark background and bright waveforms.

(Continued on following page)

Reference Information

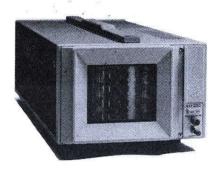
FAST TRANSFER

Fast transfer storage uses a tube with a special intermediate mesh target. This target, which is optimized for speed, captures the waveform and then transfers it to a slower, longer-storing electrode. The second target can be designed to offer bistable or variable persistence modes, in combination with the transfer mesh or by itself.

Several TEKTRONIX Oscilloscopes use this combination of capability to provide unique multimode storage. By front-panel controls, users of these instruments can select the operating mode suited to the specific measurement situation.

DIGITAL STORAGE

Although not directly comparable in some respects, digital storage is also a useful technology for waveform retention. More information is given in the sections on digital oscilloscopes, logic analyzers, and signal processing systems products.



DISPLAY MONITORS Image Characteristics

Elements that may be important to you in obtaining the best image from a display monitor include the brightness of the image, the resolution or spot diameter, the size of the image, and the phosphor type used and its characteristics.

Brightness depends on the type of crt used, the phosphor, and the accelerating voltage. In general, higher brightnesses can only be obtained at the cost of lower resolution or slower writing speed. On some monitors, a separate intensity or Z-axis input is available to modulate the brightness of the beam. Resolution is specified either by spot size or by number of line pairs in a given distance. Smaller spot sizes or greater numbers of line pairs in general mean a more detailed image can be displayed.

Screen size and the size of the graticule on conventional monitors is normally comparable to that offered on laboratory oscilloscopes (up to 8 by 10 cm). Tektronix also offers special storage monitors with 11 inch diagonal crts. These are described in the section beginning on page 13. Phosphor characteristics can be selected to optimize viewing or photography, and to match desired image decay rates. See the phosphor chart and following information.

Storage

Storage is an essential feature on monitors when the information to be presented is transitory or the image to be built up is too complex for the source to communicate all at one time. Tektronix offers both bistable storage monitors and variable persistence models. See the storage section (on page 11) for more details on the advantage of each type of storage.

Vertical and Horizontal Amplifiers

The amplifiers in display monitors must faithfully translate the input signal to a deflection on the crt screen. Two important characteristics are the bandwidth of the amplifier and the linearity, each of which contributes to how faithfully the signal will be reproduced on the screen. The phase difference and the common-mode rejection ratio determine how closely two signals can be graphed against one another and how well they can be extracted from extraneous background noise. See the general characteristics section (on page 11) for further details.

CATHODE-RAY TUBE PHOSPHOR DATA

HUMAN EYE RESPONSE

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wavelength from deep red to violet. The human eye is most sensitive to the yellow-green region; however, its responsiveness diminishes on either side in the orange-yellow area and the blueviolet region. The eye is not very receptive to deep blue or red.

If the quantity of light falling on the eye is doubled, the brightness "seen" by the eye does **not** double. The brightness of a color tone as seen is approximately proportional to the log of energy of the stimulus.

The term luminance is the photometric equivalent of brightness. It is based on measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye. The SI (international metric standard) units for luminance are candelas per meter squared, but the English footlamberts are still used extensively in the U.S. One footlambert = 0.2919 candelas/ m^2 . The term luminance implies that data has been measured or corrected to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de L'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful only when the phosphor is being viewed.

PHOSPHOR PROTECTION

When a phosphor is excited by an electron beam with an excessively high current density, a permanent loss of phosphor efficiency may occur. The light output of the damaged phosphor will be reduced, and in extreme cases complete destruction of the phosphor

PHOSPHOR DATA CHART

Phosphor	Fluorescence	Phosphorescence Where Different from Fluorescence	Relative Luminance ¹	Relative Photographic Writing Speed ²	Decay to 10%	Decay to	Decay to 0.1% (in ms)	Relative Burn Resistance	Comments	Ordering Information Option
P1	Yellowish-green	-	50%	20%	24 ms	48 ms	95	Medium	Replaced by P31 in most applications	Special order
P2	Bluish-green	Yellowish-green	55%	40%	75 μs	_	1203	Medium high	Good compromise for high- and low-speed applications. Replaced by P31 in most applications	Special order
P4	White	_	50%	40%	60 μs	470 μs	20	Medium high	Television displays	74
P7	Blue	Yellowish-green	35%	75%	0.3 s	3 s	8 sec	Medium	Long decay, double- layer screen	76
P11	Purplish-blue	-	15%	100%	80 μs	-	20	Medium	For photographic applications	78
P31	Yellowish-green	-	100%	50%	38 μs	250 μs	32	High	General purposes, brightest available phosphor	80

¹Measured with TEKTRONIX J16 photometer and J6523 luminance probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.

²P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

³Low level lasts over one minute under conditions of low ambient illumination.

may result. Darkening or burning occurs when the heat developed by electron bombardment cannot be dissipated rapidly enough by the phosphor.

The two most important and controllable factors affecting the occurrence of burning are **beam-current density** (controllable with the Intensity, Focus, and Astigmatism controls) and the length of **time** the beam excites a given section of the phosphor (controllable with the Time/Div control). Of the total energy from the beam, 90% is converted to heat and 10% to light. A phosphor must radiate the light and dissipate the heat, or like any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping the intensity down or the time short will save the screen.

SELECTING A PHOSPHOR

The catalog description of each oscilloscope indicates the phosphor normally supplied or offered as an option. Special phosphors are available for applications which require different characteristics. For example, P11 is excellent for waveform photography but due to its short persistence it is not well suited for applications requiring visual observation of low-speed phenomena. For more specific information regarding the best-suited phosphor for your particular applications, please confer with your Tektronix Field Engineer, Representative, or Distributor. They know the factors that must be considered in selection of a phosphor for any given application.

Phosphors are rated in several parameters, such as color of fluorescence or phosphore-scence, decay, etc. The table on page 10 describes the more commonly used phosphors.

KEY SPECIFICATIONS AND FEATURES

for oscilloscopes and related equipment

AMPLIFIER CONSIDERATIONS RISE TIME AND BANDWIDTH

One vital capability generally sought in an oscilloscope is sufficient bandwidth and adequate rise time.

Although rise time is usually the more important parameter when working with faster waveforms, signal bandwidth is commonly specified for lower speeds. Constraints make the two numerically related in well-designed general-purpose oscilloscopes. Bandwidth in megahertz multiplied by rise time in nanoseconds is approximately 0.35. Therefore, if your needs are defined in terms of one factor, dividing it into 0.35 will produce the other.

Bandwidth is of course defined as the frequency range in which signals are handled with less than a 3-dB loss compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, bandwidth here commonly refers to the highest frequency which can be displayed with a 3-dB or less error.

Most oscilloscope designs make use of gradual roll-offs at the high-frequency end, so in many cases a scope will be useful far beyond its specified bandwidth. Waveshapes may be altered and amplitudes reduced somewhat.

In terms of rise time, scopes ideally should have a vertical system capable of responding at least five times as fast as the fastest applied step signal (thus having a rise time less than 1/5 as great). In such a case, the rise time of the signal indicated on the scope will be in error by less than 2 percent.

Using the 1/5 and 0.35 factors together, the minimal requirements for scope bandwidth for accurate rise time measurements can be estimated using the following rule of thumb:

$$\text{Bandwidth (minimal)} \simeq \frac{\text{1.70}}{\text{Fastest Rise Time}}$$

Very accurate absolute rise time measurements are not always important. When simply comparing the rise times of two signals, scopes with a rise time equal to the rise time of the signals applied are usually considered adequate.

Besides indicating bandwidth for the vertical channel, many oscilloscope specifications also include a bandwidth figure for the horizontal and trigger channels.

Bandwidth and rise time figures also apply to many other TEKTRONIX instruments. Signal sources, probes, amplifiers, TDR systems, and many other test instruments are characterized in part by rise time. Frequency response figures are given for portable patient monitors, spectrum analyzers, and many tv products. The specifications will indicate values where these figures are relevant.

SENSITIVITY (DEFLECTION FACTORS)

Although sensitivity specifications are most often associated with oscilloscope vertical channels, specifications can also be provided for horizontal channels and trigger circuits with external inputs. Similarly, various other instruments may have a sensitivity specification relating minimum input level to some function or output level.

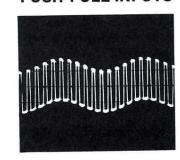
Sensitivity, in the case of oscilloscopes, refers to the input needed to produce a stated deflection of the spot on the crt. Specifications typically are given in millivolts per centimeter or division.

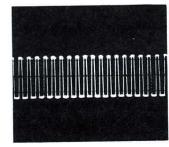
At a given state of the art, sensitivity is a tradeoff with bandwidth. The small amount of noise in even the best input circuit will mask signals which are too weak. Raising the bandwidth increases the noise picked up by the amplifiers, requiring more of a signal to create a clear display.

As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make better low-level, moderate frequency measurements. For these and other models, a set of sensitivity specifications may be given for limited frequencies as well as over the full range.

Many times, external noise will be the problem. Differential amplifiers are often used to lessen the effects of external noise and common-mode signals, thus improving the useful measurement sensitivity range.

DIFFERENTIAL, BALANCED, OR PUSH-PULL INPUTS





Differential or balanced amplifiers provide a feature beyond mere accommodation of push-pull signals: they have the ability to cancel or reject, to a high degree, any signal components equal in amplitude and phase that appear at both inputs. Such amplifiers provide a simple and accurate means of measuring the difference between two signals. They also provide a means of rejecting most unwanted signal components common to both inputs, such as power line "hum."

MULTIPLE INPUTS

It is quite often useful to be able to view any one or several of a number of input signals without disturbing connections to the oscilloscope. Several types of multiple-input amplifiers which display more than one signal on the same crt display are available.

Common applications include input-output comparisons, checking a signal against a standard, or working with complex circuits.

Two Techniques: Dual-Beam and Dual-Trace

Two techniques, dual-trace or dual-beam circuitry, are commonly used for creating two traces on a single crt. The dual-trace scope incorporates electronic switching to alternately connect two input signals to a single deflection system. The dual-beam scope, however, has two independent deflection systems within its crt. (Some models do share horizontal systems, though.) There are distinct advantages to both dual-beam and dual-trace scopes. A dual-beam scope can display two input signals separately and simultaneously. Therefore, it can show two nonrecurrent signals of short duration. Also, models with independent horizontal deflection can display nonrecurrent signals on different time bases.

The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities. This comes from using a single horizontal amplifier and one set of deflection plates. On the other hand, since a transient event might occur on one input channel while the beam is tracing the other, dual-trace scopes are not recommended for viewing fast one-shot phenomena.

Extension of the dual-trace principles has produced newer multiple-trace oscilloscopes capable of displaying up to eight traces.

TIME BASES SWEEP RATES AND SWEEP TYPES

Except in special cases, oscilloscopes have built-in sawtooth sweep generators for producing constant-speed horizontal beam deflection. In early scopes, these generators ran continuously, and horizontal calibration was based on their repetition frequency. In most modern scopes, sweeps are calibrated in terms of a direct unit of time for a given distance of spot travel across the screen; hence the term, "time base."

This technique permits:

- Direct measurement of time between events.
- 2. Viewing and measuring small portions of pulse trains.
- 3. Viewing and measuring random or aperiodic events.
- 4. Viewing and measuring single non recurrent events.

Distances representing time are measured on the scope's graticule, the ruled scale built into the display. The internal graticule built inside the crt face on modern scopes is preferable, as it eliminates parallax.

A major graticule division may be an inch, centimeter, or some other length. Some instruments have different distance-units for the vertical and horizontal scales. Graticules often have small markings which subdivide the major divisions to assist in making accurate measurements. Such subdivisions should **not** be interpreted as the distance unit in a specification.

Strictly speaking, sweep specifications are rates properly expressed as time/length. However, the term **sweep speed** (implying length/time) is often used synonymously.

RELATING SWEEP RATES, HIGH FREQUENCIES, AND RISE TIMES

The appropriate sweep rate for frequencyspecified measurements is based on the nature of the investigation. Given a moderate frequency, a sweep is usually considered adequate if it is capable of displaying one cycle across the full horizontal scale. At high frequencies, however, scopes seldom have sweeps that fast. To measure rise time as accurately as possible, a step signal (square wave, rectangular pulse, etc) should occupy most of the full vertical scale, and the rising portion of the signal should be displayed at nearly a 45° slope. This objective can be met only if the fastest sweep is able to move the beam a horizontal distance nearly equal to the full vertical scale in a time interval equal to the rise time of the vertical deflection system. Because of the compounding difficulties and cost of providing extremely fast sweeps which are both linear and accurate, this goal must be tempered somewhat in scopes having the very best vertical deflection system rise time capabilities.

In some cases rise time measurements are not made to determine actual rise time, but are done to decide whether certain limits are met or exceeded. In such cases, an adequate comparison with a standard signal of known rise time can usually be made even with a sweep which provides a fairly steep display, provided of course that the vertical deflection system rise time is good enough.

DELAYING/DELAYED TIME BASES

Delaying-sweep measurements use two linear calibrated time bases. The first time base, commonly called the delaying sweep, allows the operator to select a specific delay time. When this time is reached, the second time base, called the delayed sweep, starts. The delayed sweep is typically set a decade or two faster than the delaying sweep, and therefore offers additional resolution. The combination of these two time bases also offers increased accuracy of time interval measurement.

DIGITAL TIME DISPLAYS



You can make delay and interval time measurements with digital ease on several TEKTRONIX oscilloscopes. The DM44 option for the 400 Series allows you to read the delay time, interval frequency, or temperature right from an LED readout, with no calculation or interpolation required. The 7B85 and 7B80 Plug-ins for 7000-Series Oscilloscopes provide Δ time (dual-delayed sweep) measurements. With this feature, both ends

of the selected interval which can be independently positioned on the trace are shown by intensified regions. The time interval between those points is shown on the screen using the 7000-Series crt-readout capability.

SAMPLING

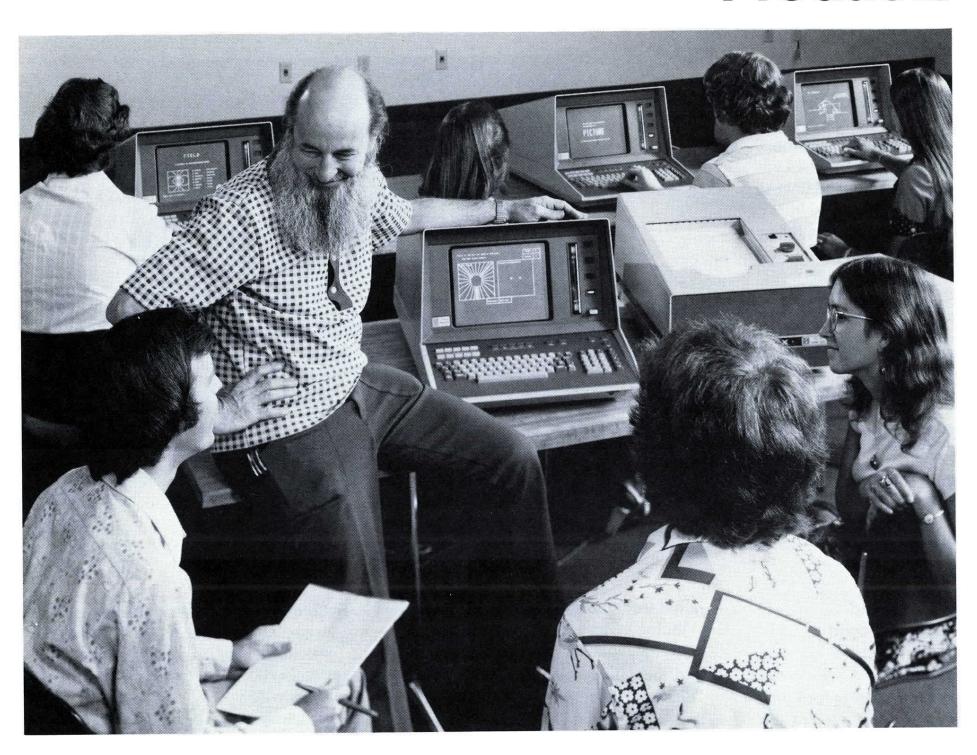
Sampling is a powerful technique for examining very fast repetitive signals. It is similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown, all seemingly at one time, on the screen of a cathode-ray tube. The graph thus produces a replica of the sampled waveforms. The principal difference in appearance between displays made by sampling techniques and conventional displays is that those made by sampling are comprised of separate segments or dots. This technique is limited to depicting repetitive signals, since no more than a portion of the signal is captured and displayed each time the signal recurs.

The sampling method, however, provides a means of examining fast-changing signals of low amplitude that cannot be examined in any other way. The system is capable of resolving events that occur in less than 30 picoseconds on an "equivalent" time base of less than 20 picoseconds per division and less than 5 mV of peak amplitude.

Tektronix uses the random sampling technique which differs from conventional sampling because it does not require a delay line or pretrigger for lead time to be visible in the display. The benefits afforded by this feature are:

- 1. Signals with no source of pretrigger can be observed.
- 2. The inherent rise time limitation of signal delay lines is eliminated.
- 3. It is no longer necessary to work into the 50 Ω characteristic impedance of a delay line, so high impedance can be retained.
- 4. External triggers may occur before, coincident with, or after the displayed signal, with lead time still visible in the display.
- 5. Display time jitter otherwise caused by pretrigger-to-signal jitter is eliminated.

Information Display Group Products



Today, scores of applications within government, industry and education, rely on Computer Graphics to find oil, fight disease, forecast budgets, stimulate education, plan cities, design circuits, unsnarl traffic—to instantly interpret complex ideas. Everything expressed in Graphics is better understood and more effectively communicated.

As the world's Graphics leader, Tektronix can give your communications a dimension you've been missing. With high resolution graphics terminals. Desktop computing calculators. And complete graphic systems. All supported by peripheral devices, proven software, wideranging sales and service — and a worldwide reputation for quality and dependability.

For additional product information and details on interface, software, and accessory support, please indicate your interest on the postcard at the back of the catalog.

4025 Computer Display Terminal

From Alphanumerics to Graphics. Now your terminals can keep pace with your needs.

The 4025 takes you beyond alphanumerics. When you're ready to go beyond data entry and editing, the 4025 is the terminal that can take you there. The 4025 gives you the unique ability to expand your terminal from basic alphanumerics, to forms ruling and then into graphics. No other terminal has such versatility. With all its options, the 4025 provides unmatched report generation capability.

4025 Specifications

Display mechanism:

Display type — Video monitor Screen size — 30 cm (12 in) diagonal Usable display area — 16.2 cm x 21.6 cm (6.4 in. x 9 in.)

Phosphor type — P39 green phosphor Video bandwidth — 20 MHz

Raster lines — Standard 525 line scan, with 480 lines displayed.

Scan - 30 Hz

Refresh rate:

Dot— 30 times/second Frame— 30 times/second

Field — 60 times/second

Display characteristics:

Cursor type — Wide underscore Character size — 7 x 9 in a 8 x 14 dot matrix

(Graphics cells are 8 x 14 matrix) Character sets:

Standard — 64/96 upper and lower case ASCII.

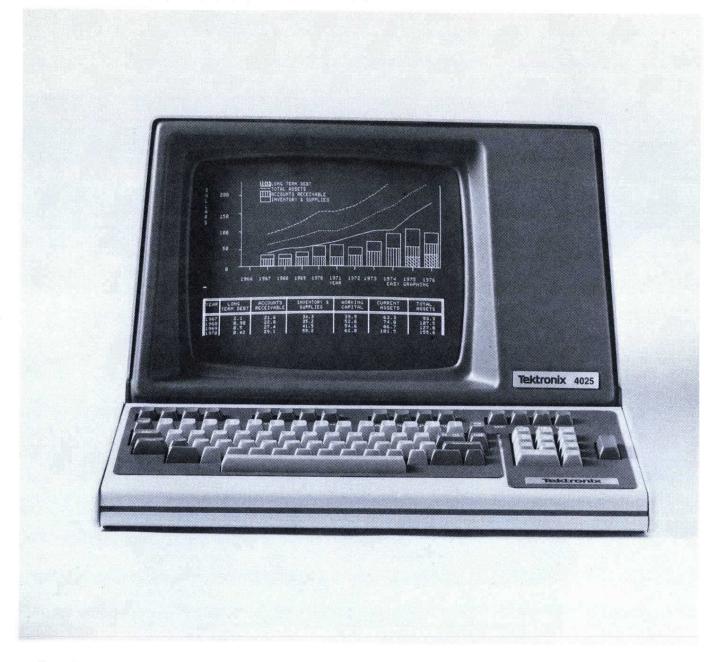
Optional — 64 characters each, to a maximum of 6 character sets; or 128 characters each, to a maximum of 3 character sets. Can include rulings or math characters, for example.

With the graphics option. Up to 31 character sets can be defined by the user.

Characters/line — 80 Lines/display — 34

Total characters/display — 2720

Visual attributes — Characters can be displayed with shaded background, inverted fields (dark on light background rather than light on dark background), or underlines. In addition, the display can "blink" (alternate) between combinations of visual attributes.



Logical attributes — Fields can be protected, modified, alphanumeric, and numeric only.

Interface characteristics:

Transmission speed — The transmitting and receiving baud rates are independently selectable up to 9600 baud. Baud rates can be entered from the keyboard or the host computer.

Interface with the host computer:

Standard — RS-232-C full duplex
Option 1 — RS-232-C half duplex, with
or without supervisory channel.
Option 2 — 20 mA current loop

Option 10 — Polling Interface permits multiple terminal configurations on one host communication line. Terminal interface is current loop using 4020 Series Polling Protocol. Communications buffered or unbuffered.

Option 11 — Polling Controller — IBM 3270 compatible. Converts IBM 3270 protocol to 4020 Series polling protocol. Will drive Option 10. Provides control for up to eight terminals in a polling system.

Buffering and editing capabilities:

Size of display memory — 4K bytes standard; may be expanded to 8K (Option 20), 16K (Option 21), or 32K (Option 22).

Parts of memory —

Monitor — Holds and displays conversational text such as conversations between the user and the host computer, or commands to the 4025.

Workspace — Holds and displays text, forms, and graphics. One or several pages of text can be saved in the workspace, edited, and later sent to the host or to a peripheral.

Keyboard Specifications:

Number of keys — 86

Lighted keys — 4 (Insert mode, TTY lock, Numeric lock, Command lockout)

Programmable keys — 80

Major keyboard functions — Typewriter keys, terminal function control, programmable function keys, numeric pad, cursor control, scolling.

Tactile features — Curved profile, tactile feedback at typing "home" position.

Relationship to display —
Detachable, flexible (8 foot) cable.
Editing keys: Delete character,
Delete line,
Erase and skip
Insert line, and
Insert mode.

Graphic specifications

Amount of Graphics Memory:
Option 23 — 4096 8-bit words
(covers 256 cells).
Option 24 — 8192 8-bit words
(covers 512 cells).
Option 25 — 16384 8-bit words
(covers 1024 cells).
Option 26 — 32768 8-bit words
(covers 2048 cells).

The maximum amount of graphics memory that may be needed depends on the number of graphics "cells" (character positions) in the part of workspace used for holding the graph. Display memory is also required to put graphics in the workspace.

Line types: Solid lines, Seven styles of dashed lines, Single points, and "Dark vectors", which erase lines previously drawn.

Type of display — Dot matrix: each graphics cell (character position) has 14 rows of 8 dots each.

Resolution — 28 addressable points/cm.

User definable Character Sets

Up to 16 fonts may be defined by the operator or the host computer.
Characters per font — 128 (or two sets of 64 each).

Number of fonts available:

Option 23 — 2. Option 24 — 4. Option 25 — 8. Option 26 — 16.

Option 31 — Character set Expansion option — permits addition of up to 6 character sets (64 characters), or three 128-character sets.

Option 32 — Ruling Characters — Optional character set which contains the special characters used to rule forms.

Option 34 — Math Characters — Optional character set which provides the special characters most commonly used in mathematics (includes special symbols and Greek letters).

Option 35 — ROM Option — required for the addition of multiple options. Refer to the option summary for list of options requiring the ROM option board.

Option 41 — Self Test — The standard 4025 performs an automatic "self test" on power-up. This test verifies the initial status, memory, and operating parameters. The optional self test feature provides additional testing capabilities to verify options and peripheral availability.

Power requirements:

Line plug and power cord — 15 ampere capability, detached

Input line voltages —

Standard —

115 VAC, 3A 90-100 V (low)

105-125 V (med)

112-136 V (high)

Option 48 —

220 VAC, 1.5 A

180-220 V (low)

208-252 V (med)

224-272 V (high)

Line frequency — 49 to 63 Hz Power consumption — 295 W

maximum at 125 VAC

Safety recognition — Listed by Underwriters Laboratories under the following standards:

114 — Office Appliances

478 — Electronic Data Processing Units and Systems

Also certified by Canadian standards Association under standard C22.2 No. 154.

Physical characteristics:

Weight — 27.2 kg (60 lbs.)

Dimensions:

Cabinet:

Height — 31.7 cm (12.5 in.)

Width — 44.5 cm (17.5 in.)

Depth — 54 cm (21.25 in.)

Keyboard:

Height — 7.6 cm (3 in.)

Width — 45.7 cm (18 in.)

Depth — 23.5 cm (9.25 in.)

Environmental:

Temperature —

 $-60 \text{ to } +50^{\circ} \text{ C (Storage)}$

+10 to +40° C (Operating)

Humidity — 0 to 95% (Storage)

0 to 70% (Operating)

Altitude — to 50,000 feet (Storage) to 15,000 feet (Operating)

4025 Option Summary

Option:

1 Half Dunlay Interface (see note
1 Half Duplex Interface (see note
2)
2 Current Loop Interface \$230
3 RS-232-C Peripheral Interface
(Transmit Only). See Note 1\$300
4 GPIB Peripheral Interface (see
note 1)
10 Polling Interface \$250
11 Polling Controller\$2,000
20 8K bytes of Display Memory\$250
21 16K bytes of Display Memory .\$750
22 32K bytes of Display Memory \$1750
23 4K bytes of Graphics Memory
(note 2)\$550
24 8K bytes of Graphics Memory
(note 2)\$800
25 16K bytes of Graphics Memory
(note 2)\$1300
26 32K bytes of Graphics Memory
(note 2)\$2300
31 Character Set Expansion \$250
32 Ruling Characters (note 3) \$150
34 Math Characters (note 3) \$100
35 ROM Expansion\$100
36 Peripherals (Used with options 3
and 4) see note 2\$150
40 Hard Capy and Video Output \$70
40 Hard Copy and Video Output\$70
41 Self Test (note 2 & 4)\$100
48 220 Volts, 50HzNo charge
Notes:
1. Requires options 35 and 36

1. Requires options 35 and 36

2. Requires option 35

3. Requires option 31

4. Option 1 & 41 cannot be configured together.

Ordering Information

4025 Computer Display Terminal . .\$3595

4024 Computer Display Terminal

The complete alphanumerics terminal

Everything you need for data entry, program writing, editing and forms fill-out. The 4024 was designed to allow fast, straight-forward interaction with your host computer and maximum efficiency in the manipulation of alphanumeric data. For writing and editing programs. Editing text. Or for filling out and editing forms.

4024 Specifications

Display Mechanism:

Display type — Video Monitor Screen size — 30 cm (12 in.) diagonal Usable display area — 16.2 cm x 21.6 cm (6.38 x 8.5 in.)

Phosphor type — P39 green phosphor Video bandwidth — 20 MHz

Raster lines: Standard 525 line scan

Raster lines: Standard 525 line scan, with 480 lines displayed.

Scan — 30 Hz

Refresh rate: Dot—30 times/second

Frame — 30 times/second

Field — 60 times/second

Display Characteristics:

Cursor type — Wide underscore Character size — 7 x 9 in a 8 x 14 dot matrix

Character sets:

Standard — 64/96 upper and lower case ASCII

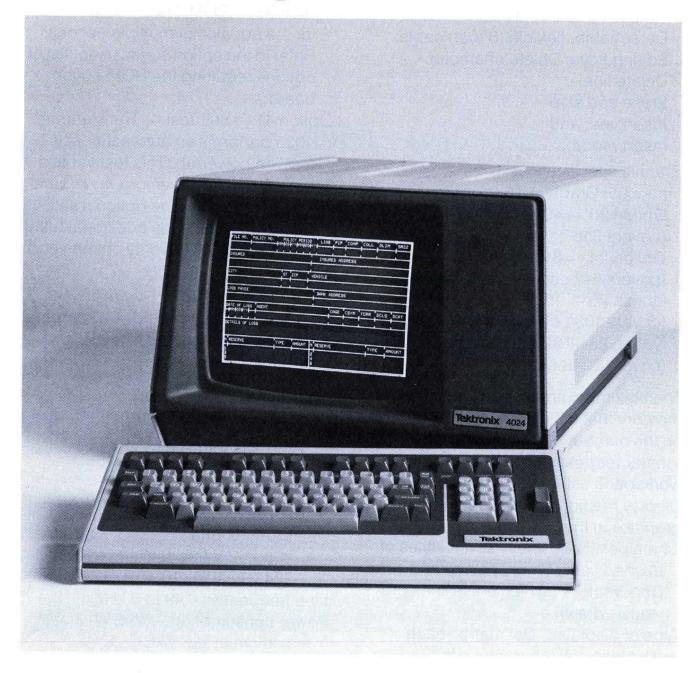
Optional (Option 32)—Rulings character set – 32 characters for single and double line ruling. Used for forms generation.

Characters/line — 80 Lines/display — 34

Total characters/display — 2740
Visual attributes — Characters can be on an enhanced background. In addition the display can "blink" (alternate) between combinations of

visual attributes.

Logical attributes — Fields can be protected, modified, alphanumeric, or numeric.



Interface characteristics:

Transmission speed — The transmitting and receiving baud rates are independently selectable using internal strap selection. The baud rates available are: 75, 110, 150, 300, 600, 1200, 2400, 4800, and 9600 baud.

Interface with Host computer:

Standard — RS-232-C full duplex Option 02 — 20 mA current loop

Option 10 — Polling Interface — permits multiple terminal configurations on one host communication line. Terminal interface is current loop using TEKTRONIX 4020 Series Polling Protocol.

Command format — English Communications — Buffered or unbuffered.

Buffering and editing capabilities:

Size of Display Memory — 4K bytes standard; may be expanded to 8K bytes (Option 20), 16K bytes (Option 21), or 32K bytes (Option 22).

Parts of Memory —

Monitor — Holds and displays conversational text, such as conversations between the user and the host computer, or commands to the 4024. Workspace — Holds and displays text or forms. One or several pages of text can be saved in the workspace, edited, and later sent to the host computer or to the printer.

Keyboard specifications: Number of keys — 86 Lighted keys — 4 (insert mode, TTY lock, Numeric lock and Command lockout) Programmable keys — 80 Major keyboard functions — Typewriter keys, terminal function control keys, programmable function keys, numeric pad, cursor control and scrolling. Tactile functions — Curved profile, tactile feedback at typing "home" position. Relationship to display — Detachable, flexible 2.5 m (7 ft) cable Editing keys — Delete character, Delete line, Erase and skip, Insert line and Insert mode. Power Requirements: Line plug and power cord — 15 Ampere capability, detached. Input line voltages — Standard — 115 VAC, 3A 90-110 V (low) 105-126 V (med) 112-136 V (high) Option 48 — 220 VAC, 1.5A 180-220 V (low) 208-252 V (med) 224-272 V (high) Line frequency — 49 to 63 Hz	Physical characteristics: Weight — 25 kg (58 lb.) Dimensions: Cabinet Height — 31.7 cm (12.5 in) Width — 44.5 cm (17.5 in) Depth — 54 cm (21.25 in) Keyboard: Height — 7.6 cm (3 in) Width — 45.7 cm (18 in) Depth — 23.5 cm (9.25) Environmental: Temperature — — 60 to +50° C (storage) +10 to +40° C (operating) Humidity —0 to 95% (storage) 0 to 70% (operating) Altitude — Storage — to 15000 m (50,000 feet) Operating — to 5000 m (15,000 feet) 4024 Option Summary Option 2 20 mA Current Loop\$230 3 RS-232-C Peripheral Interface, transmit only\$300 10 Polling Interface\$250 20 8K bytes Display Memory\$250 21 16K bytes Display Memory\$750 22 32K bytes Display Memory \$1750 32 Rulings Character set\$150 48 220 V, 50 HzNo charge
Power consumption — 285 W maximum at 125 VAC. Safety recognition — Listed by Underwriters Laboratories under the following standards: 114 — Office Appliances 478 — Electric Data Processing Units and Systems Also certified by Canadian Standards Association under standard C22.2 No. 154	Ordering Information 4024 Computer Display Terminal\$2995

4006-1 Computer Display Terminal

The power of Graphics for the price of alphanumerics.

The 4006-1 is a Tektronix break-

through towards making interactive, high-resolution Graphics applicable and affordable to cost-conscious disciplines and departments.

Priced no more than many alphanumeric terminals, the 4006-1 makes graphic capability as practical for the stockroom, the classroom and the conference room as for other departments where Graphics is used.

Specifications:

Display Medium:

Direct View Bistable Storage CRT

Display Area:

7.5 inches wide by 5.6 inches high (19.05 cm x 14.22 cm)

Alphanumeric Mode Format:

35 lines, 74 character per line 2590 characters full screen

Character Set:

63 printing characters (TTY ANSI Code)

Character Generation:

5 x 7 dot matrix

Cursor:

8 x 8 dot matrix

Graphics Display Mode:

Vectors only

Vector drawing time, $3.6 \pm .2$ ms.

Information density:

1024 X by 1024 Y addressable points 1024 X by 780 Y viewable points

Baud Rate:

Transmit and receive independently selectable from 75 to 4800 baud

Input power:

110/240 VAC (Low, Medium, High) 50 to 440 Hz, 105W

Operating Temperature:

+10° C to +40° C

Operating Altitude:

To 15,000 feet



Physical Characteristics:

Height, 12% inches (31.43 cm.) Width, 15¼ inches (38.74 cm.) Length, 27½ inches (69.85 cm.) Net weight, 42 pounds (19.05 kg.) Shipping weight, 50 pounds (22.68 kg.)

Computer Interfaces:

The 4006-1 is shipped with a Standard Data Communication Interface, with inputs and outputs conforming with EIA RS-232-C, Asynchronous Full Duplex only. Option 1: Half Duplex Interface

Companion Products:

4631 Hard Copy Unit4923 Digital CartridgeTape Recorder4662 Interactive Digital Plotter

Accessories:

Standard Accessories:

A User's Manual is supplied at no extra cost.

Ordering Information

4006-1 Computer Display Terminal \$2995

Computer Display Terminal

4010-1

Flicker-free alphanumerics with picture-perfect Graphics.

Easy input. Easy-to-use output.

The 4010-1 Computer Display Terminal is an easy to use, cost effective tool that brings out the best of Tektronix famous Graphics capability. It has been engineered for interactive communications, a variety of operating modes and easy system expansion.

Up to 1024X by 780Y viewable points may be displayed on the 4010-1's flicker-free 11" (27.9 cm) screen. The result: high-resolution graphs, charts, diagrams and renderings, without delays for printout or hand plotting. For immediate analysis and manipulation, graphic data can be input via the standard TTY-style keyboard or with the thumb-wheel controlled cross-hair cursor.

Specifications:

Display Medium:

Direct View Storage CRT.

Display Area:

7.5 inches wide by 5.6 inches high (19.05 cm x 14.22 cm).

Alphanumeric Mode Format:

35 lines, 74 characters per line, 2590 characters full screen.

Character Set:

63 printing characters. (TTY ANSI Code).

Character Generation:

5 x 7 dot matrix MOS Read-Only Memory 1200 Characters per Second

Cursor:

Pulsating 5 x 7 matrix

Graphic Display Mode

Vectors only.

Vector Drawing Time, 2.6 ms. 1024X by 1024Y addressable points. 1024X by 780Y viewable points.

Graphic Input Mode:

Thumb-wheel controlled cross-hair cursor.

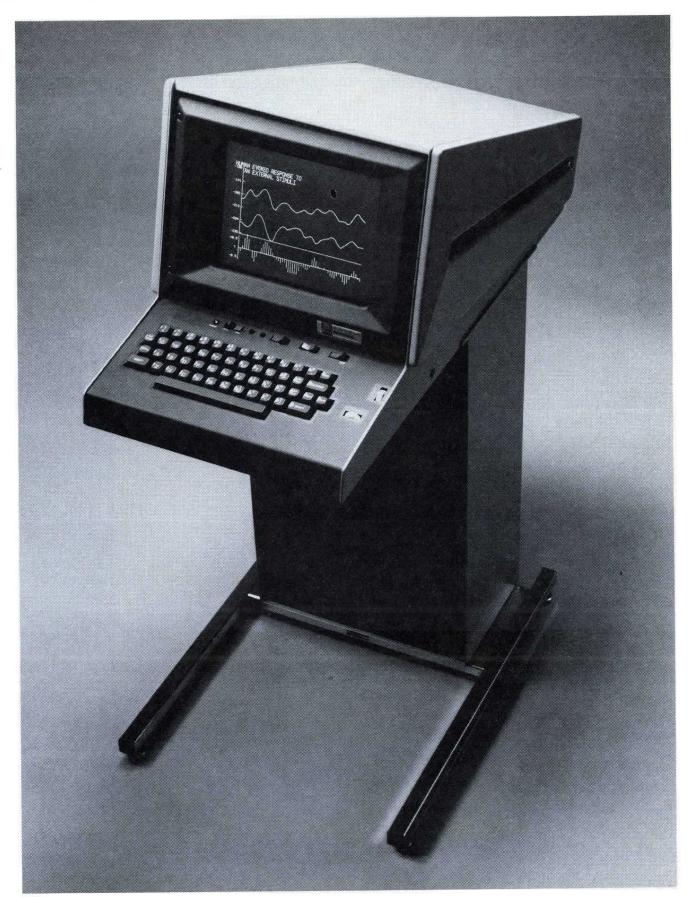
3 through 1023X, 0 through 780Y.

Input Power:

110/220 VAC (Low, Med, Hi). 50 to 400 Hz, 110W

Operating Temperature:

 $+10^{\circ}$ to $+40^{\circ}$ C.



Physical Characteristics:

Dimensions:

Height, 41½ inches (103.41 cm). Width, 15 inches (38.1 cm). Length, 28½ inches (72.39 cm).

Weight:

Net, 78 pounds (35.10 kg). Shipping, 87 pounds (39.15 kg).

Computer Interfaces:

Basic Data Communication Interface included with the 4010-1 is EIA RS-232-C compatible, Full Duplex only.

Note: EIA RS-232 is comparable to the European Standard CCITT (V.24).

Ordering Information

4010-1 Computer Display Terminal \$4950

4012/13 Graphic Display Terminals

4012: Full ASCII Characters set 4013: APL-compatible

Full ASCII, flicker-free Graphics with

APL option. Alphanumerics can transcribe computer data; Graphics can interpret and amplify that data. We've made high-resolution graphic representation and upper-and lower-case ASCII alphanumerics available in 4012 and APL-language 4013 Graphic Display terminals.

The 4012/4013's flicker-free 11-inch (27.94 cm) screen provides up to 1024X by 780Y viewable graphic points or as many as 2590 A/N characters per display. The TTY-style keyboard simplifies input, while the thumbwheel controlled cross-hair cursor enhances graphic input.

Specifications:

Display medium:

Direct View Bi-Stable Storage CRT

Display Area:

8 inches (20.3 cm) wide x 6 inches (15.2 cm) high

Alphanumeric mode:

Format

74 characters per line35 lines per display2590 characters per display

Alphanumeric cursor:

Pulsating 7 x 9 dot matrix

Character set:

94 printing characters on 7 x 9 dot matrix (Full ASCII code)
94 character APL set (4013 only)

Character size:

85 mils x 105 mils

Character generation:

7 x 9 dot matrix MOS Read-Only Memory 1,000 characters per second

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

Interactive graphics mode:

Thumbwheel controlled crosshair cursor 3 thru 1023 X, 0 thru 780 Y



Local mode:

Terminal isolated from CPU, keyboard data is displayed and executed

Hard copy mode:

Allows a copy to be made of display by a hard copy unit

Input power:

110/220 (Hi, Med, Low) VAC strappable 48 to 440 Hz, 110W

Operating temperature:

+10°C to +40°C

Operating altitude to 15,000 feet

Dimensions:

Height — 41.5 inches (105.4 cm) Width — 19 inches (48.3 cm)

Depth — 29 inches (73.7 cm)

Weight:

90 pounds (40.9 kg)

Computer Interfaces:

Note: EIA RS232 is comparable to the European Standard CCITT (V.24).

Ordering Information

4012 Computer Display Terminal . .\$6350 4013 Computer Display Terminal . .\$6850

Graphic Display Terminals

4014-1/15-1

4014-1: Full ASCII character set 4015-1: APL compatible

High-resolution, low-cost, APL option: our 19" (48.26 cm) Graphics terminal. The most effective way to display a large data base is big screen Graphics. The 19-inch (48.26 cm) flicker-free 4014-1 and APL-language 4015-1 Graphic Display Terminals give you capabilities in all kinds of applications—mapping, design, manufacturing, medicine, energy exploration and many more.

Big screen. Big features. The 4014-1 and 4015-1 offer 1024X by 780Y displayable points standard, up to 4096X by 3120Y displayable points optional, with the Enhanced Graphics Module. Full 96-character ASCII keyboard with four program-selectable alphanumeric formats. Up to 8512 characters on display at once. Graphic crosshair cursor control, and hard copy compatibility.

Specifications:

Display medium:

Direct View Bi-Stable Storage CRT

Display area:

15 inches (38.1 cm) wide by 11 inches (27.9 cm) high

Alphanumeric mode:

Four program-selectable formats:

- 1. 74 characters per line with 35 lines per display.
- 2. 81 characters per line with 38 lines per display.
- 3. 121 characters per line with 58 lines per display.
- 4. 133 characters per line with 64 lines per display.

Alphanumeric cursor:

7 x 9 dot pulsating cursor

Character set:

4014-1—Full ASCII character set (94 printing characters).

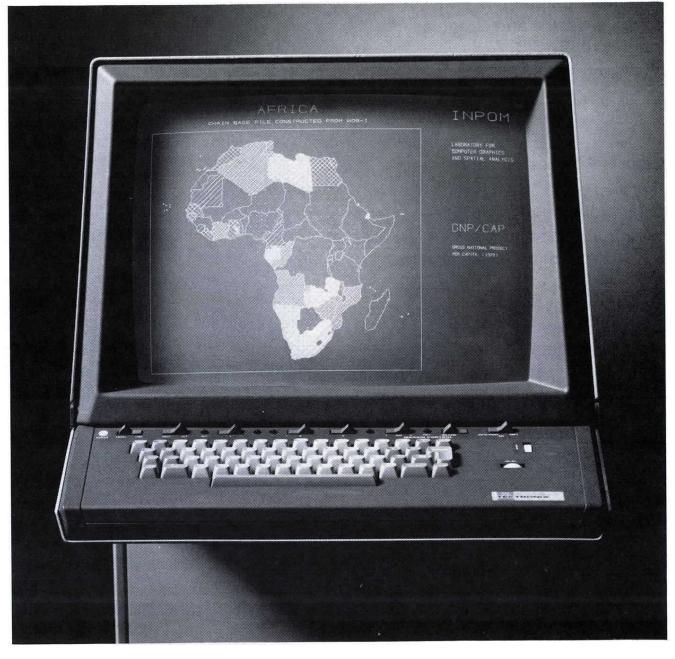
4015-1—Full ASCII and APL character sets (188 total printing characters).

Vector mode:

Vector drawing time is 5000 inches per second (127 meters).

1024(X) by 1024(Y) addressable points (10 bits).

1024(X) by 780(Y) viewable points.



Enhanced graphics module:

4096(X) by 4096(Y) addressable points (12 bits).

4096(X) by 3120(Y) viewable points.

Vector formats:

5 formats, including straight, dotted and dashed lines.

Point plotting modes:

Point Plot Mode

Special Point Plot Mode—absolutely addresses points with program control of plotted point size—.010 to .050 inch (0.25 to 1.27 mm) approximate point sizes.

Incremental Plot Mode—relative addressing 1 of 8 directions, one step at a time.

Interactive graphic mode:

Thumbwheel controlled crosshair cursor.

3 thru 1024 addressable points horizontally.

0 thru 780 addressable points vertically.

Power source:

110/220 (Hi, Med, Low) VAC 48 to 440 Hz, 350 W.

Dimensions:

Height—43½ inches (110.48 cm) Width—20 inches (50.80 cm) Length—32½ inches (82.55 cm)

Weight:

150 pounds (68 kg)

Computer Interfaces:

Basic Data Communication interface included with the 4014-1 or 4015-1 is EIA RS-232-C compatible. Full duplex only.

Note: EIA RS-232-C is comparable to the European Standard CCITT (V.24).

Ordering Information

rucinig information	
4014-1 Computer Display	
Terminal	11,650
4015-1 Computer Display	
Terminal	12,700

4051 Graphic System

Desktop Computational Power Alphanumerics and Graphics High-level BASIC Up to 32k Work Space

Central Processing Unit

Type:

LSI Microprocessing Unit.

Work Space Size:

8k bytes standard expandable to 32k bytes.

Programming Language:

BASIC with integrated operating system, built-in graphics, and numerous other extensions.

Numeric Accuracy:

14 decimal digits.

Numeric Range:

 $1 \times 10 \pm 308$

Internal Peripherals

Keyboard:

Complete upper and lower case alphanumerics with autorepeating keys. Full ASCII. 128 characters.

10 Function Keys with SHIFT for up to 20 separate function calls.

Five keys with SHIFT, control 10 different editing functions used to modify BASIC source programs.

Calculator key pad including 10 key numeric pad, 5 math-operator keys, decimal point, and parenthesis.

Control keys:

AUTO NUMBER—generates program line numbers automatically; STEP—executes program steps one at a time; AUTO LOAD—automatically leads and runs File 1 on tape; REWIND—rewinds tape; MAKE COPY—activates optional 4631 Hard Copy Unit.

Display Characteristics

Type:

Direct view storage crt.

Dimensions:

8 in wide by 6 in high (20.3 cm x 15.2 cm)

Alphanumeric Format:

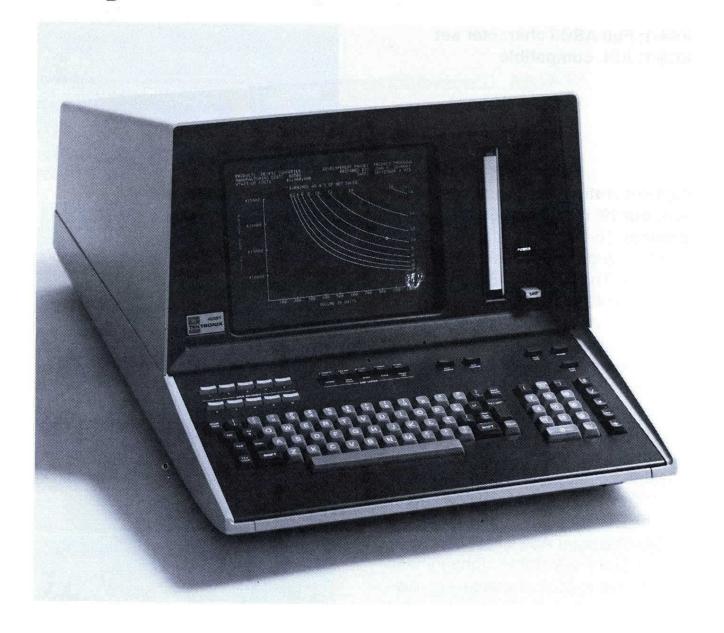
72 characters per line, 35 lines; 2520 total.

Character Set:

Full ASCII character set, including upper/lower case. Also includes Scandinavian, German, General European, and Spanish fonts.

Graphic Resolution:

1024 x 780 points.



Hard Copy:

Compatible with our 4631 Hard Copy Unit.

Tape Drive

Type:

3M DC300A cartridge.

Capacity:

300k bytes max (dependent on number of files).

System Characteristics:

File structures for storage of programs or data. Access is via 4051 BASIC operating system.

General-Purpose Interface Bus (GPIB)

Specifications:

Conforms to IEEE standard 488-1975. Byte serial, bit parallel transfer mode.

Control Mode:

External devices can be serviced via interrupt procedures available in the BASIC operating system. Enable/disable, polling, and data transfer commands are available under program control.

Power Requirements

Operates between 90V to 132V RMS, or 180V to 264V RMS, 48-66 Hz, 200W max.

4051R01 Matrix ROM:

4051R05 Binary Program Loader ROM:

4051R06 Editor ROM:

May be used to expand the capabilities of the 4051 by editing text that is collected and stored on the 4051 tape\$600

Physical Characteristics

Height:

13.6 in (34.5 cm)

Width:

18.3 in (46.5 cm)

Length:

32.5 in (82.6 cm)

Net Weight:

65 lb (29.5 kg)

Shipping Weight: 81 lb (35.8 kg).

Ordering Information

4051 Graphic System \$7500

Interactive Graphics Terminal

4081

Merging Storage and Refresh Graphics to Create A Technological First.

The 4081 Interactive Graphics Terminal has incorporated the benefits of both a refresh-type and a storage-type display via the use of a specially-designed display controller. This terminal allows the user to display storage and refreshed information simultaneously.

With the 4081 a user can display high resolution, high density pictures with storage while concurrently displaying dynamic pictures using refresh.

The 4081 Interactive Graphics Terminal provides both technologies at a significantly lower price than a refresh-only display.

Product Data:

General:

Asynchronous RS-232 communications interface operating at 110 to 4800 baud in full or half duplex mode

Cartridge magnetic tape drive with 256K-byte storage capacity

Alphanumeric keyboard with full upper and lower case ASCII characters

Twelve function keys

Joyswitch with terminator button

Four system status lights

4014 terminal emulation

Control storage standard with optional picture data storage

Up to eight peripherals

CRT Controller:

Maintains a refreshed picture 352 unique hardware dash patterns Four levels of beam intensity Writes stored image

CRT Display:

Graphic write rate of 56,000 vectorcm./sec. in refresh and 14,000 vectorcm./sec. in storage 2048 x 1536 displayable raster units Resolution of 16 line pairs/cm. Spot size of 20 mils, maximum Flicker free for up to 1600 vector cm. or 800 vectors refresh, 50,000 vector cm storage



Specifications:

Power:

115-volt, 30 amperes, 60 Hz, singlephase power

Power consumption 3450 watts, 11,782 BTU/hr.

Physical:

Height—49.6 inches (126 cm) Width—60.1 inches (152.6 cm) Depth—30.1 inches (76.5 cm) Weight—720 lb. (326.5 kg)

Environment:

Operating temperatures—+10°C to +35°C (+32°F to +95°F) Operating altitude—to 15,000 ft. (to 4572 m) Shock—20g's (non-operating)

Standard Features:

4014 Terminal Emulator
Local Graphics transfer
Local storage of graphics information
Host control of terminal functions
Command language
Device independence
Hard copy compatible
Host-Terminal data error detection

Standard Accessories:

RS-232-C Interface Terminal Manuals

Ordering Information *

4662 Interactive Digital Plotter

Compatible in all RS-232-C ASCII environments; and with Plot-10 Graphic Software.

An intelligent plotter: what will it think of next? The 4662 is the first plotter with built-in processing power. As such it has the capability to work on its own, without bogging down computational operations. Studded with state-of-the art technology, it works with an accuracy and repeatability that no other low-cost plotter can approach.

Specifications:

Performance Characteristics:

Plotting area:

X-Axis greater than 15" (381 cm) Y-Axis greater than 10" (254 cm)

Repeatability:

 $\pm 0.0025''$ (± 0.06 mm)

Default Accuracy

±0.0025 inch; ±0.4% of vector length

Boundary Definable Accuracy

±0.005 inch

Time to Maximum Velocity:

approx. 120 ms.

Data Resolution:

0.005" (0.127 mm)

Plotting rate:

16-22 IPS vector dependent (406-559 mm/sec).

Point plotting rate:

Pen action rate 10 points/sec. max.

Character set:

95 ASCII printing characters plus BEL, BS, CR, FF, HT, LF and VT control characters.

Pen Control:

By software control or by operation of front panel PEN button. Pen may be disabled manually.

Position controls:

Joystick vector rates variable from .015 ips to 4 ips. (.38 mm/sec to 102 mm/sec)

Writing method:

Nylon-tipped pen.

Paper size:

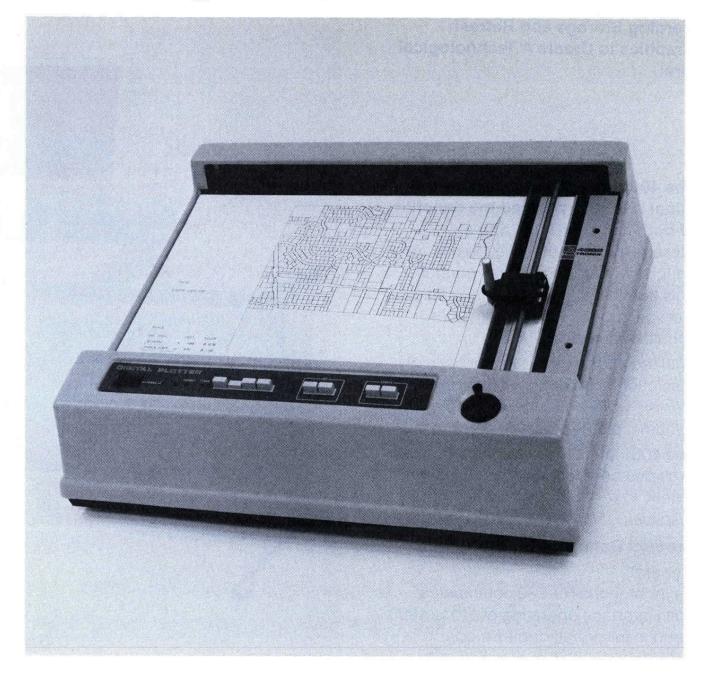
11" x 17" maximum (279 mm x 432 mm)

Paper retainer:

Electrostatic holddown.

Drive characteristics:

Pen motion in the X and Y axes is con-



trolled by four phase stepping motors operating through a precision pulley/cable system.

Operating Modes:

The 4662 has 2 input modes in RS-232-C; Alphanumeric (Alpha), Graphic plot (Graphic). The 4662 also has Graphic Input (GIN) to the host.

General Purpose Interface Bus (GPIB)

Specifications: Conforms to IEEE standard 488-1975. Byte serial, bit parallel transfer mode.

Input Power:

90W maximum, 60W typical. Selection of 105V \pm 14%, 116V \pm 14%, 210V \pm 14%, 232V \pm 14%. Line frequency 48 to 66 Hz.

Dimensions:

Width: 20%"/517 mm. Height: 8"/203 mm. Depth: 191/2"/495 mm.

Weight:

30 lbs. 4 oz., 13.8 kg.

Shipping Weight:

45 lbs. 14 oz., 20.8 kg.

Environmental:

Temperature:

Operating 0° to 50°C. Non-operating -55°C to +75°C.

Altitude:

Operating to 15,000 feet. Non-operating to 50,000.

Safety Considerations:

Designed to UL and IEC standards. UL listed. CSA approved.

Transportation:

Qualities under National Safe Transit Committee test procedure, 1A, Category II.

Standard Accessories:

Power cord.

4662 RS-232-C cable.

3 pens each, black, red, green, blue. User's Manual.

Stylus (for digitizing cursor).

Paper (100 sheets, 11" x 17" 279 mm x 432 mm) linear grid lines 10 x 10 to the inch

Optional Accessories:

Pens.

Paper. (Linear, logarithmic, blank) Dust cover.

"REMOTE CALL" foot switch.

Option 1, GPIB cable. 2 meters long. Carrying/shipping case ... No charge

Ordering Information

4662 Interactive Digital Plotter\$4195

Compatible with entire line of graphic display terminals, the 613 Storage Display Unit, the 4051 Graphic Computing System and the 4081 Interactive Graphics Terminal. Multiplexes up to four display terminals and/or display monitors.

Variable formats. Easy maintenance. Quick, clean, dry results. When onscreen data needs to be preserved 8½" x 11" (21.6 x 27.9 cm) hard copies are the answer. They're convenient, permanent and easy to work with.

Specifications:

Paper size:

8½ x 11 inches (21.6 x 27.9 cm)

Copy size:

Format A, position I and III, produces an 8.85 x 6.7 inch (22.5 x 17.0 cm) copy, oriented horizontally on an 8½ x 11 inch (21.6 x 27.9 cm) piece of paper. Format B, position II, produces a 7.1 x 5.4 inch (18.0 x 13.7 cm) copy, oriented vertically on an 8½ x 11 inch (21.6 x 27.9 cm) piece of paper [not recommended for 19" (48.26 cm) display tubes].

Copy time:

Approximately 18 seconds for first copy. Additional copies of the same display take about 10 seconds each. 36 seconds for first copy when using position III and 17 seconds for additional copies of same display.

Exposure time:

Position I and II, approximately 7 seconds; position III, approximately 14 seconds.

Warmup time:

10 minutes.

Ambient temperature:

0°C to +35°C is recommended

Power source:

(Factory-wired options)

100 VAC 50-60 Hz

115 VAC 50-60 Hz

120 VAC 50-60 Hz

200 VAC 50-60 Hz

220 VAC 50-60 Hz

230 VAC 50-60 Hz

240 VAC 50-60 Hz

Dimensions:

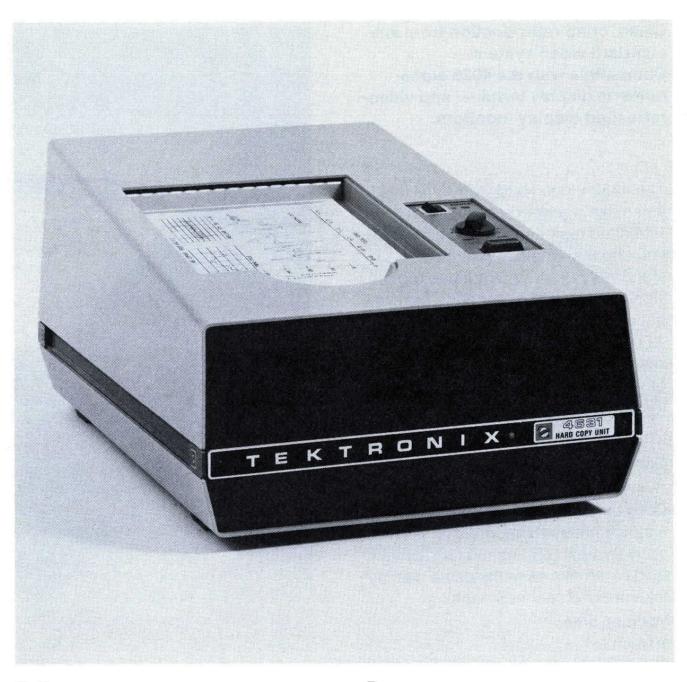
Height—11.6 inches (29.5 cm)

Width—16 inches (40.6 cm)

Length—25.5 inches (64.9 cm)

Weight:

Approximately 65 pounds (29.48 kg)



Options:

Standard accessories:

User's Manual

One 10-foot (3.05 m) Connecting Cable (Part No. 012-0547-00)

Optional accessories:

Service Manual

10-foot (3.05 m) Connecting Cable (Part No. 012-0547-00) \$80.00 20-foot (6.1 m) Connecting Cable (Part No. 012-0548-00) \$115.00 50-foot (15.2 m) Connecting Cable (Part No. 012-0549-00) \$170.00

Paper:

One roll of 3M Type 7770 Dry-Silver paper will be included with each hard copy shipment. Refills may be purchased from Tektronix, Inc. For one roll, order Part No. 006-1603-00. . . . \$50.00 For one carton of 4 rolls, order Part No. 006-1603-01. \$180.00

Remote signal input:

Remote Copy—TTL, a logic level "LO" (>1 msec.) initiates a copy command.

Output signal:

Copy Busy—Open collector low during time plus 3 seconds.

Ordering Information

4631 Hard Copy Unit\$4295

4632 Video Hard Copy Unit

Clean, crisp reproduction from any standard video system. Compatible with the 4023 alphanumeric display terminal and videorefreshed display monitors.

The 4632 Video Hard Copy Unit lets you make paper copies of any video-refreshed raster image at the line rate you choose, whether your input is standard video (TV-type), or a digital video signal. Within seconds, you've got a clean, dry 8½ x 11 inch (21.6 x 27.9 cm) copy of your display, gray scale or black/white, characters or graphics.

Specifications:

Characteristics:

Copy size:

Adjusted to 8.4" x 6.3" (21.3 x 16.0 cm)

Copy time:

Approximately 18 seconds for first copy (typical 525 line, 60 Hz display). Additional copies of the same display take about 8 seconds each.

Warmup time:

10 minutes

Ambient temperature:

0°C to +35°C is recommended

Power source:

(Factory-wired options)

100 VAC 50-60 Hz

115 VAC 50-60 Hz

120 VAC 50-60 Hz

200 VAC 50-60 Hz

220 VAC 50-60 Hz

230 VAC 50-60 Hz

240 VAC 50-60 Hz

Dimensions:

Height—11 inches (27.9 cm)

Width—16 inches (40.6 cm)

Length—25.6 inches (64.9 cm)

Weight:

Approximately 65 pounds (29.48 kg)

Options:



Option 6—Enhanced Gray Scale. \$200
Option 7—Compatible with HP2640
Series terminals. \$100
If not specified, the 4632 will be set up and shipped to operate on 525 line 60 Hz.

Standard accessories:

75 Ohm Terminator

(Part No. 011-0102-00)

User's Manual

Optional Accessories:

Service Manual

Interconnecting Cable, 75 Ohm, BNC, 25 feet (7.6 m)

(Part No. 012-0157-00)\$18

10 ft. (3.05 m), 15 pin interconnecting cable

(Part No. 012-0504-00)\$70 20 ft. (6.1 m), 15 pin interconnecting cable

(Part No. 012-0504-02)\$90

200 ft. (60.1 m), 15 pin interconnecting cable

(Part No. 012-504-03) \$230 For information concerning interface requirements for your particular video application, contact your local Tektronix Sales Engineer.

Paper:

Ordering Information
4632 Video Hard Copy Unit\$4295

File Manager

4907

Low cost mass storage, compatible with the 4051.

Now your 4051 can command a high-capacity, highly reliable mass storage device with built-in file manager and controller. Our 4907 brings together more advanced capabilities and conveniencies than you'll find integrated into any comparable peripheral. Yet its ease of operation and compact design make it a natural companion to 4051 computing.

The 4907 is a direct access, flexible disc device, with a double density read/write feature that enables up to 630,000 byte capacity per disc.

These are many of the major features and capabilities contained within the 4907:

Double-density read/write High-level system software 630,000 bytes per disc total useravailable space

Disc Caching (data buffering) in 15 caches of 256 bytes each

Up to 9 simultaneously open files
Password protected library capability
Implementation of execute-only
(secret) files

ASCII and Binary data and program storage and retrieval

Cyclic Redundancy Checking (CRC) for greater reliability

Named file saves

Dynamic file expansion

Real Time Clock

GPIB (IEEE 488-1975) compatible

As an option, up to two additional disc drives can be connected to one 4907. It is compact enough to fit on a desktop or in a rack mount.

Software commands are extensive, as you'd expect from one of the most talented file managers and mass storage devices on the market.

Specifications:

Technical:

Total number of tracks per disc: 77 max

Number of user-available tracks: 77 max

Number of sectors per track: 32



Number bytes per sector: 256
Total user-available storage per disc: 630,000

Rotational speed: 360 rpm Average access time: 340 ms Transfer time: 4.2 ms/sector

Power requirements:

100 VAC to 240 VAC, 50 Hz to 60 Hz

Power consumption:

200 watts at 120 VAC, 60 Hz Max. 2 amps

Dimensions:

Width—20.26" (51.46 cm) Depth—25.75" (65.41 cm) Height—7.7" (19.56 cm) Weight—60 lbs. (132 kg)

Standard Accessories:

4907 Installation Guide
4051 File Manager ROM Pack
4051 File Manager Operator's Manual
4051 File Manager Pocket
Reference Card
Line Cord
GPIB Cable
1 Flexible Disc
Cleaning Pads

Optional Accessories:

Option 30 — Second disc drive .\$2500 Option 31 — Third disc drive ...\$4000 Flexible discs (10 per package) 4907 Service Manual 4 meter GPIB cable

Environmental Range:

10°C to 35°C (ambient)

Storage temperature:

-30°C to +60°C (without media)

Relative humidity: 20% to 70% (25.5°C max wet bulb temperature)

Heat dissipation: 275 BTU/hr max

System operating temperature range:

Ordering Information

4907 File Manager\$3900

GMA Series OEM Computer Displays

19-inch high-performance modules Graphic and alphanumeric displays with varied storage and refresh capabilities.

The GMA Series is a new display product family designed to provide a glove fit to your OEM application. It achieves this through the blending of storage and refresh technologies, modular construction, and a variety of performance, interface, and packaging options.

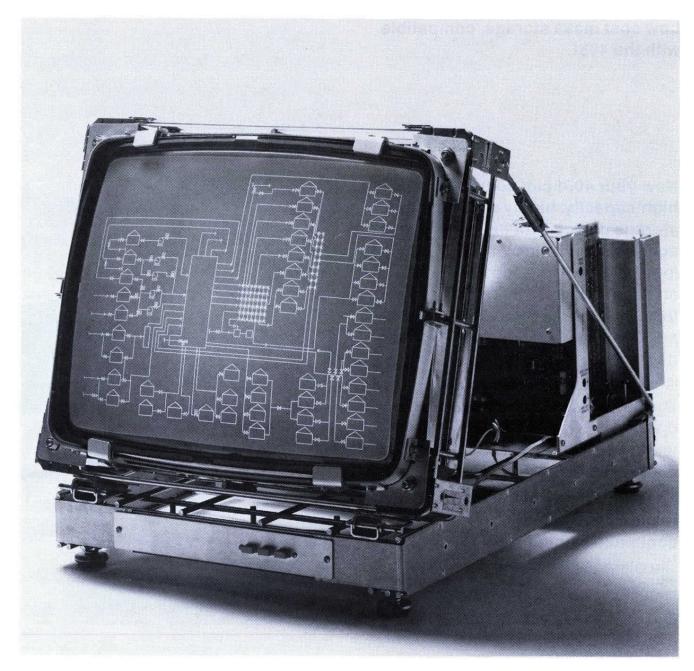
The GMA 101A is the lowest cost 19-inch DVST display available. It is tailored for applications which emphasize storage graphics, with only limited refresh capability. The fast drawing rate of the GMA 101A allows the entire screen to be redrawn in less than one second, permitting effective zooming and panning.

The GMA 102A is designed for the OEM who wants the combined benefits of storage and refresh technologies. Storage mode presents highresolution, high-density graphics at low cost, while the refresh feature adds the benefits of selective erase, interactivity, and dynamic motion with the same high resolution of storage. By placing fixed or finalized data in store while retaining dynamic or working data in refresh, you can achieve highdensity interactive graphics while allowing the computer to address the application rather than support the display. This maximizes computer efficiency and productivity, while reducing memory costs.

The modular construction of both the GMA 101A and 102A allows you to select the exact features you need to get the job done, without paying for unwanted features. You can package the display according to your own system design needs. The wireform chassis permits the display to be vertical or tilted as far back as 15° from vertical and oriented in either the horizontal or vertical (page) format. It also facilitates circuit board removal and overall servicing.

The GMA Series includes many options with such features as:

Illuminated spot overlap (12-bit resolution), which produces smooth vectors of unsurpassed quality.



A high-speed digital interface, which allows easy interfacing to a computer and faster transfer rates.

Front-panel switches for easy operator control of erase, view, and copy functions.

Blue glass filter, which enhances viewability in fluorescent light conditions and enhances display image clarity.

A high-speed vector generator (GMA 102A only), which produces more refreshed vectors without affecting image stability. It also provides bright refresh, virtually as bright as storage for 60 Hz refresh rates.

A high-speed character generator, which allows more refreshed characters per second without affecting image stability, and increases throughout.

Design Characteristics

Crt:

19-inch (48 cm) diagonally measured Direct View Storage Tube

Addressable Area:

10.5 in (26.7 cm) x 14 in (35.6 cm).

Stored Resolution:

Screen center, 80 picture elements per inch (31 picture elements/cm). Screen periphery 70 picture elements per inch (28 picture elements/cm).

Stored Dot Writing Time:

 $5 \mu s$ or less.

Stored Vector Writing Rate:

GMA 101A—3937 in/s (10 cm/ms). GMA 102A—5900 in/s (15 cm/ms).

Refreshed Vector Writing Rate GMA 101A:

(Non-store) 19,685 in/s (50 cm/ms), 650 vector inches (maximum) at 30 frames per second.

Refreshed Vector Writing Rate GMA 102A:

(Write-thru and non-store) 47,240 in/s (120 cm/ms), 1575 vector inches (maximum) at 30 frames per second.

Ordering Information*

Available to qualified OEM buyers only.

*The GMA may not be available in some areas of the world. Consult your Distributor or Representative.

OEM Storage Computer Displays 611/613

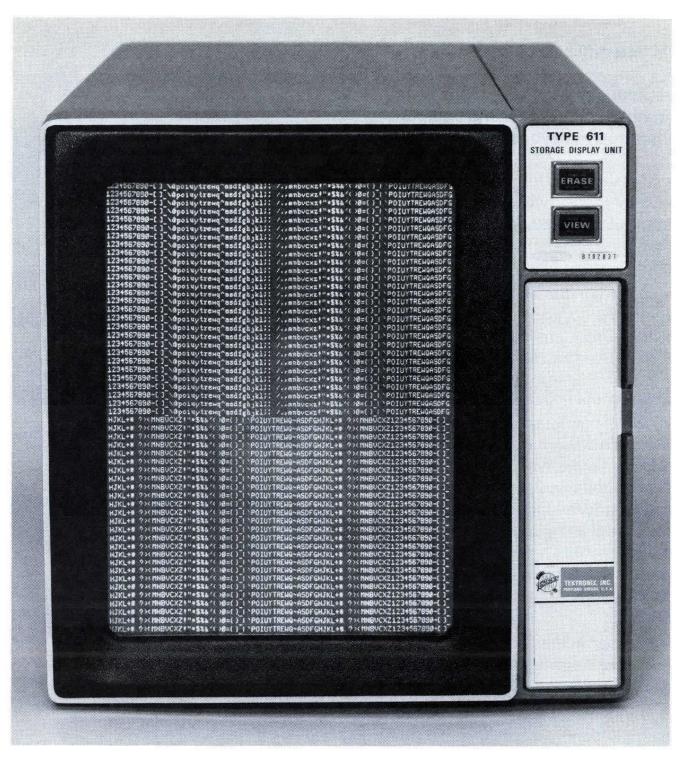
11-inch high information density alphanumeric storage displays.

The 11-inch storage display product family provides a means for the system builder to offer flicker free, high density, high resolution graphics while conserving processing memory. This is a standard benefit of storage displays driven with high performance magnetic deflection systems. Your computer needs to process the display list only once to retain the graphics quality image. Then it can address the application task rather than support refresh of the display.

One product, the 611 display, is specifically designed to be used in those applications requiring high resolution. It is capable of presenting 4000 characters based on a 70 x 90 mil matrix. Basic resolution of the display is 600 x 800 picture elements (short axis x long axis). All 611 control functions are remotely programmable.

The lower priced 613 offers 400 x 532 picture element resolution and a different cabinet styling. Display functions are all remotely programmable and designed to interface to digital TTL logic.

X and Y inputs to both displays are analog, with the writing beam resting at one of nine selectable screen positions with zero volts applied.



Design Characteristics

CRT:

11-inch (27.9 cm) diagonally measured Direct View Storage Tube.

Addressable Area:

611: Horizontal, 5.9 in. (15 cm.); Vertical, 7.9 in. (20 cm.)

613: Horizontal, 7.9 in. (20 cm.); Vertical, 5.9 in. (15 cm.)

Stored Dot Writing Time:

 $5 \mu sec or less.$

Stored Vector Writing Rate:

393/ in/sec. (10 cm/msec)

Refreshed Vector Writing Rate:

(Non-Store) 9842 in/sec (25 cm/msec)

Erase Time:

611: 500 msec or less 613: 900 msec or less

Ordering Information	
611 Storage Display	
(Vertical Format)\$3950	
611-2 Storage Display	
(Horizontal Format)\$3950	
613 Storage Display	
(Horizontal Format)	
613-1 Storage Display	
(Vertical Format)	

31 Programmable Calculator

31 programmable calculator

OEM Scientific Calculators

Complete desk-top calculator with 35 math function keys, and complete alphanumeric keyboard.

The 31 is the desk-top programmable calculator that serves as the controller for graphic calculator systems, instrumentation systems, and is powerful enough to stand alone.

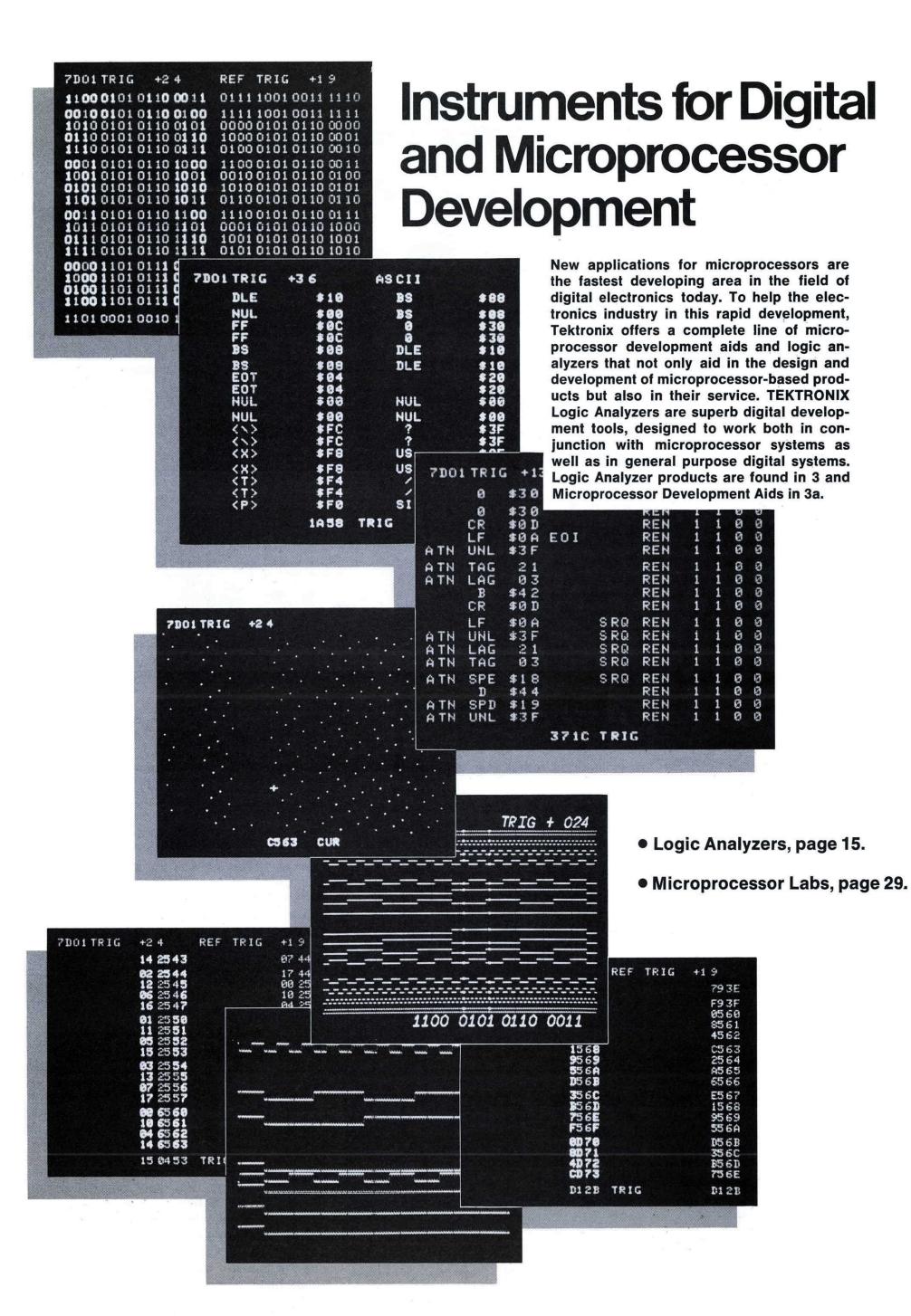
The calculator comes with a 512-step program memory and 74 data storage registers. Programs can be kept on magnetic tape cartridges or on PROM (programmable-read-only-memory). The 31 has the following features: data entry with floating, scientific, or mixed notation, conditional branching, unconditional branching, single-key register arithmetic, indirect addressing, symbolic addressing of subroutines, subroutine nesting, programmable flag, comprehensive editing, and over-range indicator. The 31 display has a 10-digit mantissa with a 2-digit exponent.

The 31 Programmable Calculator also has an optional thermal printer. This printer operates in alpha and numeric characters for two significant benefits. First, for program listing, the printer using English mnemonics lists each program step in sequence. Second, for interactive programs where the program has prompted, the printer can ask the user for specific data input, and titled solutions can easily be produced the same way.

Ordering Information

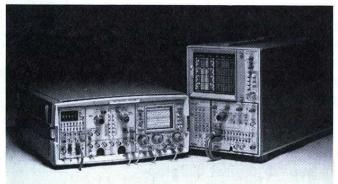
TEK31 Programmable Calculator .\$3350 Option 1 Thermal Printer add \$800





INSTRUMENTS FOR DIGITAL DEVELOPMENT

Logic analyzers represent the latest in a growing product family that is dedicated to solving the special problems encountered in the field of digital design. These problems are those generated when digital equipment exchanges information with other digital equipment over many channels simultaneously.



Tektronix offers high performance logic analyzers from two configurable instrument families.

The logic analyzer decodes electronic signals into data words. This enables the designer to check that his random logic circuitry is performing properly and to isolate trouble areas. It also enables the programmer to evaluate the performance of his software while running on its intended hardware.

Whether in design, service, or production, the logic analyzer is the essential tool for everyone who needs to quickly sort through masses of digital information.

Why consider logic analyzers?

Why can't I use a good oscilloscope instead of a logic analyzer? This is the question most of us ask when first shown a logic analyzer. An oscilloscope is still the best general purpose instrument ever developed for analyzing an electrical signal.

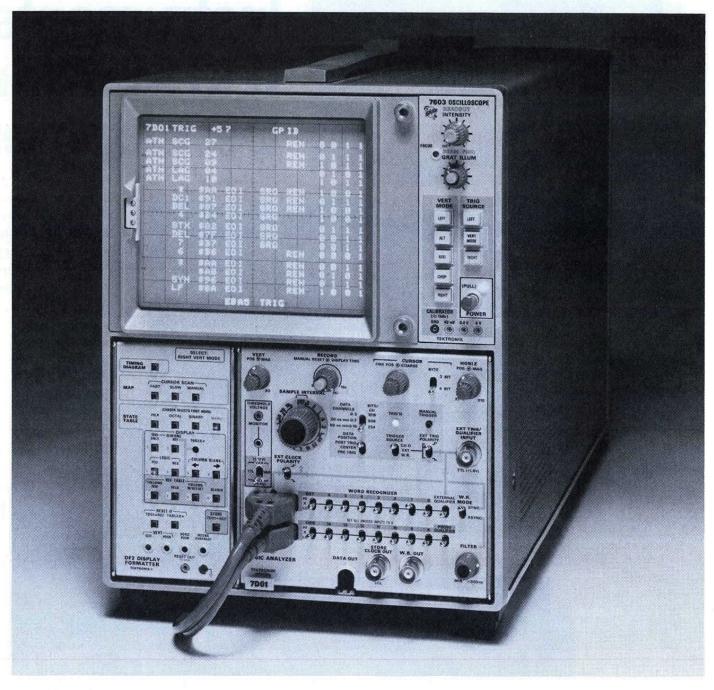
Digital systems, however, depend not on a single electrical signal but on a combination of many such signals. The signal does not carry information; rather, the unique combination of signals at a given point in time conveys digital information, or data. This is why a logic analyzer is necessary.

What does a logic analyzer do?

A logic analyzer does one important thing. It saves you time. In design and development, in service and maintenance, in troubleshooting hardware, in evaluating software, logic analyzers save you time and money by displaying logic in terms of data



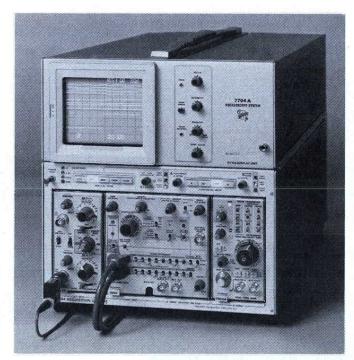
The TM 515 Traveler Mainframe accommodates the LA 501W and an SC 502 Oscilloscope to make a complete logic analysis system for "go anywhere" troubleshooting.



The 7D01 Logic Analyzer with the DF2 Display Formatter converts any 7000-Series Mainframe to a logic analyzer with seven ways to look at logic.

combinations rather than as individual signals.

To analyze signal combinations, a logic analyzer acquires signals from many channels simultaneously, and then, at an appropriate trigger, stores the signals as data levels for later display. Storage holds the data so you can have as much time as you wish for analysis.



The 7D01 Logic Analyzer can be combined with general purpose oscilloscope plug-ins to produce a complete system capable of logic analysis and analog measurements at the same time.

Sequentially shifting data into storage allows you to display data occurring before the trigger. Since the condition you're examining may be the result of earlier data combinations, you may need to look back in time from the trigger point to see what led up to it. This we call the pre-trigger display of data (or, sometimes, negative time) — the unique ability to display data that occurred before an error trigger was generated.

Likewise you can select a trigger point to display data that occurs after the triggerpost trigger display. Or, you can view a balanced display of pre- and post-trigger datacenter trigger display.

But what about that trigger? Since data is the combination of many signals, the trigger event is most likely a combination of signals. A logic analyzer needs word recognition — the ability to recognize a unique data word and generate a trigger when the word occurs.

Word recognition is often the most versatile source of triggering. Any desired parallel word (up to 16 bits) can be selected with front panel switches for Hi, Lo, or X (don't care) conditions on each channel. The word recognizer will then trigger the logic analyzer whenever an incoming parallel word matches the one selected.

The logic company

Logic analyzer systems are available within two configurable instrument families from Tektronix. Each family offers a selection of logic analyzer elements so that you can choose only as much analysis capability as you need. Each set of logic analyzers is compatible with an expanding line of instrumentation components so that you can match your logic analyzer needs to your overall instrumentation needs. In both the 7000 Series of oscilloscope-based instruments and the TM 500 family of configurable multipurpose instruments, you can match your instrument selection to your needs today. And you can expand your system as your needs grow or as we continually add new measurement capability to our equipment families.

You can choose high-performance logic analyzers from either Tektronix instrument family. Both offer:

- 16-Channel Operation to store and monitor signals on up to 16 data lines.
- · Asynchronous Timing Resolution to 15 ns.
- Deep Memory to Store Pre-Trigger Data;
 Formattable with data rates for resolution of timing problems:

Asynchronous:

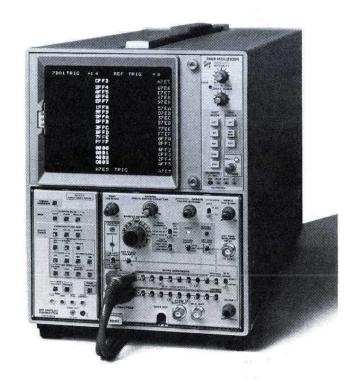
16 channels x 254 bits at 20 MHz 8 channels x 508 bits at 50 MHz 4 channels x 1016 bits at 100 MHz

Synchronous:

Up to 50 MHz

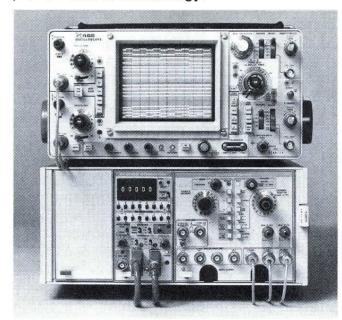
- High Impedance Probes that won't load your circuits.
- Word Recognition using 16 channels and 2 qualifiers.
- Pre-set, variable or split thresholds for working with different logic families.

Both the 7000 Series and TM 500 Family Logic Analyzers use the modular instrument packaging system. Interchangeability of packages within each family lets you mini-



The 7D01F (7D01 Logic Analyzer and DF1 Display Formatter) makes a complete, basic logic analysis system when installed in a 7603 Mainframe.

mize your investment. Both systems are continuing to grow both in logic analysis and general purpose measurements. Today's investment will not become obsolete with improvements in technology.



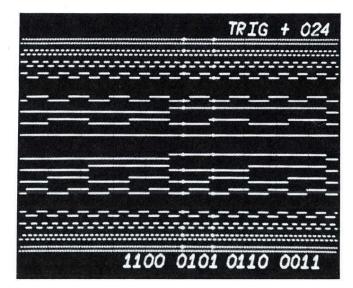
Use virtually any general purpose oscilloscope or X-Y display monitor with the LA 501W Logic Analyzer with Word Recognizer.

TEKTRONIX Logic Analyzers are engineered to provide swift solutions to your logic problems. Tektronix will continue to support your application needs in the digital world of logic analyzers as it has for years in the world of oscilloscopes.

7000-Series Logic Analyzers

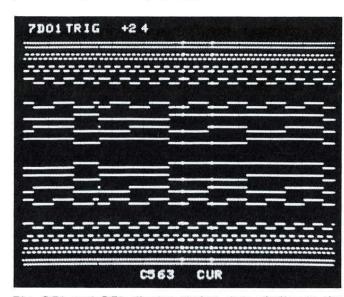
Plug-in compatibility within the family enables you to convert any existing 7000-Series Oscilloscope Mainframe into a high-performance logic analyzer. Conversely, the logic analyzer system (mainframe and logic analyzer plug-in) which you buy today can be converted later to a high-performance oscilloscope or spectrum analyzer merely with the addition of a plug-in or two. Consequently, your equipment investment is safe longer, and upgrading is cheaper than it would be with monolithic instruments.

The heart of the 7000-Series Logic Analyzer System is the 7D01 Logic Analyzer. This versatile plug-in acquires 16 channels of data simultaneously, contains its own 16-bit parallel word recognizer with two qualifiers, has a formattable memory that stores 4096 bits in 4, 8 or 16 channel format, captures



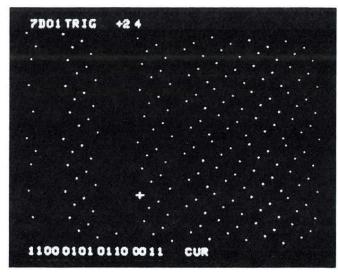
The 7D01 displays 16 channels of timing information, intensifies a movable cursor point on the data stream and displays its location and binary state equivalent on the crt.

single shot data, features a movable cursor and comes equipped with two high-Z probes plus many other features.



The DF1 and DF2 display timing data similar to the 7D01 except that state readout can be binary, hex or octal (plus IEEE 488/GPIB and ASCII in the DF2) as desired, and that the mainframe need not be equipped with crt readout.

Until recently, logic analyzers have been display limited. To choose each different display format, you needed to choose a different instrument. Now, with addition of the DF1 and DF2 Display Formatter to the 7D01 Logic Analyzer, you have numerous display formats.



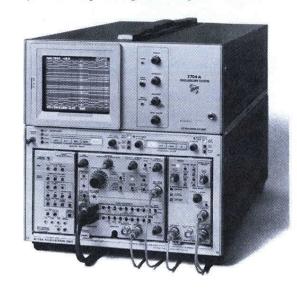
The data map display produced by the 7D01 in association with the DF1 or DF2, is reformatted for full screen display whether you use 4, 8, or 16 data channels.

TEKTRONIX Display Formatters offer you a choice as to the type of display that is best for you. The DF1 gives you five ways to look at logic in one package — Timing, Mapping and state table displays in Binary, Hexadecimal and Octal. The DF2 offers the same five display formats plus two additional modes - IEEE 488/GPIB (General Purpose Interface Bus) and ASCII (American Standard Code for Information Interchange) formats. With both the DF1 and DF2 you can use the map display for an overview of digital system performance. Whether you use 4, 8, or 16 channels, the Tektronix map is reconfigured for a full screen matrix. Or select a state table with binary, hexadecimal or octal words. Or display your data on a timing or ladder diagram for close examination of timing relationships between data lines.

Logic Analyzers

With the DF2, you can display data in ASCII format and even monitor and display activity on a GPIB data bus in GPIB mnemonics.

Another Logic Analyzer Plug-in, the DL2 Digital Latch, extends the 7D01 Logic Analyzer's measurement capability by detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone.

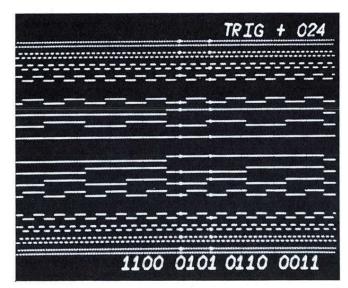


When combined with a 7D10 Digital Events Delay in four-compartment mainframe, the 7D01F System (or the 7D01 and the DF2) obtains additional triggering flexibility, whereby the trigger of the logic analyzer can be delayed by up to 107 events.

7D01 LOGIC ANALYZER

The 7D01 is a dual-wide, plug-in instrument which occupies one vertical amplifier compartment and an adjacent time base compartment in any 7000-Series Oscilloscope Mainframe. With such compatibility, you can convert your existing 7000-Series Oscilloscope to a logic analyzer, or, if you use a four-compartment mainframe, you can combine your logic analyzer with your analog oscilloscope and display the outputs of both at the same time.

In order to get efficient use of the memory at all times, the 7D01 memory is formatted according to the number of input channels used. You can select: 16 data channels of 254 bits each at a 20 MHz sample rate, 8 data channels of 508 bits each at a 50 MHz sample rate, or 4 data channels of 1016 bits each at an asynchronous sample rate of 100 MHz, or a synchronous sample rate of 50 MHz.



The 7D01 displays up to 16 channels of timing data along with the binary state and location of the word at the movable cursor position.

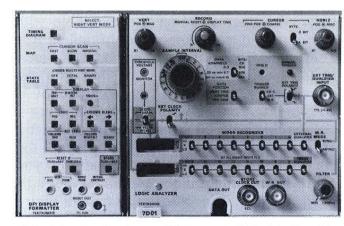
Four methods of obtaining a trigger to store and display data are available. First, you can use the manual trigger button as a trigger source even if no data has been acquired so that you can center the traces and set intensity levels. Second, a trigger can be generated by the first positive-going transition on data channel 0 (CH 0 position). Third, trigger (of either polarity) can be received through a front panel BNC Jack (EXT position). Or fourth, a trigger can be generated by a unique data combination using the word recognizer (W.R. position).

The word recognizer produces an output when the logic states of the input channels match the states of the corresponding word recognizer switches. Probe qualifier and external qualifier functions select the logic state of external signals that can aid in word recognition. A variable filter (10 ns to 300 ns) inhibits word recognizer output to prevent false triggering from glitches or data skew. The store clock out BNC provides the sampling clock, external or internal, at the front panel for interface with digital delay, frequency counters or other external test equipment.

Data displays can feature data which occurs before the trigger (PRE TRIG selection), data which occurs after the trigger (POST TRIG), or data balanced between pre-trigger and post-trigger (CENTER position selection).

The trigger location is displayed with a column of intensified dots, one on each channel. A second column of intensified dots is positioned anywhere on the display with a movable cursor (COARSE cursor moves the dots in increments of 16 sample intervals or data clocks; FINE POS moves it in single increments). An alphanumeric readout at the top of the display locates the cursor relative to the trigger (in sample or clock intervals). A second readout at the bottom of the display identifies the data word at the cursor location, in binary, hexadecimal or octal. For your convenience in reading the display, the binary state word can be grouped into 3-bit or 4-bit bytes at your selection.

Data is acquired by the 7D01 through two P6451, 10-channel, high-impedance, active probes. Each probe has eight data input channels, an external clock or qualifier channel and a ground lead. In order to minimize loading on test circuits, probe impedance is 1 M Ω paralleled by 5 pF. Grabber tips conveniently clip onto adjacent DIP leads, or by removing the grabber tip. the probe leads connect directly to 25-mil pins. Logic input thresholds can be selected at a pre-set TTL level or at any variable level between ±12 V. Additionally, one probe may be set to TTL, while the threshold of the other is varied. To assure you've selected the proper level, the threshold voltage can be continuously monitored at a front-panel jack.



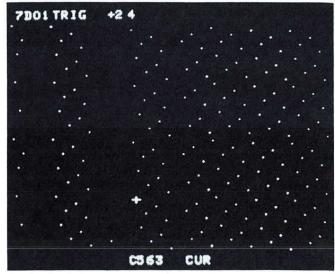
7D01F Logic Analyzer (7D01 and DF1 Display Formatter).

There are two Display Formatters available with the 7D01 Logic Analyzer—the DF1 and DF2. The two are identical in features and function except that the DF2 offers two additional display formats. Both the DF1 and DF2 offer Timing, Mapping and state table displays in Binary, Hexadecimal and Octal formats. The DF2 offers additionally formats for IEEE 488/GPIB and ASCII.

Each Display Formatter is a dedicated plugin for use with the 7D01. It occupies one vertical compartment adjacent to the 7D01 in the 7000-Series Mainframe, but does not function by itself — it connects to the 7D01. In formatting the logic display, the Display Formatter provides complete alphanumeric character generation so that the logic analysis package can be used in mainframes without crt readout (Option 01). For dedicated logic analyzer packages, this saves you \$400.

The timing diagram formatted by the Display Formatters is virtually identical to that of the 7D01 except that the state display of the cursor word may be presented in binary, hexadecimal or octal. (The DF2 offers additionally formats for IEEE 488/GPIB and ASCII.)

Map Mode



Both the DF1 and DF2 display a formatted map with up to 64K unique data word locations (254 can be displayed at one time) in a dot matrix according to value.

The map mode is used to display unique data words in memory. Up to 254 data words can be displayed at one time in a dot matrix according to value. The least significant half of the word determines the horizontal location of a word while the most significant half determines the vertical location.

In FAST or SLOW modes a "+" symbol automatically scans the map data, moving from point to point in the same order in which data was loaded into memory. A state display beneath the map (binary, hexadecimal or octal) shows the word at the "+" symbol location. In MANUAL mode the "+" symbol is manually moved across the map using the 7D01 cursor control. The cursor location in memory is displayed at the top of the display in all map modes as it is for the timing diagram.

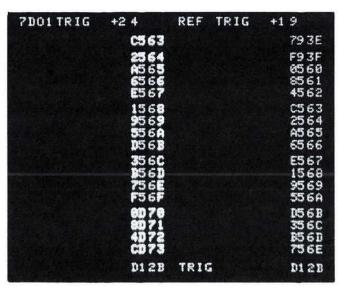
A significant feature of the Display Formatter map is that it is formatted. That is, if 16 channel operation is selected, the map can display up to 64K unique data word locations (254 at one time). However, if only 8 channels are selected, the map is reformatted to use the entire display area for 8-bit words (a 4-bit by 4-bit matrix); similarly, the map is reformatted for full crt use if 4-channel operation is selected.

State Display Mode

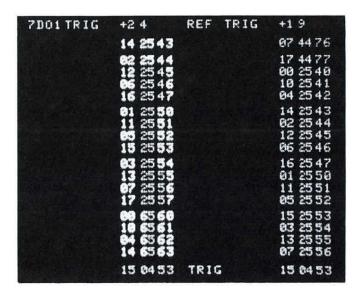
7D01TRI	+2	4	
11000101	0110	0011	
00100101 10100101 01100101 1110010	0110	01 0 1 01 1 0	
0001010 1001010 0101010 1101010	0110	1001	
0011010 1011010 0111010 1111010	0110	1101	
0000 110 1000 110 0100 110 1100 110	0111	0001	
1101000	0010	1011	TRIG

The DF1 and DF2 display a binary state table consisting of the word selected by the cursor and the 16 following words. The 18th word at the bottom is the trigger word.

With the Display Formatters, you can display state information in the format best suited to your application: binary, hexadecimal or octal. (The DF2 offers additionally formats for IEEE 488/GPIB and ASCII.) Each display presents 17 data words. An 18th word, the trigger word, is displayed at the bottom of the crt. When the trigger word occurs on the display, it flashes.



The DF1 and DF2 can display and compare new hexadecimal state data (on left) with stored reference data (on right).



The DF1 and DF2 can display octal state data for convenience to operators who prefer to work in octal-based systems. In this display new octal information (on the left) is being compared with stored reference data (on the right).

The memory stores 254 bits in 16-channel operation, 508 bits in 8-channel operation and 1016 bits in 4-channel operation. The state table (or page of data) that is displayed is selected by the cursor position. The cursor is used to page through all this data stored in memory in varying increments. Cursor FINE POS steps through data displays one word at a time. Similarly, COARSE cursor control moves the display 16 words at a time. Cursor location, relative to the trigger word, is displayed at the top of the crt.

EXCLUSIVE OR(+)

The 7D01 and DF1 or DF2 logic analysis package offers an EXCLUSIVE OR + feature that is used to compare newly acquired 7D01 data with reference data stored in the DF1 or DF2.

7DOLTRIG	-1.4	REF	TRIG	-1	4
011100100	0000 11 10	0111	00100	0100	1110
011100111 011101000 011101011 011101100	0010 11 10	0111	0011 0100 0101 0110	010	11 10 11 10
0111 0111 1 0111 1000 0 0111 1001 1 0111 1010 0	0001 11 10	0111	0111 1000 1001 1010	1001	1110
01111011 01111100 01111101 01111100		0111	1011 : 1100 (1101 : 1110 (0011	
01111111 1000 0000 1000 0001 1000 0010	0000 0001	1000	1111 0000 0001 0010	1000	0001
1000 0000	0000 0001		+1:	3 RE	SETS

The RESET IF feature automatically monitors and detects intermittent faults that may occur in the system under test. The DF1 and DF2, in combination with the 7D01, does this by automatically acquiring up to 4096 bits of data and comparing it to 4096 bits of stored reference data. If a mismatch occurs between memories, the display formatter intensifies the differences so you know exactly where the fault is located.

Both the DF1 and DF2 have 4K memories which permit reference data to be stored and displayed on the crt side by side with 7D01 data for easy comparison. Older or reference data is displayed on the right side of the crt and newer 7D01 data is displayed on the left. With the EXCLUSIVE OR + feature you can display one page of memory at a time and any differences between the two state tables will be intensified in the 7D01 table. If there are no differences the TABLE = indicator will light.

There are also two modes of automatic data acquisition in both the DF1 and DF2 that automatically compare the entire 7D01 memory to the reference memory. If a difference is detected in the RESET IF 7D01 = REF memory mode, the difference and location will be read out at the top of the 7D01 state table, intensified in the 7D01 table itself, and the number of resets required to find the error also displayed. The RESET IF TABLES=memory mode performs the same function except that it compares only the two tables selected by the cursor control one to another.

An additional feature, column blanking, gives you the ability on state displays to remove unwanted data, column by column, out of all compare functions. This permits you to concentrate your search for data by eliminating columns of data that are not relevant.

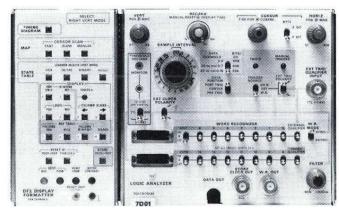
Four other features that augment each of the state displays are: reference table follows 7D01, reference table held, reference table follows with offset, and search.

When the reference table follows the 7D01, both tables begin at the same cursor location so that you can make comparisons between both 4K memories, one page at a time.

When the reference table is held, the cursor moves the 7D01 data display and holds the reference table so that you can compare one page in reference memory to any page of the new data. The amount of offset between the two tables is evident from the cursor locations displayed above both tables. Once an offset is selected in the HELD mode, the selection of FOLLOWS WITH OFFSET maintains a constant offset between the two tables. The cursor moves both displays keeping the offset constant.

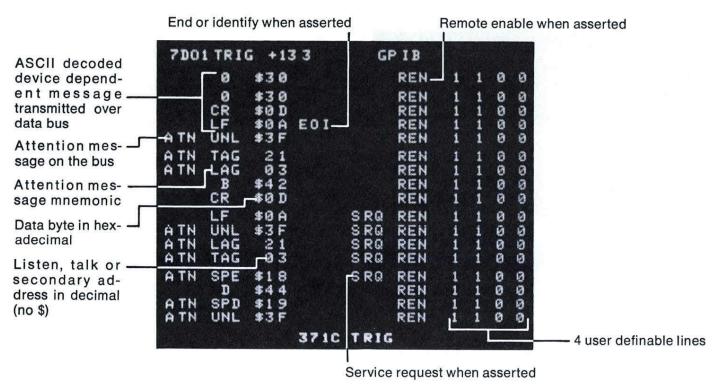
Search mode allows you to automatically scan the 7D01 memory for a word that you have stored in reference memory. This is accomplished by positioning the desired word to the first word in the reference state table. Pressing the SEARCH button will cause the Display Formatter to scan the 7D01 memory for that word. If it locates the word, it positions it to the first word in the 7D01 state display and reads out its location at the top of the crt. This operation is repeated each time the SEARCH button is pressed.

DF2 Display Formatter



7D01 Logic Analyzer with DF2 Display Formatter.

Logic Analyzers



The GPIB mode monitors and displays activity on the GPIB data bus, transfer bus (handshake lines), and management bus (control lines). Disassembled instructions are displayed on the crt in IEEE 488 message mnemonics familiar to the GPIB user.

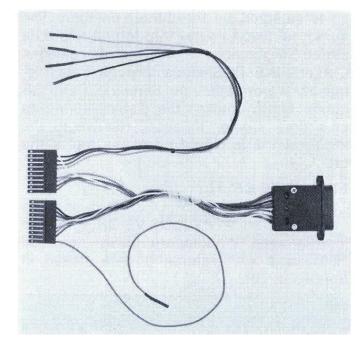
The DF2 Display Formatter is a second generation companion plug-in to the 7D01 Logic Analyzer and offers the digital designer a choice of seven display formats. Containing all of the features and functions found in the DF1 (including Timing, Mapping and state table displays in Binary, Hexadecimal and Octal), the DF2 provides two additional operational modes. These two modes are a format for ASCII and for IEEE 488/GBIB.

These two modes are selected from the DF2 front panel by pressing the MENU button. Pressing MENU will initiate a list of numbered items and display them on the crt. These numbered items are marked on the front panel from 1 to 10 (only 1 and 2 are now used).

Pressing button 1 (with the GPIB Probe Adapter connected to the leads of the P6451 Probe) will display on the crt the disassembled instruction in IEEE 488 message mnemonics familiar to the GPIB user.

Information is acquired synchronously using the data valid (DAV) line as a clock. Up to 256 instructions are stored in the 7D01 Logic Analyzer, then disassembled and displayed in format. Up to 18 instructions are displayed at one time, and, as the data is scrolled, all 256 instructions can be viewed. The states of four GPIB management lines (ATN, EOI, SRQ and REN) are displayed in GPIB mnemonics and eight data lines are displayed in hexadecimal or decimal. Four additional lines of data are user definable to provide circuit information and are displayed in binary. This display enables you to monitor and display activity on the GPIB data bus, transfer bus (handshake lines) and management bus (control lines).

Because the DF2 is attached to the 7D01 Logic Analyzer, timing information relative to the handshake lines can be displayed with 10 ns resolution. This allows you the capability of not only checking the sequence of handshake activity but measuring the time relationships as well.



IEEE 488 standard connector with quick connections to P6451 Probe.

A 24-pin GPIB adapter provides the monitoring of the GPIB bus. Using this adapter, the DF2 is stacked on the system as any other piece of GPIB equipment. With this adapter, the DF2 monitors the bus activity and pro-

7DO1 TRIG	+2 6	ASCII	
STX	@202	ETX	8003
STX SUB DC2 DC2	@202 @232 @022 @022	EOT (D) (E)	@004 @057 @144 @145
DCS DCS DCS DCS	@022 @022 @022	<u> <i> <c> <e></e></c></i></u>	@166 @151 @143 @145
DCS DCS DCS DCS	@022 @222 @222 @222	NUL NAK DC4	@000 @025 @024 @045
DC2 DC2 DC2	@222 @222 @222 @222	ENQ <p> ?</p>	@005 @160 @077 @046
	070222	TRIG	

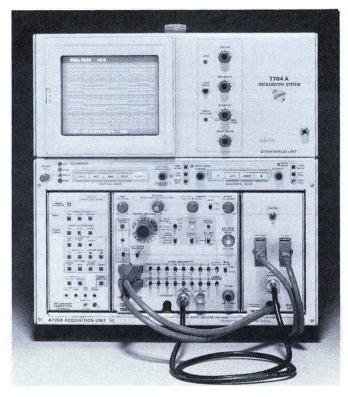
This mode displays stored data in an ASCII format. The ASCII characters are further decoded into hexadecimal (\$ precedes decode), octal (@ precedes decode), or binary. The decode of the ASCII character is determined by the state table mode previously selected.

vides for monitoring of four user-selected lines. The logic analyzer may be triggered via the word analyzer GPIB lines or external event; the user may observe events prior to as well as following the trigger.

Pressing button 2 will provide a representation of the data recorded in the 7D01 memory in all 128 possible ASCII characters. The appropriate ASCII character will be displayed in 8 or 16 channel along with the binary, octal, or hexadecimal value to the right of the character.

Digital Latch

The DL2 Digital Latch extends 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 Latch can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

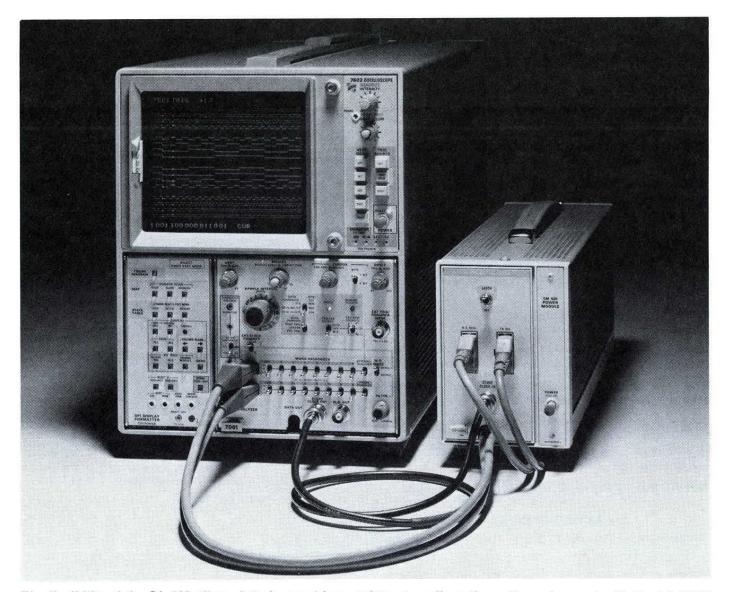


The DL2 Digital Latch extends the measurement capabilities of the 7D01 Logic Analyzer by detecting glitches which are narrower than one sample interval.

In asynchronous measurements without latching capability, high speed data anomalies go undetected if they do not appear on a clock edge. The DL2 Digital Latch allows you to expand the time frame in which information can be stored by sampling at a slower rate. The DL2 captures the glitch (or pulses which are narrower than one sample interval), holds it until the next clock edge, then expands it to one sample interval for display.

The DL2 plugs into any compartment of a 7000-Series Mainframe. Two 25-pin connectors connect the DL2 with the TEKTRONIX 7D01 Logic Analyzer. Data is acquired via the P6451 Probes which plug into the front panel of the DL2.

A two position switch allows you to select either the LATCH input mode or OFF. An asynchronous clock input is required from the STORE CLOCK OUT of the 7D01 Logic Analyzer to the STORE CLOCK IN of the DL2.



The flexibility of the DL 502 allows it to be used in a variety of configurations. It can be used with the LA 501W in all TM 500 Mainframes or as a companion to the 7D01 Logic Analyzer (as it is depicted above).

Whether you select the 7D01 Logic Analyzer or any of the combinations (7D01F, consisting of the 7D01 and DF1) or the 7D01 and DF2, you can choose any 7000-Series Mainframe for a powerful logic analysis system that is fully compatible with an extensive oscilloscope measurement system. Performance characteristics of the 7D01, DF1, DF2 and DL2 are listed here. Characteristics of the mainframes may be found on pages 45 through 62.

7D01 CHARACTERISTICS

The 7D01 acquires 4, 8, or 16 channels of data and stores the data in a 4k memory. Data storage format is selectable as 4 channels x 1016 bits, 8 channels x 508 bits, or 16 channels 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 channel mode, up to 50 MHz in the 8 channel mode, or up to 20 MHz in the 16 channel mode. External sampling clocks up to 50 MHz can be used in the 4 and 8 channel modes, and up to 25 MHz in the 16 channel mode.

An invalid light (blinking light behind knob skirt) warns the operator that he has selected:

- A sampling rate greater than 20 MHz in the 16 channel mode; or
- 2. A sampling rate greater than 50 MHz in the 8 channel mode.

SIGNAL INPUTS

Clock, Qualifier, and Data Input Source — Two multilead P6451 Probes provide connections for 10 channels (9 input and ground) each. Channels 0-7 and clock are through probe 1, and channels 8-15 and qualifier are through probe 2. Each probe attaches through a 25-pin connector at the 7D01 front panel.

Input Impedance — 1 $\mbox{M}\Omega$ paralleled by 5 pF (at probe head).

Threshold at Probe Tips — Front panel switch selects fixed TTL ($\pm 1.4 \text{ V} \pm 0.2 \text{ V}$), variable ($\pm 12 \text{ V}$) 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 — -60V or less, to at least threshold voltage plus 10 V. (Max non-destructive input ± 60 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*	Min. 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	Max. 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.

INTERNAL CLOCK

Crystal Oscillator Frequency — 100 MHz ± 0.005 MHz.

Sample Intervals — 10 ns to 5 ms/sample in a 1-2-5 sequence.

Store Clock Out Connector — Sampling clock is output during store cycle. This clock may be either the internal or external clock. ECL Level. Reverse terminated in 50 Ω . Do not terminate at receiving end.

WORD RECOGNIZER

Word Recognizer — 16 data inputs, Probe Qualifier and External Qualifier. Output is true when input conditions match settings (HI, X, LO).

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

Inputs — 16 data input channels plus 2 qualifiers.

Qualifiers — Can be used to recognize 18 bit words.

Word Selection — Made using eighteen 3-position toggle switches. Positions are HI, X (don't care), and LO.

Modes — Synchronous (looks for a match with the selected logic states only at an external clock edge) and asynchronous (looks for a match with the selected logic states at any time).

Synchronous Mode

Characteristic	Time 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.

Trigger Marker — Trigger position on crt display is marked by an intensified spot. Spot appears on all displayed channels.

DATA POSITIONING

Three position switch selects between pre-trigger, center-trigger, and post-trigger modes. In the pre-trigger mode $\approx\!90\%$ of the displayed data occurs before the trigger and $\approx\!10\%$ after. In the center-trigger mode $\approx\!50\%$ of the data occurs before the trigger and $\approx\!50\%$ occurs after. In the post-trigger mode $\approx\!10\%$ of the data occurs before the trigger and $\approx\!90\%$ after.

Logic Analyzers, Display Formatters, and Digital Latch for 7000 Series

CURSOR

Word Selection — Cursor appears as a moveable 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 \pm 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).

Cursor Byte Display — The two-position CURSOR BYTE switch selects the display format of the cursor readout to either a 3-bit or 4-bit byte. In 16 channel/3-bit byte format, the most significant byte group remains 4 bits.

DISPLAY

Type — Data is displayed as a timing diagram. The number of sample intervals between the trigger and the word selected by the cursor appears as an alphanumeric readout. The word selected by the cursor is displayed as ones and zeros in 3-bit or 4-bit groups.

Display Time — A rotary control is used to select the time for which stored data will be held for display before a new record cycle starts. Variable from less than 1 s to at least 10 s. A detent position provides indefinite storage of data. A new record cycle can be started at any time by pushing the MANUAL RESET button.

Vertical Display Controls (VERT POS/MAG) — A variable vertical magnifier control magnifies the on-screen display from X1 to X5. A concentric vertical position control positions the display within the graticule area.

Horizontal Display Controls (HORIZ POS/MAG) — A variable horizontal magnifier control magnifies the on-screen display from X1 to approximately X9. A concentric horizontal position control positions the display within the graticule area.

Display Format — Selectable by a switch (DATA CHANNELS).

Format	Bits/Chan	Display
Chan 0-3	1016 bits	1 group of 4 traces
Chan 0-7	508 bits	2 groups of 4 traces each
Chan 0-15	254 bits	4 groups of 4 traces each

Crt Retrace Blanking Time —

Format	Bits Blanked
Chan 0-3	8 bits
Chan 0-7	4 bits
Chan 0-15	2 bits

Trigger Intensified Marker — Intensified zone indicating the trigger point, selectable by a switch (DATA POSITION).

Data Position Switch Setting	Intensified Zone Location	
Pre-trigger	Near extreme right of display	
Center-trigger	Near center of display	
Post-trigger	Near extreme left of display	

Trigger Intensified Marker Accuracy — Position of intensified zone with respect to word recognizer output.

Sample Interval Maximum Control Setting Bit Error	
10 ns	±4 bits
20 ns	±3 bits
50 ns to 5 ms	±1 bit

DATA OUTPUT

Connector — A 25-pin connector (inside 7D01) provides output of stored data from the 7D01. It also provides control signals necessary for transfer of that data to other equipment. All outputs are ECL levels.

Parallel Data — 16 pins provide parallel access to stored data.

Serial Data — One pin provides serial access to stored data.

Flag — A positive-going edge on this pin indicates the end of each channel.

Format — 2 pins are used to identify the stored format as 4 channels x 1016 bits, 8 channels x 508 bits, or 16 channels x 254 bits.

Frame — Occurs every 16th sweep. A positive-going edge indicates end of channel 3. Negative during channel 3.

Display/Store Mode — Store HI Display LO

Trigger Marker Output — LO = marker point in data stream

External Display Clock Input — Allows data output at externally selected rates 1 Hz-2 MHz.

POWER

Line Voltage Ranges — Determined by the 7000-Series Oscilloscope Mainframe.

Power Consumption — 32 W at nominal line voltage.

ENVIRONMENTAL

Temperature — Operating: 0° C to $+40^{\circ}$ C. Nonoperating: -40° C to $+75^{\circ}$ C.

Altitude — Operating: to 15,000 feet. Nonoperating: to 50,000 feet.

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, ½ sine, 11 s duration, 2 shocks in each direction along 3 major axes, for a total of 12 shocks.

INCLUDED ACCESSORIES

Two, P6451 Data Input Probes (010-6451-00).

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 488/GPIB. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

INCLUDED ACCESSORIES

GPIB Probe Adapter 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.

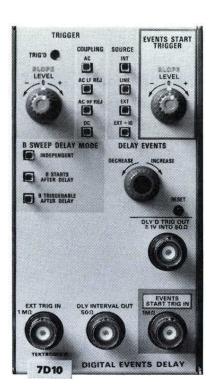
Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock—20 ns.

ORDERING INFORMATION

7D01F Logic Analyzer (7D01 and
DF1 Display Formatter)\$4390
7D01 Logic Analyzer
DF1 Display Formatter\$1395
DF2 Display Formatter\$1945
DL2 Digital Latch \$1500
7603 Oscilloscope*\$2050
7603 Option 01
(Deletes one readout board) Sub \$400
7704A Oscilloscope*\$3325
7704A Option 01
(Deletes one readout board) Sub \$400

*See pages 45 through 62 in this catalog for details on these and additional 7000-Series Mainframes. See pages 63 through 80 for details on complementary 7000-Series Plug-ins.



7D10 Digital Events Delay

The 7D10 or 7D11 let you add delay to your 7D01 Logic Analyzer trigger. The 7D11 has all of the features of the 7D10, plus it delays by time as well as digital events. Both units provide a trigger pulse output upon counting a preselected number of digital pulses.

For example, you can start the delay counter with the W.R. out pulse, count some number of clock pulses, and then supply an external trigger to the 7D01. See page 71 for complete details.



7D11 Digital Delay



DD 501 Digital Delay

Delay by Events Counting Rate to 65 MHz
Divide by N Mode with Counting Rate to
20 MHz

Delays by up to 99,999 Events Companion Unit for Any Logic Analyzer

The DD 501 provides delay by events in a plug-in for TM 500 Mainframes. Using five thumbwheels on the control panel, the operator can set any desired delay from 1 through 99,999 events. When the number of input events reaches the preset count, the DD 501 will put out a trigger pulse which can be used for triggering a logic analyzer, oscilloscope, or counter.

The logic analyzer memory window is easily delayed from the trigger by a selected count using the DD 501.

Because the DD 501 creates its delay by counting a number of pulses rather than by analog timing of an interval, jitter is not a problem, even when viewing pulses toward the end of a long train. Events can be counted at frequencies up to 65 MHz. With the selected number of events clearly displayed on the thumbwheel dials, the operator knows at all times what part of a pulse train he is viewing on the accompanying logic analyzer or oscilloscope.

Digital Events Delay Digital Delay Digital Delay

7D10 7D11 DD 501

EVENTS DELAY

Count - 1 to 99,999 events.

Max 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 M Ω , 20 pF.

Slope — Either + or -, selectable.

Sensitivity - 85 mV p-p @ 30 MHz.

Frequency Response — Up to 65 MHz at 120 mV sensitivity.

Minimum Detectable Pulse Width - 5 ns.

Threshold Level Range — From -1.5 V to +1.5 V (-15 V to +15 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 (\simeq 5 mA).

Light — Indicates output trigger.

GENERAL

Temperature — Operating 0° C to $+50^{\circ}$ C. Non-operating: -40° C to $+75^{\circ}$ C.

Altitude — Operating: to 15,000 ft; Nonoperating to 50,000 ft.

Shipping Weight — 3 lb.

Dimensions — 2.6 in wide, 5 in high, 12.2 in deep $(6.6 \times 12.7 \times 31 \text{ cm})$.

ORDERING INFORMATION

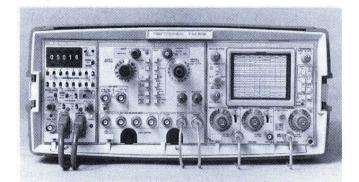
DD 501 Digital Delay *\$750

*The DD 501 must be plugged into a TM 500 Mainframe to achieve a working unit.

Logic Analyzers

Logic Analyzers, Word Recognizer and Digital Latch for TM 500 Series

Configurability and portability are the key concepts for every instrument in the TM 500 Family. The LA 501W Logic Analyzer System, made up of the LA 501 Logic Analyzer and the WR 501 Word Recognizer, for example, can be used with any 50 kHz bandwidth oscilloscope or X-Y monitor. This means you probably can use your present oscilloscope to display logic. Since the oscilloscope is externally coupled, you can leave your logic analyzer (not connected to the oscilloscope display) alone with your digital system, waiting in a baby-sitting mode, for a fault to occur. Baby-sitting becomes easier and cheaper using the LA 501W, and it frees the designer for more important tasks. Only when the logic analyzer has acquired and stored sufficient data do you need to connect your oscilloscope for logic display. In the meantime, your oscilloscope has been free for other uses.



An LA 501W Logic Analyzer includes word recognizer combined with an SC 502 Oscilloscope in a TM 515 Traveler Mainframe to produce a "go anywhere" logic analyzer system.

Using the TM 515 Traveler Mainframe, your logic analyzer becomes a "go anywhere" system. This fully portable power module/mainframe can accommodate not only the LA 501W Logic Analyzer System, but an oscilloscope as well. As a traveling test station, your oscilloscope retains its general purpose usefulness; it becomes dedicated to the logic analyzer only when you choose to display data.

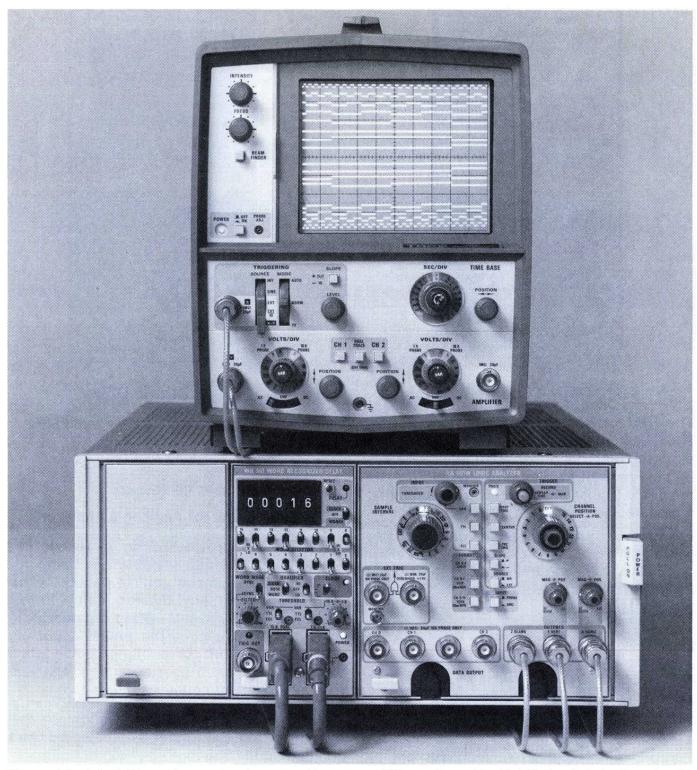
Another unique feature of logic analysis in the TM 500 Family allows triggering from a different set of 16 channels than the 16-data lines being displayed. For example, you can display the contents of a data bus, but trigger from an independent address bus. Additionally, you can select a delay of up to 99,999 clock pulses or word triggers before the LA 501W receives a trigger.

A feature that extends the LA 501W Logic Analyzer's measurement capability is the DL 502 Digital Latch. It can detect narrow pulses in a data stream that cannot be captured by a logic analyzer alone.

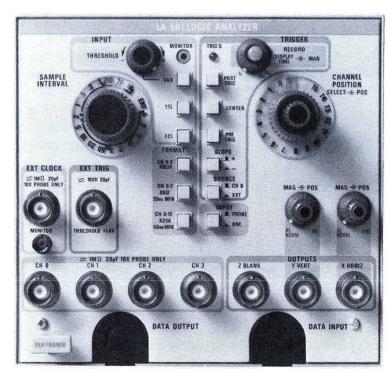
LA 501 Logic Analyzer

The LA 501 Logic Analyzer is a dual-wide, plug-in instrument that operates in any TM 500 Series Power Module Mainframe. It is normally used in conjunction with the WR 501 (to form the LA 501W Logic Analyzer System) but also may be operated separately when triggers are available from the system under test.

The LA 501 or the WR 501 may be purchased



The modular LA 501W can be used with any oscilloscope or X-Y monitor with 500 kHz bandwidth. Here its display is shown on a low-cost T922.

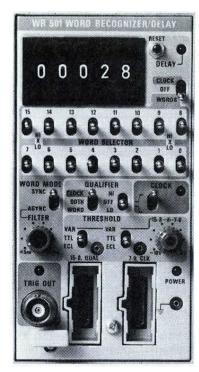


LA 501 Logic Analyzer

and operated separately. The LA 501 is a good choice in logic analysis when triggers are readily available from the system under test. The LA 501, when purchased separately, comes with a P6450, 16-channel passive probe.

For minimal circuit loading when using the LA 501 above, four front-panel BNC connectors provide high impedance inputs for 10X probes. They drive channels 0 through 3 when the input selector is in the BNC position.

Logic Analyzers, Word Recognizer and Digital Latch for TM 500 Series



WR 501 Word Recognizer with Digital Delay

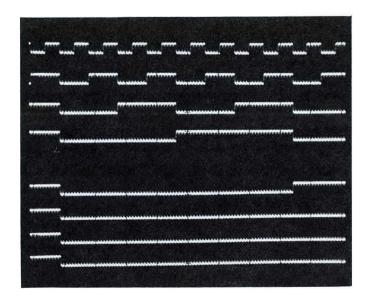
The WR 501 is a 16-bit parallel Word Recognizer with digital delay that produces trigger pulses when a preselected word occurs. It occupies one plug-in position in any TM 500 Series Power Module Mainframe.

Normally used with the LA 501, the WR 501 may also be used separately as a word recognizer to generate triggers for oscilloscopes or other measurement instruments. When used in the LA 501W System, it gives you fast access to any unique word in the data stream.

LA 501W Logic Analysis System

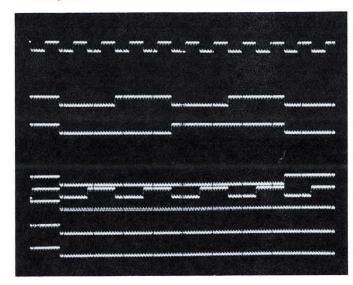
The LA 501W Logic Analysis System operates in any 3, 4, 5 or 6-compartment TM 500 Series Power Module Mainframe. This combination complements virtually any 50 kHz oscilloscope or X-Y monitor to provide a versatile logic analysis system.

In order to get efficient use of memory at all times, the LA 501W memory is formattable according to the number of input channels used. You can select: 16 data channels of 256 bits at a 20 MHz sample rate, 8 data channels of 512 bits at 50 MHz rate, or 4 data channels of 1024 bits each at an asynchronous sample rate of 100 MHz, or a synchronous sample rate of 50 MHz. Pre-, center, or post-trigger data can be recorded at a sample rate from 5 ns to 10 ns.



The LA 501W display includes biphase tick marks. These are an aid in timing comparisons (each is equivalent to one sample interval or synchronous clock), and as a quick indication of whether a line is high or low.

Data is acquired through two P6451 high-impedance, active probes. They provide a total of 18 inputs to the WR 501 — 16 data input channels, one clock input, and one qualifier input. There are separate threshold controls (TTL, ECL and variable $\pm 10V$) for each probe.

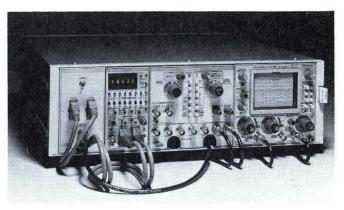


A CHANNEL/POSITION selector allows you to vertically reposition any trace anywhere on the display for easier time comparisons. Here channel 1 is repositioned between channels 4 and 5.

Stored data is displayed as a timing diagram in groups of four traces. Vertical and horizontal position and magnifier controls provide the capability to zoom in on any segment of the timing diagram. Biphase timing tick marks on each channel provide

excellent visual resolutions to indicate whether an inactive line is high or low and facilitate easy timing comparisons. Channel-to-channel timing comparisons are easy because any trace can be moved vertically and thus positioned next to any other trace.

The LA 501W Logic Analysis System may be combined with counters, pulse generators, multimeters and oscilloscopes into a compact package using TM 500 Series Power Module/Mainframes. The TM 500 Series also offers you a choice of benchtop, rackmount, rollabout, or portable configurations to match your application.



The DL 502 Digital Latch can be used in a variety of configurations, including all TM 500 Mainframes.

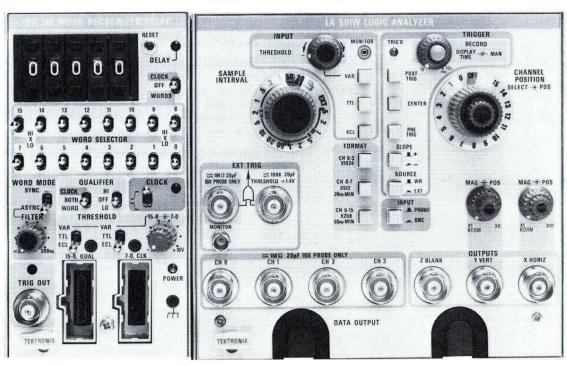
Digital Latch

The TEKTRONIX DL 502 Digital Latch extends the LA 501W 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. Operating in an asynchronous mode, the 16-channel Digital Latch can detect spikes or glitches between system clock edges that are narrower than the sample clock 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 allows you to expand the time frame in which information can be stored by sampling at a slower rate. The DL 502 captures the glitch (or pulses which are narrower than one sample interval) holds it until the next clock edge, then expands it to one sample interval for display.

The DL 502 plugs into any compartment of a TM 500 Mainframe. Two 25-pin connectors connect the DL 502 with the LA 501W or 7D01 Logic Analyzer. Data is acquired via P6451 Probes which plug into the front panel of the DL 502.

A two position switch allows the user to select either the LATCH input mode or OFF. An asynchronous clock input is required from the STORE CLOCK OUT of the LA 501W or 7D01 Logic Analyzer to the STORE CLOCK IN of the DL 502.



LA 501W Logic Analyzer System

Logic Analyzers, Word Recognizer and Digital Latch for TM 500 Series

LA 501W CHARACTERISTICS

LA 501W characteristics apply to both LA 501 and WR 501 separately, except where functions of each are described separately.

The LA 501W acquires 4, 8 or 16 channels of data and stores the data in memory. Data storage format is selectable as 4 channels x 1024 bits, 8 channels x 512 bits, or 16 channels x 256 bits.

DATA INPUTS

Data Channels — 16 channels divided between two probes. Channels 0-7 (and clock) are in probe 1. Channels 8-15 (and qualifier) are in probe 2.

Input Impedance — 1 M Ω paralleled by 5 pF.

Sensitivity at Probe Tips — 500 mV p-p minimum centered around threshold.

Threshold at Probe Tips — Switch selects fixed TTL (1.4 V \pm 0.2 V), ECL (-1.26 V \pm 0.01 V), or variable (at least -10 V to at least +10 V). Front panel jack on WR 501 for monitoring variable threshold settings.

Maximum Safe Input Voltage - ±60 V.

Interface — A high-speed interface provides transfer of the incoming data signals to the LA 501 Logic Analyzer through internal cables. This enables the WR 501 probes to provide input for both plug-ins.

MEMORY

Storage — 4096 bits.

Format — Front Panel Selectable.

Data Channels Displayed	Bits per Channel	
0-3	1024	
0-7	512	
0-15	256	

DATA TIMING

Asynchronous (internal clock) — Sampling intervals are selectable from 10 ns to 5 ms ($\pm\,0.005\,\%$) in 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

Synchronous (external clock)

Data Channels Dis- played	Maxi- mum Clock Freq	Mini- mum Clock Width*	Mini- mum Data Setup Time	Mini- mum Data Hold Time
0-3	50 MHz	10 ns	18 ns	0 ns
0-7	50 MHz	10 ns	18 ns	0 ns
0-15	20 MHz	25 ns	23 ns	0 ns

^{*}High and low clock width.

TRIGGER

Source — Pushbutton provides selection of trigger source from the WR 501 or External Trigger inputs.

Triggered Light — Indicates display trigger has occurred.

Slope — Selects positive or negative slope as the active edge external triggers. Selects word or word on WR (internal) triggers with digital delay set at 0 or OFF.

DATA POSITIONING

Three pushbuttons to select pre-trigger, center-trigger, and post-trigger modes. In the pre-trigger mode $\approx\!90\%$ of the displayed data occurs before the trigger and $\approx\!10\%$ after. In the center-trigger mode $\approx\!50\%$ occurs before the trigger and 50% after. In the post-trigger mode $\approx\!10\%$ occurs before the trigger and $\approx\!90\%$ after.

WORD RECOGNIZER (WR 501)

Inputs — 16 data inputs plus a clock and qualifier.

Word Selection — Made using sixteen three-position toggle switches. Positions are HI, X (don't care), and LO.

Qualifier — Can expand the word recognizer to 17 bits, act as a gate for the external clock or do both.

Clock — Selects positive- or negative-going edge of clock input signal. Used for synchronous operation.

Modes — Front panel selection of synchronous word recognition (a trigger is produced only when the operator selected word occurs at a clock edge; either position, positive or negative edge, may be selected), or asynchronous word recognition (a trigger is produced anytime the recognized word occurs).

Synchronous Mode -

Minimum Set-up time 18 ns
Minimum Hold time 0 ns
(Filter is automatically disabled)

Asynchronous Mode and Filter -

Minimum coincidence time is variable from 15 ns or less to 200 ns or more.

DIGITAL DELAY

Delay Selection — Five thumbwheel switches provide selection of any delay-by-events or delay-by-words from 0 to 99,999.

Modes — Two delay modes (delay-by-events count or delay-by-word triggers) or OFF.

Indicator — An LED is lit during the delay interval.

Reset — Pushbutton resets the delay counter.

Output Connector (TRIG OUT) — The trigger from the WR 501 is available via the internal interface to the LA 501, or at a front panel BNC connector. This produces a trigger after word recognition and the delay selected. The signal is TTL compatible.

Characteristic	ic Requirement	
HI	≥2.2 V	
LO	≤0.6 V	
Impedance	≥50 Ω	

Maximum Trigger Delay —

Word Recognition Mode	Delay to front panel Trigger Output (referred to probe tips — digital delay set to 00,000)
Synchronous	≤50 ns from edge of clock input and word pattern match.
Asynchronous	≤50 ns + selected filter time from word pattern match.

DISPLAY

Type — Data is displayed as a timing diagram.

Display Time — Variable from less than 1 s to at least 10 s. A detent position provides indefinite storage of data. A new record cycle can be started at any time by pushing the MANUAL Pushbutton.

Vertical Display Controls (VERT POS/MAG) — A variable vertical magnifier control magnifies the on-screen display from X1 to X5. A concentric vertical position control positions the display within the graticule area.

Horizontal Display Controls (HORIZ POS/MAG) — A variable horizontal magnifier control magnifies the on-screen display from X1 to approximately X10. A concentric horizontal position control positions the display within the graticule area.

Display Format — Selectable by a switch (DATA CHANNELS).

Format	Bits/Channel	Display
Chan 0-3	1024 bits	1 group of 4 traces
Chan 0-7	512 bits	2 group of 4 traces each
Chan 0-15	256 bits	4 groups of 4 traces each

Crt Retrace Blanking —

Format	Bits Blanked/Channel 2 bits	
Chan 0-3		
Chan 0-7	1 bit	
Chan 0-15	½ bit	

DATA OUTPUT

Connector — A 25 pin connector (inside LA 501W) provides output of stored data from the LA 501W. It also provides control signals necessary for transfer of that data to other equipment.

Parallel Data — 16 pins provide parallel access to stored data. ECL levels.

Serial Data — One pin provides serial access to stored data. ECL levels.

Flag — A positive-going edge on this pin indicates the beginning of each channel. ECL levels.

Format — 2 pins are used to identify the stored format as 4 channels x 1024 bits, 8 channels x 512 bits, or 16 channels x 256 bits.

POWER

Line Voltage Ranges — Determined by the TM 500-Series Mainframe.

Power Consumption — 45 W (LA 501W) at nominal line voltage.

ENVIRONMENTAL

Temperature — Operating: 0-40°C (0-50°C only in TM 506 and TM 515 Mainframes). Nonoperating: -40°C to +75°C.

Altitude — Operating: to 15,000 ft. Nonoperating: to 50,000 ft.

Vibration — With the operating instrument, vibration frequency swept from 10 to 50 to 10 cps at one minute per sweep. Vibrate for 15 minutes along each of the three major areas at 0.015 inch total displacement. Hold three minutes at any major resonance, or if none, at 50 cps. Total time 54 minutes.

Shock — Operating and nonoperating: 30g's, $\frac{1}{2}$ sine, 11 ms duration. Two shocks in each direction along three major areas, for a total of 12 shocks.

Transportation — Qualified under National Safe Transit Committee test procedure 1A, Category 11.

DIMENSIONS AND WEIGHTS (LA 501W)

Weight	kg	lb
Net Weight	3	6.6
Dimensions	cm	in
Height	12.5	4.9
Width	20.1	7.8
Depth	30.0	11.8

DL 502 CHARACTERISTICS

The 16-channel DL 502 aids the LA 501W or 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 DL 502 plugs into any compartment of a TM 500 Mainframe. Two 25-pin connectors connect the DL 502 with the LA 501W or 7D01 Logic Analyzer. Data is acquired via two P6451 Probes which plug into the front panels of the DL 502.

Minimum pulse width to initiate latch - 5 ns.

Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock-20 ns.

ORDERING INFORMATION

LA 501W* Logic Analyzer\$4450
LA 501W OPT 05* (Add one TM 515 Power Module)\$4775
LA 501W OPT 49* (Delete one P6451 probe)\$4150
LA 501** Logic Analyzer \$3250
WR 501* Word Recognizer\$1500
Interface Kit to convert LA 501 and WR 501 to a LA 501W. Order 040-0806-01
P6108 Probe, 10X Attenuation, 2 Meter Cable (010-6108-03) \$55
DL 502 Digital Latch \$1350
TM 515*** Power Module \$325
TM 506*** Power Module\$250
TM 504*** Power Module\$190
TM 503*** Power Module\$170
TM 501† Power Module\$135
RTM 506*** Rackmount Power Module\$340
*Included Accessories, LA 501W and WR 501 — Two

*Included Accessories, LA 501W and WR 501 — Two 10 channel (9 input and ground) P6451 Acquisition Probes.

**Included Accessories, LA 501 — One 16-channel P6450 Passive input probe.

***Operation of the LA 501W, LA 501 or the WR 501 requires a TM 500 Series Power Module. Details on these as well as the full line of TM 500 Series instrumentation begins on page 133. Additionally, operation of the LA 501W or LA 501 requires an X-Y display monitor or an oscilloscope.

†Accepts either the WR501 or DL502.

OPTIONAL ACCESSORIES

P6108 — A 10X probe (10 M Ω , 13 pF), for use with the LA 501 or DD 501 Digital Delay. Order four probes for use with the four high speed data channels of the LA 501. For the external clock input of the LA 501, order one additional probe. P6450 Probe Package — Replacement probe for LA 501 Logic Analyzer. P6451 Probe Package - Replacement active probe for LA 501W, WR 501, 7D01 or 7D01F. (Two probes are needed for 16-channel operation). Lead sets - 40 cm, color coded replacement lead set for the P6450 Probe or the P6451 Active Probe. 10 leads/set - connects probe head to 0.025 in square pins. (012-0655-01)\$35 Same lead set with hook tips. (Note: EMI can exist with the 40 cm length. This can be a problem if using a digital latch.) BNC Cable — 50 Ω , 18 in.



Probe Holder — Clip-on holder accommodates probe pod from P6450 or P6451.

(352-0473-01)\$2.50

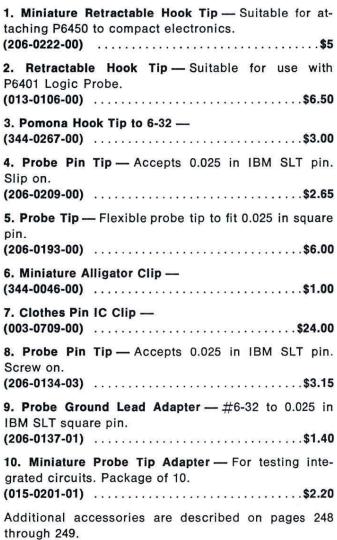
Lab Cart, Model 3

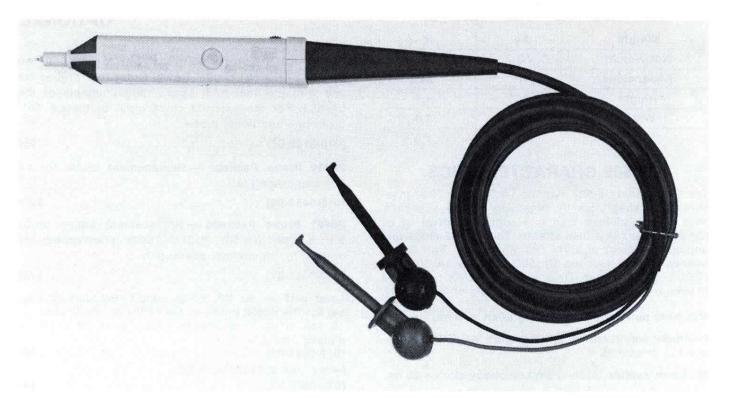


A rollabout cart which carries any 7000-Series Mainframe with 7D01F Logic Analyzer, or any laboratory or portable oscilloscope, on its top tray. Two underslung trays accept up to two TM 504 Mainframes with LA 501W Logic Analyzer and other TM 500-Series modular instrumentation.

Logic Analyzer Accessories







P6401 Logic Probe

TTL/DTL Compatible

Detects Steady Logic Levels

Detects Trains of Logic Pulses

Detects Abnormal Conditions

Strobed Detection of Logic Pulses

Store Mode

Protected against Overvoltage

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.

State or Condition

Steady high state Steady low state Pulse trains (normal logic switching)

Abnormal state (between high and low) Open circuit

Excessive input voltage greater than 6 V

Alternating between high state and indeterminate state

Alternating between low state and indeterminate state

Single or very low duty cycle logic pulse

Indication

Steady red light Steady green light Blinking red and green light at full intensity

No lights

No lights

Both red and green lights lit

Blinking red light

Blinking green light

Using STORE mode, one light will be on initially. Event has occurred when second light is lit.

SPECIFICATIONS

Low State Input Voltage Range — 0 V to +0.7 V ± 0.125 V.

High State Input Voltage Range — 2.175 V ± 0.125 V to Vcc.

Minimum Recognizable Pulse Width — 10 ns.

Impedance — \approx 7.5 k Ω paralleled by \approx 6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 $k\Omega.$

Max Safe Input — ±150 V (dc or rms).

Minimum Recognizable Strobe Pulse Width - 20 ns.

Max Safe Strobe Input — ±30 V (dc or rms).

Strobe Input Impedance — 5.6 k Ω within 20%.

ORDERING INFORMATION

P6401 5 ft. Probe (010-6401-01)\$99

Includes: Hook Tip (206-0114-00)

Strobe Lead (175-0958-01)

Strobe Lead (175-0958-00)

Probe Tip to 0.025 in square pin adapter

(206-0137-01)

White Plug (348-0023-00)

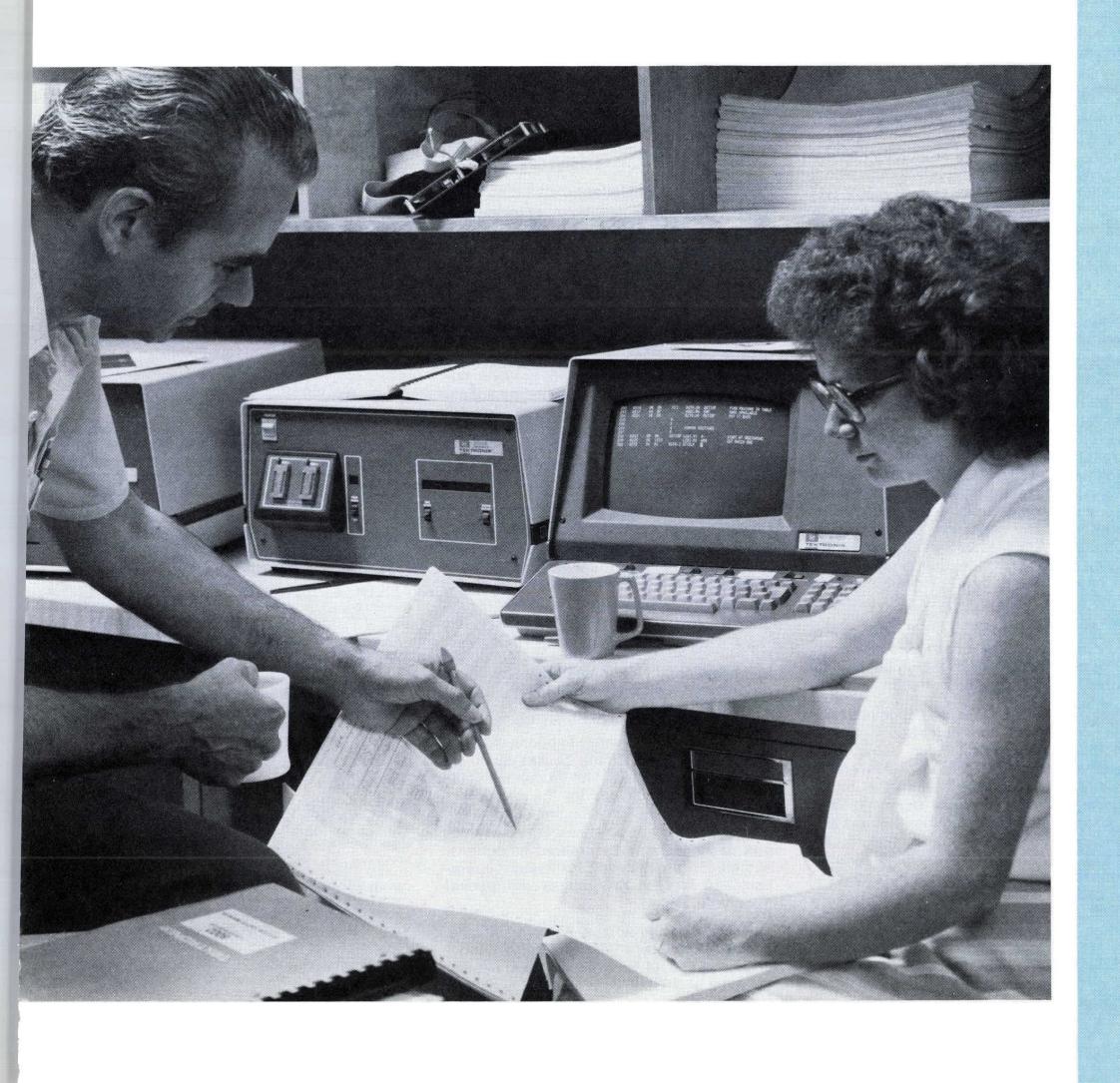
2 Alligator Clips (344-0046-00)

Accessory Pouch (016-0537-00) not shown

Instruments for Digital Development

Microprocessor Labs

3a



Multiple Microprocessor Support

Real-Time Trace Option

The 8002 Microprocessor Lab is a complete software development system for the design of microprocessor-based products. A key feature is its ability to support many microprocessor chips, including the Intel 8085A and 8080A, Motorola 6800, Texas Instruments TMS9900, and Zilog Z80A. In addition to multiple microprocessor support, the 8002 offers a superior operating system and powerful text editor, assembler, and debugging programs; three optional levels of emulation for software debugging, partial and full emulation; and a real-time prototype analyzer option offering all the capabilities of a microprocessor analyzer with eight channels of external input.

Software Development and Debugging

In a typical design sequence, software is developed using all the resources of TEK-DOS, the disc-operating system software for the 8002 Microprocessor Lab. TEKDOS performs flexible disc and file utility functions, data transfer functions, and system/peripheral device control functions. In addition to relieving the user of these housekeeping chores, TEKDOS also supervises the text editor, assembler, and linker programs and the optional emulation support, debugging system, and PROM programming routines.

Program entry and editing may be accomplished module by module. The line-oriented text editor provides 150 60-character lines of buffer workspace, and offers several convenience features for preparing, correcting, and modifying the program quickly and easily. The macro assember allows a multiple-step routine to be defined by one new command. At the end of each work session, file space is allocated by TEKDOS; duplicate files of important material may be readily created. When program entry has been completed, all program files may be merged with a single TEKDOS command.

The assembler processor, with the appropriate disc inserted in the flexible disc drive, performs program assembly functions for each microprocessor supported by the 8002.

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 to the microprocessor that will finally be installed in the user's prototype. Execution is performed under control of the debugging 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 can then be reassembled and executed again. This procedure continues until the program is correct.



The 8002 Microprocessor Lab consists of the 8002 mainframe; the dual flexible disc unit; an optional system terminal (TEKTRONIX CT8100 or CT8101 recommended); and two sets of assembler software for two different microprocessors, chosen from the microprocessors supported at time of purchase. An emulator processor module for each microprocessor the system supports, and its associated prototype control probe, are offered as options.

Partial and Full Emulation

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 8002 to the prototype in stages. The developmental software runs using 8002 memory space and prototype I/O and clock. The 8002 memory mapping feature allows memory to be gradually mapped over to the prototype in 128-byte address blocks. Throughout partial emulation, the user has access to prototype circuitry through the debugging system, which enables him, as before, 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 debugging system. All I/O and timing functions are directed by 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, then, the user may still direct program activity from the 8002.

8002 CHARACTERISTICS

The 8002 Microprocessor Lab is a modular system whose mainframe houses up to 20 plug-in circuit boards. Two Assembler Software Support packages for the microprocessors of choice are selected at the time of purchase; their associated Emulator Support packages may be ordered as options. A terminal is necessary for system operation, and may be ordered as an optional peripheral.

The Real-Time Prototype Analyzer module, additional 16K byte Program Memory modules, and PROM Programmer modules for the 1702 or 2704/2708 are available as system options.

A system communications module provides three RS-232-C-compatible ports for interface with system peripherals. Two ports are designated for such peripherals as the optional TEKTRONIX CT8100 Crt Terminal, CT8101 Console Terminal, and LP8200 Line Printer. The remaining port is designated as a communications port for use with a modem. Baud rate is selectable for each port as 110, 300, 600, 1200, or 2400.

8002 PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	24.7	9.6
Width	48.3	18.8
Length	57.3	22.3
Weight	kg	Ib
Net	30	66

8002 ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +35°C (+32°F to 95°F).
Storage	Not available.
Humidity	To 90° relative noncondensing.
Altitude	
Operating	To 15,000 ft max.
Storage	To 50,000 ft max.

8002 ELECTRICAL CHARACTERISTICS

Ac Input Voltages	115 V ac ±10% or
	230 V ac ±10%.
Frequency Range	60 Hz (50 Hz special order).

8002 DUAL FLEXIBLE DISC CHARACTERISTICS

Flexible Disc Unit — The Flexible Disc Unit consists of two disc drives, a controller, and power supplies. The two disc drives are designated as drive 0 and drive 1. Drive 0 is the default system drive. System programs are placed in this drive, including discoperating system programs, the text editor, and the debugging routines peculiar to a specific emulator processor. Drive 1 may be used for storing user files, for modifying user files, or as a scratch data area. Drive 0 or drive 1 may be designated as the system drive

Disc Organization — Each disc contains 77 concentric tracks. Each quarter track, or block, is split into eight sectors, and each sector can contain 128 bytes. Due to directory limitations, a maximum of 72 files

can be contained on one disc. The disc-operating system reserves track 0 for the disc directory; tracks one through four are normally automatically reserved for system programs.

Write Protection — Each disc has a write-protect slot. If the slot is covered, the disc is write-enabled; if the slot is not covered, the disc is write-protected. If an attempt is made to write to a write-protected disc, an error message will be displayed on the appropriate peripheral.

ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	+10°C to 35°C (+50°F to 95°F).
Storage	Not available.
Humidity	
Operating	To 90% relative noncondensing.
Storage	Not available.
Altitude	
Operating	To 15,000 feet max.
Storage	To 50,000 feet max.

PHYSICAL CHARACTERISTICS

Size	cm	in
Height	27	10.5
Width	44	17.5
Length	60	23.6
Weight	kg	lb
Net	38.6	85

ELECTRICAL CHARACTERISTICS

Line Voltages	Voltage	Current
	115 V ac ±10%	3.5 A
	230 V ac ±10%	2.0 A
Line Frequency	60 Hz (50 Hz special order).	

DISC UNIT CHARACTERISTICS

Capacity		Bits	Bytes
Per Disc	$77 \times 32 \times 128 \times 8 \text{ bits} =$	2,523,136	315,392
Per Track	$32 \times 128 \times 8 \text{ bits} =$	32,768	4,096
Per Sector	128 x 8 bits =	1,204	128
Access Time	10 ms/track		

ORDERING INFORMATION* 8002 Microprocessor Lab\$9950



The 8001 Microprocessor Lab consists of the 8001 mainframe; an optional system terminal (TEKTRONIX CT8100 or CT8101 recommended); and a Microprocessor Support Package for the microprocessor selected. A support package includes an emulator ROM, an emulator processor, and a prototype control probe.

Multiple Microprocessor Support Real-Time Trace Option

The 8001 Microprocessor Lab is a total hardware debugging environment for the design of microprocessor-based products. A key feature is its ability to support many microprocessor chips, including the Intel 8085A and 8080A, Motorola 6800, Texas Instruments TMS9900 and Zilog Z80A. In addition to multiple microprocessor support, the 8001 offers three emulation modes for software debugging, partial and full emulation, as well as a real-time prototype analyzer option offering all the capabilities of a microprocessor analyzer with eight channels of external input.

Three Emulation Modes

In a typical design sequence, software is first developed independently using time-sharing, a minicomputer, another development system, or some other means. It is then downloaded to the 8001. At this point the in-prototype emulation and software/hardware integration capabilities of the 8001 come into play.

In emulation mode 0, the software runs only on the emulator processor. This enables the program to be debugged on a microprocessor identical to the one that will ultimately be used in the completed product. In emulation modes 1 and 2, the prototype control probe is connected to the emulator processor at one end and plugged into the prototype's empty microprocessor socket at the other.

Partial emulation (mode 1) lets the user release control in methodical steps from the 8001 to the prototype. The developmental software runs using 8001 memory space and prototype I/0 and clock. The 8001 memory mapping feature allows memory to be gradually mapped over to the prototype in address blocks. Throughout partial emulation, the user has access to prototype circuitry via the powerful 8001 debugging system, which enables him to trace, set breakpoints, examine and change memory and register contents.

Full emulation (mode 2) lets the user exercise the program on the prototype while still

maintaining complete control through the Microprocessor Lab. All I/O and timing functions are directed by 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, then, the user may still direct program activity through the prototype control probe.

8001 CHARACTERISTICS

The 8001 Microprocessor Lab is a modular system whose mainframe houses up to 20 plug-in circuit boards. An emulator processor module for the microprocessor of choice, its associated prototype control probe, and a ROM-based software module are provided with the system. Additional Emulator Processor packages are available as options for each microprocessor the system supports. A terminal is necessary for system operation, and may be ordered as an optional peripheral.

The Real-Time Prototype Analyzer module, additional 16K byte Program Memory modules, and PROM Programmer modules for the 1702 or 2704/2708 are available as system options.

A system communications module provides three RS-232-C-compatible ports for interface with system peripherals. Two ports are designated for such peripherals as the optional TEKTRONIX CT8100 Crt Terminal, CT8101 Console Terminal, and LP8200 Line Printer. The remaining port is designated as a communications port for use with a modem. Baud rate is selectable for each port as 110, 300, 600, 1200, or 2400.

8001 PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	24.7	9.6
Width	48.3	18.8
Length	57.3	22.3
Weight	kg	lb
Net	30	66

8001 ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +35°C (+32°F to 95°F).
Storage	Not available.
Humidity	To 90° relative noncondensing.
Altitude	
Operating	To 15,000 feet max.
Storage	To 50,000 feet max.

8001 ELECTRICAL CHARACTERISTICS

Ac Input Voltages 115 V ac ±10% or

230 V ac \pm 10%. Frequency Range 60 Hz (50 Hz special order).

ORDERING INFORMATION*
8001 Microprocessor Lab\$7650

^{*}The 8002 and 8001 may not be available in some areas of the world. Consult your Distributor or Representative.

Emulator Processor and Prototype Control Probe Support Packages

The 8002 and 8001 Microprocessor Labs currently support five different microprocessors: the Intel 8085A and 8080A, Motorola 6800, Texas Instruments TMS9900, and Zilog Z80A. Tektronix will continue to introduce support for selected microprocessors on a regular schedule.

Emulator packages for the 8002 and 8001 may be ordered as system options; one emulator package is provided at the time of purchase with the 8001. These options provide the 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 to the full 64K bytes of Microprocessor Lab program memory.

The prototype control probe, which links the emulator processor to the prototype system, allows partial and full in-circuit emulation.

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.

8080 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8080 and 8080A refer to microprocessors manufactured by Intel Corporation. Tektronix, Inc., does not guarantee that other vendors' versions of the 8080 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft of cable from the emulator processor to the interface assembly.

1.5 ft of cable from the interface assembly to the 40 pin plug.

Cable Configuration

2 40 conductor ribbon cables with alternating ground and signal paths.

1.5 ft 2 twisted pair 40 conductor cables.

Termination

The interface assembly contains resistive termination and receivers for data, address, and control from the emulator processor module.

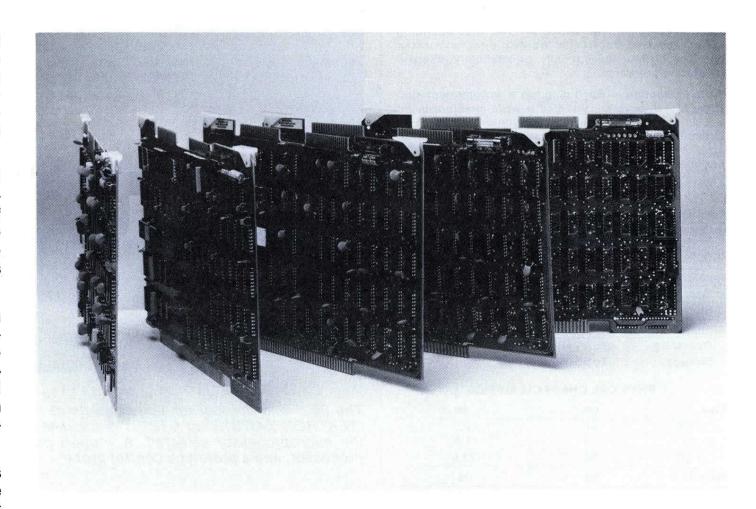
1.5 ft Not terminated.

40 pin plug-40 pin spring plate protected plug. When used with a zero insertion force socket, an included 40 pin low profile DIP socket must be used between the zero insertion force socket and the 40 pin probe plug.

TIMING CHARACTERISTICS

Emulation Interface Delays*

To 8080 from Interface Assembly	Тур	Max (in ns)
ø1	44	60
ø2	44	60
HOLD	44	67
RESET	44	67
RDY**	35	40
INT	63	104
DATA	44	53



From 8080 to Interface Assembly	Тур	Max (in ns)
HOLDA***	39	55
SYNC	37	45
WAIT	37	45
WR	37	45
DBIN	37	45
INTE	39	55
ADDRESS	27	35
DATA	50	63

*Assumes 6 ft of cable at 1.5 ns/ft.

**RDY is ignored unless user memory or I/O is accessed in control mode 2 or special mode.

*The equation for \underline{HOLDA} to tristate timing is as follows: $HOLDA \cdot \overline{DBIN} = FLOAT$. Tristate of data and address follows the trailing edges of DBIN or WR by approximately 20 ns.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Price
8001 Microprocessor Lab	\$7650		
Option 01 8080 Microprocessor Support Package	NC	8001F01	\$2950
8002 Microprocessor Lab	\$9950		
Option 01 8080 Assembler Software Support	NC	8002F01	\$ 550
Option 16 8080 Emulator Support	+\$1850	8002F16	\$1950
Option 31 8080 Prototype Control Probe	+\$ 850	8002F31	\$ 950

6800 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

6800 refers to microprocessors manufactured by Motorola Corporation. Tektronix, Inc., does not guarantee that other vendors' versions of the 6800 will be compatible with the TEKTRONIX Microprocessor

PHYSICAL CHARACTERISTICS

Length 6 ft of cable from the emulator processor to the interface assembly.

1 ft of cable from the interface assembly to the 40-pin plug.

Cable Configuration

2 40 conductor ribbon cables with alternating ground and signal paths.

2 twisted pair 40 conductor cables made up of signal/ground pairs.

TIMING CHARACTERISTICS Emulation Interface Delays*

To 6800 from Interface Assembly	Maximum	TPCS! (in ns)
ø1	26	_
ø2	26	_
NMI	30	200
IRQ	67	200
RESET	94	200
HALT**	72	
DATA	28	114 (input setup)
DBE****	_	_
TSC***	not used	

From 6800 to Interface Assembly	Maximum	TAD ²	(in ns)
ADDRESS	20	300	
DATA****	28	460	
VMA	45	300	
R/W	63	300	
ВА	35	N	

*Assumes 6 ft of cable at 1.5 ns/ft.

**HALT must occur within 80 ns after the falling edge of ø1 to be recognized at the rising edge of the following ø2.

***Delay to tristate, TSD=36 ns. Tristate is performed by the interface buffers, not by the 6800.

****Data from the 6800 will be available to the prototype 460 ns after the rising edge of Ø1 or DBE + 36 ns, whichever is greater.

ITPCS—Control signal setup time prior to ø2 fall-

²TAD—Output propagation delay from clock after ø1 rising edge.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	\$7650		
Option 02 6800 Micro- processor Support Package	NC	8001F02	\$2950
8002 Microprocessor Lab	\$9950		
Option 02 6800 Assembler Software Support	NC	8002F02	\$ 550
Option 17 6800 Emulator Support	+\$1850	8002F17	\$1950
Option 32 6800 Prototype Control Probe		8002F32	\$ 950

Emulator Processor and Prototype Control Probe Support Packages

Z80 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

Z80 and Z80A refer to microprocessors manufactured by Zilog Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the Z80 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft of cable from the emulator processor to the interface assembly.

1 ft of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft 2 40 conductor ribbon cables with chassis ground plane and signal paths.

1 ft 2 40 conductor twisted pair cables.

Termination

6 ft The interface assembly contains receivers for data, address, and control from the Z80 emulator processor module.

1 ft Not terminated.

TIMING CHARACTERISTICS

The Z80 emulator processor was designed to match the ac characteristics of the Z80 microprocessor with two exceptions. Those exceptions are:

Prototype Clock

The prototype clock may not be stretched over a total of 10 μ s during any one memory or I/0 request when a Microprocessor Lab memory access may occur in the next cycle. This exception is valid only if the prototype clock runs in excess of 1 MHz.

NMI

NMI (Non Maskable Interrupt) must occur one-half cycle earlier than in a standard Z80 configuration. This means the NMI must occur before the next to last trailing edge of the M cycle just prior to M1.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	\$7650		
Option 03 Z80 Micro- processor Support Package	NC	8001F03	\$2950
8002 Microprocessor Lab	\$9950		
Option 03 Z80 Assembler Software Support	NC	8002F03	\$ 550
Option 18 Z80 Emulator Support	+\$1850	8002F18	\$1950
Option 33 Z80 Emulator Prototype Control Probe	+\$ 850	8002F33	\$ 950

TMS9900 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

TMS9900 refers to microprocessors manufactured by Texas Instruments Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the TMS9900 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft of cable from the emulator processor to the interface assembly.

9.5 in of cable from the interface assembly to the 64 pin plug.

Cable Configuration

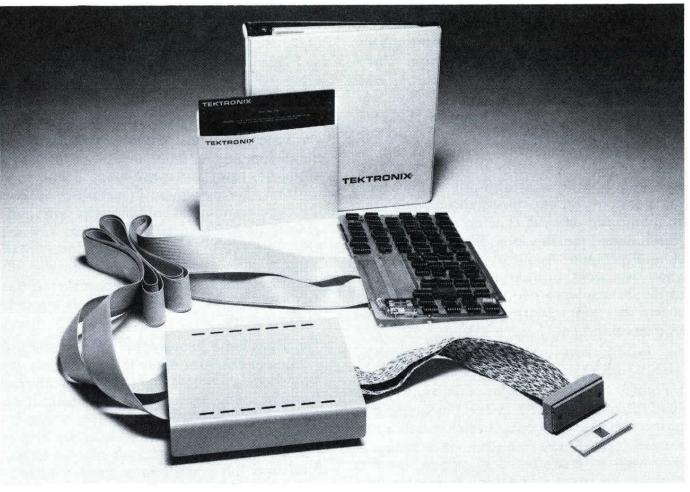
6 ft 2 40 conductor ribbon cables with chassis ground plane and signal paths.

9.5 in 2 32 conductor twisted pair cables.

Termination

6 ft The interface assembly contains receivers for data, address, and control from the TMS 9900 emulator processor module.

9.5 in Not terminated.



TIMING CHARACTERISTICS

To TMS9900 from nterface Assembly	Emulation Typical	Interface Delays* Maximum (in ns)
ø1	41	59
ø2	41	59
ø3	41	59
ø4	41	59
CRUIN	12	23
INTREQ	12	18
1C0	12	23
IC1	12	23
IC2	12	23
IC3	12	23
HOLD	12	18
READY	12	18
LOAD	12	18
RESET	68	98
DATA	14	21

From TMS9900 to Interface Assembly	Typical	Maximum (in ns)
DBIN	24	41
MEMEN	12	18
WE	12	18
CRUCK	12	23
CRUOUT	12	23
HOLDA	12	23
WAIT	12	23
IAQ	12	23
ADDRESS	14	21
DATA	14	21

*Assumes 1.5 ft of cable at 1.5 ns/ft.

Note: All inputs and outputs of the 64 pin plug at the end of the prototype control probe are buffered by 74LSXXX type devices. In all cases, data and control should not change during clock ø1.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	\$7650		
Option 04 TMS9900 Microprocessor Support Package	+\$ 400	8001F04	\$3350
8002 Microprocessor Lab	\$9950		
Option 04 TMS9900 Assembler Software Support	NC	8002F04	\$ 550
Option 19 TMS9900 Emulator Support	+\$2100	8002F19	\$2200
Option 34 TMS9900 Prototype Control Probe	+\$1000	8002F34	\$1100
Option 49 16K Memory Module*	+\$1100	8002F49	\$1210
DOINES DON'T DE TRANSPORTE DE LA TRANSPO	according to	7727 7477	

*One supplied with either Microprocessor Lab.

8085 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8085 and 8085A refer to microprocessors manufactured by Intel Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the 8085 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft of cable from the emulator processor to the interface assembly.

1 ft of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft 2 40 conductor ribbon cables with chassis ground plane and signal paths.

1 ft 2 40 conductor twisted pair cables.

Termination

t The interface assembly contains receivers for data, address, and control from the 8085 emulator processor module.

1 ft Not terminated.

AC CHARACTERISTICS

Emulation Clock
Mode 1 or Mode 2
(user's clock), with
8085 Prototype Control Probe.

Mode 0 (system clock)

6.25 MHz max*; crystal,
RC timing network or
TTL input to X1.

6.25 MHz ±0.01%

Operational Speed

Full speed or 1 wait state per machine cycle during 8001/8002 program memory access selectable with jumper

One wait state per machine cycle is inserted when using DEBUG breakpoints (BKPT) regardless of jumper position. When the Real-Time Prototype Analyzer option is installed, real-time operation with breakpoints automatically ensured during DEBUG by using the event triggers (EVT).

*A clock error detection circuit ensures that the user's clock is operational and basically within Intel max (1 μ s) and min (160 ns) specifications.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	\$7650		
Option 05 8085 Micro- processor Support Package	NC	8001F05	\$2950
8002 Microprocessor Lab	\$9950	- /	
Option 05 8085 Assem- bler Software Support	NC	8002F05	\$ 550
Option 20 8085 Emu- lator Support	+\$1850	8002F20	\$1950
Option 35 8085 Proto- type Control Probe	+\$ 850	8002F35	\$ 950

Real-Time Prototype Analyzer

The Real-Time Prototype Analyzer, Option 46 for the 8002 and 8001 Microprocessor Labs, is comprised of a real-time trace module, a data acquisition interface, and an 8-channel general logic probe. This option provides a real-time trace of the user program executing on the emulator processor, with 43 channels of data acquired simultaneously. The prototype address bus, data bus, control bus, and any eight external locations on the prototype circuit may be monitored without slowing up the operational speed of the processor. The Real-Time Prototype Analyzer is indispensable when isolating critical timing errors and hardware/software sequence discrepancies during the final integration phases of prototype development.

The analyzer module is a separate plug-in circuit card that may be inserted into either the 8002 or 8001 system mainframe. The P6451 Probe connects to the prototype circuitry and permits data transference from the prototype to the analyzer. Data from the prototype is buffered and driven by the probe to the data acquisition interface, and then loaded into the analyzer module's real-time trace buffer.

As the user program executes on the emulator processor, 48-bit data words are sequentially acquired from the prototype and loaded into the real-time trace buffer. Each data word contains 16-bit data from the address bus; 8-bit or 16-bit data from the data bus; 8-bit data from the test probe; 3-bit data identifying cycle type (read, write, I/O, memory, or instruction fetch); and 5-bit data used internally to identify last start/ stop of the emulator processor. The analyzer will continue to acquire these sequential cycles of logic input until the processor is stopped or the real-time trace buffer is frozen by a specified trigger occurrence. The real-time trace buffer can retain up to 128 data words in pre-, variable center, or post-trigger modes; thus enabling the storage of pertinent program bus transactions.

The Real-Time Prototype Analyzer offers expanded breakpoints to aid in efficient location of prototype problems. Two event comparators located within the analyzer module can be utilized to halt program execution and stop real-time trace. A trigger may be generated on any specific data occurrence in the address bus, data bus, test probe input, and instruction cycle type. Triggering may be immediate; delayed by counting the number of passes; or delayed by counting the number of clock select outputs (clock select may be by microseconds, milliseconds, emulator clocks, etc.). In addition, an output pulse may be generated, via the data acquisition interface, to trigger a logic analyzer or an oscilloscope.

The two event comparators (triggers) may be set to designate a break or halt in the program execution. These comparators may be used as independent breakpoints; or they may be used together to enable a breakpoint on a specific event combination. The program execution can be halted when

two trigger events occur simultaneously; when one trigger event precedes another; or when either trigger event occurs. When a break in the program execution takes place, program transactions stored in the real-time trace buffer may be displayed or printed.

Data stored in the real-time trace buffer is displayed sequentially in the order it was acquired from the prototype. Buffer content may be displayed in whole or in part. Optional command parameters are available to limit the storing of data to any specific transaction type, such as memory reads only. If the total buffer contents are displayed, a blank line will separate the data sequence associated with each program starting point.

The Real-Time Prototype Analyzer features a convenient and easy-to-understand display format. With this format, the address location, data, probe input, and control bus data of each acquired transaction are displayed. If the transaction was an instruction fetch, the instruction is also disassembled into the appropriate mnemonic readout unique to the emulator type being used.

The Real-Time Prototype Analyzer functions in all emulation modes and operates with all commercial microprocessors supported by the 8002 and 8001 Microprocessor Labs.

REAL-TIME PROTOTYPE ANALYZER CHARACTERISTICS OPERATIONAL SPEED CHARACTERISTICS

Processor	
8085	3.125 MHz (internal clock)
8080	2.08 MHz
6800	1.00 MHz
Z80	4.00 MHz
TMS9900	3.33 MHz

*Maximum processor clock rate for Real-Time Prototype Analyzer operation.

INPUT/OUTPUT CHARACTERISTICS Variable Threshold

Range >+10 V dc to < -10 V dcPreset TTL Voltage $+1.4 \text{ V dc} \pm 200 \text{ mV}$ Event Trigger Out High level voltage out (when Vcc=Min, Vi=0.5, Ro=50 Ω to GND) is >2 V dc.

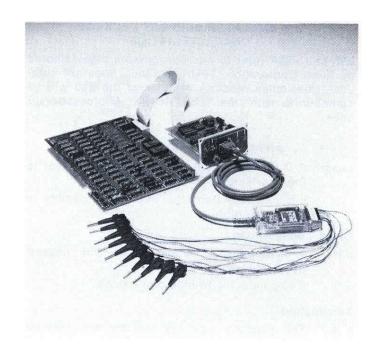
Adjustments—Variable Threshold may be adjusted from >+10 V dc to <-10 V dc with a screwdriver adjustment accessible at the rear panel of the Microprocessor Lab. This voltage must be monitored with a voltmeter having an input impedance of at least 10 M Ω .

Jumpers—With the internal jumper in position '0-3' the clock threshold is designated to be the same as channels 0-3. In position '4-7' the jumper designates the clock threshold to be the same as channels 4-7.

Cable Length — 50 cm (19.5 in).

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Micro- processor Lab	\$7650		
Option 46 Real- Time Prototype Analyzer	+\$1950	8001F46	\$2150
8002 Micro- processor Lab	\$9950		
Option 46 Real- Time Prototype Analyzer	+\$1950	8002F46	\$2150



1702 and 2704/2708 PROM Programmer

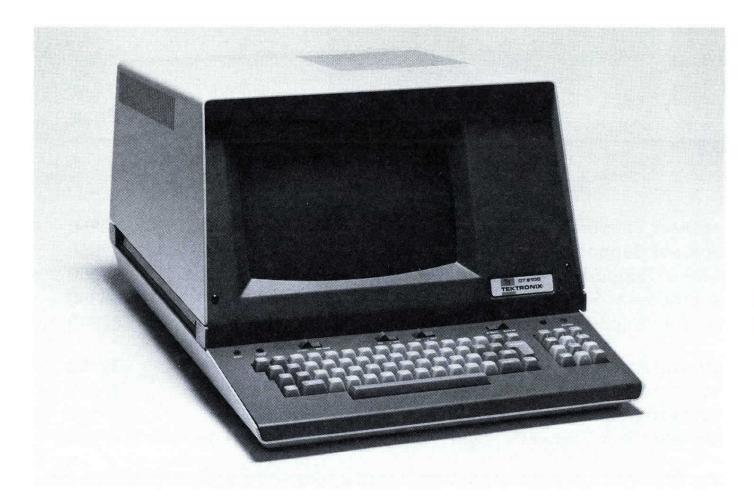
The 1702 and 2704/2708 PROM Programmer, Options 47 and 48 for the 8002 and 8001 Microprocessor Labs, provide the ability to program either 1702 or 2704/2708 erasable PROM chips. When the module is installed in an 8002 or 8001 mainframe, the PROM Programmer software enables communication between 8002 or 8001 program memory and the PROM installed in the front-panel PROM programming porch.

1702 or 2704/2708 PROM Programmer software transfers one data byte at a time, and actual addresses are assigned. Data may be written from 8002 or 8001 program memory (WPROM); read from PROM into program memory (RPROM); or compared on the system terminal (CPROM).

The RPROM command allows the programmed PROM to be read into program memory and dumped to the system console. The CPROM compare function performs an address-by-address comparison between the PROM and the program under development. When an inequality between PROM bytes and memory bytes occurs, the memory address, memory byte content, and PROM byte content are displayed on the system console. A successful comparison between designated PROM and memory bytes is indicated by an End of Job message on the console.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Micro- processor Lab	\$7650		
Option 47 1702 PROM Programmer	+\$500	8001F47	\$550
Option 48 2704/2708 PROM Programmer	+\$500	8001F48	\$550
8002 Micro- processor Lab	\$9950		
Option 47 1702 PROM Programmer	+\$500	8002F47	\$550
Option 48 2704/2708 PROM Programmer	+\$500	8002F48	\$550



CT8100 Crt Terminal

The CT8100 Crt Terminal is an optional peripheral recommended for use with the 8002 and 8001 Microprocessor Labs.

The CT8100 is interfaced to the 8002 or the 8001 through an EIA standard RS-232-C port on the system communications module. Data formats and baud rate are switch-selectable for TTY or EIA operation.

The keyboard provides selection of the full ASCII set of 96 characters.

The console screen provides space for 24 lines of 80 characters each, allowing the 12-

inch diagonal, refreshed crt to display up to 1920 characters.

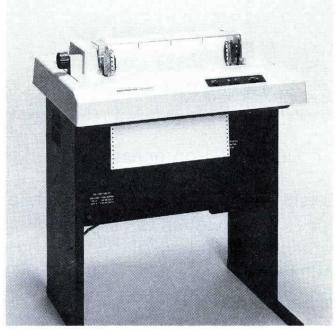
ELECTRICAL CHARACTERISTICS

115/230 (Hi, Medium, Lo) V ac, 50 to 400 Hz; nominal 220 W.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	33.02	13
Width	45.72	18
Length	68.58	27
Weight	lb	
Net	46	
Shipping	67	

ORDERING INFORMATION CT8100 Crt Terminal\$3495



LP8200 Line Printer

The LP8200 Line Printer is an optional system peripheral for the 8002 and 8001 Microprocesor Labs.

The LP8200 is serially interfaced to either Microprocessor Lab through an EIA standard RS-232-C port on the system communications module. Baud rates of 300 to 9600 are selectable.

The printout provides space for 132 characters/line, 6 lines/vertical inch. The full ASCII set of 96 upper/lower case characters is provided.

ELECTRICAL CHARACTERISTICS

Voltage Frequency Power

90 to 132 V ac or 180 to 264 V ac. 50 or 60 Hz ± 1 Hz. 400 W max (printing); 200 W max (idle).

PHYSICAL CHARACTERISTICS

		1101100
Dimensions	cm	in
Height	85.09	33.5
Width	69.85	27.5
Length	55.12	21.7
Weight	lb	
Net	102	

ORDERING INFORMATION

LP8200 Line Printer\$3765

CT8101 Console Terminal

The CT8101 Console Terminal is an optional peripheral recommended for use with the 8002 and 8001 Microprocessor Labs.

The CT8101 is interfaced to the 8002 or 8001 through an EIA standard RS-232-C port on the system communications module. Data formats and baud rate are switch-selectable for TTY or EIA operation.

The keyboard provides selection of the full ASCII set of 96 characters. It also features character repeat when any key is pressed at the same time as the REPEAT key.

ELECTRICAL CHARACTERISTICS

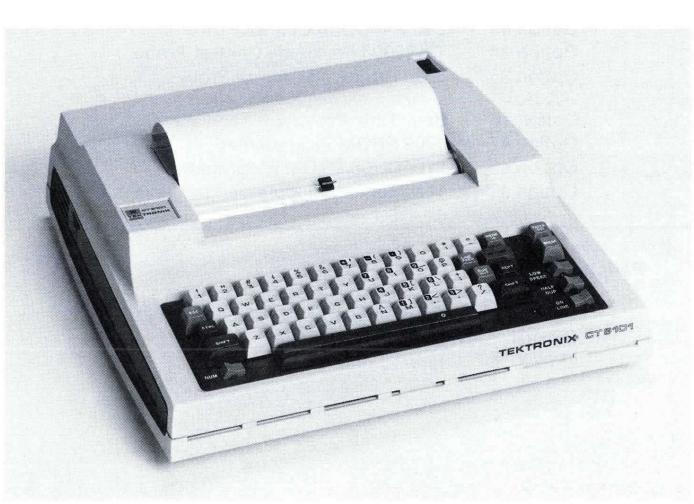
Voltage	115 V RMS; +10%, -15%.
Frequency	47 through 63 Hz.
Power	75 W max.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	10.79	4.25
Width	37.08	14.60
Length	38.73	15.25
Weight	lb	and the second

Net 11.20 (including paper)

ORDERING INFORMATION
CT8101 Console Terminal\$1395



8001 and 8002 Microprocessor Lab Ordering Information

0	ption Descriptio	on	Factory Price	Field Number	Field Price
800	1 Microprocess	or Lab	\$7650		
Select one with initial order	Option 01 Option 02 Option 03 Option 04 Option 05	8080 Microprocessor Support Package 6800 Microprocessor Support Package Z80 Microprocessor Support Package TMS9900 Microprocessor Support Package 8085 Microprocessor Support Package Real-Time Prototype Analyzer	NC NC NC +\$ 400 NC +\$1950	8001F01 8001F02 8001F03 8001F04 8001F05	\$2950 \$2950 \$2950 \$3350 \$2950
	Option 47 Option 48 Option 49	1702 PROM Programmer 2704/2708 PROM Programmer 16K Memory Module	+\$ 500 +\$ 500 +\$1100	8001F47 8001F48 8001F49	\$ 550 \$ 550 \$1210
8002	2 Microprocess	or Lab	\$9950		
Select two with initial order	Option 01 Option 02 Option 03 Option 04 Option 05	8080 Assembler Software Support 6800 Assembler Software Support Z80 Assembler Software Support TMS9900 Assembler Software Support 8085 Assembler Software Support	NC NC NC NC	8002F01 8002F02 8002F03 8002F04 8002F05	\$ 550 \$ 550 \$ 550 \$ 550 \$ 550
	Option 16 Option 17 Option 18 Option 19 Option 20	8080 Emulator Support 6800 Emulator Support Z80 Emulator Support TMS9900 Emulator Support 8085 Emulator Support	+\$1850 +\$1850 +\$1850 +\$2100 +\$1850	8002F16 8002F17 8002F18 8002F19 8002F20	\$1950 \$1950 \$1950 \$2200 \$1950
	Option 31 Option 32 Option 33 Option 34 Option 35	8080 Prototype Control Probe 6800 Prototype Control Probe Z80 Prototype Control Probe TMS9900 Prototype Control Probe 8085 Prototype Control Probe	+\$ 850 +\$ 850 +\$ 850 +\$1000 +\$ 850	8002F31 8002F32 8002F33 8002F34 8002F35	\$ 950 \$ 950 \$ 950 \$1100 \$ 950
	Option 46 Option 47 Option 48 Option 49	Real-Time Prototype Analyzer 1702 PROM Programmer 2704/2708 PROM Programmer 16K Memory Module	+\$1950 +\$ 500 +\$ 500 +\$1100	8002F46 8002F47 8002F48 8002F49	\$2150 \$ 550 \$ 550 \$1210
Peri	pherals				
	CT8100 CT8101 LP8200	Crt Terminal Console Terminal Line Printer	\$3495 \$1395 \$3765		

7000-Series Instruments

Pick a Plug-in Oscilloscope for:

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.

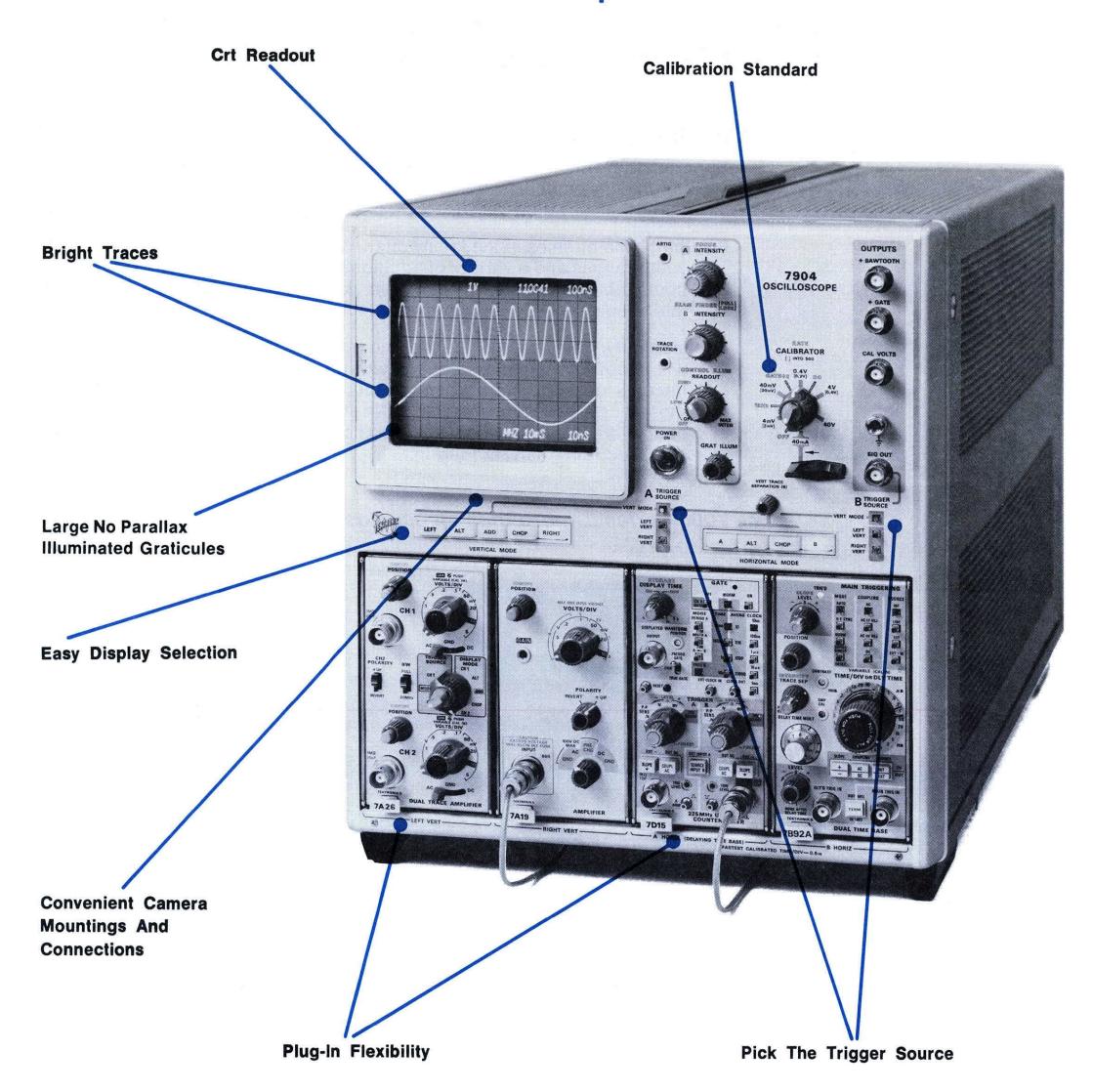
Flexibility. Mainframes in the family offer a choice of popular bandwidth ranges and a variety of additional features. With over 35 compatible plug-ins to choose from, you can configure a flexible scope package based on your individual needs.

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 but it. Three of Tektronix' most recent developments in plug-in scope capability are: The Fast Storage Oscilloscope, the Logic Analyzer Plug-in, and the Spectrum Analyzer Plug-in.

The 7000 Series ... more than an oscilloscope.



7000 Series...more than an oscilloscope



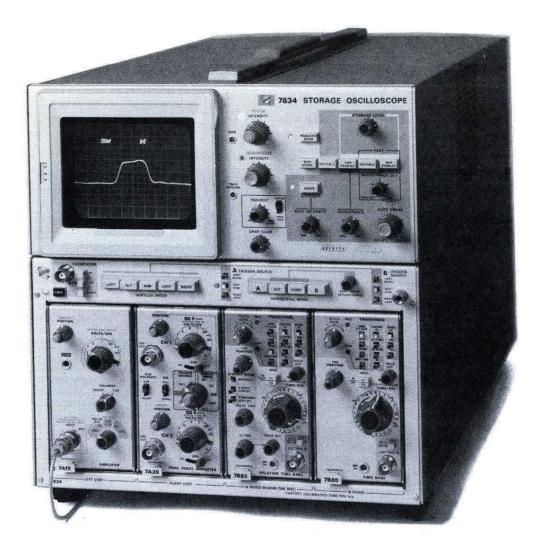
The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix heritage of bringing to the laboratory the ultimate in measurement technology.

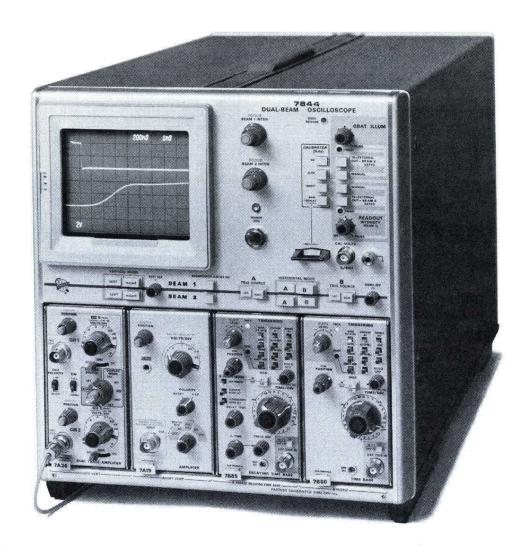
Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent cathode-ray-tube mainframes and instrumentation plug-ins.

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 reflect the latest technology at their inceptions, yet each fits a well planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to and adopt 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 plugin 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 condensed scan on a reduced area in the center of the crt.

Large Illuminated Graticules Eliminate Parallax

The display area is 8 by 10 divisions (0.9, 0.98, 1.0, or 1.22 cm/div depending upon mainframe) with a parallax-free graticule. All graticules are illuminated except the 7313.

Convenient Camera Mountings and Connections

A standard bezel connector matches all

*Not available in mainframes or plug-ins with "N"

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. Not available on the 7313.

Plug-ins

Flexible Measurement Systems

More than thirty 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 square wave for adjusting probe compensation, or a 1 kHz frequency standard in the 7800- and 7900-Series Mainframes. The output is available in several dc or 1 kHz square-wave 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.

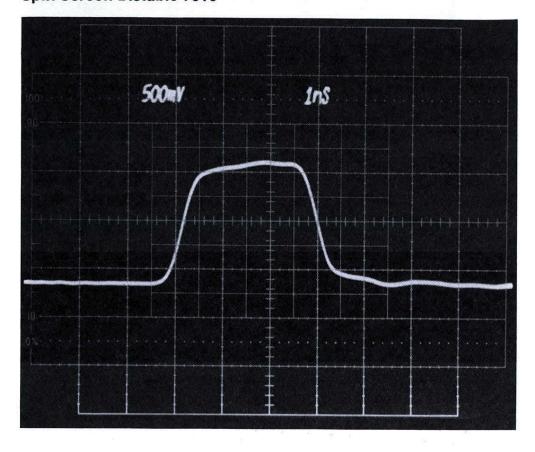
Mainframe Flexibility

Numerous options add even more flexibility in creating the oscilloscope system that most closely meets your measurement requirements.

7000-Series Reference

STORAGE

Readout Stored with the Waveform
Fast Stored Writing Speeds
Multimode 7834/7633/7623A
Variable Persistence 7613
or
Split Screen Bistable 7313

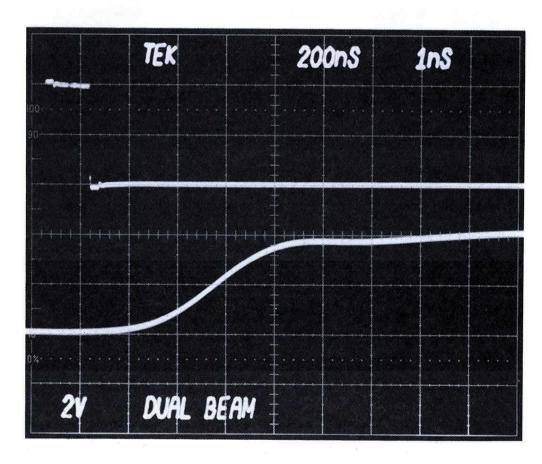


DUAL BEAM

400 MHz Bandwidth

Full Vertical and Horizontal Cross-over Switching (one input shown at two sweep speeds)

Full Overlap on 8 x 10 cm Display



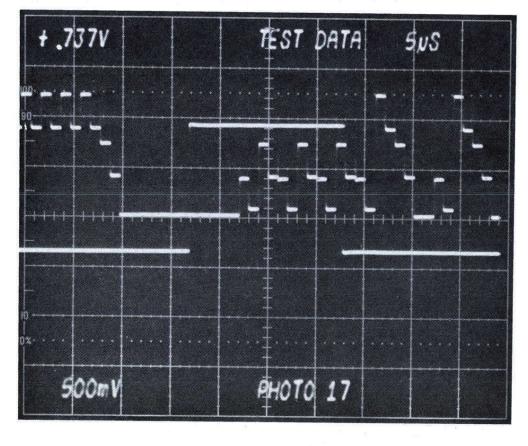
DIGITAL

Sample and Hold Dvm Measures Difference Voltage between Two Points on Complex Waveform (gate waveform indicates two points—leading and trailing edges—where voltage difference is made—+0.737 V)

Readout Unit Identifies this Waveform as TEST DATA-PHOTO 17

Counter/Timer Measurement with Analog Display

Compare Digital Measurement with Analog Display



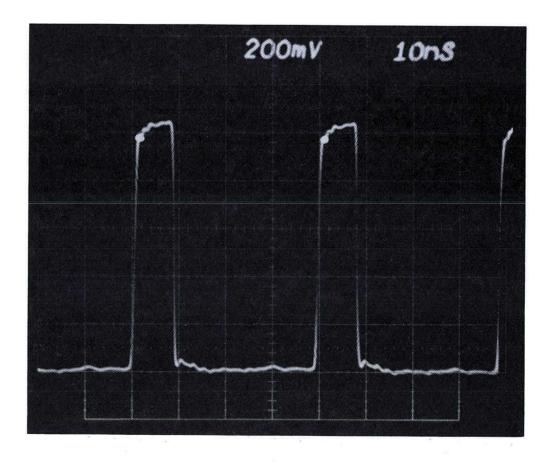
SAMPLING

Two-Dot Time Measurement

Calibrated Delayed Sweep

Simultaneous Sampling & Conventional Displays

Operational Ease of a Conventional Oscilloscope



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. (Systems for digitally reconstructing signals, sometimes included under the broad umbrella of storage, are discussed on pages 193 and 194).

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, and mesh transfer—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 55 through 62. A review, though, of storage concepts should prepare the reader to evaluate the various alternatives more knowledgeably.

Bistable

Phosphor target bistable, available on the 7313 Mainframe, offers a low-cost alternative with relatively long view times. Waveform storage takes place directly on the crt phosphor. This easy-to-use technique offers the flexibility of split-screen storage. Upper and lower halves of the screen may be stored independently. Thus, a reference signal may be stored on one half for comparison against signals on the other half.

Phosphor target bistable has a relatively slow writing speed and a dim contrast between the trace and the background brightness.

Bright Bistable

Bright 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

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

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, fast provides increased storage writing speed. For example, in the reduced scan display mode, the variable persistence writing speed of 5.4 cm/ μ s is increased to 2500 cm/ μ s by selecting fast variable persistence. The 2500 cm/ μ s writing speed is fast enough to capture a single event equivalent to the 7834's 400-MHz bandwidth or a 900 ps rise time.

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.

Digitals

The 7000-Series Digital Plug-ins include: a universal counter/timer, 525 MHz direct frequency counter, digital multimeter with temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special readout 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 solution 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 lets you see leading edges with pretrigger or bandwidth-limiting delay line, you have a wide choice of sampling heads at minimal cost, and you get the convenience of sampling and conventional displays at the same time on the crt.

The sampling waveform on the preceding page was displayed using the 7S14. You can position the two bright dots to any two points in a waveform which is displayed at 10 ns/div or faster. The separation between dots is controlled by a calibrated 10-turn DTM dial. Repeated time measurements on similar waveforms may be made more rapidly and accurately and with less fatigue using this unique two-dot method.

Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 60 GHz is provided by the 7L5, 7L13 and 7L18 Spectrum Analysis. 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 for more information.

7000-Series Reference

7000-SERIES VERTICAL SYSTEM SPECIFICATIONS

PAGE	AMPLIFIER		7A11	7A13	7A15A	7A16A	7A17	7A18	7A19	7A21N	7A22	7A24	7A26
			78	79	78	78	78	80	79	79	79	80	80
PERFORN FEATURE			Low-capaci- tance FET probe amplifier	Differential dc offset, high-freq cmrr ampli- fier	Low-cost conven- tional input amplifier	Wide-band- width con- ventional input amplifier	Low-cost, easy to customize amplifier	Dual- channel amplifier	Wide-band- width 50-Ω input amplifier	Direct crt access	Dc-coupled, high-gain differential amplifier	Dual- channel 50-Ω amplifier	Dual- channe amplific
MIN DEFI			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	<4 V/div	10 μV/div	5 mV/div	5 mV/di
WITHOUT			2% (integral)	1.5%	2%	2%		2%	3%	_	2%	2%	2%
7900	7904	BW	250 MHz	105 MHz P6053B* 105 MHz P6106** 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	500 MHz	1 GHz	1 MHz ± 10%	350 MHz	200 MHz
FAMILY (0°C to 30°C)	R7903 R7912 ^b	Tr	1.4 ns	3.4 ns P6053B* 3.4 ns P6106** 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.8 ns	350 ps	350 ns ± 9%	1.0 ns	1.8 ns
		SIG OUT BW	140 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz		1 MHz ± 10%	140 MHz	140 MHz
	7844/R	BW	200 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz ³	1 GHz	1 MHz ± 10%	300 MHz	180 MHz
7800 FAMILY O°C to		Tr	1.8 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	350 ps	350 ns ± 9%	1.2 ns	1.9 ns
35°C)	7834	BW	200 MHz	95 MHz P6053B* 95 MHz P6106** 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz	_	1 MHz ± 10%	300 MHz	180 MHz
		Tr	1.8 ns	3.7 ns P6053B* 3.7 ns P6106** 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
	7704A	BW	170 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	170 MHz	150 MHz	75 MHz	250 MHz4	-	1 MHz ± 10%	200 MHz	170 MHz
	Opt 9 (0°C to 30°C)	Tr	2.1 ns	3.5 ns P6053B* 3.5 ns P6106** 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
	30-0)	SIG OUT BW	70 MHz	60 MHz P6053B* 60 MHz P6106** 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz		1 MHz ± 10%	70 MHz	70 MHz
		BW	170 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	160 MHz	150 MHz	75 MHz	200 MHz		1 MHz ± 10%	200 MHz	150 MHz
700 AMILY	7704A	Tr	2.1 ns	3.5 ns P6053B* 3.5 ns P6106** 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
(i		SIG OUT BW	70 MHz	60 MHz P6053B* 60 MHz P6106** 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	_	1 MHz ± 10%	70 MHz	70 MHz
		BW	150 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	_	1 MHz ± 10%	160 MHz	140 MHz
	R7704	Tr	2.4 ns	3.5 ns P6053B* 3.5 ns P6106** 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
	and the second	SIG OUT BW	60 MHz	55 MHz P6053B* 55 MHz P6106** 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	-	1 MHz ± 10%	60 MHz	60 MHz
	7603/R 7633/R	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
	7623A/R 7613/R	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
	7603N Opt 11 ⁵	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
AMILY nd TORAGE		BW	25 MHz	25 MHz P6062B 24 MHz P6055	25 MHz	25 MHz	25 MHz	25 MHz	25 MHz		1 MHz ± 10%	25 MHz	25 MHz
AMILY	7313 R7313	Tr	14 ns	14 ns P6062B 15 ns P6055	14 ns	14 ns	14 ns	14 ns	14 ns		350 ns ± 9%	14 ns	14 ns
		SIG OUT BW	60 MHz	55 MHz P6062B 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz		1 MHz ± 10%	60 MHz	60 MHz

System Environmental Specifications (apply to all instruments except where noted)—Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

¹Accuracy 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%.

²Obtained with X10 gain at reduced bandwidth of 10 MHz.

³Bandwidth is 325 MHz to 10 mV/div.

4Bandwidth is 200 MHz at 10 mV/div.

⁵All 7000-Series Plug-ins are compatible with the 7603N Opt 11. However, they do not meet the rigid environmental specifications required by the military.

⁶Refer to Transient Digitizer, R7912 not available with signal outputs.

*P6053B has Trace Identify

**P6106 has Ground Reference

RECOMMENDED COMBINATIONS 7000-SERIES MAINFRAMES AND TIME BASES

MAINFRAME		7904 R7903	7834	7844/R	7704A R7704	7603/R	7603N Opt 11	7633/R 7623A/R	7613/R	7313/R
Time Base	PERFORMANCE FEATURE		380	• IND	ICATES RE	COMMEND	ED COMBI	NATION		
7B50A	Single time base					•		•	•	•
7B53A	Dual time base with mixed sweep				•	•	• *	•	•	•
7B53A Opt 05	7B53A with tv sync triggering				•	•		•	•	•
7B80	Single time base (used also as delayed time base)	•	•	•	•					
7B85	Single time base with delaying and $\boldsymbol{\Delta}$ delay sweep function	•	•	•	• (1)					
7B92A	Dual time base with display switching	•	•	•	• (1)					

^{*7}B53AN Opt 11 is recommended; one is supplied with 7603N Opt 11S system. $\ensuremath{^{(1)}}$ No trace separation.

7000-SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART*

		PASSIVE V	OLTAGE 1-M	Ω INPUT COI	MPATIBLE				PASSIVE 50-Ω INPI			ROBES 50 Ω UT COMPATI		cu	IRRENT PROB	ES
PROBE		P6101 1 Meter	P6106 1 Meter P6053B 3.5'	P6055 3.5'	P6009 9'	P6015 10'	P6062B 6'	P6105 P6108 2 Meter	P6056 6'	P6057 6'	P6202 2 Meter	P6046 6'	P6201 6'	w/passive term P6021 5' 10 mV/mA	w/passive term P6022 5' 10 mV/mA	P6302/ AM 503 6'
FEATURE	s	Miniature Probe	Fastest Probes Compatible with 1-MΩ Input	Adj Attenuation for Differential Use	1.5 kV Compatibility	40 kV Pk Pulse Com- patibility	Selectable Attenuation	Miniature Probe	Fastest 10X Passive Probe Low C	Fastest 100X Pas- sive Probe Low C	10-MΩ Input Impedance Dc, Off- set	Differential Probe High Cmrr	Low Capacitive Loading Ac Coupling Dc Offset	Current	Ac High Frequency	Dc High Current
ATTENUA	TION	1X	10X	10X	100X	1000X	Selectable	10X	10X	100X	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
7900 FAMILY	7A11* 7A13 7A15A 7A16A 7A18 7A19 7A22 7A24 7A26	Nc 34 MHz 34 MHz 34 MHz 34 MHz Nc 1 MHz Nc 34 MHz	Nc 105 MHz 75 MHz 200 MHz 75 MHz Nc Nc Nc Nc 175 MHz	Nc 65 MHz Nc 1 MHz	Nc 85 MHz 70 MHz 130 MHz 70 MHz Nc Nc	Nc 65 MHz 60 MHz 80 MHz 60 MHz Nc Nc	75 MHz 75 MHz Nc 1 MHz Nc	Nc 75 MHz 75 MHz 75 MHz Nc Nc	500 MHz 350 MHz	105 MHz 80 MHz 205 MHz 75 MHz 480 MHz 350 MHz	105 MHz 80 MHz 205 MHz 75 MHz 300 MHz 290 MHz 185 MHz	70 MHz 60 MHz 90 MHz 60 MHz 95 MHz 95 MHz 85 MHz	105 MHz 75 MHz 215 MHz 75 MHz 430 MHz 310 MHz 180 MHz	55 MHz 50 MHz 45 MHz 55 MHz 45 MHz Nc 1 MHz Nc 55 MHz	150 MHz 90 MHz 70 MHz 150 MHz 70 MHz Nc 1 MHz Nc 140 MHz	45 MHz 45 MHz 40 MHz 45 MHz 40 MHz 50 MHz 1 MHz 45 MHz 45 MHz
7800 FAMILY	7A11 7A13 7A15A 7A16A 7A18 7A19 7A22 7A24 7A26	Nc 34 MHz 34 MHz 34 MHz 34 MHz Nc 1 MHz Nc 34 MHz	NC 95 MHz 75 MHz 160 MHz 85 MHz Nc Nc Nc Nc 145 MHz	Nc 65 MHz Nc 1 MHz Nc	Nc 85 MHz 70 MHz 110 MHz 80 MHz Nc 1 MHz Nc 105 MHz	Nc 60 MHz 55 MHz 75 MHz 60 MHz Nc 1 MHz Nc 75 MHz	Nc 75 MHz 85 MHz Nc 1 MHz Nc	No 100 MHz 75 MHz 100 MHz 85 MHz No No No 100 MHz	400 MHz 300 MHz	400 MHz 300 MHz	100 MHz 80 MHz 170 MHz 75 MHz 320 MHz 270 MHz 150 MHz	70 MHz 60 MHz 85 MHz 65 MHz 95 MHz 90 MHz 85 MHz	100 MHz 80 MHz 165 MHz 90 MHz 360 MHz 280 MHz 155 MHz	55 MHz 50 MHz 45 MHz 55 MHz 45 MHz Nc 1 MHz Nc 55 MHz	130 MHz 85 MHz 70 MHz 130 MHz 70 MHz Nc 1 MHz Nc 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 7A18 7A19** 7A22 7A24 7A26	Nc 34 MHz 34 MHz 34 MHz 34 MHz Nc 1 MHz Nc 34 MHz	NC 100 MHz 70 MHz 145 MHz 75 MHz Nc Nc Nc Nc 140 MHz	Nc 65 MHz Nc 1 MHz	Nc 85 MHz 65 MHz 115 MHz 70 MHz Nc Nc 105 MHz	Nc 65 MHz 55 MHz 75 MHz 60 MHz Nc Nc 75 MHz	Nc 70 MHz 75 MHz Nc 1 MHz Nc	NC 70 MHz 70 MHz 100 MHz 75 MHz Nc NC	250 MHz 200 MHz	250 MHz 200 MHz	100 MHz 75 MHz 160 MHz 75 MHz 220 MHz 185 MHz 160 MHz	70 MHz 55 MHz 80 MHz 60 MHz 85 MHz 80 MHz	100 MHz 70 MHz 150 MHz 75 MHz 215 MHz 180 MHz 140 MHz	55 MHz 50 MHz 45 MHz 55 MHz 45 MHz Nc 1 MHz Nc 55 MHz	125 MHz 85 MHz 70 MHz 125 MHz 70 MHz NC 1 MHz NC 115 MHz	45 MHz 40 MHz 40 MHz 45 MHz 40 MHz 45 MHz 1 MHz 45 MHz 45 MHz 45 MHz
7600 FAMILY	7A11 7A13 7A15A 7A16A 7A18 7A22 7A26	Nc 34 MHz 34 MHz 34 MHz 34 MHz 1 MHz 34 MHz	Nc 75 MHz 60 MHz 95 MHz 70 MHz Nc 95 MHz	Nc 55 MHz 1 MHz	Nc 60 MHz 55 MHz 85 MHz 65 MHz	Nc 55 MHz 50 MHz 65 MHz 55 MHz 65 MHz	Nc 70 MHz 60 MHz 95 MHz 70 MHz 1 MHz 95 MHz	Nc 70 MHz 60 MHz 95 MHz 70 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
7313	7A11 7A13A 7A15A 7A18 7A22	20 MHz 20 MHz 20 MHz 20 MHz 1 MHz	25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	23 MHz 23 MHz 23 MHz 23 MHz 1 MHz	25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	24 MHz 24 MHz 24 MHz 24 MHz 1 MHz	25 MHz 25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	25 MHz 25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	No No No No	X C C C C C C	25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	25 MHz 25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	25 MHz 25 MHz 25 MHz 25 MHz 1 MHz	24 MHz 24 MHz 24 MHz 24 MHz 1 MHz	22 MHz 22 MHz 22 MHz 22 MHz 1 MHz	22 MHz 22 MHz 22 MHz 22 MHz 21 MHz

*Note: The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.

If there is no bandpass specified the probe/plug-in combination is compatible but not recommended.

** = Option 09 Mainframe

Nc = Not compatible

DIMENSIONS AND WEIGHTS 7000-SERIES MAINFRAMES AND PLUG-INS

								D==0.4	7000	Pacoc	7603N	7603N	7633, 7623A, 7613,	R7633, R7623A, R7613,		G-INS DOUBLE
Dimensions	1	7904	R7903	7844	R7844	7834	7704A	R7704	7603	R7603	OPT 11S	OPT 11	7313	R7313	SINGLE	
	in	13.5	5.3	12.9	7.0	13.6	13.6	7.0	11.4	5.25	11.5	11.5	12.0	5.25	5.0	5.0
Height	cm	34.3	13.5	32.8	17.8	34.5	34.5	17.8	29.0	13.3	29.2	29.2	30.5	13.3	12.7	12.7
	in	12.0	19.0	12.0	19.0	12.0	12.0	19.0	8.7	19.0	9.7	9.7	8.7	19.0	2.8	5.5
Width	cm	30.5	48.3	30.5	48.3	30.5	30.5	48.3	22.1	48.3	24.6	24.6	21.2	48.3	7.1	14.0
v 200	in	23.3	22.8	23.8	24.8	23.2	22.7	22.4	24.0	24.7	25.2	23.5	23.5	22.3	14.5	14.5
Length	cm	59.2	57.9	60.5	63.0	58.9	57.7	56.9	61.0	62.7	64.0	59.7	59.7	56.6	36.8	36.8
Weights (approx)		•	****													
The second price and the second secon	lb	32	27	36	33	35.5	30	44	30	30	45	36	30	32	2	9
Net	kg	14.5	12.2	16.3	15.0	16.1	13.6	20.0	13.6	13.6	20.4	16.3	13.6	14.5	0.9	4.1
	Ib	44	52	47	63	47	43	77	46	62	72	42	42	62	5	12
Shipping	ka	20	23.6	21.3	28.5	21.3	19.5	35.0	20.8	28.2	32.7	19.0	19.0	28.2	2.3	5.4

7000-Series Reference

SUMMARIZED CAMERA CHARACTERISTICS

					LENS		FII	M BACKS	
CAMERA	RECOMMENDED FOR	PERFORMANCE FEATURES AND BENEFITS	MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3.25 x 4.25 in Polaroid Film except where noted)	ORDI- NARILY USED	OPTIONAL AND INTER- CHANGEABLE	PRICE with back ordi- narily used
C-51	7904, R7903, 7844, 7704A	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 Roll	Polaroid Pack and 4 x 5 in Graflok	\$1460
C-53	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	Polaroid Roll and 4 x 5 in Graflok	\$1200
C-59	7603 7603N11S	General-purpose at low price.	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 in	Polaroid Pack	Polaroid Roll and 4 x 5 in Graflok	\$730
C-5B	AII	Low cost.	f/16	0.67 or 0.85 select- able	0.02	9.76 x 12.2 cm	Polaroid Pack	None	\$300

^{*}Relative light-gathering power.

Recommended Cameras and Adapters

OSCILLOSCOPE

RECOMMENDED CAMERA C-53 or C-51

7904, R7903, 7844, 7704A 7633, 7623A, 7613, 7834

C-53

7603, 7603N Opt 11S C-59 C-50 Series Camera Adapter, Part Number 016-0249-03, included with camera.

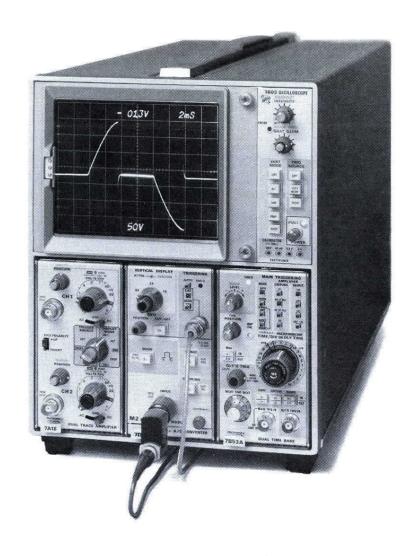
For full details see camera section, page 225.

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.

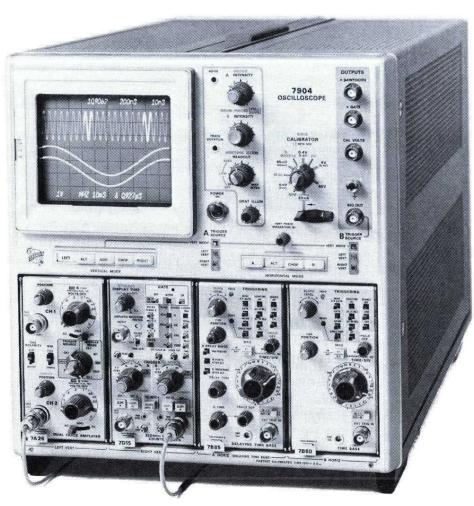
For full details see SCOPE-MOBILE® Cart section, page 256.





7000-Series Nonstorage Mainframes





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.

Choose from a variety of features, including bandwidth, dual-beam, alphanumeric displays, rackmounting, and three- or four-plug-in flexibility:

7900 Series	500 MHz	page 46
7800 Series	400 MHz	page 48
7700 Series	200 MHz	page 50
7600 Series	100 MHz	page 52

500 MHz at 10 mV/div

1-GHz Direct-access Unit
(less than 4 V/div)

500 ps/div Fastest
Calibrated Sweep Rate
Greater than 15 cm/ns Enhanced
Writing Speed
Crt Readout
Over 30 Compatible Plug-ins
900-MHz FET Probe Available

The 7904 and 5¼ in rackmount R7903 are the widest real-time-bandwidth, general-purpose oscilloscopes available today. The 7A19 Amplifier/7904 Mainframe attains 500 MHz at 10 mV. 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 excellent visual brightness and an 8 x 10 cm display area. The C-51R Camera, Writing Speed Enhancer, 10,000 ASA film and P11 phosphor can produce writing speeds of at least 9 cm/ns. Speeds up to 15 cm/ns are possible when an optional max-brightness crt with a 4 x 5 cm display area is used.



7904 and R7903 - 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 — Repetition rate is approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned 4 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 — Repetition rate is approx 200 kHz.

X-Y Mode — Phase shift is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, Option 02) between vertical and horizontal 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 plugins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

7904 and R7903 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 — No charge.

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 51/4 in of rack height in a standard 19 in rack. It is fan-cooled and comes complete with slide-out chassis tracks.

Min Photographic Writing Speed (Using Polaroid Film 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.

Crt	Writing Sp	eed cm/ns 11	Camera	Lens
	Type 410	Type 47		
Standard 8 x 10 cm	6.1	3.1	C-51R	f/1.2 1:0.5
Option 04 4 x 5 cm	10.0	5.0	C-51R	f/1.2 1:0.5

The following table lists the approx relative writing speed of three types of Polaroid film and the gains that can be achieved by controlled fogging with the Writing Speed Enhancer. See chart on page 48 for further information.

Po	olaroid Film		Approx Relative Writing Speed							
Туре	ASA Equivalent Speed	Unfo	Unfogged							
	<i>⊗</i>	Print viewed with front illum- ination	Print viewed with back illum- ination	Print viewed with front illum- ination*						
107	3000	1 (Reference)	Print base is opaque	3						
47	3000	1	1.2	3						
410	10,000	2	2.2-2.4	4						

^{*}Viewing a fogged print with back illumination does not increase the apparent writing speed.

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. Max 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 Ω (±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 Ω ($\pm 1\%$).

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω .

7904 — OUTPUTS/INPUTS

+ Sawtooth — Sawtooth starts 1 V or less from ground (into 1 M Ω). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (\pm 5%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is approx 950 Ω .

+ GATE — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable Output voltage is 0.5 V (\pm 10%) into 50 Ω , 10 V (\pm 10%) into 1 M Ω . Rise time is 5 ns or less into 50 Ω ; output R is approx 950 Ω .

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . Bandwidth depends upon vertical plug-in. See the Vertical System Specifications Chart. Output R is approx 950 Ω .

Camera Power — Three-prong connector to the left of the crt provides power, ground, and remote singlesweep 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 Ω). Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is approx 950 Ω .

+Gate — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V ($\pm 10\%$) into 50 Ω . 10 V ($\pm 10\%$) into 1 M Ω . Rise time is 7 ns or less into 50 Ω . Output R is approx 950 Ω .

Sig Out — Selected by TRIGGER SOURCE switches. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . Bandwidth depends on the vertical plug-in. See the Vertical System Specifications Chart. Output R is approx 950 Ω .

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 singleshot 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 01.

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. Max 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. Max power consumption, 160 W, 2 A at 115 V line, 60 Hz.

7904 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); 9-pin cablemount plug (134-0049-00).

R7903 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); rack-mounting hardware.

Dimensions and Weights — See page 43.

For Recommended Cameras — See page 44.

7904 ORDERING INFORMATION (Plug-ins not Included)

7904	Oscilloso	ope		٠.		•		•	•	•	٠	. \$5	250	
		7904	OP.	τιο	NS	;								
Option	01 without	Crt R	lead	loui	t		•				. 5	Sub	\$400	
- The second sec	DESCRIPTION OF THE PROPERTY OF	1211									102	7 195005000	S. A. S.	

Option 02	X-Y Horiz CompAdd \$150
Option 03	Emi Modification Add \$250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor)Add \$500
Option 78	P11 PhosphorNo charge

7904 CONVERSION KITS

040-0605-03	Crt Readout\$480
040-0606-00	X-Y Horiz Comp\$200
040-0570-00	Emi Modification\$300

R7903 ORDERING INFORMATION (Plug-ins not Included)

R7903 Oscilloscope\$4750

	R7903 OPTIONS
Option 01	without Crt ReadoutSub \$400
Option 03	Emi ModificationAdd \$250
Option 04	Max Brightness Crt With Reduced
	Area (Specify Phosphor)Add \$500

040-0605-03	Crt	Readout .		 ٠.		•	٠.		٠.	. \$	480
040-0647-00	Emi	Modificat	ion	 	•	020		•		. \$	280

Option 10 Pulsed GraticuleAdd \$100

400-MHz Bandwidth

Dual Beam

Full Vertical Crossover Switching

8 x 10 cm Full Scan Overlap Crt

Crt Readout

1 ns/div Max Calibrated Sweep

1-GHz Direct-access Unit
(less than 4 V/div)

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.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe 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 ± 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° 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 - No charge.

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.

Minimum Photographic Writing Speed — 1.7 cm/ns using Polaroid type 47 film, C-51R and optional P11 phosphor. In typical camera applications, P31 phosphor has about one-half the writing speed of P11 phosphor. Writing speed can be increased by using the TEKTRONIX Writing Speed Enhancer or Polaroid type 410 film or both.

The following table lists the approx relative writing speed of three types of Polaroid film and the gains that can be achieved by controlled fogging with the Writing Speed Enhancer.

P	olaroid Film	Actual Relative Film Writing Speed											
Туре	ASA Equivalent Speed	Unfo	gged	Fogged									
		Print viewed with front illum- ination	Print viewed with back illum- ination	Print viewed with front illum- ination*									
107	3000	1 (Reference)	Print base is opaque	3									
47	3000	1	1.2	3									
410	10,000	2	2.2-2.4	4									

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

The Photographic Writing Speed Enhancer (Opt 22) provides a preset automatic method of photographic writing speed enhancement. Opt 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available. With Opt 22, photographic writing speed can be increased approx 2 times.



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 Ω .

Current Output — 40 mA ($\pm 1\%$) rectangular wave-shape, front panel current loop 7844, optional current loop adapter (012-0341-00) required for R7844.

OUTPUTS/INPUTS

A and B + Sawtooth — Sawtooth starts 1 V or less from ground (into 1 M Ω). Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is approx 950 Ω .

A and B + Gate — Positive-going rectangular wave-form derived from Main or Delayed Gate. Output voltage 0.5 V (\pm 10%) into 50 Ω . 10 V (\pm 10%) into 1 M Ω . Rise time is 5 ns or less into 50 Ω . Output R is approx 950 Ω .

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-50-Series Cameras.

Probe Power — Two connectors provide correct operating voltages for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — Selectable 115 V nominal (90-132 V), 230 V nominal (180-264 V).

Line Frequency — 48 to 440 Hz.

Max Power Consumption — 235 W, 2.9 A at 60 Hz 115 V line.

INCLUDED ACCESSORIES

R7844 — 1 rackmount hardware kit, 1 rackmount slide guide (351-0314-00).

Dimensions and Weights - See page 43.

For Recommended Cameras — See page 44.

ORDERING INFORMATION

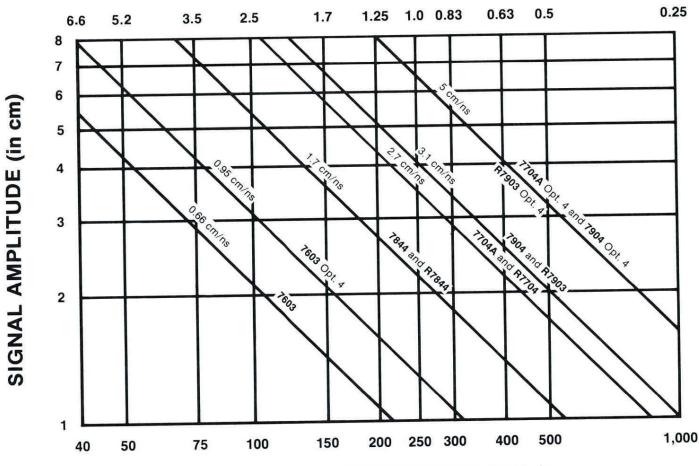
(Plug-ins not Included)

7844 Oscilloscope		٠		[:•)	•		•	٠	•	٠	•	•	•	. \$7650
R7844 Oscilloscope	•	•		٠		٠				٠	٠			. \$7950

OPTIONS

	OF HONO
Option 03	Emi ModificationAdd \$250
Option 22	Writing Speed Enhancer
Modifica	tionAdd \$275
	P11 Phosphor No charge

STEP RISE TIME (ns)



SINE WAVE FREQUENCY (MHz)

The above graph shows the relationship of writing speed to practical measurement parameters of signal amplitude and frequency or rise time.

The vertical scale is the maximum peak-to-peak signal amplitude. The horizontal scale below the graph is maximum sine-wave frequency. Above the graph, the horizontal scale is the equivalent signal rise time for nonsinusoidal signals. These speeds assume a horizontal spot velocity that is small compared to the maximum vertical velocity. The step rise time is assumed to be a linear ramp

measured between 10% and 90% points. The diagonal lines represent the minimum photographic writing speeds for 7000-Series Mainframes and are all measured under the following conditions: Camera, TEKTRONIX type C-51R, f 1.2, with the shutter opened before the sweep and closed 5 seconds after the sweep. Phosphor, P11 (optional). Film, Polaroid type 47 (ASA 3,000), no fogging for film speed enhancement, developed for 20 seconds at 25°C and viewed with back illumination.

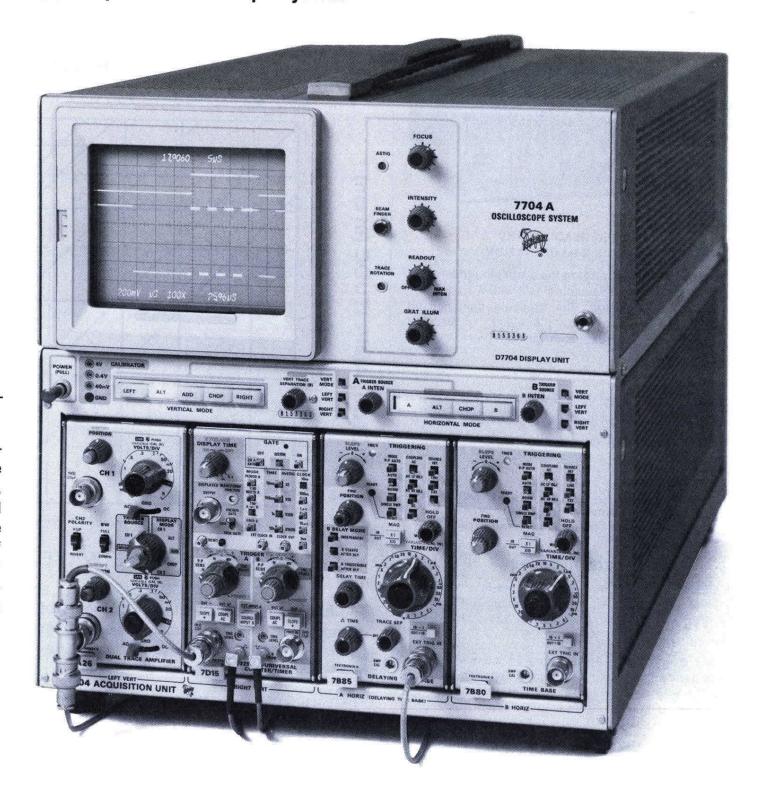
Dc to 200 MHz with Optimum
Pulse Response
Dc-to-250 MHz Bandwidth Option
Greater than 15 cm/ns
Enhanced Writing Speed with
Optional Crt and WSEN
Crt Readout

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.

The 7704A modularity permits the addition of a processing module. With this addition and a Controller, the 7704A is converted into a Digital Processing Oscilloscope. This modularity also provides for easy maintenance.

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. The standard crt affords 5.3 cm/ns writing speed (C-51R Camera, P11 phosphor, and 10,000 ASA film), without enhancement, and 8 cm/ ns with the TEKTRONIX Writing Speed Enhancer. With the optional crt and film fogging technique, writing speed can be increased to at least 15 cm/ns. This writing speed reserve means reduced intensity setting for improved trace definition. See chart on page 49 for additional information.



Characteristics are common to all mainframes unless noted.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe 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.

 $\begin{tabular}{lll} \textbf{Modes of Operation} & \textbf{—} \end{tabular} \begin{tabular}{lll} \textbf{LEFT}, & \textbf{ALT}, & \textbf{ADD}, & \textbf{CHOP}, \\ \textbf{RIGHT}. & \end{tabular}$

Chopped Mode — 7704A, repetition 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, repetition rate is internally selectable, approx 20 kHz or 200 kHz; R7704, fixed at approx 200 kHz.

X-Y Mode — Phase shift is within 2° 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 less than 2° 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.

Option 04, Max 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-reprate, high-speed signals.

Option 78, P11 Phosphor — No charge.

Minimum Photographic Writing Speed (Using Polaroid Film without Film Fogging) — Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical application, P31 phosphor has approx one-half the writing speed of P11 phosphor. See chart on page 47 for further information.

Mainframe	P11 Writin		Camera	Lens			
	Type 410	Type 47					
7704A R7704 8 x 10 cm	5.3	2.7	C-51R	f/1.2 1:0.5			
7704A Option 04 4 x 5 cm	10.0	5.0					

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. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

External Z-Axis Inputs (R7704 only) — High sensitivity input: minimum pulse width to blank trace is 30 ns at 2 V; 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; input R is 500 Ω within 10%. Max input voltage is 15 V (dc + peak ac) and p-p ac.

High Speed Input — Minimum pulse width to blank trace is 3.5 ns at 60 V; 60 V p-p for fully intensity range from dc to 100 MHz. A positive signal blanks the trace; input R is 18 k Ω within 20%. Max 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 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω 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 Ω , 10 V (\pm 10%) into 1 M Ω . Rise time is 20 ns or less into 50 Ω ; output R is 950 Ω nominal.

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . The bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart. Output R is 950 Ω nominal.

External Single-sweep Reset — Ground closure, rearpanel input to reset sweep.



The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

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 Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and gnd 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).

Max 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- Ω cable (012-0057-01); 20 in cable, two-pin-to-BNC (175-1178-00); rackmounting hardware.

Weights and Dimensions — See page 43.

For Recommended Cameras — See page 44.

ORDERING INFORMATION (Plug-ins not Included)

7704A	Oscilloscope	٠			•	٠	•	•			. \$3325
R7704	Oscilloscope										. \$4275

7704A OPTIONS

Option 01	without Crt Readout and Probe Power Sub \$400
Option 03	Emi Modification Add \$250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor) Add \$500
Option 09	Bandwidth Change (250 MHz)Add \$200
Option 78	P11 Phosphor No charge
Option 01 Option 02 Option 03 Option 05	R7704 OPTIONS without Crt ReadoutSub \$400 X-Y Horiz CompAdd \$150 Emi ModificationAdd \$250 Line Freq Change
Company of the Compan	Hz) (not required for 7704A)Add \$125
Option 78	P11 Phosphor No charge

7704A CONVERSION KITS

	7704A CONVERSION KITS
040-0613-00	Crt Readout and Probe Power\$480
040-0612-00	Emi Modification\$285
040-0619-00	Sig Out/In\$125

R7704 CONVERSION KITS

040-0533-01	Crt Readout\$480
040-0529-00	X-Y Horiz Comp\$110
040-0562-00	Emi Modification\$275

7000-Series 100-MHz Wide Performance Oscilloscopes

Dc-to-100 MHz Bandwidth

61/2 in Crt

Crt Readout

51/4 in Rackmount

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.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition 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° 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.

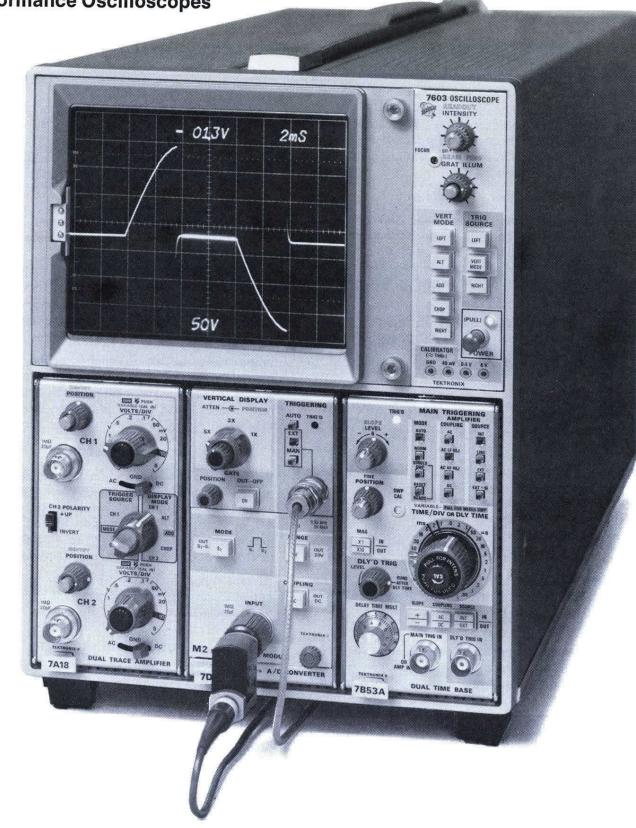
Option 01, without Crt Readout - No crt readout.

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.)

Minimum Photographic Writing Speed — Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer.



Crt	Writ	ing Spe	Camera	Lens			
	Type	107/47	Туре	410			
	P31	P11	P31 P11				
Standard 8 x 10 div					C-50	f/1.9	
(1.22 cm/div)	100	150	200	300			
Option 04 8 x 10 div (1 cm/div)	200	300	400	600		1:0.7	

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. Max 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 MΩ). Output R is 950 Ω. Output voltage is 1 V/div (\pm 10%) into 1 MΩ, 50 mV/div (\pm 15%) into 50 Ω.

+ Gate — Positive pulse of the same duration and coincident with sweep. Output R is 950 Ω . Output voltage is 10 V (\pm 10%) into 1 M Ω , 0.5 V (\pm 10%) into 50 Ω . Rise time is 20 ns or less into 50 Ω . Source is selectable from Main, Delay, or Auxiliary Gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 0.5 V/div ($\pm 10\%$) into 1 M Ω , 25 mV/div ($\pm 10\%$) into 50 Ω . Output R is 950 Ω . 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 Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition 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 gnd 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 400 Hz (7603); 50 Hz to 60 Hz (R7603).

Option 05, Line Frequency Change (50-400 Hz) — Converts the R7603 to 50-400 Hz operation (not required for 7603).

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan for the R7603.

Included Accessories — (For 7603 and R7603) 20 in cable (two-pin-to-BNC) (175-1178-00); crt filter (Blue 337-1700-01, Clear 337-1700-04). The R7603 includes rackmounting hardware.

Dimensions and Weights — See page 43.

For Recommended Cameras — See page 44.



The R7603 requires only 51/4 in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

ORDERING INFORMATION

(Plug-ins not Included)

7603	Oscilloscope	٠	•	٠	٠	٠		٠	٠	٠			. \$2050
R7603	Oscilloscope	•	٠	٠	٠	٠	٠	٠	٠		•		. \$2350

7603 OPTIONS

Option 01	without Crt ReadoutSub \$400
Option 03	Emi ModificationAdd \$250
Option 04 Reduced	Max Brightness Crt With Area (Specify Phosphor)Add \$200
Service and the service of the servi	with Internal Spectrum Graticule\$50
Option 08	Protective Panel Cover Add \$100

R7603 OPTIONS

Option 01	without Crt ReadoutSub \$400
Option 03	Emi ModificationAdd \$250
Option 04 Reduced	Max Brightness Crt With Area (Specify Phosphor)Add \$200
(50-400 H	Line Freq Change dz)Add \$300 ired for 7603)
	with Internal Spectrum Graticule\$50

7603 CONVERSION KITS

040-0654-02	Crt Readout\$480
040-0662-00	Emi Modification\$300
040-0629-01	Sig Out/In\$120
040-0686-00	Power Supply to Light
Plug-in Pus	hbuttons
040-0718-00	X-Y Horiz Comp\$150
	R7603 CONVERSION KITS
040-0674-02	Crt Readout\$480
040-0679-00	Emi Modification\$275
040-0633-00	Sig Out/In\$85
040-0686-00	Power Supply to Light
Plug-in Pus	hbuttons\$30
040-0718-00	X-Y Horiz Comp\$150
РНО	SPHOR OPTIONS (7603/R7603)
Option 76 P7	PhosphorNo charge
Option 77 P7	NE SALISADA SE POPULATA DA CARACTERIA DE CAR

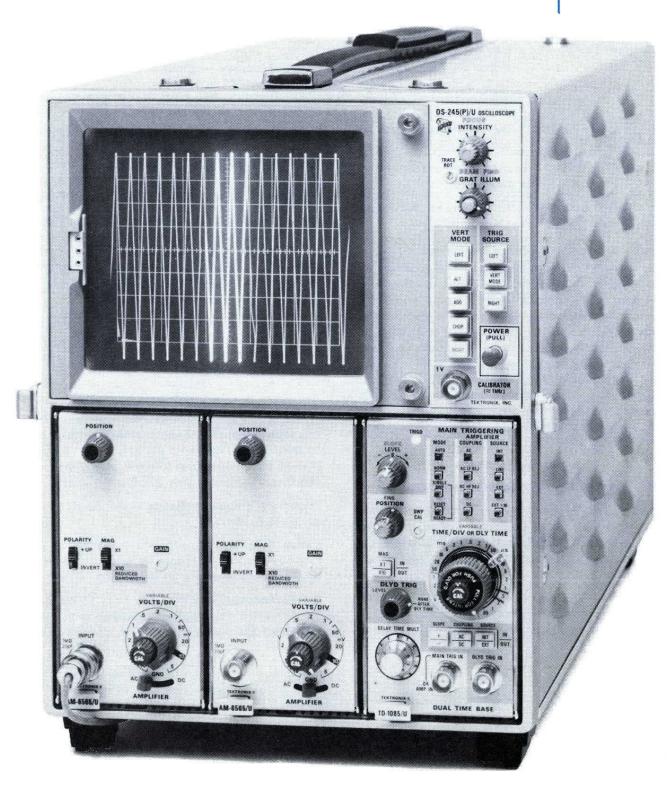
7000-Series Ruggedized Oscilloscope System

7603N11S

Ruggedized for Extreme Environments
Meets or Exceeds MIL-O-24311 (EC)
(AN/USM-281C Specifications)
Large Bright Display—6½ 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 X10 gain, "X" sensitivity in X-Y mode, triggering frequency range, delaying and delayed sweep speeds, and crt size.



53

7603N11S Ruggedized Oscilloscope System

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.

ENVIRONMENTAL

Temperature — Nonoperating -62° C to $+75^{\circ}$ C, operating -28° C to $+65^{\circ}$ C.

Humidity—0 to 95% rh over entire temperature range, operating or nonoperating.

Altitude — Nonoperating sea level to 50,000 ft, operating sea level to 15,000 ft.

Vibration (Operating) — 5 to 15 Hz at 0.060 in ± 0.012 in p-p amplitude, 16 to 25 Hz at 0.040 in ± 0.008 in p-p amplitude, 26 to 33 Hz at 0.020 in ± 0.004 in p-p amplitude.

Shock (Operating) — 9 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 greater than 600 hours is met as tested under the following conditions: temperature $+40^{\circ}\text{C}$ $\pm2^{\circ}\text{C}$; relative humidity 70% $\pm5\%$; vibration 25 Hz at 0.040 in ±0.0008 in p-p amplitude for 10 minutes of each "Power On" hour during each day of the 8 hour manned schedule; power cycled at 4 hour intervals with 10 minutes power off for each 4 hour period of the manned test schedule. An MTBF of greater than 2000 hours 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 Plugins are compatible (except those which require crt readout).

Display Modes — LEFT, ALT, ADD, CHOP, RIGHT. Chopped frequency is approx 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. Max sensitivity is 0.5 mV at 10 MHz with X10 gain. Ac-coupling lower —3 dB point is less than 2 Hz. Rise time is 5.4 ns with less than 2% aberrations.

Input R and C — 1 M Ω within 2%, less than 27 pF.

Max Input Voltage — 400 V (dc + peak ac).

Dc Stability - Less than 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 less than 2° from dc to 35 kHz. Bandwidth is at least 2 MHz. Rise time is less than 175 ns. Using the 7B53AN11 time-base external amplifier, 10 mV, 100 mV, and 1 V sensitivities (\pm 10%) are available. Input R and C for 7B53AN11 is 1 M Ω 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 μ s/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 μ s/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 μ s/div, within 2% from 5 s/div to 1 s/div. Incremental linearity is within 0.2% of full scale. Jitter is less than 1 part in 20,000 of X10 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 \div 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 $M\Omega$ 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 M Ω within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; dc, dc to 50 MHz.

Sweep Rate — 0.05 $\mu s/\text{div}$ to 0.5 s/div in 22 steps (1-2-5 sequence). The delayed sweep runs after delay time or is triggerable after delay time.

Sweep Accuracy — Within 3% from 50 ms/div to 0.5 μ s/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 $6\frac{1}{2}$ in crt permits 2 cm of linear overscan in both axes, making a total viewing area of approx 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. Max input voltage is 10 V (dc + peak ac).

OUTPUTS

Calibrator (BNC Connector on Front Panel) — 1 V within 1%, 1 kHz square wave 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 greater than 50 ns. All amplitudes are minimum and measured when working into at least 100 k Ω and 15 pF.

POWER REQUIREMENTS

Input Voltages — 100, 110, 120, 220, and 240 V ac \pm 10% internally selectable with quick-change Jumpers with 47.5—440 Hz single phase line frequency. Max 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)

Two P6006 probe packages (010-0127-00); two 8 ft long $50-\Omega$ BNC cables (012-0366-00); two BNC female to uhf male adapters (103-0015-00); two BNC male to uhf female adapters (103-0032-00); two BNC male to binding post adapters (103-0033-00); two BNC T connectors (103-0030-00). One set of technical manuals (not packaged in cover).

Dimensions and Weights — See page 43.

For Recommended Cameras — See page 44.

ORDERING INFORMATION

7603N11S Oscilloscope
System (AN/USM-281C)
Order 7603NMS\$3875

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)	\$2050
7A15AN11 Amplifier Plug-in (AM-6565/U) Order 7A15ANM	\$400
7B53AN11 Time Base* Plug-in (TD-1085/U) Order 7B53ANM	\$1050
016-0553-00, C281 Cover	

W/Accessories\$120

^{*}Requires modification for use in the 7844.

7000-Series Storage Mainframes Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from $\simeq 0.03$ cm/ μ s for mechanical, spectrum analysis, or TDR applications, to 2500 cm/ μ s for capturing fast single events such as high speed digital logic. A selection of storage modes offer the following features:

BistableLong View Time

Variable

Persistence High Contrast Displays

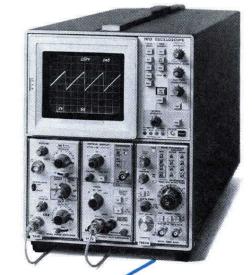
FAST Bistable Captures Fast Single or

Multiple Events

FAST Variable

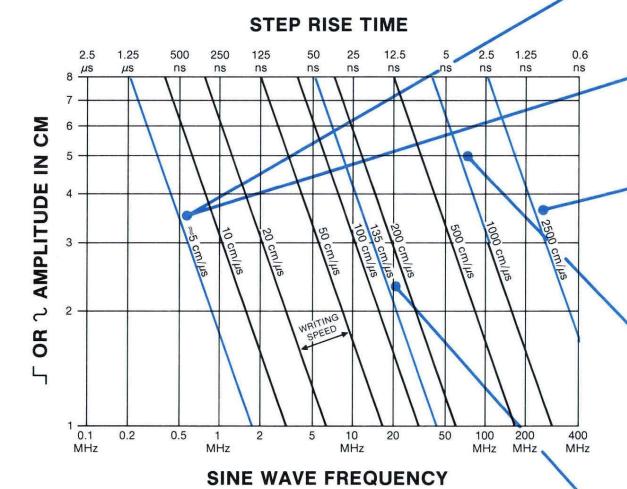
Persistence Provides Maximum

Stored Writing Rate

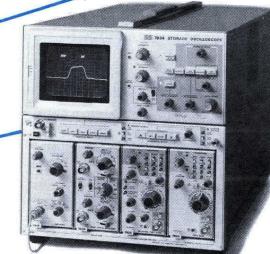


7613 Variable Persistence

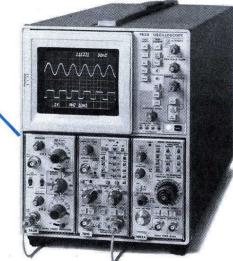
7313 Split Screen Bistable



Graph shows the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.



7834 **FAST Multimode**



7633

7800-Series Storage	400 MHz	page 56
7600-Series Storage	100 MHz	page 58
7300-Series Storage	25 MHz	page 61



7623A **FAST Multimode**

2500 cm/ s Stored Writing Speed
4 Plug-in Compartments
Dc-to-400 MHz Bandwidth
Multimode Storage
Long View Time

The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/ μ s, enabling you to capture single-shot rise times to 1.4 ns, 3.5 cm high, at full reduced scan amplitude. 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/ μ s (reduced scan). View time at least 30 s.

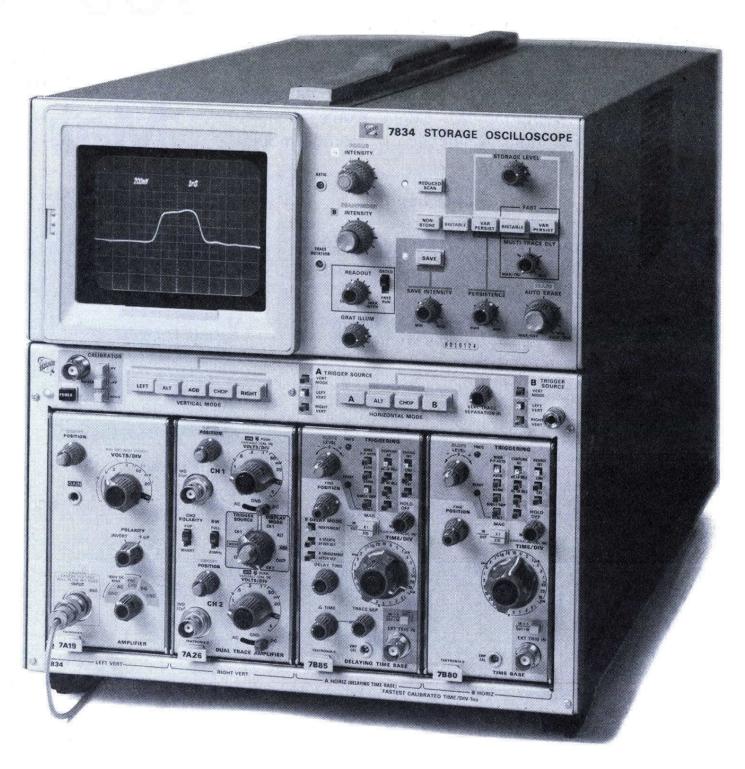
FAST Bistable increases bistable writing rates to 350 cm/ μ s (reduced scan).

Bistable lets you store displays for long periods of time.

Variable Persistence gives you high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, you get continuous bright displays of new information as old information fades from the crt.

The 4-compartment flexibility lets you perform more than one measurement 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 in laser fusion, digital design and non-destructive component testing applications.



VERTICAL SYSTEM

Input—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 7A19 Amplifier plug-in (325 MHz at 10 mV).

Mainframe Step Response—0.9 ns or less with 7A19 Amplifier plug-in (1.1 ns at 10 mV).

Chopped Mode—Repetition rate is approximately 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 4 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—Repetition rate is approx 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 \times 10-division (0.9 cm/div) graticule in full scan and 8 \times 10-division (0.45 cm/div) in reduced scan.

Option 01, without Crt Readout and Probe Power— Deletes crt readout and probe power.

Accelerating Potential—Approx 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 less than 1 s to greater than 10 s.

Multitrace Delay—Adjusts the transfer cycle time in the FAST transfer modes. Continuously variable from less than 1 s to greater than 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 (Approx)	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 (.2 div/ μs)
View Time*	30 s	30 min	30 s	30 min
Erase Time (Approx	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.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to- peak Sine wave	Step Response
Reduced Scan 5,500 div/μs	≥1 ns/div	7.1 div 250 MHz	7.7 div 1.4 ns
(0.45 cm/div)	≥1 1137 U1V	8 div 221 MHz	8 div 1.45 ns
Full Scan	>10 == /div	3.2 div 30 MHz	3 div 10 ns
300 div/µs (0.9 cm/div)	≥10 ns/div	6.4 div 15 MHz	5 div 16.6 ns

OUTPUTS/INPUTS

+Sawtooth—Positive going with baseline at 0 V ± 1 V into 1M Ω . Voltage is 1 V/div ($\pm 10\%$) into 1 M Ω , 50 mV/div ($\pm 15\%$) into 50 Ω . Output R is approx 950 Ω .

+ Gate—Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V ($\pm 10\%$) into 1 M Ω , 0.5 V ($\pm 10\%$) into 50 Ω . Output R is approx 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 ($\pm 10\%$) into 1 M Ω , 25 mV ($\pm 10\%$) into 50 Ω . Output R is approx 950 Ω . Bandwidth depends upon vertical 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.

CALIBRATOR

Voltage Output—Square wave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 k Ω ; 4 mV, 40 mV, and 0.4 V into 50 Ω . Amplitude accuracy is within 1%; repetition rate is 1 kHz within 25%

Current Output—40 mA available through CALIBRA-TOR output with optional BNC to current loop adapter.

Dimensions and Weight. See page 43.
For Recommended Cameras—See page 44.

POWER REQUIREMENTS

Line Voltage Ranges—90 V-132 V. 180 V-250 V.

Line Frequency-48-440 Hz.

Max Power Consumption—215 watts.

Included Accessories—Gray crt filter (installed) (378-0625-02) green crt filter (378-0625-08); power cord (161-0066-00).

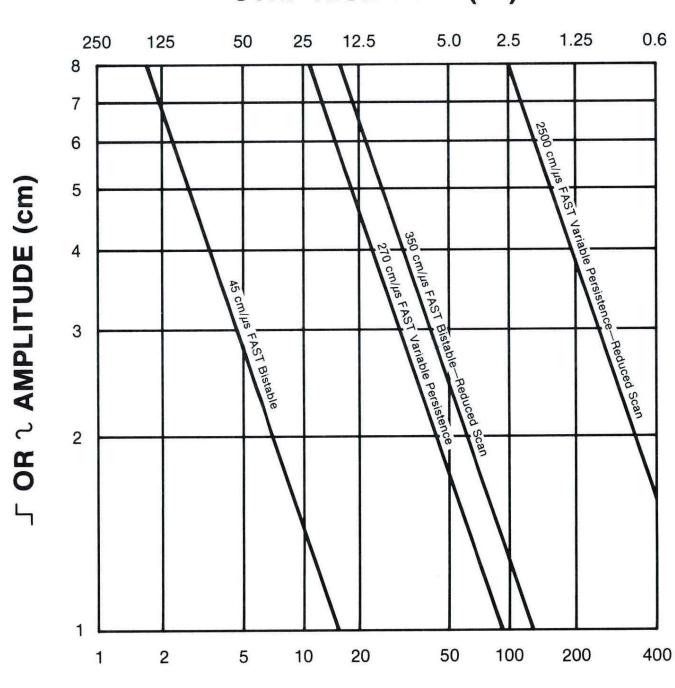
ORDERING INFORMATION

(Plug-ins not Included)
7834 Storage Oscilloscope\$7100

OPTIONS

OFTIONS	
Option 01 Without Crt Readout and Probe	
PowerSub \$40	0
Option 02 X-Y Mode Phase CorrectionAdd \$15	0
Option 03 Emi ModificationAdd \$25	0
For Rackmounting, order Cradle	
Mount Adapter 040-0560-00\$14	0

STEP RISE TIME (ns)



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

7633

1000 cm/μs Stored Writing Speed Long View Time Multimode Storage Dc-to-100 MHz Bandwidth

The TEKTRONIX 7633 Storage Oscilloscope provides 2200 div/ μ s (1000 cm/ μ s) 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 top writing speed of 1000 cm/ μ s (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 of fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms. The instrument's capability and versatility make it a problem solver in computer sciences, aerospace, ballistics, communications, and many other fields.

Characteristics are common to the 7633 and the 7623A unless noted.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

Chopped Mode — Repetition rate is approx 1 MHz.

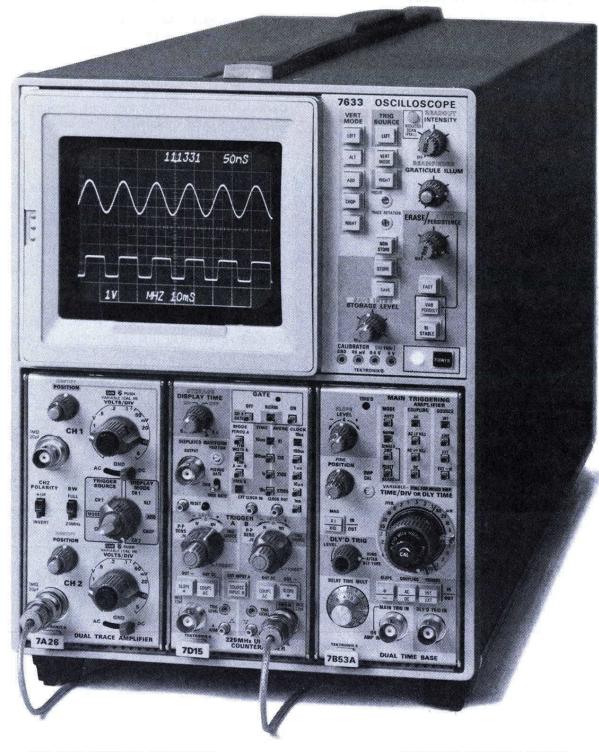
Delay Line — Permits viewing leading edge of displayed waveform.

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 less than 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 — Approx 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 max, 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. Max 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 Persis- tence	FAST Bistable	Variable Persis- tence	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 (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

Reduced Scan (7633 Only)

Display Mode	FAST Variable Persis- tence	FAST Bistable	Variable Persis- tence	Bistable
Stored Writing Speed	1000 cm/μs	180 cm/μs	1.35 cm/μs	0.9 cm/μs
View Time	30 s*	30 min. minimum	30 s*	30 min. minimum
Erase Time (Approx)	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.

7623A

135 cm/µs Stored Writing Speed **Long View Time Multimode Storage** Dc-to-100 MHz Bandwidth

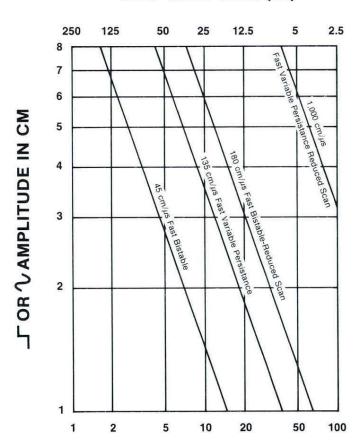
The TEKTRONIX 7623A Storage Oscilloscope has all the features and performance of the 7633 except the reduced scan mode.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to- peak Sine	Step Response
Reduced Scan**		7.1 div 100 MHz	7.7 div 3.5 ns
2200 div/μs (0.45 cm/div)	≥5 ns/div	8 div 89 MHz	8 div 3.7 ns
Full Scan 150 div/μs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz 6.4 div 7.5 MHz	3 div 20 ns 5 div 33 ns

^{**}Applies to 7633 only.

STEP RISE TIME (ns)



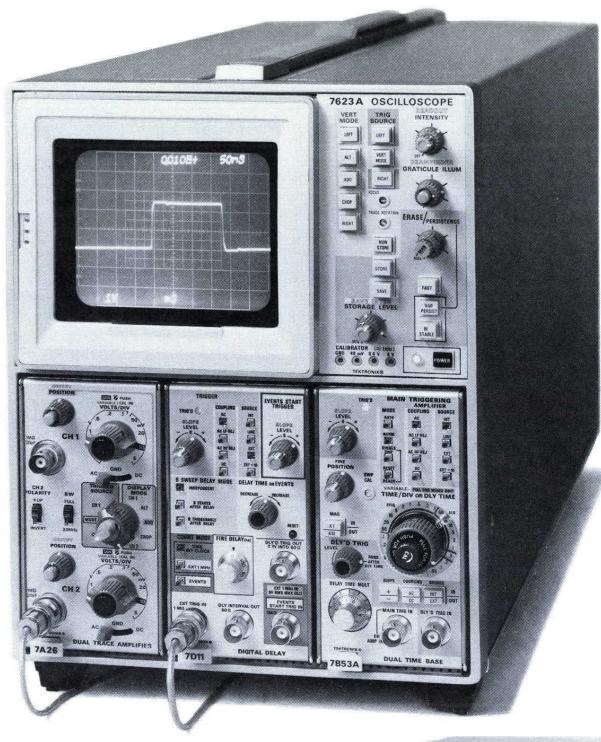
SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

OUTPUTS/INPUTS

- +Sawtooth Sawtooth starts 1 V or less from ground (into 1 $\mathrm{M}\Omega).$ Output voltage is 50 mV/div (±15%) into 50 Ω , 1 V/div (±10%) into 1 M Ω . Output R is 950 Ω within 2%.
- +Gate Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 $\Omega,$ 10 V (±10%) into 1 $M\Omega.$ Rise time is 20 ns or less into 50 Ω , output R is 950 Ω 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 (±10%) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . Bandwidth depends on vertical plug-in. Output R is 950 Ω 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.

CALIBRATOR

Voltage Output - Rectangular waveshape, positivegoing from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 M Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% ($+15^{\circ}$ C to $+35^{\circ}$ C); within 2% (0°C to +50°C). Repetition 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 gnd pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges - 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quickchange jumpers.

Line Frequency — 50-60 Hz.

Option 05, Line Frequency Change (50-400 Hz) - Converts the 7633 and R7633 to 50-400 Hz operation.

Max 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 43. For Recommended Cameras — See page 44.

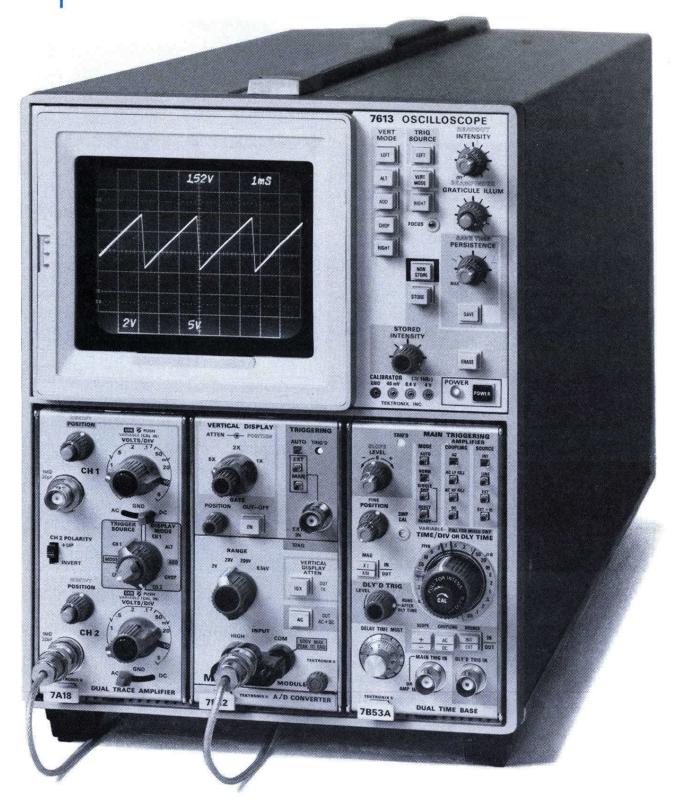
ORDERING INFORMATION (Plug-ins not Included)

7633 Storage Oscilloscope		 •		. \$520	U
R7633 Storage Oscilloscope				. \$550	0
7623A Storage Oscilloscope .				. \$397	' 5
R7623A Storage Oscilloscope		 •	٠	. \$427	' 5

OPTIONS

Option 01	without Crt Readout Sub \$400
Option 03	Emi ModificationAdd \$250
Option 05	Line Freq Change
	(50—400 Hz)Add \$300

CONVERSION KITS
Crt Readout (040-0748-01 Cabinet)\$480
(040-0759-01 Rackmount)\$480
Emi Modification
(040-0663-00 Cabinet)\$300
(040-0678-00 Rackmount)\$285
Sig Out/In (040-0629-01 Cabinet)\$120
(040-0633-00 Rackmount)\$85
Power Supply to Light Plug-in
Pushbuttons (040-0686-00)\$30



Variable Persistence Storage 4.5 cm/μs Stored Writing Speed Dc-to-100 MHz Bandwidth Burn Resistant Crt 51/4 in Rackmount

The TEKTRONIX 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/ μ 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). The 7613 crt is burn resistant and doesn't require any special operating precautions.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition 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.

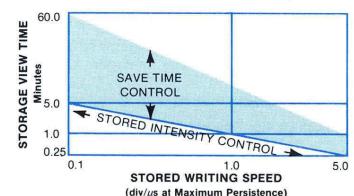
Nonstore Mode — For displaying waveforms in the conventional (nonstorage) mode.

Store Mode — For displaying waveforms using the variable persistence storage feature.

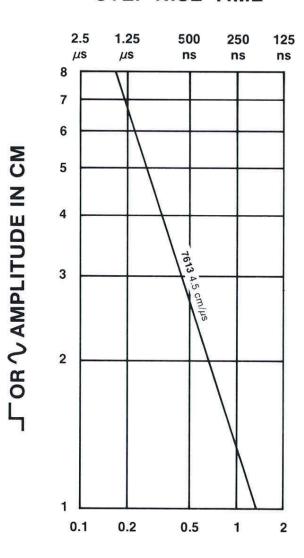
Max Stored Writing Speed — Greater than 4.5 cm/µs.

View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the max writing speed the view time is 15 seconds or 0.25 minutes with the stored intensity 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 below).



STEP RISE TIME



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed for a given sine wave or step rise time at a given amplitude.

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).

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. Max 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 set.

Beam Finder - Limits display within graticule area.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 M Ω). Output voltage is 50 mV/dlv (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω within 2%.

+ Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V ($\pm 10\%$) into 50 Ω , 10 V ($\pm 10\%$) into 1 M Ω . Rise time is 20 ns or less into 50 Ω ; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . Bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart. Output R is 950 Ω 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.

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 Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition 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 gnd pin jacks.

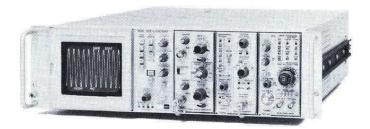
POWER REQUIREMENTS

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.

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.



The R7613 requires only 51/4 in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

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.

Weights and Dimensions — See page 43.
For Recommended Cameras — See page 44.

ORDERING INFORMATION (Plug-ins not Included)

7613 Storage Oscilloscope\$3150

R7613 Std	orage Oscilloscope\$3450
	7613 OPTIONS
Option 01	without Crt ReadoutSub \$400
Option 03	Emi ModificationAdd \$250
Option 05	Line Freq Change
	(50-400 Hz)
Option 06	Special Int Graticule
3.75	(Spectrum Analyzer) Add \$50
Option 08	Protective Panel Cover Add \$100
	R7613 OPTIONS
Option 01	without Crt ReadoutSub \$400
Option 03	Emi ModificationAdd \$250
Option 05	Line Freq Change (50-400 Hz) Add \$300
Option 06	Special Int Graticule
	(Spectrum Analyzer) Add \$50
	7613 CONVERSION KITS
040-0656-02	Crt Readout\$480
040-0663-00	Emi Modification\$300

Power Supply to Light

Power Supply to Light

R7613 CONVERSION KITS

Sig Out/In\$120

Plug-in Pushbuttons\$30

Crt Readout\$480

Emi Modification\$285

Sig Out/In\$85

Plug-in Pushbuttons\$30

040-0629-01

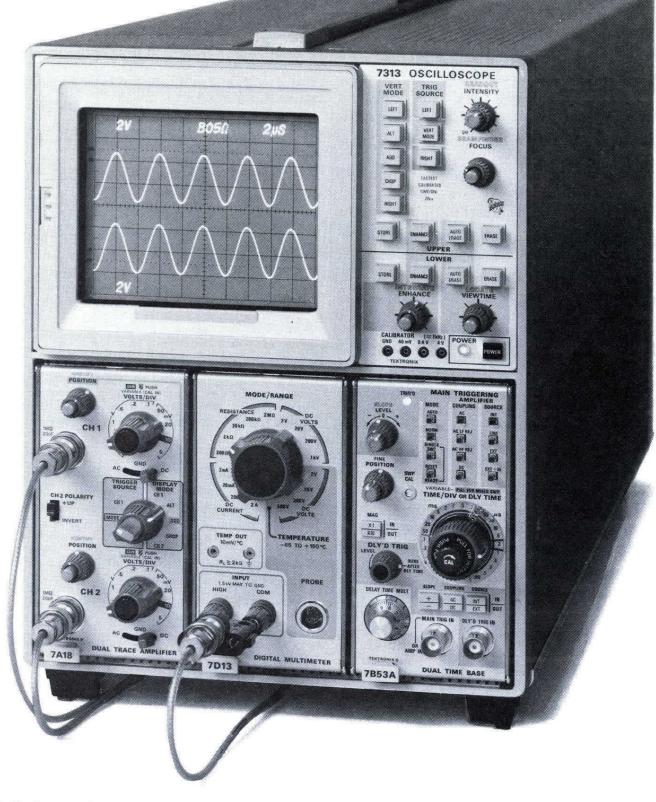
040-0686-00

040-0676-02

040-0678-00

040-0633-00

040-0686-00



Split-Screen Bistable Storage 4.9 cm/µs Stored Writing Speed Dc-to-25 MHz Bandwidth Burn-Resistant Crt 51/4 in Rackmount

The TEKTRONIX 7313 Storage Oscilloscope offers split-screen bistable operation or non-storage operation. It has a stored writing speed of 5 div/ μ s. Stored traces may be viewed for at least 30 minutes on a display area of 8 x 10 div (0.98 cm/div). The 7313 crt is burn resistant.

The split-screen storage crt allows for both a stored display and a real-time display on the same crt at the same time. This capability is useful in many applications. The operator may wish to store a reference trace and then view the change in waveform characteristics as he varies circuit components. He can do this easily by operating half the display in a stored mode and the other half in a conventional mode. Thus, amplitude, duration, and other characteristics of waveforms displayed in the conventional mode may be precisely adjusted to the stored reference trace.

7313 and R7313 Bistable Storage Oscilloscopes

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit, limited to 25 MHz

Modes of Operation — LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

Channel — One right-hand plug-in compartment; compatible with all 7000-Series Plug-ins.

Fastest Calibrated Sweep Rate - 20 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.

STORAGE CRT AND DISPLAY FEATURES

Split-Screen Bistable Storage Crt — Internal 8 x 10 div (0.98 cm/div) non-illuminated graticule. Store on upper or lower half of screen with nonstore display on other half. Store on entire screen or nonstore on entire screen. Independent operation on both halves.

Accelerating Potential — 4 kV.

Phosphor — P1.

Stored Writing Speed — Normal, 500 div/ms; adjustable to at least 5000 div/ms in Enhance Mode.

Storage View Time — At least 30 minutes.

Autoerase View Time Range — 0.5 or less to at least 10 s after end of sweep.

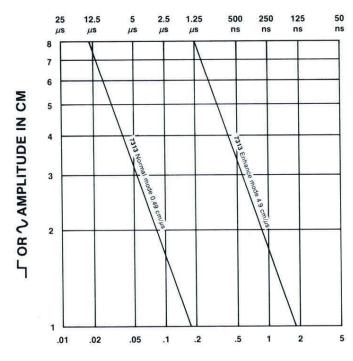
Erase Time — 400 ms or less.

Enhance Mode — Controls single-sweep writing capabilities of the storage crt. Up to 5000 cm/ms or better can be stored with minimal loss of resolution and contrast.

Integrate Mode — Provides additional writing speed for repetitive signals by allowing the storage target to integrate the written information over several signal repetitions.

Autoerase Mode — Viewing time continuously variable up to 10 s. The sequence begins with the arrival of the signal. The signal initiates a sweep. After each sweep, the stored display is retained and further sweeps are locked out for the viewing interval selected by the VIEW TIME Control. Then the display is erased and the time-base enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. The stored display may also be erased by the MANUAL control.

STEP RISE TIME



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

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. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

+ Sawtooth — Sawtooth starts 1 V or less from ground (into 1 M Ω). Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω within 2%.

+ Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V ($\pm 10\%$) into 50 Ω , 10 V ($\pm 10\%$) into 1 M Ω . Rise time is 20 ns or less into 50 Ω ; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . Bandwidth depends on vertical plug-in. Output R is 950 Ω 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. Internally selectable for either or both halves of crt.



The R7313 requires only 51/4 in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

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 Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition 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 gnd 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 — 50-400 Hz (7313), 50-60 Hz (R7313).

Option 05, Line Frequency Change (50-400 Hz) — Converts the R7313 to 50-400 Hz operation (not required for 7313).

Max Power Consumption — 180 W, 2 A at 115 V line, 60 Hz. Fan cooling is provided for the R7313.

Included Accessories (for 7313 and R7313) — 20 in cable (two-pin-to-BNC) (175-1178-00); green crt light filter (378-0625-08). The R7313 includes rackmounting hardware.

Weights and Dimensions — See page 43.

For Recommended Cameras — See page 44.

ORDERING INFORMATION (Plug-ins not Included)

7313 Store	age Oscilloscope\$3125
R7313 Std	orage Oscilloscope\$3425
	7313 OPTIONS
Option 01	without Crt ReadoutSub \$400
Option 03	Emi ModificationAdd \$250
	R7313 OPTIONS
Option 01	without Crt ReadoutSub \$400
Option 03	Emi Modification Add \$250
Option 05	Line Freq Change (50-400 Hz) Add \$300
	Not Required for 7313
	7313 CONVERSION KITS
040-0655-02	Crt Readout\$480
040-0664-00	Emi Modification\$285
040-0629-01	Sig Out/In\$120
040-0686-00	Power Supply to Light
	Plug-in Pushbuttons\$30
	R7313 CONVERSION KITS
	HISTS CONVENSION KITS
040-0675-02	Crt Readout\$480
040-0678-00	Emi Modification\$285
040-0633-00	Sig Out/In\$85
040-0686-00	Power Supply to Light

Plug-in Pushbuttons\$30

7000-Series Plug-ins

For the 7000-Series you can select from over thirty 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, spectroscopy, 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.



Amplifiers

Pages 64-66

Eleven vertical amplifiers offer choices in system bandwidth, number of input channels, vertical sensitivity, input impedance, and differential inputs.



Time Bases

Pages 67-69

Five horizontal time bases offer choices in sweep speeds, single or dual sweeps, and now, digital delta delay measurements.



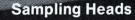
Five plug-in units offer a choice of single- and dual-channel sampling, general-purpose sampling combined with time domain reflectometry, sampling sweep, and dual delay line.



Digital Measurements

Pages 71-75

Six digital instruments, one with three interchangeable modules, offer unique solutions to complex measurement problems. Timing and amplitude measurement instruments interact with the oscilloscope to easily obtain accurate measurements of complex signals.



Pages 78-80

Ten sampling heads offer choices in input impedance, equivalent bandwidth, and triggering for a matched sampling system.





7D01 Logic Analyzer, see page 71 DF1 Display Formatter, see page 23 DF2 Display Formatter, see page 23 DL2 Digital Latch, see page 23

Special Purpose Plug-ins

7CT1N Curve Tracer see page 212
7L5/L1/L2/L3 Spectrum Analyzer see page 182
7L12 Spectrum Analyzer see page 180
7L13 Spectrum Analyzer see page 178
7L18 Spectrum Analyzer see page 176
7K11 CATV Preamplifier see page 184
7M13 Readout Unit see page 70

7A11

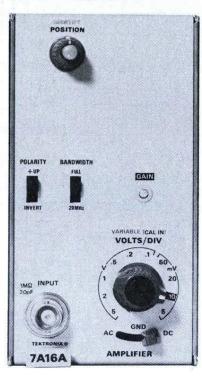


0

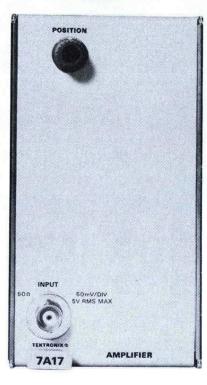
7A15A



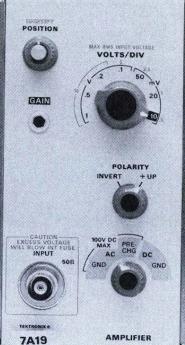
7A16A



7A17



7A19



7A11

Built-in FET Probe DC-to-250 MHz Bandwidth (7900 Family) 5 mV/div to 20 V/div **Calibrated Deflection Factors** Dc Offset

Lit Pushbuttons

7A11

The 7A11 is a wideband plug-in amplifier. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 M Ω) 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-in attenuators and dynamic signal range.

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 VARI-ABLE is continuous between steps to at least 50 V/div.

Input R and C — 1 M Ω 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
Max Dc- coupled Input	200 V (dc + peak ac, ac com- ponent to 50 kHz)	200 V (dc + peak ac, ac com- ponent to 40 MHz)	200 V (dc + peak ac, ac com- ponent to 70 MHz)
Max Ac- coupled Input (Dc Com- ponent)		±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 hour after 20 minute warm-up. Drift with ambient temperature (constant line voltage), 200 μV/°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 OFF-SET OUT jack allows for monitoring of the offset voltage. OFFSET OUT source resistance is 500 Ω within

Included Accessories — Capacitor-coupler head (011-0110-00); retractable hook tip (013-0106-00); probe tip ground adapter (013-0085-00); 3 in ground lead (nose) (175-0849-00); 3 in ground lead (screw-in) (175-0848-00); 12 in ground lead (screw-in) (175-0848-02); three miniature alligator clips (344-0046-00); two insulated sleeves (166-0404-01); probe hook tip (206-0114-00); probe tip to GR 50 Ω termination (017-0088-00); 18 in cable (offset out) (175-1092-00).

Order 7A11 Amplifier \$1450

7A15A

Dc-to-80 MHz Bandwidth (7900 Family) 5 mV/div to 10 V/div **Calibrated Deflection Factors** 500 μ V/div at 10 MHz (X10 Gain)

The 7A15A is an easy-to-use, 80-MHz amplifier that features a X10 magnifier to increase the sensitivity to 500 μ 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.

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 μ 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 Ω within 2%; \approx 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Accoupled: 500 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less.

Order 7A15A Amplifier \$400

7A16A

Dc-to-225 MHz Bandwidth (7900 Family) 5 mV/div to 5 V/div **Calibrated Deflection Factors**

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.

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 VARI-ABLE is continuous between steps to at least 12.5

Input R and C — 1 M Ω within 2%; \approx 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Accoupled: 500 V (dc + peak ac); ac component 500 V p-p max, 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 hour warm-up.

Order 7A16A Amplifier \$700



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 subpanel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

Deflection Factor - Adjustable to 50 mV/div. There is no step attenuation.

Input Z — 50 Ω .

Max Input Voltage — 5 V rms.

Order 7A17 Amplifier \$180

Dc-to-500 MHz Bandwidth (7900 Family) 10 mV/div to 1 V/div Calibrated Deflection Factors Optional ±500 ps Variable Delay Line

The 7A19 is a high-performance, wide-bandwidth, single-trace plug-in amplifier designed primarily for use with the 7900-, 7800-, and 7700-Family Mainframes. The polarity of the display is selectable, either normal or inverted.

Deflection Factor — 10 mV/div to 1 V/div in 7 calibrated steps (1-2-5 sequence). Accuracy is within 3%.

Input R — 50 Ω .

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is $\pm\,500$ ps.

Order 7A19 Amplifier \$1225

7A19 OPTION

7A21N

Bandwidth to 1 GHz (7900 & 7800 Family Only) Less than 4 V/div Deflection Factor Single and Differential Inputs Positioning Control

The 7A21N unit is designed so that high-frequency or fast rise time signals may be ac-coupled directly into the wide-bandwidth crt of the 7900- and 7800-Family Oscilloscopes. Two front-panel input connectors allow single-ended or differential operation (internally selected). Vertical-trace positioning is controlled on the front panel.

Direct access means that the vertical amplifier is bypassed. Interconnection boards and coupling cables are supplied with each 7A21N. The 7A21N is not a plug-in since it is hardwired to the crt vertical deflection system even though it is installed in a vertical compartment. The 7A21N does not incorporate crt readout or an internal trigger.

When used in 7900-Family Oscilloscopes, vertical mode switching is inoperative, and plug-ins can't be used in the adjacent vertical channel.

With the 7844 or R7844 Oscilloscopes, the 7A21N may be used in one or both vertical compartments. When one 7A21N is used with Beam 1 left vertical compartment, preamps or specialized plug-ins may be used with Beam 2 right vertical compartment, leaving the crt readout operative for Beam 2 and the horizontal compartments. Vertical mode switching is inoperative when a 7A21N is used with Beam 1. When two 7A21Ns are used, crt readout and vertical mode switching are inoperative. Horizontal mode switching is always operative.

An 80-ns pretrigger should be provided for fast singleshot events. If this is impractical, use a 7M11 Dual Delay Line in the signal path. The 7A21N is compatible only with the 7900- and 7800-Family Oscilloscopes.

Bandwidth — 20 kHz to 1 GHz.

Deflection Factor — Less than 4 V/div.

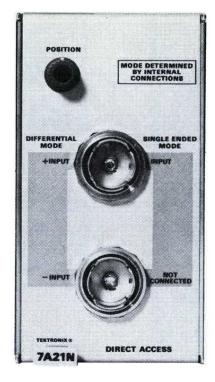
Input Z — 50 Ω .

Max Input Voltage — 25 V dc, 100 V pulsed ac.

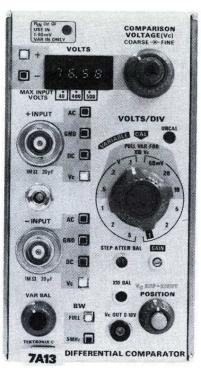
Included Accessories — Interconnecting board assembly.

Order 7A21N Direct Access\$975

7A21N



7A13



7**A**22



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

Lit Pushbuttons

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 \pm 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.

Input R and C — 1 M Ω within 0.15%; \approx 20 pF. R in $\approx \infty$, 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	1mV to 50mV/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 Range	±10 V	±100 V	±500 V
Max Dc- coupled Input (Dc + Peak Ac at 1 kHz or Less)	±40 V	±400 V	±500 V
Max Ac- coupled Input (Dc Voltage)		±500 V	

Max Input Gate Current — 0.2 nA or less from 0°C to +35°C; 2 nA or less at +35°C to +50°C.

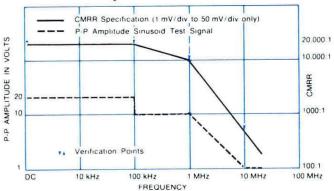
Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minute warm-up. Long term, 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hour interval after 20 minute 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 μ V (200 μ V 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 μ s to recover to within 2 mV and 0.1 ms to recover to within 1 mV after a pulse of \pm 10 V or less, regardless of pulse duration.

Internal Comparison Voltage — Range, 0 V to ± 10 V; accuracy, $\pm (0.1\%$ of setting + 3 mV); Vc output R, approx 15 k Ω .

Common-Mode Rejection Ratio



At least 2000:1, 10 mV/div to 50 mV/div (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\$1900

7A22

Dc-to-1 MHz Bandwidth

10 μ V/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*

The 7A22 is a differential amplifier well suited for difficult low-amplitude, low-frequency measurements.

*With constant temperature. See dc stability specifications.

Bandwidth — Hf -3 dB point; selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; rise time in 1 MHz position is 350 ns $\pm 9\%$. Lf -3 dB point; selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate with-

in 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 μ 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 Ω within 1%; \approx 47 pF.

Max Input Gate Current — Differentially measured, 40 pA (\pm 25°C) and 200 pA (\pm 50°C) at 10 μ V/div to 10 mV/div; 10 pA (\pm 25°C) and 20 pA (\pm 50°C) at 20 mV/div to 10 V/div. Single ended, one-half the differential measurement. Display shift is \pm 4 div (\pm 25°C) and \pm 20 div (\pm 50°C) at 10 μ V/div (ac-coupled).

Signal and Offset Range

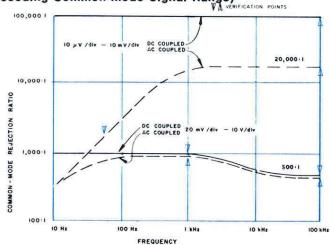
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common- mode Signal Range	±10 V	±100 V	±50	00 V
Max Dc- coupled Input (Dc + Peak Ac at 1 kHz or Less)	±15 V	±200 V	±50	00 V
Max Ac- coupled Input (Dc Voltage)	dc re	±5 ejection, at	00 V least 4 x	105:1
Dc 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 μ V (p-p) or 0.1 div, whichever is greater in any minute after 1 hour warm-up. Long term, 10 μ V (p-p) or 0.1 div, whichever is greater in any hour after 1 hour warm-up. Drift with ambient temperature (constant line voltage) is 50 μ V/°C or less.

Displayed Noise — 16 μ V or 0.1 div (whichever is greater) at max bandwidth; source resistance 25 Ω or less measured tangentially.

Overdrive Recovery — 10 μs 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)



7A18

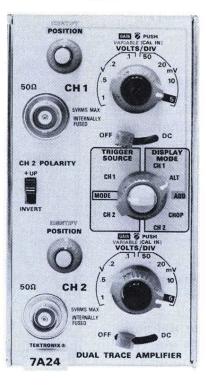
Dc-to-75 MHz Bandwidth 5 mV/div to 5 V/div Calibrated Deflection Factors

The 7A18, the basic building block of 3- and 4-trace operation, is a dual-trace plug-in amplifier. The 7A18 features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selectivity and color-keyed control grouping. The 7A18 has a trace identify function. Polarity of channel 2 is selectable.

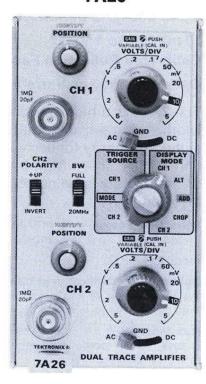
7A18



7A24



7A26



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 M Ω within 2%; \approx 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Accoupled: 500 V (dc + peak ac); ac component 500 V p-p max, 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 hour warm-up.

Common-Mode Rejection Ratio (ADD, CH 2 Invert) — At least 10:1, dc to 50 MHz.

Order 7A18 Amplifier\$850

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 pushbuttons of the standard 7A18. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

Offset Range Display — ± 200 div max, 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 Add \$115

7A24

Dc-to-350 MHz Bandwidth (7900 Family) 5 mV/div to 1 V/div Calibrated Deflection Factors 50-Ω Input

The 7A24, a high-performance, wide-bandwidth, dual-trace amplifier, is designed primarily for use with the 7700-, 7800-, and 7900-Series Mainframes. The 7A24 offers 350 MHz bandwidth and 5 mV/div sensitivity; this provides the 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.

Deflection Factor — 5 mV/div to 1 V/div in 8 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.

 ${\bf Max\ Input-}5\ {\bf V\ rms};\ {\bf 0.5\ W\ max\ input\ power,\ internally\ protected}.$

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 1 hour warm-up.

Order 7A24 Amplifier \$1450

7A26

Dc-to-200 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div Calibrated Deflection Factors

1-M Ω 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.

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.

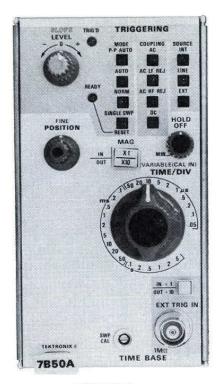
Input R and C — 1 $M\Omega$ within 2%; \approx 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Accoupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

Common-Mode Rejection Ratio (ADD, CH 2 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 hour warm-up.

Order 7A26 Amplifier \$1325



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 7313 and 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, $+15^{\circ}$ C to $+35^{\circ}$ C, with any 7000-Series Mainframe. Derate accuracies by an additional 1% each for 0°C to $+50^{\circ}$ C.

Time/Div	Unmagnified	Magnified
5 s/div to 1 s/div	4%	*
0.5 s/div to 0.5 μs/div	2%	3%
0.2 "s/div to 0.05 "s/div	3%	4%

Fastest calibrated sweep rate is limited to 20 ns/div by 7313 mainframe.

Trigger Holdoff Time —

MIN Holdoff	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
Setting	0.5 μs/div to 50 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at I 2 sweep lengths for sweep rates of 20 ms/div or faster	

Triggering —

Sensitivity (AUTO and NORM modes)

	Triggering	ering Min Signal Re	
Coupling	Frequency Range	Int	Ext
40	30 Hz to 50 MHz	0.3 div	50 mV
AC	50 MHz to 150 MHz	1.5 div	250 mV
AC LF	30 kHz to 50 MHz	0.3 div	50 mV
REJ ²	50 MHz to 150 MHz	1.5 div	250 mV
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
DC3	Dc to 50 MHz	0.3 div	50 mV
DC ₃	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.

Sensitivity (P-P AUTO MODE) (Ac or Dc Coupling)

Triggering Frequency	Min Signal Required		
Range	Int	Ext	
200 Hz to 50 MHz	0.5 div	125 mV	
50 MHz to 150 MHz	1.5 div	375 mV	

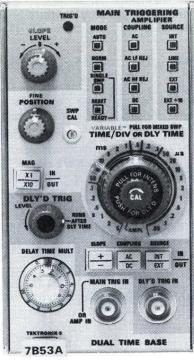
Option 02

X-Y Phase Shift (Determined by the circuitry in mainframe) — For mainframes without X-Y horizontal compensation, the mainframe phase shift specification is 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.

Order 7B50A Time Base\$625

7B50A OPTION

Order Option 02, X-Y......Add \$50



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 7313 and 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.

DELAYING SWEEP

Sweep Rate — 0.05 μ 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 mainsweep 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%	*	*
0.5 s/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

^{*}Unspecified

Delay Time Multiplier Range — 0 to 10 times the DELAY TIME/DIV setting from 5 s/div to 1 μ 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 μ 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 $+15^{\circ}$ C to $+35^{\circ}$ C.

Jitter — 0.05% or less of TIME/DIV setting.

Trigger	ing .

riggering -	Triggering	Min Signal Required		
Coupling	Frequency Range	Int	Ext	
Ac	30 Hz-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 mV	
Ac Lf Rej*	30 kHz-10 MHz 150 kHz-10 MHz 10 MHz-100 MHz	0.3 div 	100 mV 500 mV	
Ac Hf Rej	30 Hz-50 kHz	0.3 div	100 mV	
Dc	Dc-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 mV	

*Will not trigger on sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

^{*}Unspecified

² Will not trigger on sine waves of less than 8 div INT, or 3 V EXT, 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.

7000-Series Delayed and Δ Delaying Time Bases

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 — Max input voltage is 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C is 1 M Ω 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 μ 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 μs/div to 0.05 μs/div	4%	5%	4.5%	6%
50 ms/div to 0.5 μs/div	3%	4%	3.5%	5%

Delayed Sweep Gate — Output voltage is approx +3.5 V into at least 10 k Ω shunted by 100 pF or less, or 0.5 V into 50 Ω . Rise time is 50 ns or less; output R is 350 Ω 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 Signa	l Required
		Int	Ext
Ac	30 Hz-10 MHz	0.3 div	100 mV
	10 MHz-100 MHz	1.5 div	500 mV
Dc	Dc-10 MHz	0.3 div	100 mV
	10 MHz-100 MHz	1.5 div	500 mV

Internal Trigger Jitter - 1 ns or less at 75 MHz.

External Trigger Input — Max input voltage is 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C is 1 M Ω 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 μs (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 overseas, 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.

Order 7B53A Dual Time Base \$1050

7B53A OPTION

Order Option 05, Tv Triggering......Add \$75

Option 05 — Deletes ac line trigger and External \div 10 from trigger source.

7B85 Features:

△ Time Measurements with Crt Readout

Delay Time Measurements with Crt Readout

Vertical Trace Separation between Two Delayed Sweeps

Both Feature:

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

TRIGGERING

LEVEL

MODE COMPLINE SOURCE
PAUTS AC IS REAL LINE

READY ROBBE AC IS REAL LINE

TIME

POSITION

SMALE SWP DC

HOLD

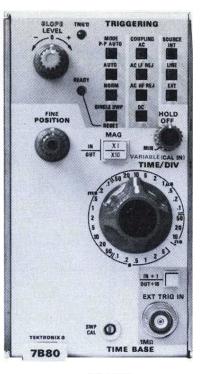
OFF

MAG

AC IS REAL LINE

TIME/DIV

AT TIME TO IS



7B85

7B80

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.)

Together they provide the Δ 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 Δ 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 Δ 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;

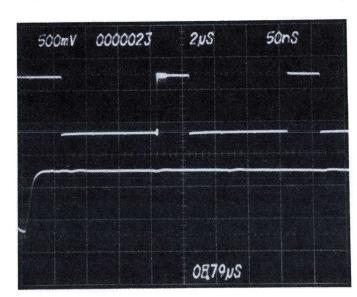


Fig 1. Delaying and delayed sweeps are shown with the mainframe selecting ALT sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the crt.

the Δ TIME knob adjusts the time between the two intensified zones. Now, the crt digital readout shows the Δ time between the two delays.

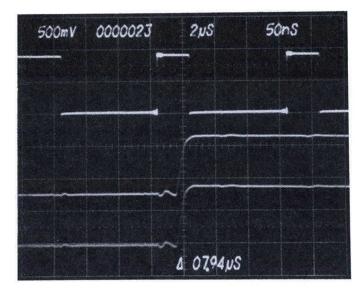


Fig 2. With the mainframe still selecting ALT sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower crt edge shows the time between the two sweep delays. The TRACE SEPARATION knob is used to position the second delayed sweep below the first delayed sweep with up to 3 div of separation.

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.

Sweep Accuracy — Measured over the center 8 div, $+15^{\circ}$ C to $+35^{\circ}$ C, in the 7700, 7800, or 7900-Series Mainframe. Derate accuracies by an additional 1% for 0°C to $+50^{\circ}$ C.

Time/Div ¹	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, 7600, and 7300-Series Mainframes.

Trigger Holdoff Time -

Minimum Holdoff	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
Setting	0.5 μs/div to 10 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff 2 sweep lengths div or faster	time through at least for rates of 20 ms/

 \triangle Time Range — 0 to at least 9 times TIME/DIV setting.

 \triangle Time Accuracy — (+15°C to +35°C)

Within (0.5% measurement \pm 0.3% of TIME/DIV setting \pm 1 least significant digit) from 20 ms/div to 100 ns/div.

Trace Separation Range — Functional only in \triangle 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 \pm 0.1 ns, or less.

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes) — (from repetitive signals)

	Triggering	Min Signal Required			
Coupling	Frequency Range	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	30 kHz to 50 MHz	0.3 div	50 mV		
Rej²	50 MHz to 400 MHz	1.5 div	250 mV		
Ac Hf Rej	30 Hz to 50 kHz	0.3 div	50 mV		
Dc³	Dc to 50 MHz	0.3 div	50 mV		
	50 MHz to 400 MHz	1.5 div	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 Int, or 3 V Ext, 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	Min Signal Required			
Frequency Range	Int	Ext		
200 Hz to 50 MHz	0.5 div	125 mV		
50 MHz to 400 MHz	1.5 div	375 mV		
Low Frequency Response: At least 50 Hz	2.0 div	500 mV		

External Trigger Input — Max input voltage is 250 V (dc + peak ac). Input R and C is 1 M Ω within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ± 1.5 V in EXT \div 1, and at least ± 15 V in EXT \div 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.

Order	7B80	Time	Base						. \$875
Order	7B85	Delay	ing Ti	me	Ba	ase	٠.		\$1025

7B80 OPTION



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

Lit Pushbuttons

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).

The 7B92A features calibrated sweeps from 0.2 s/div to 0.5 ns/div. Other features include alphanumeric readout for those oscilloscopes having crt readout systems, contrast control to regulate intensity differences between main and delayed sweeps, and continuous sweep delay from 0 to 9.8 times the delay time selector setting. When operating in the AUTO mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

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 seconds).

Differential Delay Time Measurement Accuracy — $(+15^{\circ}\text{C to } +35^{\circ}\text{C})$

Sweep Speed

0.2 s/div to 0.1 μs/div	Both delay time mult dial settings at 0.5 or greater	\pm (0.75% of measurement $+$ 0.25% of full scale)
	One or both delay time mult dial settings at less than 0.5	\pm (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	\pm (1% of measurement $+$ 0.5% of full scale)
	One or both delay times less than 25 ns	±(1% of measure- ment + 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 \pm 15°C to \pm 35°C.

Delay Time Jitter — Not applicable for the first 2% of max available delay time (DELAY TIME MULT dial setting greater than 0.2).

0.2 s/div to 50 μs/div	1 part in 50,000 of the max available delay time	
20 μs/div to	1 part in 50,000 of the max	

Max available delay time is 10 times the TIME/DIV or DLY TIME switch setting.

MAIN TRIGGERING

Auto, Norm

Coupling	Triggering	Min Signal Required			
Coupining	Frequency Range	Int	Ext		
A Control	30 Hz-20 MHz	0.5 div	100 mV		
Ac	20 MHz-500 MHz	1.0 div	500 mV		
Ac Lf Rej	30 kHz-20 MHz	0.5 div	100 mV		
	20 MHz-500 MHz	1.0 div	500 mV		
Ac Hf Rej	30 Hz-50 kHz	0.5 div	100 mV		
Dc	Dc-20 MHz	0.5 div	100 mV		
	20 MHz-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 M Ω inputs (1 M Ω is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1 M Ω 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 \div 10.

7000-Series Curve Tracer and Readout Unit

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	Min Signal Required		
Couping	Frequency Range	Int	Ext		
	Ac	30 Hz to 20 MHz	0.5 div	100 mV	
	AC	20 MHz to 500 MHz	1.0 div	500 mV	
	Dc	Dc to 20 MHz	0.5 div	100 mV	
	DC	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 M Ω inputs (1 M Ω is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1-M Ω input, and 1 W average for 50- Ω input. Range of trigger level is at least \pm 3.5 V in EXT.

Order 7B92A Dual Time Base\$2100



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 semi-conductor devices to power levels up to 0.5 W. The 7CT1N operates in horizontal or vertical compartments of 7000-Series Oscilloscopes.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

		X1		X10
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Max Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±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, indicating that dangerous voltages may exist at the test terminals, appears on the front panel.

STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μ A/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 Ω ± 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 1 step increments between 0 and 10.

Offset — Selectable to 5 steps. Polarity aids or opposes the step polarity.

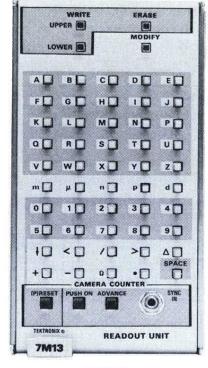
Vertical Deflection Factors — 10 nA/div to 20 μ A/div with the \div 1000 control activated. 10 μ A/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% \pm 0.2 nA per displayed horizontal 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 on 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 Ω when it is used in the horizontal compartment

Order 7CT1N Curve Tracer\$825



7M13

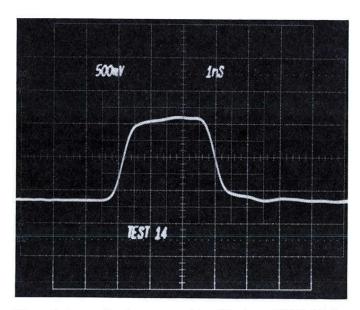
Easy and Convenient Identification of Photographed Displays

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 Accessory — Remote-advance cable (012-0339-01).

Order 7M13 Readout Unit\$500



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\$16

Delay by Time or Events

Digital Delay Readout to 7½ 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 7D10/7D11 Digital Delay Plugins give stable delayed triggers for measurements requiring low jitter. The 7D11 also provides precision time delays. The 7D10/7D11 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 7D10/7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see Fig 2).

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 7D10/7D11 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 7D10/7D11 triggers on. From a vertical compartment, the 7D10/7D11 can trigger a time base such as 7B80, 7B53A, or another 7D10/7D11 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

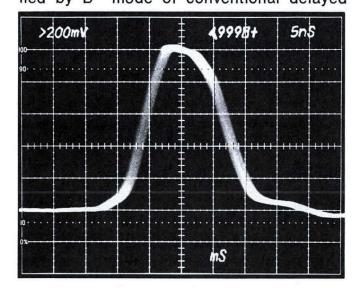


Fig 1. Delay-by-time. A 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.





sweep (see Fig 2). When used in the A horizontal compartment, the 7D10/7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D10/7D11. 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 7D10/7D11 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.

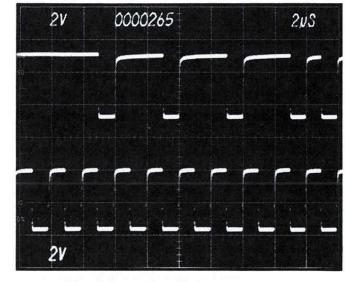


Fig 2. Delay-by-events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.

EVENTS DELAY

Events Delay Range — One to 107 events.

Delay Increment — One event.

Insertion Delay — 35 ns ±5 ns.

Recycle Time — Less than 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 M Ω ±5%, 20 pF ±2 pF	

	Coup- Frequency		Min Signal Required	
	ling	Range	Int	Ext
	Ac	30 kHz-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV
Sensi- tivity	Ac Lf Rej*	30 kHz-10 MHz 150 kHz-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV
	Ac Hf Rej	30 Hz-50 kHz	0.3 div	150 mV
	Dc	Dc-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV

*Will not trigger on sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

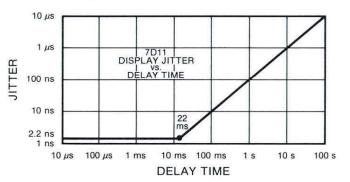
	Events Start Trigger
Source	External Only
Coupling	Dc Only
Max Input Voltage	150 V dc $+$ peak ac
Level Range	±3 V
Input R and C	1 M Ω within 5%, 20 pF \pm 2 pF
Sensitivity	100 mV minimum, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.

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 X10-7 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 . Rise time 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 . Rise time and fall time: 5 ns or less. Accuracy: equal to delay interval less 20 to 30 ns.

READOUT

Display — $7\frac{1}{2}$ 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 7D10 Digital Events Delay Unit \$1025 Order 7D11 Digital Delay Unit\$1725







Versatile 0.01% A/D Converter with Vertical Amplifier

3 Plug-in Modules Available
Automatic, Manual, or External Triggering
Automatic Polarity and Overrange
Indicators

Lit Pushbuttons

The 7D12 A to D Converter, constructed in modules, is a versatile and expandable DVM measurement system. The 7D12 and three interchangeable modules will make most DVM measurements, including dc volts, resistance, temperature, one- or two-point sample and hold, and true rms volts.

The 7D12 is designed for use with all 7000-Series Oscilloscope Mainframes with crt readout.

7D12/M1 MULTIFUNCTION MODULE

Temperature Mode
4½ Digit Crt Readout
100 μV Resolution
Probe Measures Temperature or Voltage

The M1 Multifunction Module measures dc volts, resistance, and temperature. The input can be elevated 1 kV above ground without probe, with a 10-M Ω input impedance on the dc volts scale. When the temperature probe is used, a front-panel analog output of 10 mV/°C (0°C = 0 V) is available regardless of model selected.

Dc Voltage Range — 0 to 1000 V in four ranges. $4\frac{1}{2}$ -digit presentation of 1.9999 V, 19.999 V, 199.99 V, 1000 V. Accuracy is $\pm 0.03\%$ of reading $\pm 0.005\%$ of full scale from $+20^{\circ}\text{C}$ to $+30^{\circ}\text{C}$; $\pm 0.04\%$ of reading $\pm 0.005\%$ of full scale from $+15^{\circ}\text{C}$ to $+40^{\circ}\text{C}$. Input impedance is 10 M Ω on all ranges. Max safe input is 1 kV peak between either connector and ground. Polarity is automatic. Cmrr is at least 80 dB at 60 Hz (100 Ω imbalance). Normal-mode rejection ratio is at least 50 dB at 60 Hz.

Resistance Range — 0 to 20 M Ω in six ranges. 4½-digit presentation of 199.99 Ω , 1.9999 k Ω , 19.999 k Ω , 199.99 k Ω , 1.9999 M Ω , 19.999 M Ω full scale. Accuracy is $\pm 0.09\%$ of reading $\pm 0.01\%$ of full scale from $+15^{\circ}\text{C}$ to $+40^{\circ}\text{C}$. Input is fuse protected.

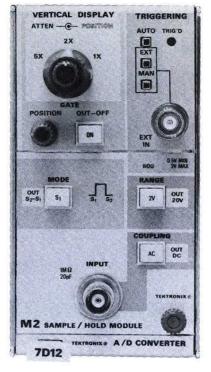
Temperature Range — -55° C to $+150^{\circ}$ C in one range. Accuracy ($+15^{\circ}$ C to $+40^{\circ}$ C ambient) is $\pm 1^{\circ}$ C from -55° C to $+125^{\circ}$ C, $\pm 2^{\circ}$ C above $+125^{\circ}$ C. Temperature out is 10 mV/°C into a load of at least 2.10°

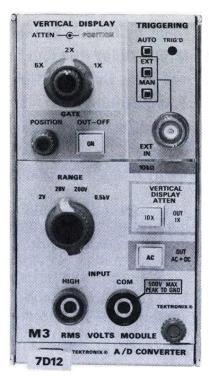
Settling Time — 2 s or less to within 1 count of final reading (voltage and resistance modes).

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.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.







7D12/M1

7D12/M2

7D12/M3

Included Accessories — P6058 voltage/temperature probe package (010-0260-00); pair of test leads (012-0427-00). (See 7D13 for P6058 probe specs.)

7D12/M2 SAMPLE/HOLD MODULE

Oscilloscope-controlled Sampling DVM

10-ns Aperture Uncertainty

Input Signal and Sample Points Displayed on Crt

3½ Digit Crt Readout

Approaching 0.25% Accuracy

1-mV Resolution

25-MHz Bandwidth

0-to-2 V and 0-to-20 V Input Range, 200 V with P6055 Probe

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 S1 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 S2-S1 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.

Sample-gate Display Amplitude — 2 div, rise time and fall time 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 M Ω and 20 pF.

Max Input Voltage - 100 V peak.

Measurement Readout — 0 to 20 V in two ranges. 3½-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 (S2-S1 mode) — 30 ns to 5 ms with repetitive signal. 150 μ s 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.

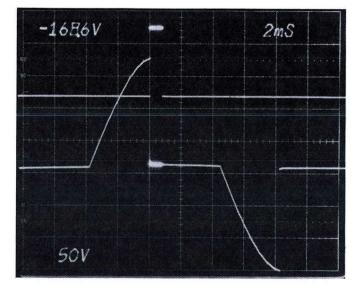
Settling Time — 40 ns.

Accuracy without Probe (40 ns after Input Signal Step Function)

Temperature Range	S1 Mode	S2-S1 Mode
+20°C to +30°C	±0.15% of p-p in- put voltage, ±0.1% of reading, ± 2 counts, ± % of ac decay*	±0.25% of p-p input voltage, ±0.15% of reading, ± 2 counts, ± % of ac decay*
+15°C to +40°C	\pm 0.25% of p-p in- put voltage, \pm 0.2% of reading, \pm 3 counts, \pm % of ac decay*	±0.35% of p-p 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.

7D12/M3

True Rms Measurements with Isolatedanalog Display (Floating Common-mode Capability)

Measures Ac + Dc or Ac Only
40 Hz-to-100 kHz Ac Voltage Range
0.25% Accuracy from 40 Hz to 40 kHz
3½ Digit Crt Readout
1 mV Resolution
500 V Max Peak Common-mode Voltage

The M3 RMS Volts Module measures the true rms voltage of signals from 40 Hz to 100 kHz. Voltages up to 1 kV peak may be measured while floating the input connectors.

Input R and C — 1 M Ω ; \simeq 50 pF. Max Crest Factor — 5 (crest factor = $\frac{E_{pk}}{E_{RMS}}$). Max Input Voltage

Range		2 V, 20 V, 200 V	0.5 kV
Ac	Max Input between connectors	2.5 X range peak	500 rms 1 kV peak
or Dc coupled†	Max Input between either connector and chassis ground	500 V peak	500 V peak

†Ac-coupling adds an additional 200 V dc isolation.

Digital System Cmrr — 66 dB at dc to 60 Hz, decreasing 20 dB per decade for higher frequencies (100- Ω imbalance load).

Measurement Readout — 0 to 500 V rms in four ranges. $3\frac{1}{2}$ digit presentation of 1.999 V, 19.99 V, 199.9 V, 0.500 kV full scale.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

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.

Accuracy — Stated with form factor of 1.2 or less (form factor = $\frac{E_{RMS}}{E_{average}}$); +15°C to +40°C*.

Range	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz	40 kHz to 100 kHz
2 V, 20 V	±0.5%	±0.25%	±0.25%	±0.5%
200 V	±0.5%	±0.25%	±0.5% plus 1% of reading	±0.5% plus 1% of reading
500 V	±1%	±1%	±2% plus 1% of reading	±2% plus 1% of reading

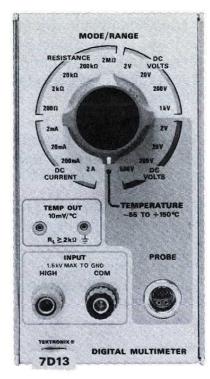
*Accuracies represent a percentage of full scale. For signals with form factors greater than 1.2, add \pm [0.1% x (form factor -1)] to the above percent of full scale accuracy specifications.

Analog-Signal Display — Bandwidth is dc to 700 kHz, max slew rate limited to full scale voltage \div 1 μ s (100 V/ μ s max). Vertical sensitivity is 100 mV/div to 500 V/div in 12 steps (1-2-5 sequence, combining M3 and 7D12 vertical display attenuation). Accuracy is within 5%, and aberrations are 5% or less.

Included Accessories — Pair of test leads (012-0427-00).

7D12/M1/M2/M3 ORDERING INFORMATION

7D12 A/D Converter (Modules
not Included\$825
M1 Multifunction Module\$450
Option 02 without P6058 Sub \$100
M2 Sample/Hold Module\$775
Option 02 without P6055 Sub \$120
M3 RMS Volts Module\$600



7D13

Temperature Mode
1.5 kV Max Common-mode Voltage
Probe Measures Temperature or Voltage
3½ Digit Crt Readout

The 7D13 is a digital multimeter designed for use in all 7000-Series Oscilloscope Mainframes with crt readout. The 7D13 functions in any compartment.

The 7D13 measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6058 voltage/temperature probe. The temperature probe functions regardless of 7D13 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. Almost any npn transistor may be used as a separate sensor to make small-space "free air" measurements.

When the 7D13 is used, the character generator traces out a $3\frac{1}{2}$ digit display on the crt and a legend for units like $k\Omega$, mA, °C.

Dc Voltage Range — 0 to 1000 V in four ranges. $3\frac{1}{2}$ -digit presentation of 1.999 V, 19.99 V, 199.9 V, and 1000 V full scale. Accuracy is $\pm 0.1\%$ of reading ± 1 count from $+15^{\circ}$ C to $+40^{\circ}$ C, $\pm 0.2\%$ of reading ± 2 counts from 0°C to $+50^{\circ}$ C. Input impedance is 10 M Ω on all ranges. Max safe input is 1.5 kV peak between either contact and ground, 1.0 kV peak between voltage contacts.

Dc Current Range — 0 to 2 A in four ranges. $3\frac{1}{2}$ digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is $\pm 0.5\%$ of reading ± 2 counts from $+15^{\circ}$ C to $+40^{\circ}$ C, $\pm 0.7\%$ of reading ± 4 counts from 0° C to $+50^{\circ}$ C. Max input is 3 A (fuse protected). Input impedance is 0.2 V/full scale current $+0.3~\Omega$.

Resistance Range — 0 to 2 M Ω in five ranges. $3\frac{1}{2}$ -digit presentation 199.9 Ω , 1999 Ω , 19.99 k Ω , 199.9 k Ω , and 1999 k Ω full scale. Accuracy is $\pm 0.5\%$ of reading ± 1 count from $+15^{\circ}$ C to $+40^{\circ}$ C, $\pm 0.8\%$ of reading ± 2 counts from 0°C to $+50^{\circ}$ C. Input is fuse protected.

Temperature Measurement Range — -55° C to $+150^{\circ}$ C in one range. $3\frac{1}{2}$ digit presentation to $+150^{\circ}$ C. Accuracy ($+5^{\circ}$ C to $+40^{\circ}$ C ambient) is $\pm 1^{\circ}$ C from -55° C to $+125^{\circ}$ C, $\pm 2^{\circ}$ C above $+125^{\circ}$ C. Accuracy (0° C to $+50^{\circ}$ C ambient) is $\pm 2^{\circ}$ C from -55° C to $+125^{\circ}$ C, $\pm 3^{\circ}$ C above $+125^{\circ}$ C.

Setting Time — 1.5 s or less (voltage, current, and resistance modes).

Polarity — Automatic indication.

Max Common-mode Voltage — 1.5 kV peak between two terminals and ground.

Normal-mode Rejection Ratio — At least 30 dB at 60 Hz, increasing at 20 dB/decade.

Common-mode Rejection Ratio — With a 1 k Ω imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

Overrange Indication — When overrange occurs, the readout blinks and the most significant digit displays a 2.

Recycle Time — 5 measurements per second.

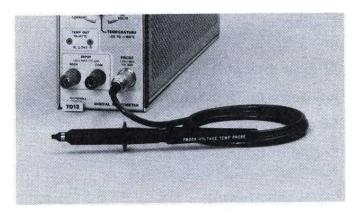
Temperature Out — 10 mV/°C into a load of at least $2 \text{ k}\Omega$.

Included Accessories — P6058 Voltage/Temperature Probe package (010-0260-00); pair of test leads (003-0120-00).

Order 7D13 Digital Multimeter\$775

7D13 OPTION

Order Option 02 without P6058 Probe Sub \$90



P6058 PROBE

The P6058 Probe is a combination 1X dc voltage and temperature measuring device. The temperature-sensing element consists of a transistor installed in the tip that plugs into the end of the probe body. For voltage measurements, a twelve inch and five inch "common" (low) strap is provided. There is no external ground on the P6058 body; ground or the low-potential point of the circuit under test is referenced to the common strap, a floating common that has no tie to chassis ground. This lead may be floated at up to 40 V dc above chassis ground. The probe tip may be 500 V above ground.

The retractable hook tip must be used on the probe when voltage measurements are made.

Temperature is measured by applying the flat surface of the probe tip to the device to be measured.

Dc Voltage Range — 0 to 1000 V. Accuracy is $\pm 0.1\%$ of reading ± 1 count.

Max Safe Input — 500 V peak between high and common; 40 V peak between common and chassis ground.

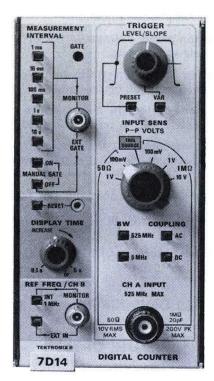
Temperature Range — See the 7D13 for the accuracy of a P6058/7D13 combination.

Cable — 46 in including probe body. Output connector is four-pin locking type for attaching the P6058 to the 7D13. Supplies power to the probe sensor transistor and signal to the digital multimeter.

Net Weight — Approx 5 oz.

P6058 Voltage/Temperature Probe Order 010-0260-00\$125

Includes P6058 Probe (010-0259-00): probe retractable hook tip (013-0121-00); 12 in ground lead screw-in (175-0991-00); two miniature alligator clips (344-0046-00).



7D14

Frequency Measurements Directly to 525 MHz

Trigger Indicator Display

No-warm-up Oscillator

50- Ω and 1-M Ω Inputs

Signal Conditioning via Mainframe Trigger Source

Lit Pushbuttons

The 7D14 is a directly gated digital counter plug-in unit designed for use in all 7000-Series Oscilloscope Mainframes with crt readout. It will function in any plug-in compartment. The 7D14 has three modes of operation: frequency—0 to 525 MHz, frequency ratio (A/B)—0 to 10⁵:1 and totalize—0 to 10⁸.

The 7D14 counts directly to 525 MHz. The gated approach makes possible "single event" counting which is frequently very desirable in rapid burst measurements. The resolution and accuracy can be improved by increasing the measurement interval.

Measurements which were previously impossible can now be made with an oscilloscope having a digital counter plug-in. By locating the counter in one of the vertical compartments of the oscilloscope and operating the scope in the delaying time-base mode, the B sweep (delayed sweep) can drive the counter gate. By doing this, signals may be displayed on the screen. Those being counted will be intensified.

With the 7D14 in a vertical compartment, the output of its trigger circuit can be displayed directly on the crt. This provides an indication of the actual triggering point, thus many signals that were difficult to trigger on in the past can now be measured with much greater reliability. Selective triggering is now possible too.

When the 7D14 is used in a horizontal plugin compartment, a signal connected to a vertical plug-in may be internally routed to it by the trigger source switches. All the 7000-Series Vertical Plug-ins are available as signal conditioners for the counter. Another advantage is the reduction of circuit loading. One connection to the oscilloscope deflects the vertical and provides the input for the counter.

FREQUENCY MEASUREMENTS

Input — Channel A, 0 to 525 MHz. Upper bandwidth may be restricted to 5 MHz to filter incoming high frequency noise.

Measurement Interval (Time Base) — 1 ms to 10 s in five decade steps. Up to 0.1 Hz resolution can be obtained.

Accuracy — Within $\pm \frac{1}{\text{total count}} \pm \text{time base.}$

Time-base Stability — Within $\pm 0.00005\%$, 0°C to +50°C ambient temperature.

Long-term Drift — 1 part or less in 107/month.

Input Characteristics

	Channe	el A	Channel	(a)
	50 Ω	1 ΜΩ	В	Trigger Source
Dc- coupled	Dc to 525 MHz	Dc to 525 MHz	Ac- coupling only	Ac- coupling only
Ac- coupled	200 kHz to 525 MHz	5 Hz to 525 MHz	10 Hz to 2 MHz	5 Hz to 525 MHz*
Sensi- tivity	100 mV p-p (35 mV rms)	100 mV p-p (35 mV rms)	800 mV p-p	1.5 graticule div*
Input R & C	50 Ω	1 MΩ ≈20 pF	10 kΩ ≈30 pF	Depends on amplifier plug-in used
Max Voltage	10 V rms	200 V (dc + peak ac) to 5 MHz 50 V (dc + peak ac) 5 MHz to 525 MHz	15 V (dc + peak ac) to 2 MHz	Depends on amplifier plug-in used

^{*}Bandwidth and sensitivity limited by mainframe, sensitivity derated above 150 MHz.

FREQUENCY RATIO

Range — Channel A: 0 to 525 MHz. Channel B: 10 Hz to 2 MHz.

TOTALIZE

Range — 0 to 108.

Gating — Operated manually or with an electrical gate. The external gate input is compatible with the sweep gate from the oscilloscope mainframe. Reset and external gate signals compatible with TTL logic.

MONITORS

Monitor/Ext Gate — Provides crystal-based time markers of +5 V; width determined by the measurement interval.

REF FREQ/CH B Monitor — Provides a crystal-based, 1-MHz, +5 V output pulse. This connector functions as CH B input in the EXT IN mode.

READOUT

Display — Eight digits with leading zero suppression, positioned decimal, MHz or kHz legend.

Display Time — 0.1 to 5 s; also a preset position for infinite display time.

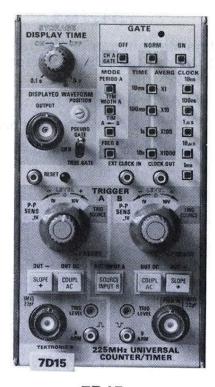
TRIGGERING

Level/Slope Range — + and -0.5 V with INPUT at 100 mV.

Displayed Trigger Indicator — Displayed amplitude of Schmitt trigger output is approx 0.2 div.

Included Accessory — BSM male to BNC female adapter (103-0036-00).

Order 7D14 Digital Counter\$1275



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

Lit Pushbuttons

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 selectable 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.

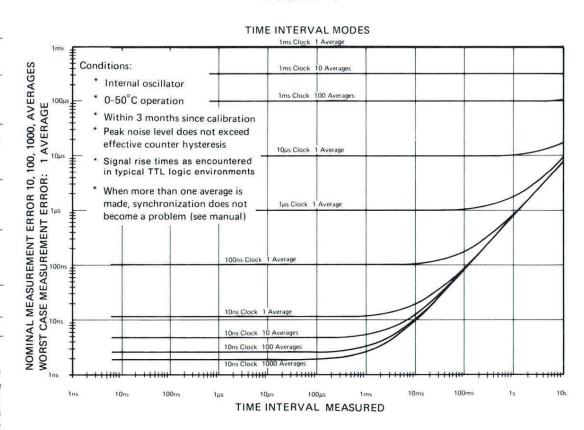
The 7D15 has high resolution because of a 10 ns clock, one of five clock positions obtainable from the front panel. A front-panel Clock Out connector makes the selected

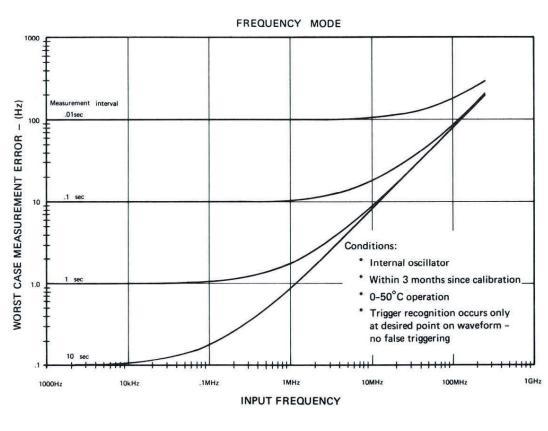
Modes of Operation

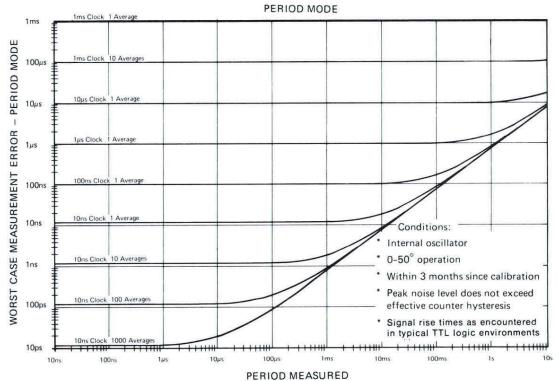
Frequency	Range	Dc to 225 MHz Resolution 0.1 Hz maximum
Mode	Accuracy	$\epsilon_{\text{freq(Hz)}} = \pm \text{ TB } \cdot f_{\text{in}} \pm \frac{1}{T}$
Period and	Range	10 ns to 10 ⁵ seconds with averaging times of X1 to X1000 in decade steps. Resolution: 10 picoseconds maximum
Multi-Period Mode	Accuracy	$\epsilon_{\text{period(s)}} = \pm \text{ TB} \cdot P_{\text{in}} \pm \frac{10^{-9}}{M} \pm \frac{2E_{\text{npk}}}{\frac{dv}{dt} \cdot M} \pm \frac{P_{\text{ck}}}{M}$
Time Interval TI and (TI	Range	6 ns to 10 ⁵ seconds with averaging times of X1 to X1000. 0.1 ns resolution (usable)
Average) Mode	Accuracy Worst Case (Nominal)	$\epsilon_{\text{TI(s)}} = \pm \text{ TB} \cdot P_{\text{in}} \pm \frac{P_{\text{ck}}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{\text{npk}}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	Range	10-7 to 104
Manual Stop Watch	Range	0 to 10 ⁵ seconds
Totalize, Ch B	Range	0 to 108 counts

NOTE: Formulas given where ε is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period or time interval of unknown signal; M is the number of averages given; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{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.

ACCURACY







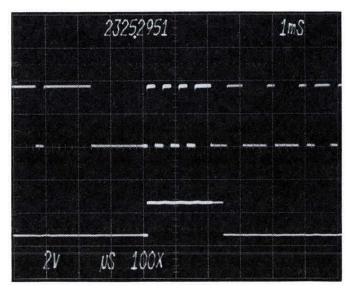


Fig 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time interval measurement from third to seventh pulse on crt display. Counter Ch A is "armed" with leading edge of B gate while Ch B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. Crt readout displays the result of 2325.295 μ s.

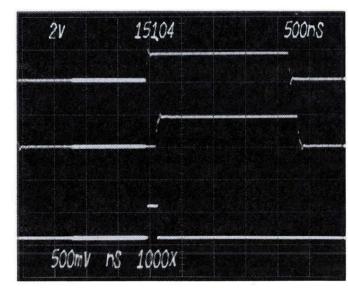


Fig 2. The propagation delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. Crt readout displays the result of 151.0 ns.

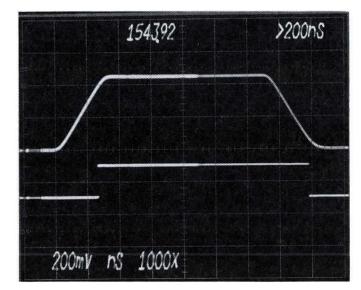


Fig 3. Independent slope and level control allows the user to *visually select* precise points on the waveform where the counter starts and stops. Crt readout displays the result of 1543.9 ns.

7000-Series Dual Delay Line and Sampling Units

clock signal available at a front-panel connector. This provides a time mark function that is TTL compatible and will drive a 50 Ω 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 8 digit crt display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the crt display.

INTERNAL TIME BASE

Crystal Oscillator — Accuracy: within 0.5 ppm (0°C to +50°C ambient). Long-term drift: 1 part or less in 10^7 per month. Oscillator is temperature compensated; no warm up is required.

OUTPUT SIGNALS

Clock Out — Logical 1 \geq +0.5 V into 50 Ω . Logical 0 \leq 0 V into 50 Ω . TTL compatible without 50 Ω load (1.6 mA current capacity).

A and B Trigger Level — $Z_{\text{out}} \approx$ 1 k $\Omega,~V_{\text{out}} = \pm 0.5$ V into 1 M $\Omega.$

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 — Allows selection of readout "follow or store."

Display Time — 0.1 to 5 s; also a preset position for infinite display time.

Readout — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a > 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 p-p. 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 M Ω 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.

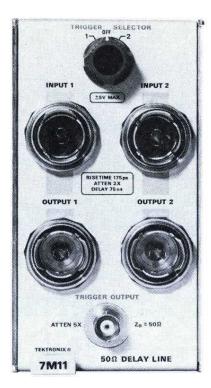
Arming Inputs — Input R and C: 10 k Ω and 20 pF. Sensitivity arm A: logical 1 \geq +0.5 V, logical 0 \leq +0.2 V. Sensitivity arm B: logical 1 \leq +0.2 V, logical 0 \geq +0.5 V.

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\$1850



7M11

75 ns Time Delay
Selectable Trigger Out
175 ps Rise Time

The 7M11 is a passive dual delay line unit 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 rise time, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a rise time of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay — 75 ns within 1 ns.

Delay Difference — 30 ps or less between channels.

Rise Time — 175 ps or less.

Attenuation — 2X within 2% into 50 Ω .

Input Impedance — 50 Ω within 2%.

Max Input Voltage — ±5 V rms.

TRIGGER OUTPUT

Rise Time — 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

10 in BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00).

Order 7M11 Delay Line Unit.....\$450



7S11

2 mV/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 X10 the offset voltage within 2%. Source R is 10 k Ω within 1%.

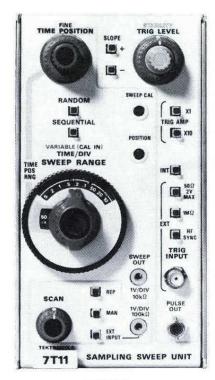
Delay Range — At least 10 ns for comparing two signals in a dual-trace application.

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\$850



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 \simeq 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 4 steps; real time is 0.5 ms to 50 ms in 3 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 X1 TRIG AMP mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 TRIG AMP, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 50 Ω within 10%. Max input voltage is 2 V (dc + peak ac).

Ext 1-M Ω Input — Frequency range is dc to 100 MHz in X1 TRIG AMP mode. Sensitivity range is 12.5 mV to 2 V p-p (dc to 100 MHz) in X1 TRIG AMP, 1.25 mV to 2 V p-p (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 1 M Ω within 5%. Max input voltage is 100 V p-p to 1 kHz (derating 6 dB per octave to a min 5 V p-p).

Ext HF Sync — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 M Ω . Max input voltage is 2 V p-p.

Int Trigger Source (Sine-wave 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 p-p (referred to the vertical input) in X1 TRIG AMP; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 TRIG AMP.

Random Mode Trigger Rate — 100 Hz min.

Display Jitter — Measured under optimum trigger conditions with TIME/DIV switch clockwise.

Time Pos Range	Sequential Mode	Random Mode	
50 μ s 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 rise time or less.

*Trigger circuits will operate to dc with pulse triggering, except for HF Sync.

Trigger Kickout — 2 mV or less into 50 Ω (except HF SYNC).

Display Scan Rate — Continuously selectable from at least 40 sweeps/s to less than 2 sweeps/s.

External Scan — Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 k Ω within 10%. Max input voltage is 100 V (dc + peak ac).

Sweep Out — 1 V/div within 2%. Source R is 10 $k\Omega$ 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); 10X 50 Ω attenuator (011-0059-02); SMA (3 mm) male to BNC adapter (015-1018-00); SMA (3 mm) male to GR874 adapter (015-1007-00).

Order 7T11 Sampling Sweep Unit \$2475

7S12

45 ps TDR or 30 ps 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, doublewidth 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 rise time of 45 ps (return from shortcircuit termination) and distance range to 290 ft in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 m ρ /div to 500 m ρ /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 rise time 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 pre-trigger signal is not available.

CHARACTERISTICS

System Performance with S-6 and S-52

System Rise Time — 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 μs round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude — At least +200 mV into 50 Ω .

Input Characteristics — Nominal 50 Ω , feed-through signal channel (termination supplied). SMA (3 mm) connectors.

Jitter — Less than 10 ps (without signal averaging). **Aberrations** — +7%, -7%, total of 10% p-p within

Aberrations — +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 μ s round trip.



Pulse Amplitude — At least +400 mV into 50Ω .

Input Characteristics — Nominal 50 Ω test-line connection (cable and T supplied). BNC connectors.

Jitter — Less than 20 ps (without signal averaging).

Aberrations — +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 X10-3) 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 X10 dc offset through 10 k Ω .

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 μ s, 1 μ s, 0.1 μ 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 μ 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.

Display Modes — Repetitive or single sweep, manual or external scan.

 $\begin{tabular}{ll} \textbf{Signal Outputs} & --- \end{tabular} & \textbf{Pin jacks provide both vertical signal and sweep outputs.} \end{tabular}$

INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); tdr slide rule (003-0700-00).

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
 \$2.85

 Red, 18 in, Order 012-0180-00
 \$3.00

 Black, 8 in, Order 012-0181-00
 \$3.00

 Black, 18 in, Order 012-0182-00
 \$3.00

 Tape Dial (Calibrated in Feet)
 \$12.50

 Tape Dial (Calibrated in Meters)

Order 331-0276-00\$12.50

NOTE: See 1502-1503 Portable TDR Cable Tester on page 170.

7000-Series Sampling Heads

S-1

Dc-to-1 GHz Bandwidth Clean Transient Response

The S-1 Sampling Head is a low-noise, 350-ps rise time 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.

Rise Time — 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%, -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 less than 500 mV p-p.

Input Characteristics — Nominally 50 Ω . Safe overload is ± 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 \$600

S-2

Dc-to-4.6 GHz Bandwidth

Displayed Noise Less than 6 mV (Unsmoothed)

The S-2 Sampling Head is a 75 ps rise time 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.

Rise Time — 75 ps or less.

Bandwidth — Equivalent to dc to 4.6 GHz at 3 dB

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

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 less than 200 mV p-p.

Input Characteristics — Nominally 50 $\Omega.$ 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\$725

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe.
Order (Std) 015-0041-00\$95
P6056 10X Passive Probe, Order (Std) 010-6056-03\$110
P6057 100X Probe, Order (Std) 010-6057-03\$110
Coupling Capacitor, GR874-K, Order 017-0028-00\$51
Power Divider GR874-TPD, Order 017-0082-00\$210
GR to BNC Adapter,













S-3A

Compact, 4.5 Ft, 100 k Ω , 2.3 pF Probe Dc-to-1 GHz Bandwidth Displayed Noise Less than 3 mV (Unsmoothed)

The S-3A Sampling Head is an active sampling-probe unit with 100 k Ω , 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

Rise Time — 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 and -1 V, X1 range, or +2 V and -2 V, X2 range, to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the probe attenuators.

Included Accessories — 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½ in ground lead (175-1017-00); 12½ in ground lead (175-1018-00); 3 in cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-01); 50 Ω voltage pickoff (017-0077-01); carrying case (016-0121-01); 3 in elec lead (175-0849-00); 6 in elec lead (175-0849-01).

Order S-3A Sampling Head\$900

S-4

25 ps Sampling Head Dc-to-14 GHz Equivalent Bandwidth Displayed Noise Less than 5 mV (Unsmoothed)

The S-4 Sampling Head is a 25 ps rise time 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.

Rise Time — 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, unsmoothed; 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 $\Omega.$ Safe overload $\pm\,5$ 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 adapter (015-1007-00); SMA male-to-male adapter (015-1011-00); 5/16 in wrench (003-0247-00).

Order S-4 Sampling Head\$1325

S-5

1 M Ω , 15 pF Input Impedance Passive Probe Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns rise time sampling unit with a 1 $M\Omega,$ 15 pF input impedance. When used with the included P6010 passive probe, the input impedance increases to 10 $M\Omega,$ 10 pF while maintaining the 1 ns rise time at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Rise Time — 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.

7000-Series Sampling, Trigger Countdown, and Pulse Generator Heads

Displayed Noise — S-5 only, 500 μ V or less (includes 90% of dots). S-5/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. S-5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.

Input Characteristics — S-5 only, 1 M Ω within 1% paralleled by 15 pF. S-5/P6010, 10 M Ω paralleled by approx 10 pF.

Attenuator Accuracy — Probe attenuation is 10X within 3%

Included Accessories — P6010 probe package (010-0188-00), 50 Ω termination (011-0049-01).

Order S-5 Sampling Head \$600

OPTIONAL ACCESSORIES	
Probe Tip-to-BNC Adapter,	
Order 013-0084-01	8
Probe Tip-to-GR Adapter,	
Order 017-0076-00\$3	0
Probe Tip-to-GR Terminated Adapter,	
Order 017-0088-00	0

S-6

30 ps Rise Time Displayed Noise Less than 5 mV

Loop-through Input

(Unsmoothed)

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

Rise Time — 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

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. Max safe overload is \pm 5 V.

Included Accessories — 50 Ω termination (015-1022-00); 1 ns 50 Ω cable (015-1019-00); SMA (3 mm) female-to-female adapter (015-1012-00); SMA male-to-GR874 adapter (015-1007-00); combination wrench (003-0247-00).

Order S-6 Sampling Head \$1250

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\$60
5-ns 50 Ω Signal Cable, Order 015-1006-00\$110
Male-to-GR874 Adapter, Order 015-1007-00\$40
Female-to-GR874 Adapter, Order 015-1008-00\$50
Male-to-N Female Adapter, Order 015-1009-00\$47
Male-to-7-mm Adapter, Order 015-1010-00\$170
Male-to-Male Adapter, Order 015-1011-00\$16
Female-to-Female Adapter, Order 015-1012-00\$16
Coupling Capacitor, Order 015-1013-00\$130

50 Ω Power Divider 1, Order 015-1014-00\$200
500-ps 50 Ω Semirigid Cable, Order 015-1015-00\$40
SMA T Adapter, Order 015-1016-00 \$27
SMA Male-to-BNC Female Adapter, Order 015-1018-00\$6
1-ns 50 Ω Cable, Order 015-1019-00\$60
SMA Male Short-Circuit Termination, Order 015-1020-00
SMA Female Short-Circuit Termination, Order 015-1021-00\$15
SMA Male 50 Ω Termination, Order 015-1022-00\$32

Order 011-0049-01\$25
50 Ω Feed-through (5 W), Order 011-0099-00 \$35
50 Ω 2X Attenuator, Order 011-0069-02\$30
50 Ω 2.5X Attenuator, Order 011-0076-02\$30
50 Ω 5X Attenuator, Order 011-0060-02\$30
50 Ω 10X Attenuator, Order 011-0059-02\$30
50 Ω 18 in, Coaxial Cable, Order 012-0076-00\$15
EO () 40 in Cooxiel Cable Order 012 0057 01 \$15



3 ft Sampling-Head Extender, Order 012-0124-00..\$149 6 ft Sampling-Head Extender, Order 012-0125-00..\$164

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 max.

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\$825

S-52

25 ps Rise Time 200 mV into 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 — Rise time is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 800 ns, pulse period 16 μ s within 2 μ s. 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 — Rise time 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, 50 Ω semirigid coax delay line (015-1023-00).

Order S-52 Pulse Generator Head\$825

SAMPLING HEAD WEIGHTS (Approx)

	8	S-1	S	-2	s-	3A	S	-4	S	-5	S	6-6	S	-51	S	-52	S-	-53	S-	-54
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	1	0.5	1	0.5	3	1.4	1	0.5	0.6	0.3	1	0.5	1	0.5	0.8	0.3	0.8	0.3	0.8	0.3
Shipping	3	1.4	3	1.4	5	2.3	2	0.9	2	0.9	2	0.9	5	2.3	1	0.5	1	0.5	1	0.5

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 or for other applications.

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 — Rise time 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 μ s 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\$600

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 — Rise time is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μ s within 2 μ s. 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 — Rise time 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 μ s or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μ s 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 \$500

7514

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 like conventional oscilloscope nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation.

VERTICAL CHANNEL

Modes — Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 Vertical (Y), Channel 2 Horizontal (X).

Input Impedance — Nominally 50 Ω .

Bandwidth — Equivalent to dc to 1 GHz.

Rise Time — 350 ps or less.

Step Aberrations — +2%, -4%, total of 6% p-p 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 ±3%.

Max Input Voltage — ± 5 V.

Input Signal Range — 2 V p-p max 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.

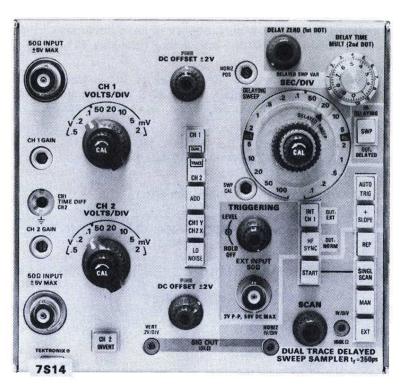
TIME BASE

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 per div of horizontal deflection; 10 k Ω source resistance.



DELAYING SWEEP

Range — 10 ns/div to 100 μ s/div in 13 steps (1-2-5 sequence).

Accuracy — Within $\pm 3\%$, excluding first one-half div of displayed sweep.

Delayed 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 position of the time interval represented by 10 div of the delaying sweep selected.

Delay Accuracy — Within $\pm 1\%$ of 10 div when measurement is made within the last 9.5 div.

DELAYED SWEEP

Range — 100 ps/div to 100 μ 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 div 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 div of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

Delay Jitter — Less than 0.05% of the time represented by 1 div of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources — Internal from Channel 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μ s or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave 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 on either a + slope or a - slope of the triggering signal.

Auto Trigger 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 approx the p-p 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 sine waves 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 7S14 Dual-Trace
Delayed Sweep Sampler\$2700

5000-Series Instruments

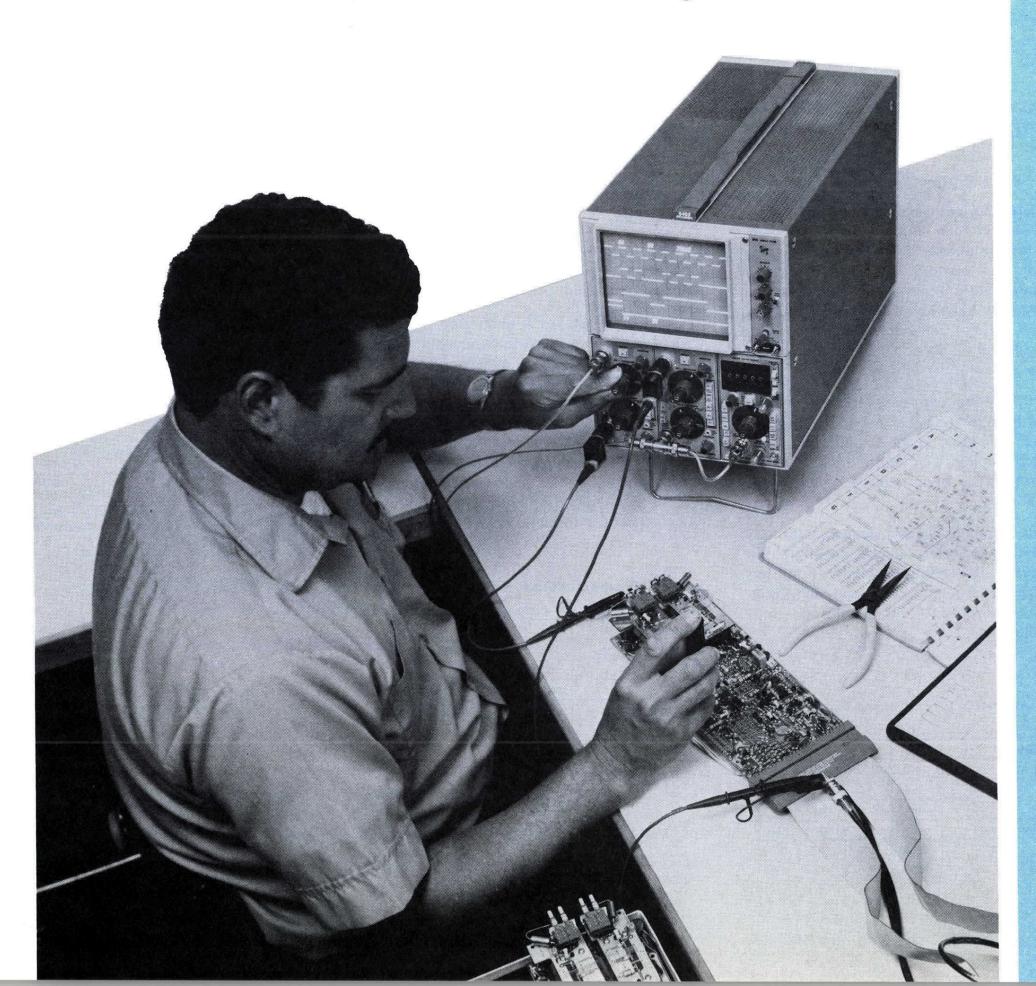
Pick a 5000-Series Plug-in Oscilloscope for:

Performance Value . . . The 5400 Series is designed for the costconscious user as an alternative to the monolithic scope; it gives you 60-MHz bandwidth in both non-store 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 insuring yourself a share in the future.

The 5000 Series . . . an extra margin of value.



5000-Series Reference

Low Cost

2 MHz or 60 MHz Bandwidth

Sampling to 1 GHz

0 to 100 kHz Spectrum Analysis

7 Oscilloscope Models

23 Plug-ins Available

Dual-Beam and Storage Displays

Crt Readout (5400 Series Only)

Large 6½ in Crt (8 x 10 div)

10 μV/div High Gain Differential Amplifier

1 to 8 Trace Capability

Delayed-Sweep Time Bases

Y-T or X-Y Operation

Color-Coded Front Panels

Bench-to-Rack Convertibility

The 5000-Series Oscilloscope is designed to provide optimum versatility and performance at the lowest possible price.

5100-Series Oscilloscopes

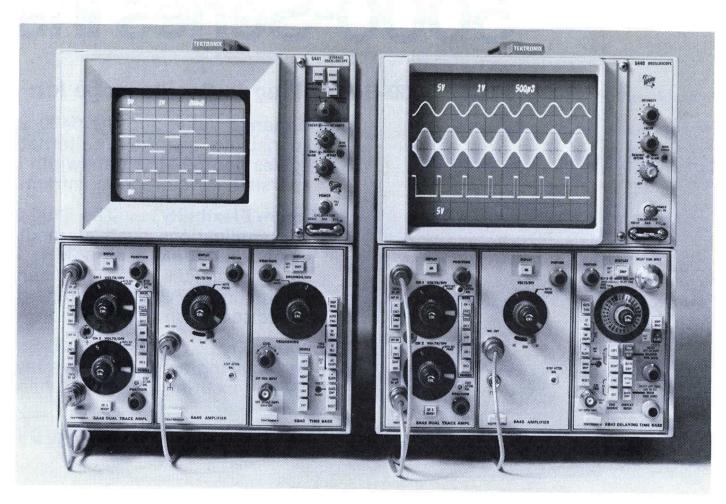
Five 5100-Series Oscilloscopes are available. They include single-beam, dual-beam, and storage displays. The storage display units feature bistable, split-screen storage with burn-resistant phosphor. The dual-beam display units have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drive both beams.

The 5100 Series features 2 MHz mainframes with large 6½" crts that accommodate two vertical deflection plug-ins and one horizontal deflection plug-in. It can be easily converted from bench to rackmount configuration.

To date, 16 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 and the 5S14N, a general-purpose, 1 GHz dual-trace sampling plug-in.

5100-Series Dimensions and Weights

	Cab	Rackmount		
Dimensions	in	cm	in	cm
Height	11.9	30.2	5.3	13.3
Width	8.4	21.3	19.0	48.3
Length	20.4	51.8	19.0	48.3
Weight (approx)	lb	kg	lb	kg
Net	23.0	10.4	24.0	10.9
Shipping	32.0	14.5	43.0	19.5



5400-Series

5400-Series Oscilloscopes

Two 5400-Series display units are presently available: a single-beam, non-storage display and a variable persistence storage display. Both feature crt readout of plug-in scale factors.

Like the 5100 Series, the 5400 Series features 3 plug-in compartments and benchmount-to-rackmount convertibility.

The 5400 Series takes a giant step in performance; it offers 60 MHz bandwidth. The 5400 Series 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.

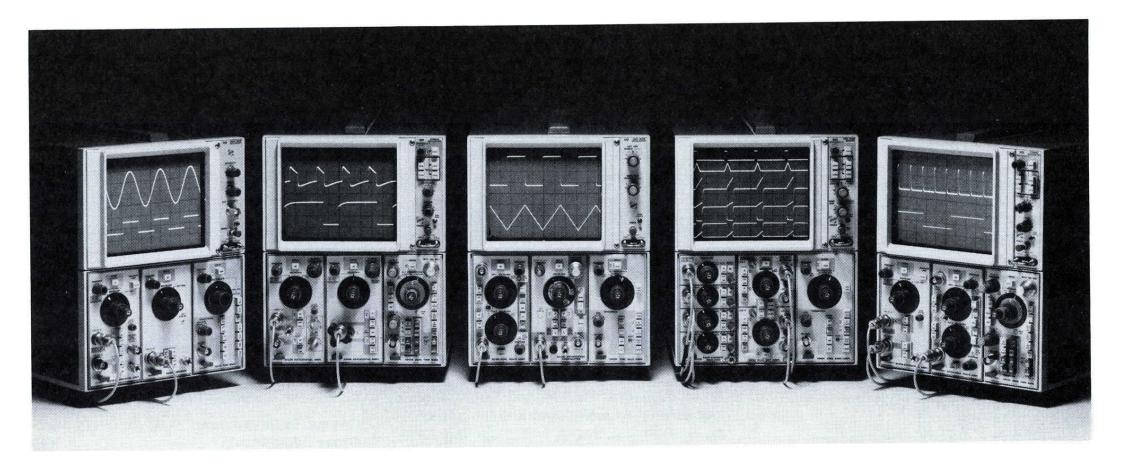
5400-Series Dimensions and Weights

	Cab	Rackmount		
Dimensions	in	cm	in	cm
Height	11.9	30.2	5.3	13.3
Width	8.4	21.3	19.0	48.3
Length	20.4	51.8	19.0	48.3
Weight (approx)	Ib	kg	Ib	kg
Net	25.0	11.3	26.0	11.8
Shipping	34.0	15.4	45.0	20.4

Whether you choose the 2 MHz 5100 Series or the 60 MHz 5400 Series, TEKTRONIX 5000-Series Oscilloscopes always give you the most versatility and performance for your dollar.

MAINFRAMES

Mainframe/ Display Unit	Page	Beams	Storage	Display Size
5110	90	Single		8 x 10 div (1.27 cm/div)
5111	90	Single	Bistable	8 x 10 div (1.27 cm/div)
5112	90	Dual		8 x 10 div (1.27 cm/div)
5113	90	Dual	Bistable	8 x 10 div (1.27 cm/div)
5115	90	Single	Bistable	8 x 10 div (1.27 cm/div)
5440	85	Single		8 x 10 div (1.22 cm/div)
5441	86	Single	Variable Persistence	8 x 10 div (0.9 cm/div)



5100-Series

PLUG-IN VERSATILITY

Twenty-three plug-ins are now available in the 5000-Series Family. All these plug-ins are compatible with the 5400 Series, and all but 7 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 delay time base.

Three 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 curve-tracer 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 either the 5100 or the 5400 Series to 1 GHz at 2 mV sensitivity.

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.

AMPLIFIERS

Prod- uct	Page	Туре	Minimum Deflection Factor	Band- width —3 dB	Cmrr
5A13N	93	Single	1 mV/div	2 MHz	10,000:1
5A14N	92	Four	1 mV/div	1 MHz	
5A15N	92	Single	1 mV/div	2 MHz	
5A18N	92	Dual	1 mV/div	2 MHz	
5A19N	93	Single	1 mV/div	2 MHz	1000:1
5A21N	93	Single (voltage and current)	50 μV/div 0.5 mA/div	1 MHz	100,000:1
5A22N	94	Single	10 μV	1 MHz	100,000:1
5A23N	92	Single	10 mV/div	1.5 MHz	
5A24N	92	Single	50 mV/div	2 MHz	
5A26	94	Dual	50 μV/div	1 MHz	100,000:1
5A38	87	Dual	10 mV/div	35 MHz	
5A45	87	Single	1 mV/div*	60 MHz	
5A48	87	Dual	1 mV/div*	60 MHz	

^{*}Bandwidth is dc to 25 MHz at 1 mV/div and 2 mV/div and 60 MHz at 5 mV/div through 10 V/div.

Time-Base Plug-ins

Prod- uct	Page	Туре	Sweep Rate	Mag	Single Sweep	Volts/ Div Ext Mode
5B10N	95		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	95	Dual Delay- ing	A 1 μs to 5 s B 2 μs to 0.5 s	X10 —	Yes —	50 mV and 500 mV
5B13N	95		1 μs to 100 ms			50 mV
5B31	88	Digital Delay- ing	0.2 μs to 5 s	X10	Yes	50 mV
5B40	88		0.1 μs to 5 s	X10	Yes	50 mV
5B42	88	Delay- ing	A 0.1 μs to 5 s B 0.1 μs to 0.5 s	X10 X10	Yes —	50 mV
5B44	89	Dual Delay- ing	50 ns to 2 s	X10	Yes	50 mV

Special-Purpose Plug-ins

Product	Page	Description
5CT1N	96	Semiconductor Curve Tracer
5L4N	96	Low-Cost Spectrum Analyzer
5S14N	96	Dual-Trace Delayed Sweep Sampler

5000-Series Plug-in Dimensions and Weights

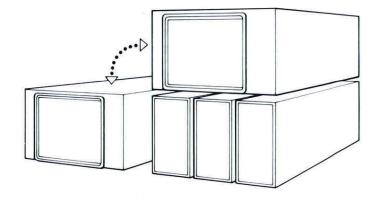
Dimensions	Hei	ght	Wie	dth	Len	gth
	in	cm	in	cm	in	cm
Single Width	5.0	12.7	2.6	6.6	12.0	30.5
Double Width	5.0	12.7	5.2	13.2	12.0	30.5
Weight (approx)	N	et	Ship	ping		
	lb	kg	lb	kg		
Single Width	2.8	1.3	10.0	4.5		
Double Width	5.8	2.6	10.8	4.9		

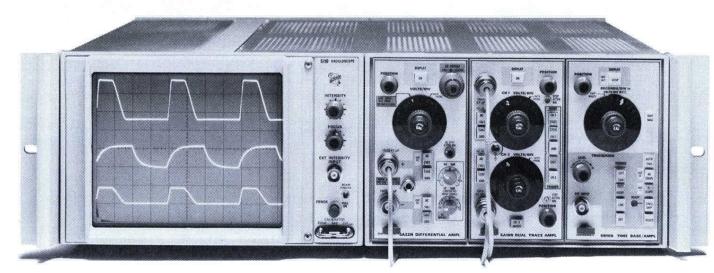
NEW FOR 1978

Rear Panel Signal Outputs, an optional feature for all 5100-Series Mainframes.

CONVERTIBILITY: Cabinet-to-Rackmount, Rackmount-to-Cabinet

All 5000-Series Oscilloscopes are available in either cabinet or rackmount configurations. Kits are also available to convert existing units from cabinets to rackmount, or from rackmount to cabinet configurations (see conversion kits at right).





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 Rackmo	un	t,														
Order 040-0583-02			٠	٠	٠	•	٠	•	•	٠	٠	٠	÷	٠		\$95
Rackmount to Cabi																
Order 040-0584-03							٠		9.0	•						\$75

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-skirt 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	Probe	Туре	Attenuation	Standard Length	Features	Package Number
5A14N	P6060	Voltage	10X	6′	Full bandwidth, low cost, (not compatible with crt readout).	010-6060-03
5A15N 5A18N	P6062B	Voltage	1X/10X	6′	Full bandwidth, switchable attenuation, ground reference button.	010-6062-13
5A23N	P6101	Voltage	1X	2 m	Full bandwidth, miniature. Modular construction simplifies repair.	010-6101-03
	P6060	Voltage	10X	6′	Full bandwidth, low cost, (not compatible with crt readout).	010-6060-03
5A13N 5A21N*	P6062B	Voltage	1X/10X	6′	Full bandwidth, switchable attenuation, ground reference button.	010-6062-13
5A22N 5A26	P6101	Voltage	1X	2 m	Full bandwidth, miniature. Modular construction simplifies repair.	010-6101-03
	P6055	Voltage	Adjustable to 10X	3.5′ only	Adjustable attenuation. Will give up to 20,000: 1 CMRR when used in pairs. (5A21N, 5A22N and 5A26).	010-6055-01
×	P6105	Voltage	10X	2 m	Full bandwidth, miniature. Modular construction simplifies repair.	010-6105-03
5A38 5A45 5A48	P6062B	Voltage	1X/10X	6′	Switchable attenuation (full bandwidth in the 10X position) ground reference button.	010-6062-13
	P6101	Voltage	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 93-94 for complete information.

CARTS

SCOPE-MOBILE® Carts — For cabinet models, order TEK Lab Cart, Model 3; for rackmount models, order TEK Rack Cart, Model 7.

CAMERAS

All 5100 Series — C-5B, suitable for repetitive or stored traces.

5100 Storage Instruments, 5440 (with P or R back), 5441 (with G back) — C-59, general purpose.

For full details see Camera Section, page 225.

ACCESSORIES

Blank Plug-in Kit — (040-0818-01)

Blank Panel — (016-0195-00)

Viewing Hoods — (016-0154-00, or 016-0260-00 folding)

Protective cover — (016-0544-00)

For full details see Accessories Section, page 254.

Low Cost

Dc to 60 MHz

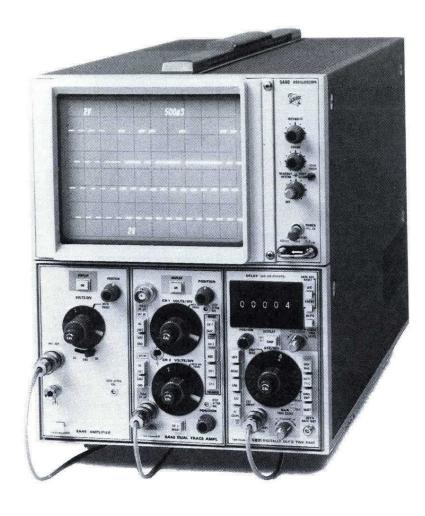
Sampling to 1 GHz

Crt Readout

3-Plug-in Flexibility

Choice of 23 Plug-ins

Bench to Rack Convertibility



The 5440 combines versatility and low cost in a 60 MHz general-purpose, plug-in oscilloscope. It features crt readout of plug-in scale factors, a 3-plug-in mainframe, a choice of 23 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.

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.

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 (5A13N, 5B10N, etc).

Deflection Factor—Determined by plug-in unit.

Bandwidth— 60 MHz max, determined by plug-in

unit.

Chopped Mode—The 5440 will chop between chan-

nels 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—5 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 (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 Ω paralleled by approx 40 pF. Max 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 2 times the line frequency.

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Writing speed can be increased with the TEKTRONIX Writing Speed Enhancer (see camera section for more information).

Writing Sp P31 Phosphor				Camera	Lens
10,000	3000	10,000	3000		
ASA	ASA	ASA	ASA		
180	90	245	125	C-59R	f/2.8 0.67 mag
330	160	450	230	* ** C-50R	f/1.9 0.7 mag

^{*}Slight cropping of the graticule corners.

Beam Finder—Intensifies trace and brings it into graticule areas.

Ambient Temperature—Performance characteristics valid from 0°C to $+50^{\circ}\text{C}$ unless otherwise specified.

Line Voltage Range— 100, 110, 120, 200, 220, and 240 V ac \pm 10%; (Except that max input should not exceed 250 V ac.) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Max 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 — See camera section, page 225.

ORDERING INFORMATION

(Plug-ins not included)

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 51/4 in rackmount oscilloscope with slide-out assembly.

5440 Oscilloscope	1870	٠	٠	•		٠	•	•	•	•	٠	٠	•	٠	•	\$155	0
R5440 Oscilloscope	(R	a	C	k	Ti	n	0	u	n	t)					\$160	0

OPTIONS

Option 01 without Crt ReadoutSub	400
Option 03 User Addressable Crt Readout Add	\$65
Option 04 Protective Panel Cover	¢20
(Cabinet Model Only)Add	\$20
Option 76 P7 PhosphorNo Cha	arge
Option 78 P11 PhosphorNo Cha	arge

Conversion Kits

Cabinet-to-Rackmount,	Order 040-0583-02	\$95
Rackmount-to Cabinet,	Order 040-0584-02	\$75
Crt Readout, Order 040	0-0691-01	\$430

^{*}Plug-ins with a suffix N (5A13N, 5B12N, etc) do not provide crt readout.

^{**}The 5B10N, 5B12N, and 5B13N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.

^{**}Requires optional battery pack (016-0270-00) for operation with the 5440.

Low Cost

Variable Persistence Storage

Crt Readout

Dc to 60 Mz

3-Plug-in Flexibility

23 Versatile Plug-ins

Bench to Rack Convertibility

5 div/μs Stored Writing Speed

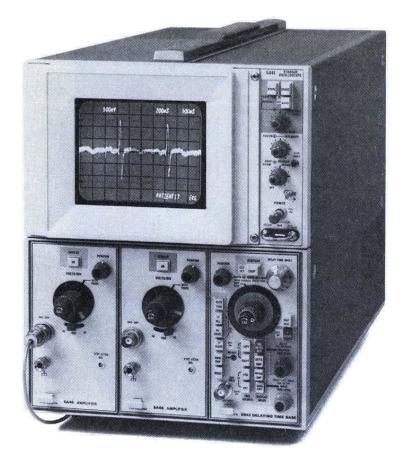
With the 5441 Variable Persistence Storage Oscilloscope, view time at normal intensity can be varied from a fraction of a second to more than 5 minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

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 23 plug-ins, you can make virtually any measurement from dc to 60 MHz.



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- 60 MHz max, determined by plug-in.

Chopped Mode—The 5441 will chop between channels at approx 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— 5 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.

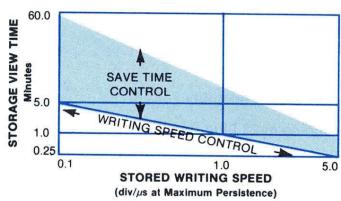
Max Stored Writing Speed—Writing speed greater than 5 $div/\mu s$ for a view time of 15 s.

Storage View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the max writing speed the view time is 15 seconds 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 above).

Save Mode—Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.

Erase Time— $0.5 s \pm 10\%$.



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 approx 10 k Ω paralleled by approx 40 pF. Max input 50 V (dc + peak ac).

OTHER CHARACTERISTICS

Beam Finder—Intensifies trace and brings it into graticule area.

Calibrator—Voltage amplitude 400 mV $\pm 1\%$. Current amplitude 4 mA $\pm 1\%$. Frequency is 2 times line frequency.

Ambient Temperature—Performance characteristics valid from 0° C to $+50^{\circ}$ C unless otherwise specified.

Line Voltage Ranges— 100, 110, 120, 200, 220, and 240 V ac \pm 10%; (Except that max input should not exceed 250 V ac.) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Max 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.

Option 05—A 1 div/ μ s writing speed can be ordered (at a significantly lower price) when a writing speed of 5 div/ μ s is not required.

For Recommended Cameras — See camera section, page 225.

ORDERING INFORMATION

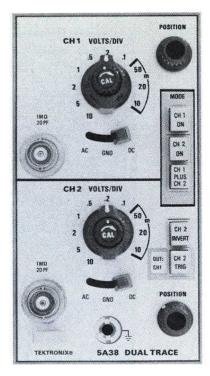
(Plug-ins not Included)

5441 Oscilloscope\$2650
R5441 Oscilloscope (Rackmount)\$2700
OPTIONS
Option 01 without Crt ReadoutSub \$400
Option 03 User Addressable Crt ReadoutAdd \$65
Option 04 Protective Panel Cover (Cabinet Model Only) Add \$20
Option 05 Reduce Writing Speed to 1 div/µsSub \$300

CONVERSION KITS

Cabinet-to-Rackmount, Orde	er 040-0583-02\$95
Rackmount-to-Cabinet, Orde	er 040-0584-03\$75
Crt Readout, Order 040-0691	

5A38



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 5400-Series Mainframes. It features 10 mV/div sensitivity and crt readout of deflection factor.

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.

Rise Time—≤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 Ω shunted by approx 20 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max 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/ $^{\circ}$ C vertical shift with line voltage held constant.

5A38 Dual-Trace Amplifier\$415

5A48



Dc-to-60 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A48 is a dual-trace 60 MHz plug-in amplifier for use only with the 5400-Series Mainframe. The 5A48 features five operating modes and selectable trigger source.

Bandwidth—Dc coupled, dc to at least 60 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 (lower 3 dB point).

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 one or channel two.

Rise Time— 5.8 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 Ω within 1%, approx 24 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac); ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 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.

5A48 Dual-Trace Amplifier\$570

5A45



Low Cost

DC-to-60 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A45 is a single-trace, 60 MHz plug-in amplifier for use only in 5400-Series Mainframes. It features 5 mV/div sensitivity (1 mV/div at 25 MHz) and crt readout of deflection factor.

Bandwidth—Dc coupled, greater than 60 MHz for 5 mV/div through 10 V/div deflection factors, greater than 25 MHz for 1 mV/div and 2 mV/div deflection factors. Ac coupled, lower end response ≤10 Hz (≤1.0 Hz with 10X probe) for all deflection factors.

Rise Time— \leq 14 ns, 1 mV/div and 2 mV/div. \leq 5.8 ns, 5 mV/div through 10 V/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.

Input R and C—1 M Ω , shunted by approx 20 pF.

Max Safe Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 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.

5A45 Single-Trace Amplifier\$295



5B40

Low Cost 10 ns/div to 5 s/div Calibrated Time Base Triggering to 60 MHz

The 5B40 Time Base is designed for use in 5400-Series Mainframes. It features sweep rates from 10 ns/div to 5 s/div and crt readout of the sweep rate selected.

Sweep Rate— 0.1 μ 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 graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmag	nified	Magnified				
	+15°C to +35°C		+15°C to +35°C	0°C to +50°C			
1 s/div to 0.5 μs/div	3%	4%	4%	5 .5%			
5 s/div and 2 s/div,							
0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%			

TRIGGERING

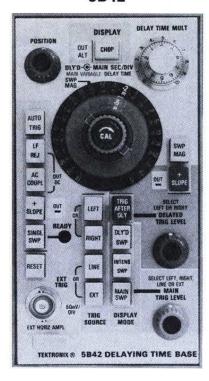
Coupling	Frequency Range	Minimum Signal Required						
	50	Int	Ext					
Dc	Dc to 10 MHz 10 MHz to 60MHz	0.4 div 1.0 div	60 mV 150 mV					
Ac	Trigger requirer below 50 Hz.	ments increa	ise					
Lf Rej	Trigger requirer below 7.5 kHz.	ments increa	ise					
Hf Rej	Trigger requirer above 50 kHz.	ments increa	ıse					

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

External Trigger Input-Max input voltage is 350 V dc + peak ac, 350 V p-p ac at ≤ 1 kHz. Input R and C is 1 $M\Omega$ paralleled by approx 24 pF. Trigger level range is $\geq \pm 1.5 \text{ V}$.

External Horizontal Input-Deflection factor is 50 mV/div $\pm 3\%$. Input R and C is 1 M Ω paralleled by approx 24 pF. Dc coupled bandwidth is dc to \leq 2 MHz. The ac coupled lower response is \leq 50 Hz. Max input voltage is 350 V (dc + peak ac) or 350 V p-p ac at \leq 1 kHz.

5B42





10 ns/div to 5 s/div Calibrated Time Base Single-Sweep Operation Triggering to 60 MHz

The 5B42 Delaying Time Base is designed specifically for use with 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.

Sweep Rate— 0.1 μ 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 the X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy-Measured over the center 8 div.

Time/Div	Unmag	nified	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 μs/div	3%	4%	4%	5.5%				
5 s/div and 2 s/div,								
0.2 μ s/div and 0.1 μ s/div	4%	5%	5%	6.5%				

TRIGGERING

Coupling		Frequency Range	Minimum Signal Required		
		**	Int	Ext	
Dc	5400 ampl 5400 ampl 5100 ampl	Dc to 10 MHz 10 MHz to 60 MHz Dc to 2 MHz	1.0 div	100 mV 400 mV 100 mV	
Ac		Requirements increase below 50 Hz.			
Ac Lf Rejection		Requirements incre	ase		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

External Trigger Input-Max 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 CHARACTERISTICS

Delay Time Multiplier Range-0.2 to 10 times the TIME/DIV setting.

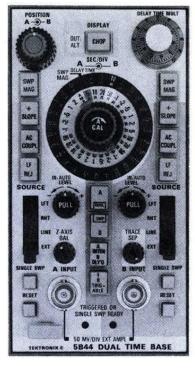
Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 μ s to 0.5 s delay time. Within 2% plus 0.2% of full scale for 1 s to 5 s delay time.

Jitter-Less than 0.05% of the time represented by one div of delaying sweep selected.

5B31



5B44



DELAYED SWEEP

Sweep Rate— 0.1 μ 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.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
0.1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
0.5 s/div to 0.2 s/div,	4%	5%	5%	6.5%
$0.2 \mu\text{s/div}$ and $0.1 \mu\text{s/div}$				

TRIGGERING

Coupling		Frequency Range	Min Signal Required Int	
Dc	5400 ampl	Dc to 10 MHz	0.4 div	
	5400 ampl	10 MHz to 60 MHz	1.0 div	
	5100	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.

5B31

Jitter-Free Digital Delay Delay by Time or Events 20 ns/div Sweep Rate

Crt Readout

The 5B31 Digitally Delayed Time Base features easy and accurate operation. It adds digital delay to the 5400-Series Oscilloscopes, and may be used only in a 5400-Series Mainframe.

The 5B31 can be used in many applications that call for accurate time delays and/or jitter-free displays, such as analyzing highjitter digital data or machinery controls or production line testing. Its simple operation is helpful in production and education environments.

The 5B31 can delay by time or by events, and its digital delay system eliminates most inherent delay jitter. The delay mode is selected by pushbutton: the highly accurate delay time (from 1 μ s to 99,999 μ s) or the number of events (up to 99,999) is clearly displayed on thumbwheel dials.

CHARACTERISTICS

Sweep Rate— $0.2 \,\mu s/div$ to $5 \, s/div$ in 24 calibrated steps (1-2-5 sequence). 20 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

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
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div, 2 s/div, and 0.2 us/div	4%	5%	5%	6.5%

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

TRIGGERING

Coupling	Amplifier Type 5400 Plug-ins	Frequency Range	Minimum Signal Required	
Dc		Dc to 10 MHz	Int 0.4 div	Ext 100 mV
		10 MHz to 35 MHz	1.0 div	400 mV
		35 MHz to 60 MHz	2.0 div	600 mV
	5100 Plug-ins	Dc to 2 MHz	0.4 div	
Ac		Requirements 50 Hz.	nts incre	ase below

External Trigger Input—Max 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 Ω within 2%, approx 24 pF. Trigger level range is at least ± 2.0 V.

DELAY BY MICROSECOND

Delay Range— 0 to 99,999 μs in 1- μs steps.

Differential Time Measurement Accuracy—Within 2 parts in 10⁵ plus 1 part in 10⁵ per month.

Jitter—Less than $10 \text{ ns} + 1 \text{ part in } 10^7 \text{ of selected delay.}$

DELAY BY EVENTS

Delay Range- 1-event steps from 0 to 99,999.

Triggering—Dc coupled from left vert only. Separate slope and level controls provided.

Amplifier Type	Frequency Range	Minimum Signal Required
5400	Dc to 10 MHz	0.4 div
5400	10 MHz to 20 MHz	1.5 div
5100	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.

DELAYED GATE OUT

Amplitude—Approx 2.5 V from $50-\Omega$ source will drive one standard TTL load. Rises at end of delay, falls at end of sweep.

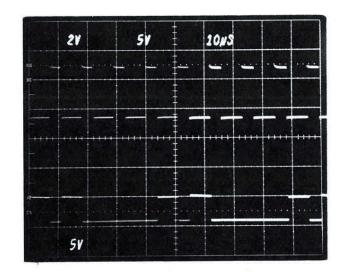


Figure 1. The above waveform shows a pre-set delay of 5 events such that the intensified zone starts on the 6th event.

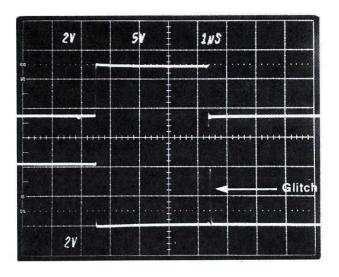


Figure 2. By triggering on a specific event, you can locate a glitch in a waveform. The above photo shows the same waveform as in Figure 1 triggered on the 5th event. Now you can locate the glitch that occurs on the falling edge of the above waveform.

5B44

Two Independent Sweeps

5 ns/div Sweep Rates

Dual Sweep by Sweep Switching Techniques

Crt Readout

The 5B44 Dual Time Base brings fast (5 ns/div) dual sweep display capability to 5400-Series Mainframes.

Sweep switching techniques enable both sweeps to be viewed at the same time. For example, in the "A" intensified, "B" delayed mode, both the intensified and the delayed waveforms are presented at full screen width, with independent control of horizontal and vertical positioning.

Versatile and symmetrical triggering controls let you independently select A and B sweep trigger sources from either left hand or center compartments, or from external inputs. For example, this feature lets you display two asynchronous signals, giving you almost two scopes in one.

The 5B44 also features crt readout and an edge lighted seconds/div selector switch.

CHARACTERISTICS

The following applies to both A and B sweeps and triggering circuits, unless otherwise noted.

Sweep Accuracies—Measured over the center 8 div for A and B sweeps.

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 μs/div	3%	4%	4%	5.5%
2 s/div and 0.2 μs/div to 100 ns/div	4%	5%	5%	6.5%
50 ns/div	4%	5%	6%	7%

Sweep Rate— 50 ns/div to 2 s/div in 25 calibrated steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 magnifier. Uncalibrated, continuously variable between steps up to 5 s/div (A sweep only).

TRIGGERING

Coupling	Triggering	Minimum Signal Required		
	Frequency Range	Int	Ext	
Dc	Dc to 10 MHz 10 MHz to 60 MHz	0.4 div 1.0 div	100 mV 400 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 triggering, sweep generator produces one sweep. Single sweep on both A and B sweep.

External Trigger Input—Max 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 Ω within 2%, paralleled by approx 26 pF. Trigger level range is at least ± 2 V. External trigger inputs on both A and B sweep.

EXTERNAL HORIZONTAL INPUTS

Deflection Factor— 50 mV/div ±3%.

Input R and C — 1 M Ω ± 2% paralleled by \simeq 26 pF.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

DELAYING SWEEP CHARACTERISTICS

Delay Time Multiplier Range— X0.2 to X10 the A sweep TIME/DIV setting.

Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 μ s to 1 s of A sweep rate setting. Within 2% plus 0.2% of full scale for 2 s/div.

Jitter—Less than 0.05% of the delaying sweep TIME/DIV.

ORDERING INFORMATION

5B40 Time Base\$38	0
5B42 Delaying Time Base\$69	5
5B31 Digitally Delayed Time Base \$64	5
5B44 Dual Time Base \$89	5

Low Cost

Dc to 2 MHz

Sampling to 1 GHz

Choice of 16 Plug-ins

Rear Panel Signal Outputs Optional

5110

The 5110 is a single-beam nonstorage oscilloscope featuring a large $6\frac{1}{2}$ " diagonal (1.27 cm/div) crt.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μ V/div), four-channel differential at 50 μ 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 timebase 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.

5111

The 5111 is a single-beam, split-screen, bistable storage oscilloscope with a large-screen, 6½" diagonal (1.27 cm/div) display.

The 5111 extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography.

The 5111 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 timebase plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

 ${\bf Crt}$ — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

Max Stored Writing Speed — At least 20 div/ms.

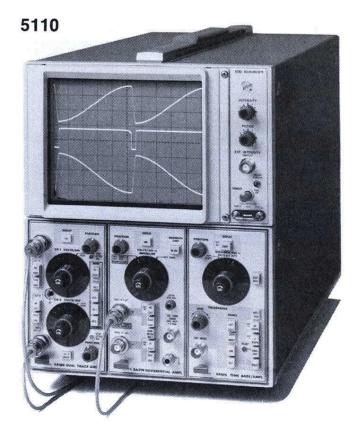
Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — Approx 250 ms.

5112

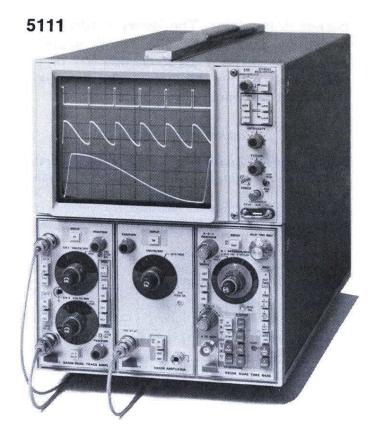
The 5112 is a dual-beam nonstorage oscilloscope featuring two independent vertical systems referenced against a common horizontal deflection system.

The 5112 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.



Lowest cost single-beam nonstorage oscilloscope with plug-in configurability

8 channels at 1 mV/div, 4 channels at 50 μ V/div, 2 channels at 10 μ V/div, with appropriate amplifiers



Single-beam storage oscilloscope Bistable, split-screen display Stored writing speed \geq 20 div/ms Storage view time up to 10 hrs at reduced intensity

When teamed up with the appropriate differential amplifiers, the 5112 can display up to four channels of high-gain (50 μ V) differential information for use in the biophysical, electromechanical, and component testing fields.

CRT AND DISPLAY FEATURES

 \mathbf{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.

5113

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 (Option 03 provides 200 div/ms for the center 6 x 8 div). View time is at least 1 hr at normal intensity and can be increased to 10 hr 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.

Max Stored Writing Speed — At least 20 div/ms. At least 200 div/ms at lower stored brightness (over center 6 x 8 div) with Option 03.

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 ms.

Option 03 Fast Writing Speed Crt — Increases stored writing speed to 200 div/ms (center 6 x 8 div).

5115

The 5115 is a single-beam bistable storage oscilloscope with a writing speed of at least 200 div/ms in the normal mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage view time is at least 1 hr at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hrs at reduced intensity, after which time intensity may be increased to original level. Variable brightness also gives optimum photographic results and allows for the integration of multiple traces.

The 5115 is useful in a wide variety of fields, including education, biophysical engineering, component testing, and industrial electronics.

When using two amplifiers and a dual timebase 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.

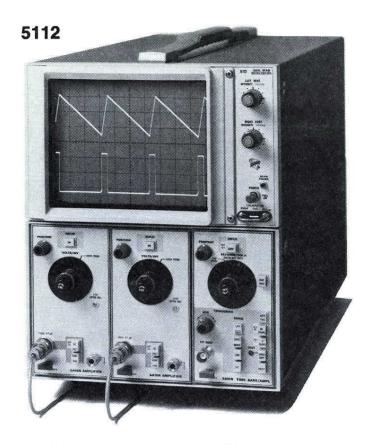
Phosphor — Similar to P1.

Max Stored Writing Speed — At least 200 div/ms in the normal mode and 800 div/ms in the enhanced mode.

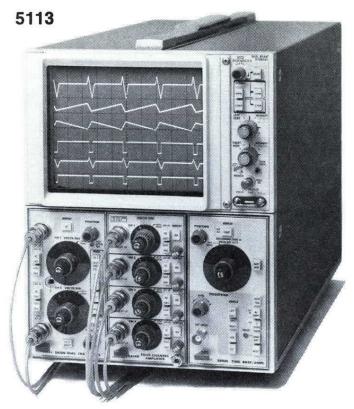
Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — Approx 250 ms.

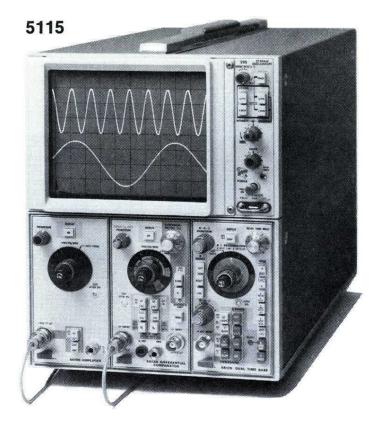
^{*}Illuminated graticule available at extra cost. Contact your local Tektronix Field Engineer.



Dual-beam nonstorage oscilloscope
Two independent vertical systems
Common horizontal deflection system
Can display two single-shot signals
without time-sharing, or up to eight
signals in the CHOP mode



Dual-beam bistable storage oscilloscope Same features as 5112, plus split-screen storage. Stored writing speed \geq 20 div/ms, on \geq 200 div/ms with Option 03



Single-beam bistable storage oscilloscope Fastest stored writing speed in the 5100-Series line:

- \geq 200 div/ms in normal mode
- > 800 div/ms in enhanced mode

Storage view time up to 10 hrs at reduced intensity

NEW FOR 1978

Rear Panel Signal Outputs, an optional feature for all 5100-Series Mainframes.

COMMON CHARACTERISTICS

for 5110, 5111, 5112, 5113, 5115 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 max.

Chopped Mode — (5110, 5111, 5115) 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 $\simeq 5~\mu s$, consisting of $\simeq 3~\mu s$ displayed, $\simeq 2~\mu s$ blanked. Chop or alternate mode is selected at the time base unit.

Chopped Mode — (5112, 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 $\simeq 5~\mu s$, consisting of $3\mu s$ displayed, $\simeq 2~\mu s$ blanked. Chop or alternate mode is selected at the time base unit.

Alternate Mode — (5110, 5111, 5115) 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 — (5112, 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 μ s/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode — Phase shift within 1° from dc to 100 kHz.

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 Ω .

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.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics valid from 0°C to +50°C.

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac $\pm 10\%$; (Except that max input should not exceed 250 V ac.) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Typical Power Consumption — For 5110, 53 W. For 5111, 74 W. For 5112, 67 W. For 5113, 88 W. For 5115, 74 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 k Ω paralleled by approx 40 pF. Max input ± 50 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.

ORDERING INFORMATION

(Plug-ins not Included)

												150							
Cabinet Model 5110 Oscilloscope	•	•	•	•		•			•	٠		•	•	•	•	•	. \$	77	5
5111 Oscilloscope	•		٠	•	•	•	٠		•						•		\$1	40	0
5112 Oscilloscope			•				•	٠	٠			•			٠		\$1	30	0
5113 Oscilloscope	•	•	•		•	•	•	٠	٠	•	٠	•			/(*)		\$1	92	5
5115 Oscilloscope			٠	•				•		٠	•	٠	٠	•	٠	•	\$1	47	5
Rackmount Model																			
R5110 Oscilloscope	•			•		•	•			٠	•	•	•		•		. \$	82	5
R5111 Oscilloscope	•	•	•			•				٠				٠	٠		\$1	45	0
R5112 Oscilloscope	•	٠	٠														\$1	35	0
R5113 Oscilloscope	•		•	٠	٠	•		٠			٠				•		\$1	97	5
R5115 Oscilloscope		٠	•	٠			٠		٠	•		•			٠		\$1	52	5

OPTIONS

	OPTIONS
Only) - The	Protective Panel Cover (Cabinet Models cover protects the front panel and knobs portation and storage
Option 03	Fast Writing Speed Crt (5113, R5113 Only)
	Add Rear Panel Signals Out (All
	Phosphor (5110, R5110, 5112, R5112
Option 78 I Only)	P11 Phosphor (5110, R5110, 5112, R5112

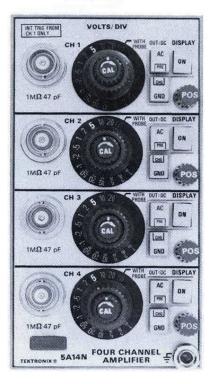
CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit,

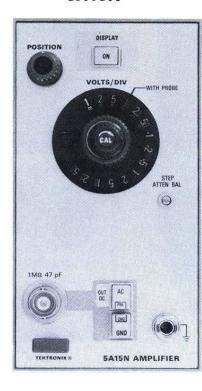
Orger	040-0583-02	• • •			• •				•	• •		• •		٠.	. \$95
Rackn	nount-to-Cabi	net	Con	ve	rsi	on	K	it,							
Order	040-0584-03										٠.		•	٠.	. \$75
Protec	ctive Panel Co	ver	Kit,	6											
Order	040-0620-00														. \$22

For Recommended Cameras — See camera section, page 225.

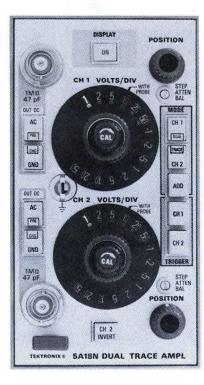
5A14N



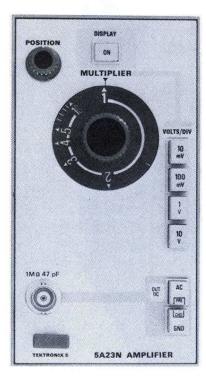
5A15N



5A18N



5A23N



5A24N



5A14N

1 mV/div to 5 V/div

The 5A14N Four-Channel 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 one 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 to 12.5 V/div.

Input R and C — 1 M Ω within 1%, approx 47 pF.

Max 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.

5A15N

1 mV/div to 5 V/div

The 5A15N Single-Channel Amplifier features easy to use front-panel controls and can be used in any 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 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 M Ω within 1%, approx 47 pF.

 ${f Max\ Input}$ — Dc coupled, 350 V (dc + peak ac). Accoupled, 350 V dc.

5A18N

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 one or two only, channels one and two added, channel two inverted and channel one alternated or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

CHARACTERISTICS

Bandwidth — Dc coupled, dc to at last 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 M Ω within 1%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Accoupled, 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A23N

10 mV/div to 10 V/div Calibrated Deflection Factors

The 5A23N is a general-purpose amplifier for the 5000-Series Oscilloscopes. Featuring low cost 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 Mainframes for Y-T displays, or in the right compartment for X-Y displays.

Bandwidth — Dc coupled, dc to at least 1.5 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 1.5 MHz at all deflection factors.

Deflection Factor — 10 mV/div to 10 V/div within 3% in 4 calibrated decade steps. A lighted multiplier control provides continuous variation between steps, and extends the deflection factor range to 100 V/div. Accuracy is within 5% at X2 and X5 multiplication.

Input R and C — 1 M Ω within 1%, approx 47 pF.

Max Input — 350 volts (dc + peak ac).

5A24N

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% in soldering pad matrix for use by the customer who wishes to build his own input circuits for special applications. Customerbuilt circuits are powered through the circuit board which provides access to all mainframe power supplies.

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 midattenuator 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 — Approx 100 k Ω , approx 30 pF.

Max Input — 50 volts (dc +peak ac).

ORDERING INFORMATION

5A14N Four-Trace Amplifier\$820
5A15N Single-Trace Amplifier\$190
5A18N Dual-Trace Amplifier \$415
5A23N Single-Trace Amplifier \$160
5A24N Single-Trace Amplifier \$95

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 plugin amplifier for the 5000 Series. It incorporates a number of performance features that makes it particularly versatile, especially in multitrace combination with other 5000-Series Amplifier Plug-ins. The following operational areas describe the functions of the 5A13N.

Conventional Mode — As a conventional amplifier, 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 — As a differential amplifier, 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 — As a comparator amplifier, the 5A13N uses its differential capabilities, but 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 max 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 M Ω , approx 51 pF.

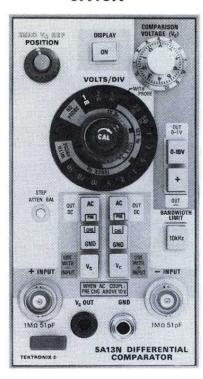
Signal Range

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	±350 V
Max Ac Coupled Input (Dc Voltage)	±3	50 V

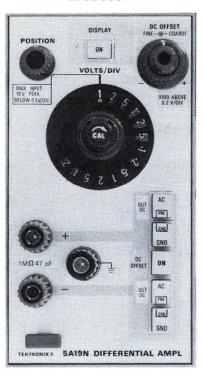
Max Input Gate Current — 0.1 nA or less (equivalent to 100 μ V or less, depending on external loading) at 25°C.

Overdrive Recovery — 1 μ s 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.

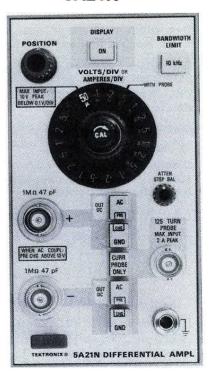
5A13N



5A19N



5A21N



Internal Comparison Voltage — Ranges, 0 V to \pm 10 V and 0 V to \pm 1 V. Accuracy, within 0.2% of dial setting plus 5 mV from \pm 1 V to \pm 10 V; within 0.2% of dial setting plus 1 mV from \pm 25 mV to \pm 1 V on the 0 V to \pm 1 V range. From 0 V to \pm 25 mV, use the on-screen display for greater resolution. Vc output R, approx 15 k Ω .

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 Hz. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

5A13N Differential Comparator Amplifier\$720

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.

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 M Ω within 0.3%, approx 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
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	± 38	50 V
Max Ac Coupled Input (Ac Voltage)	± 38	50 V
Dc Offset 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.

5A19N Differential Amplifier \$235

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 μ V/div, dc coupled differential amplifier for the 5000 Series. The 5A21N has a current probe input.

VOLTAGE CHARACTERISTICS

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 μ 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.

Input R and C — Voltage mode, 1 M Ω within 0.15%, approx 47 pF.

Max 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
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 μ V or less, depending on external loading), at 25°C.

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio — Ac coupled, 50 μ 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 at 50 μ V/div and 100 μ V/div with up to 20 V p-p sine wave, decreasing by less than 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.

Additional information on following page.

CURRENT PROBE INPUT CHARACTERISTICS (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.

Max Input Current — 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise — 300 μ A or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to ± 50 °C.

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 Field Engineer for details.

5A22N

Dc-to-1 MHz Bandwidth 10 μV/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 lowamplitude, low-frequency areas.

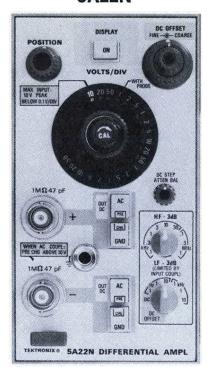
CHARACTERISTICS

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 μ 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 μ 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 μ V/div to 100 μ V/div with up to 20 V p-p sine wave, decreasing by less than 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.

5A22N



Signal and Offset Range

Deflection Factor Settings	10 μ V 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)	±12 V	± 350 V		
Max Ac Coupled Input (Dc Voltage)	±350 V Dc rejection, at least 4 x 10 ⁵			
Dc Offset Range	+0.5 V to -0.5 V	+50 V to 50 V		

Input R and C — 1 M Ω within 0.15%, approx 47 pF.

Overdrive Recovery — 10 μs 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.

Max Input Gate Current — 200 pA or less.

Displayed Noise — 20 μV at max bandwidth, source resistance 25 Ω or less, measured tangentially.

Drift with Temperature — 100 μ V/°C or less.

5A22N Differential Amplifier\$615

5A26

Two Differential Amplifiers in One Plug-In 50 μ V/div Sensitivity at 1 MHz

100,000: 1 Cmrr

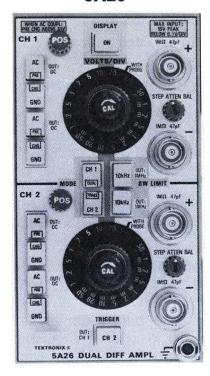
Crt Readout

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 μ 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.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

5A26



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 μ 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 Ω within 0.15% paralleled by approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 10 V peak ac
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 μ V or less, depending on external loading) at

Displayed Noise — 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio

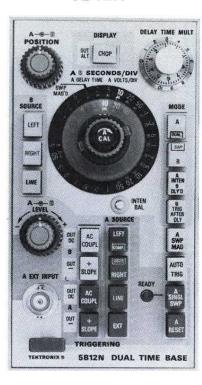
Dc Coupled 50 µV/div to 50 mV/div	At least 100,000:1 from do to 30 kHz with up to 20 V p-p sine wave							
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sine wave							
Ac Coupled 50 μV/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz							
With 2 P6062A Probes	400:1 at 10X probe atten- uation							

5A26 Dual Differential Amplifier \$635





5B12N



5B13N



5B10N

100 ns/div to 5 s/div Calibrated Time Base Single Sweep

Direct Readout X10 Mag

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.

Triggering the 5B10N is straightforward even with the many triggering modes which are pushbutton selected. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line, and external.

CHARACTERISTICS

Sweep Rates — 1 μ 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% at 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
DC	External	200 mV	200 mV
Ac	Requ	uirements increas	se 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 - Max input is 350 V (dc + peak ac). Input R and C is 1 M Ω 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 Ω within 2%, approx 70 pF.

Max Input Voltage — 350 V (dc + peak ac).

ORDERING INFORMATION

5B10N	Time	Base	/Amp	lifier	٠	 		\$290
5B12N	Dual	Time	Base			 		\$620
5B13N	Time	Base				 		\$155

5B12N

100 ns/div to 5 s/div Calibrated Time Base **Dual and Delayed Sweep Direct Readout X10 Mag**

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 μ 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 µs/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 μ s/div to 0.5 s/div in 20 calibrated steps.

B Sweep Accuracy — Within 3% from 1 μ s/div to 0.1 s/div. Within 4% at 0.2 μ s/div, 0.5 μ 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	Requ	uirements increa	se 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

Single Sweep — Same as for ac and dc coupled.

External Trigger Input - Max input voltage is 350 V (dc + peak ac). Input R and C is 1 M Ω within 2% paralleled by approx 70 pF. Trigger level voltage range is +5 V to -5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Accuracy — 1 μ 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 μ s to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay

Jitter - Less than 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 Ω within 2%, approx 70 pF.

Max Input Voltage — 350 V (dc + peak ac).

5B13N

1 μ s/div to 100 ms/div Calibrated Time Base External Horizontal Input

The 5B13N is a low-cost, general-purpose time base for 5000-Series Oscilloscopes. The 5B13N suits applications such as basic laboratory use by students, production testing, scientific research, and others.

CHARACTERISTICS

Sweep Rates - 1 µs/div to 100 ms/div within 5% in 6 calibrated decade steps. A lighted multiplier control provides continuous, uncalibrated variation between steps and extends the pushbutton-selected rate to at least 1 s/div.

TRIGGERING

Coupling		Sensitivity and Frequency Range
Ac	Int	0.4 div from 50 Hz to 100 kHz, increasing to 1 div at 1 MHz
	Ext	200 mV from 50 Hz to 1 MHz

External Trigger Input — Max input voltage is 200 V (dc + peak ac). Input R and C is approx 100 k Ω paralleled by approx 1000 pF. Trigger-level voltage range is +1.5 V to -1.5 V.

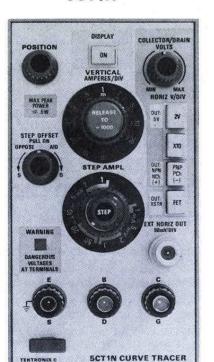
EXTERNAL HORIZONTAL INPUT

Deflection Factor — 50 mV/div, accurate to within 5%. A continuously variable deflection factor multiplier provides variation between 50 mV/div and 0.5 V/div.

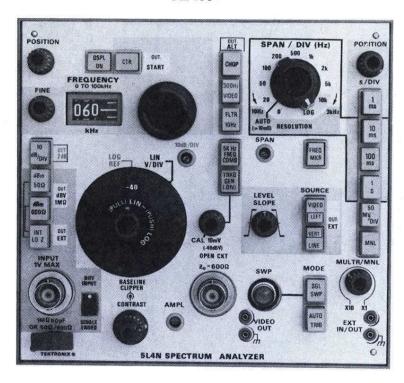
Bandwidth — Dc to at least 100 kHz.

Input R and C — Approx 50 k Ω paralleled by 1000 pF. Max Input Voltage — 200 V (dc + peak ac).

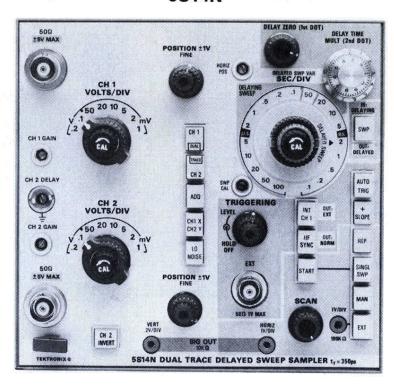
5CT1N



5L4N



5S14N



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 212.

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 186.

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.

AMPLIFIER CHARACTERISTICS

Modes — Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 vertical (Y), Channel 2 horizontal (X).

Input Impedance — Nominally 50 Ω .

Bandwidth - Equivalent to dc to 1 GHz.

Rise Time - 350 ps or less.

Step Aberrations — +2%, -3%, total of 5% p-p within first 5 ns, $\pm 1\%$ 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 $\pm 3\%$.

 ${\bf Max\ Input\ Voltage --} \pm 5\ {\bf V}.$

Input Signal Range — 2 V p-p max 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-k Ω source resistance.

Channel Delay Difference — Adjustable to zero or for any time difference up to at least 1 ns.

TIME BASE CHARACTERISTICS

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 ten div of the Delaying Sweep selected.

Horizontal Signal Output — 1.0 V per div of horizontal deflection; 10-k $\!\Omega$ source resistance.

DELAYING SWEEP CHARACTERISTICS

Range — 10 ns/div to 100 μ s/div in 13 steps (1-2-5 sequence).

Accuracy — Within $\pm 3\%$ excluding first $\frac{1}{2}$ 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 ten div of the Delaying Sweep selected.

Delay Accuracy — Within $\pm\,1\%$ of ten div when measurement is made within the last 9.5 div.

DELAYED SWEEP CHARACTERISTICS

Range — 100 ps/div to 100 μ s/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within $\pm 3\%$ excluding first ½ 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—Less than 0.05% of the time represented by 1 div of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

Signal Source — Interval from channel 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μ s or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave 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 approx 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 sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

5S14N Sampler\$2325

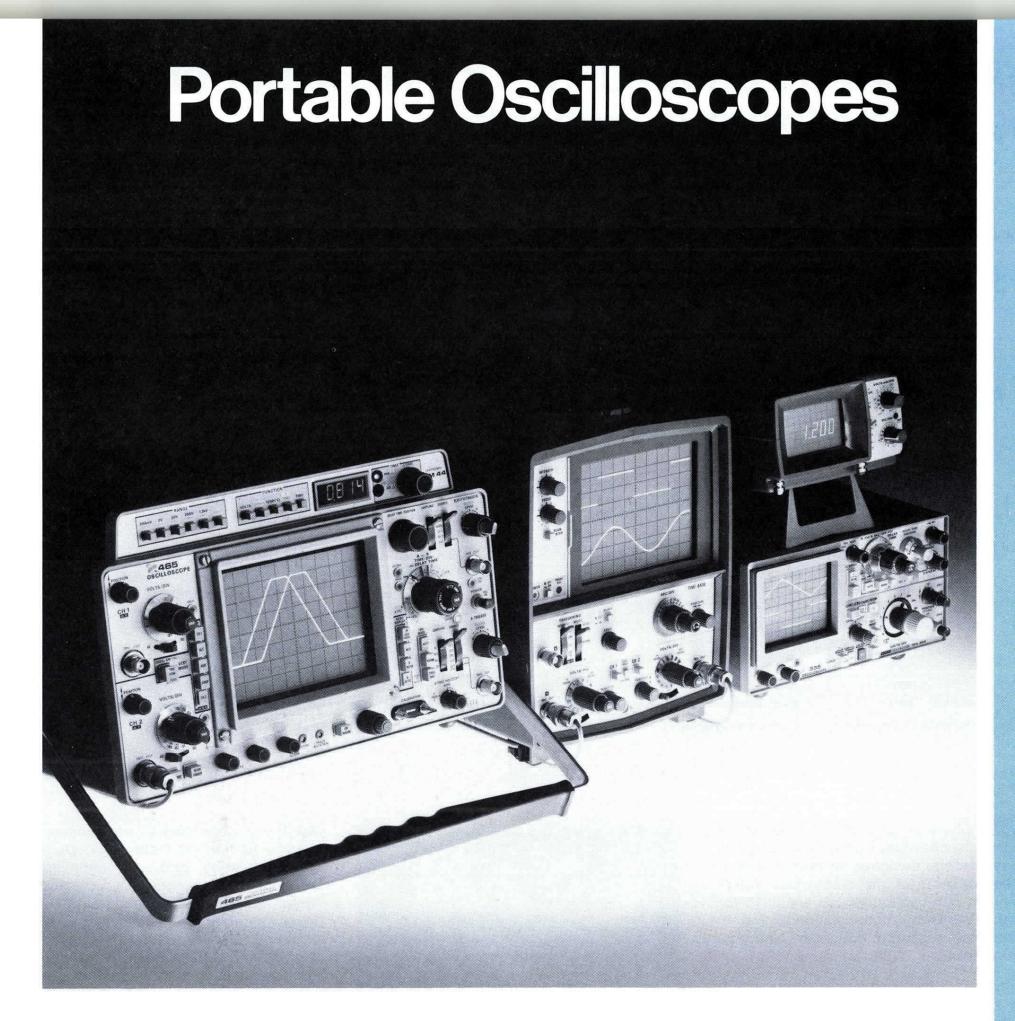


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Here's how to choose the TEKTRONIX Portable that's right for your application.

For Accuracy and Versatility in the Field, Take One of Our 22 Portable Oscilloscopes.

	Product	Bw	Dual Trace	Delayed Sweep	Fastest Sweep Rate	Other Special Features	Price
Storage Models	466	100 MHz @ 5 mV/div	yes	yes	5 ns/div	3000 div/μs stored writing speed	\$4895
	464	100 MHz @ 5 mV/div	yes	yes	5 ns/div	110 div/μs stored writing speed	4120
	434	25 MHz @ 10 mV/div	yes		20 ns/div	Split-screen storage	3245
	314	10 MHz @ 1 mV/div	yes		100 ns/div	Only 10.5 lbs (4.8 kg)	2385
	214	500 kHz @ 10mV/div	yes		1 μs/div	Only 3.5 lbs (1.6 kg)	1520
	T912	10 MHz @ 2 mV/div	yes		50 ns/div	Low-cost bistable storage	1350
Nonstorage Models	485	350 MHz @ 5 mV/div	yes	yes	1 ns/div	Widest bw in a portable	5225
	475A	250 MHz @ 5 mV/div	yes	yes	1 ns/div	High-performance 250-MHz portable	3555
	475	200 MHz @ 2 mV/div	yes	yes	1 ns/div	Highest gain-bw in a portable	3195
	465	100 MHz @ 5 mV/div	yes	yes	5 ns/div	Cost effective for 100-MHz bw	2295
	465M	100 MHz @ 5 mV/div	yes	yes	5 ns/div	Triservice standard 100-MHz scope	2345
	455	50 MHz @ 5 mV/div	yes	yes	5 ns/div	Cost effective for 50-MHz bw	1850
	335	35 MHz @ 10 mV/div	yes	yes	20 ns/div	Only 10.5 lbs (4.8 kg)	1925
	326	10 MHz @ 10 mV/div	yes		100 ns/div	Internal battery	2180
	323	4 MHz @ 10 mV/div			500 ns/div	Only 7 lbs (3.2 kg)	1445
	221	5 MHz @ 5 mV/div			100 ns/div	Only 3.5 lbs (1.6 kg)	1025
	213	1 MHz @ 20 mV/div			400 ns/div	DMM/Oscilloscope @ 3.7 lbs (1.7 kg)	1520
	212	500 kHz @ 10 mV/div	yes		1 μs/div	Low cost for dual trace & battery	1080
	T935A (New)	35 MHz @ 2 mV/div	yes	yes	10 ns/div	Variable trigger-holdoff and differential	1435
	T932A (New)	35 MHz @ 2 mV/div	yes		10 ns/div	Delayed sweep and differential	1155
	T922	15 MHz @ 2 mV/div	yes		20 ns/div	Low-cost dual-trace scope	850
	T922R	15 MHz @ 2 mV/div	yes		20 ns/div	Rackmount version of T922	1220
	T921	15 MHz @ 2 mV/div			20 ns/div	Lowest-cost TEKTRONIX Portable	695
Time Interval Readout	DM44	Optional, factory-installed, o	lirect numerical read	dout of time intervals a	and DMM functions for the	464, 465, 466, 475, and 475A	445

^{*}U.S. sales prices are F.O.B. Beaverton, OR. For price and availability outside the United States, please contact the nearest Tektronix Field Office, Distributor or Representative. Prices are subject to change without notice.

Tektronix offers an unmatched selection of 22 portable oscilloscopes, including six storage models, designed to meet the testing requirements of the electronics industry. These high-quality scopes are used for computer servicing, communication system maintenance, research, education, and production testing.

Your specific measurement needs should guide you in selecting the TEKTRONIX Portable that's best for you. First consider your performance, price, and weight requirements. Then choose a model from one of our four oscilloscope lines. Each combines portability, reliability, and ruggedness with unique features and capabilities.

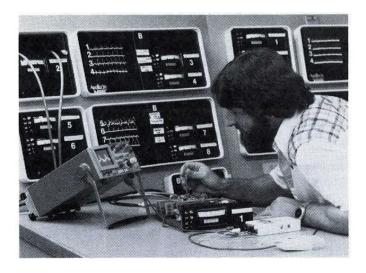


400-Series Performance Leaders

Take lab quality into the field with TEK-TRONIX 400-Series Portable Oscilloscopes. Choose from nine models, including the 350-MHz 485, the widest bandwidth portable available today and the 100-MHz High-Speed Storage 466 with a 3000 div/ μ s (1350 cm/ μ s) stored writing speed.

All these instruments are backed by exclusive IC and crt technology, years of reliability testing, and our continuing commitment to excellence in scope design. All weigh less than 26 pounds (11.8 kg). Various models feature bandwidths from 25 MHz to 350 MHz, dual trace, delayed sweep high-speed storage, external trigger view, graticule illumination, variable-trigger holdoff, and optional battery power with the 1106 Clip-on Battery Pack (when the scope is ordered with Option 07). For easy operation, all have color-coded controls and an automatic volts/div readout (except for the environmentalized 465M). There's even the DM 44 Option, a direct numerical readout available on five models for simple, quick, and highly-accurate differential-time and DMM measurements.

Take advantage of the 400-Series' unique features for your computer servicing, point-of-purchase terminal repair, and communication system maintenance applications. Or use one of the 400-Series Scopes in its rackmount version for your in-plant service or production testing work. Descriptions of these nine lab-quality models begin on page 100.

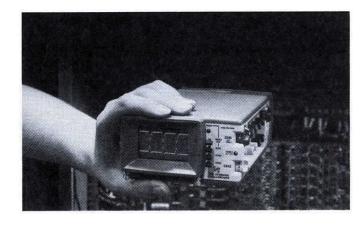


300-Series Portables—Excellent Size/Weight/Performance Combinations

SONY/TEKTRONIX 300-Series Oscilloscopes demonstrate that a precision scope can weigh less than 11 pounds (5.0 kg) and still contain many of the high performance capabilities found on our 400-Series Portables. This family features bandwidths from 4 MHz to 35 MHz, long-term storage, delayed sweep, battery operation and low-power consumption.

SONY/TEKTRONIX builds these portables tough to withstand the strains of high altitude and extreme humidity. Two models are especially designed for severe environments and meet the MIL-Std-202C, Method 106B test for humidity.

Take one of our four 300-Series Scopes with you for servicing medical electronics, on-board ship equipment, or remote computer terminals—wherever light-weight, medium-size scopes are required. Detailed specifications start on page 112.



200-Series Miniscopes

Have you ever tried carrying an oscilloscope up a ladder and across a catwalk in a processing plant? Or wished that the offshore platform had a nearby ac power outlet? Then you know that for many oscilloscope applications, light weight and battery operation are absolute necessities.

Introducing the TEKTRONIX 200-Series Miniscopes. Powered by rechargeable, internal NICAD batteries or external ac, and weighing less than 3.7 pounds (1.7 kg) each, these four instruments offer solutions to your measurement requirements that you can hold in the palm of your hand.

We designed the 200 Series for portability and ease-of-operation. Then we added the features most useful for remote servicing. Bandwidths range from 500 kHz to 5 MHz. One model, the 214, offers storage capabilities, and another, the 213, combines scope and DMM functions.

Attached color-coded probes and cable storage compartments facilitate scope set-up and operation. Simplified slope and triggering controls make one-hand operation easy. Included neck straps free your hands for other tasks. Rugged impact-resistant cases on these double-insulated instruments afford shock protection and make floating measurements possible. Their 6 x 10 division (0.5 cm/div) crts are easy to read. And with their small, 3 x 5.25 x 9.50 inch (7.6 x 13.2 x 22.6 cm) size, each 200-Series Miniscope fits easily into your briefcase or toolbox.

Examine the features of the four 200-Series models beginning on page 117. We think you'll find that these oscilloscopes really are the perfect traveling companions.



T900-Series Low-Cost Oscilloscopes

T900-Series Oscilloscopes combine low cost with Tektronix quality and reliability. Choose from five bench-top models and one rackmount. And new this year are the T932A and T935A which add even more features to the T900 Series. Bandwidths range from 10 MHz to 35 MHz. Family capabilities include dual trace, delayed sweep, variable-trigger holdoff and bistable storage—all at a price your instrumentation budget will appreciate.

We built several features into all our T900 scopes that make them ideal for education, production testing, consumer electronics repair, and general service applications. Their large, bright, 8 x 10 cm crts are especially useful during classroom demonstrations. Simple control design and colorcoded front panels make teaching scope operation fast and easy. For television repair, ty triggering capabilities are standard on the non-storage models. At 18 pounds (8.2 kg) or less, the five bench-top models are light-weight, rugged and easy to transport. And to make the price even more attractive, we include 10X attenuation probes with these five scopes.

The T900-Series design focuses on reliability and ease-of-operation. All critical active components are pretested to insure high reliability. Modular circuitry simplifies calibration and repair. A beam finder helps you locate the trace. An external graticule eliminates parallax errors in crucial measurements. And built-in delay line lets you see the leading edge of the signal.

To increase the capabilities of your T900 Instrument while still keeping it a truly low-cost portable, we've developed an inexpensive line of accessories like the C-5B Camera, modular probes, a dust cover and a viewing hood. Accessories begin on page 128. T900 Specifications start on page 122.

Accessories to complete Your Oscilloscope System

Extend your measurement capabilities with TEKTRONIX Probes, Cameras, Battery Packs and SCOPE-MOBILE® Carts.

A complete line of voltage, current, temperature, FET, and logic probes are designed to work efficiently with your TEKTRONIX Oscilloscope. Scope cameras let you record the results of your work. Two battery packs can power your oscilloscope where line power isn't available. And a SCOPE-MOBILE® Cart makes transporting your test equipment easy.

Recommended probes, cameras carts and accessories are included in the ordering information for each oscilloscope. For complete information on battery packs, see page 128. For all other accessories, page 225.

Here's the Person to Talk to.

Your Tektronix Field Engineer, Distributor or Representative doesn't expect you to base your portable scope selection on a lot of verbiage. Your applications have to be satisfied. You want a demonstration of performance before you make a commitment. You want prices, hard specifications, a written quotation, and a taste of the quality services you'll receive. That's what he's there for. He's the person to see for accurate, reliable service instruments.

350 MHz Dual Trace Oscilloscope



350 MHz at 5 mV/div
1 ns/div Sweep Rate
3.0 div/ns Writing Speed
1 MΩ and 50 Ω Input Impedances
Input Protection 50 Ω Internal
Automatic Deflection Factor Readout

Pushbutton Ext Trigger View

Weighs Only 21 Lb

At just 21 pounds, the 1 ns/div dual-trace 485 is the only truly 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 3.0 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 M Ω). 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.

And 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 in singleshot 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 ground-based laser/radar acquisition system, the 485's alternate sweep switching mode proved an important factor.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth* and Rise Time — (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 ΜΩ	Dc to 250 MHz, 1.4 ns	Dc to 200 MHz, 1.8 ns

*Measured at -3 dB. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Lower -3 dB point, ac coupling 1X probe: 1 kHz or less for 50 $\Omega,$ and 10 Hz or less for 1 M $\Omega.$ 10X probe: 100 Hz or less for 50 $\Omega,$ and 1 Hz or less for 1 M $\Omega.$

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence), accurate $\pm 2\%$. 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), X-Y (Ch 1-Y and Ch 2-X), ADD (Ch 1 \pm 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 M Ω impedances are available at a single BNC connector by pushbutton selection.

 $50~\Omega$ $\pm 0.5\%;$ 1.15:1 or less from 20 mV/div to 5 V/div to 350 MHz, vswr 1.25:1 or less at 5 mV/div to 10 mV/div.

Input R and C — 1 M Ω ±1% paralleled by approx 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.

Max Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approx: 5 V rms continuous 0.1 watt-second for instantaneous voltages of 5 V to 50 V.		
	Ac Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.	
1 MO	Dc Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.	
1 ΜΩ	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 div

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 approx 4 div from the A sweep).

CALIBRATED SWEEP DELAY

Delay Time Range — 0 to X10 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	\pm (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 X10 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

Coupling		ling	To 50 MHz	To 350 MHz	
Dc	Internal External		0.3 div deflection 20 mV 1.5 div deflecti 100 mV		
Ac			Signals below 16 Hz are attenuated		
Ac	Lf	Reject	Signals below 16 kHz are attenua		
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 approx 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 \div 10.

A Sources — Internal, line, external, external ÷ 10.

 ${\bf B}$ Sources — B runs after delay time, internal, external, external \div 10.

External Inputs — R and C approx 1 M Ω paralleled by approx 20 pF. Max input voltage; 500 V (dc + peak ac), 500 V p-p to 1 kHz.

X-Y OPERATION

Full Sensitivity X-Y (Ch 1 Vert, Ch 2 Horiz) — 5 mV/ div to 5 V/div, accurate $\pm 2\%$. Y-axis bandwidth identical Channel 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 div display, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2 div increments. P31 phosphor standard; P11 optional without extra charge. 21 kV accelerating potential.

Photographic Writing Speed — At least 1.5 div/ns with standard P31 phosphor and at least 3 div/ns with optional P11 phosphor using the TEKTRONIX C-31R Camera and 3000 speed film.

Auto Focus — Automatically maintains beam focus for all intensity settings.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

Z-Axis Input — Rise time \simeq 15 ns. Input R \simeq 500 Ω . +0.2 V (dc to 20 MHz) decreases intensity. + 2 V (dc to 2 MHz) blanks max intensity trace.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Nonoperating: -35° C to $+75^{\circ}$ C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes. .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, ½ sine, 11-ms duration, 2 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 rise time (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%. Amplitude is 5 V \pm 0.5% into 1 M Ω and 0.5 V \pm 1% into 50 Ω (\pm 0.5%). Optional BNC accessory current loop provides 50 mA \pm 1%. Selectable repetition rates are 1 kHz and 1 MHz \pm 0.25%. Specifications apply over \pm 15°C to \pm 35°C range.

A Sweep Output — Open circuit, approx 10 V positivegoing sawtooth; into 50 Ω , approx 0.5 V.

A and B Gate Outputs — Open circuit, approx 4 V positive-going rectangular pulse; into 50 Ω approx 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 max power consumption at 115 V. Line frequency 48 to 440 Hz.

	Cab	inet	Rackmount	
Dimensions	in	cm	in	cm
Height	6.6	16.8	7.0	17.7
Width	12.0	30.5	19.0	48.3
Depth			18.0	45.7
(handle extended)	20.6	52.3		
(handle not extended)	18.5	47.0		
Weights (Approx)	lb	kg	lb	kg
Net (with accessories)	24	10.9		
Net (without accessories)	21	9.5	26.2	11.9
Shipping	33	15	54	24.5

INCLUDED ACCESSORIES

 $50-\Omega$, 18-inch BNC cable (012-0076-00), two BNC jack posts (012-0092-00), two $50-\Omega$ 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\$5225
R485 Oscilloscope,7 in rack model\$5350
485-1 or R485-1 Oscilloscope, without A Ext Trigger Display
485-2 or R485-2 Oscilloscope, without A Ext Trigger Display and with 50 Ω input only instead of selectable input
impedance Sub \$350

INSTRUMENT OPTIONS

Option 04	Emc Modification	Add \$40
Option 78	P11 Phosphor	No Charge

For more information on instrument options, see your Tektronix Field Engineer, Distributor, or Representative.

OPTIONAL ACCESSORIES

Probes -

	i i			Bandwidth*
Input Terminal	Probe Type	Attenua- tion	Input Impedance	with 485
	P6056 6 ft	10X	500 Ω 1 pF	350 MHz
	P6057 6 ft	100X	5000 Ω 1 pF	350 MHz
50 Ω	P6201	1X	100 kΩ 3 pF	220 MU-
	FET 2 Meter	10X Head	1 MΩ 1.5 pF	330 MHz
		100X Head	1 MΩ 1.5 pF	
50 Ω or 1 M Ω	P6202 2 Meter	10X 100X Head (optional)	10 MΩ 2 pF	285 MHz
	P6106 2 Meter	10X	10 MΩ 13 pF	250 MHz
1 MΩ Input	P6063B 6 ft	1X Switchable 10X	1 MΩ 12 pF	6 MHz
			10 MΩ 14 pF	200 MHz
Current Probe	Probe Type	Cali- bration	Insertion Impedance	Bandwidth* with 485
	P6022	1 mA/mV 10 mA/mV (Select- able)	.03 Ω @ 1 MHz In- creasing to .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 Adapter — The adapter provides an accurate 50 mA square-wave calibrator when connected to the 485 voltage calibrator. The rise time is approx 25 ns.

25 ns.		
Order 012-0341-00		\$28
50 Ω 5X Pad — Pr	ovides reverse	termination for the

Order 011-0060-02	 		\$30
Folding Visuing H	 Folds &	- 7/ × 41/-	v 714 in

Folds to % x 6% x 13% in.

Order 016-0082-00\$14.75

calibrator.

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.

Order 200C\$170

1105 Battery Power Supply — Provides 2.3 hours of battery operation.

Order 1105 Battery Power Supply\$845

Rack Adapter — 016-0558-00\$180

RECOMMENDED CAMERAS

	General mounting	Camera — In	cludes 016-
	100		\$750
	High Spe g adapter	r a — Includes	016-0306-00
Order C	-31R	 	\$1000

For further information see camera section.

400-Series Portable Oscilloscopes

250-MHz, 200-MHz, 100-MHz Dual-Trace Oscilloscopes



Except for the TIME/DIV and VOLTS/DIV controls, the 465 pictured above is identical in appearance to the 475 and 475A.

1 ns/div Sweep Rate (475) (475A)
5 ns/div Sweep Rate (465)
8 x 10 cm Calibrated Display
Trigger View
Automatic V/div Readout
Versatile Trigger Selection
Battery Operation (Optional)

All three of these TEKTRONIX Portables feature high performance and light weight for making complex measurements in the field.

- 1) The 475A is a new portable with 250 MHz at 5 mV/div. It features wider bandwidth than the 475, plus a more concise spot size and trace for particular applications.
- 2) 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.
- 3) The 465, long considered the industry standard, features 100 MHz at 5 mV/div.

Both the 475 and 475A offer 1% (1 ns/div) timing accuracy, which can be critical in servicing computers. The 465 can be found in numerous service applications, and has proved to be one of the most popular oscilloscopes available.

All three oscilloscopes are light, compact, and rugged for portability and durability, yet each contains a big, 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 chose 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 three instruments are widespread. The 475 performs tests and measurements aboard flight test aircraft, in both stationary and portable modes. The 465 troubleshoots radio/remote-controlled cranes. The 465 is also used to maintain mini-computers for one of the nation's largest department store chains. And a leading computer hardware manufacturer uses the 465 because of its wide bandwidth.

CHARACTERISTICS

All characteristics are common to the 465, 475 and 475A except where indicated.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth* and Rise Time — (at all deflection factors from 50 Ω terminated source)

	-15°C to +40°C	+40°C to +55°C
465	Dc to 100 MHz, 3.5 ns	85 MHz, 4.1 ns
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 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 465 — 5 mV/div to 5 V/div 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 (465/475) to at least 25 V/div (475A). In cascade mode sensitivity is approx 1 mV/div (465); approx 400 μ V/div (475); and approx 2.5 mV/div (475A). Cascaded bandwidth is at least 50 MHz (465/475/475A) when signal out is terminated in 50 Ω .

Display Modes — Ch 1; Ch 2 (normal and inverted), alternate, chopped (465 — approx 250 kHz rate, 475/475A — approx 1 MHz rate), added; X-Y (Ch 1-X, Ch 2-Y).

CMRR — Common-mode rejection ratio at least 20 dB at 20 MHz (50 MHz for 475/475A) 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 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 Ω ±2% paralleled by approx 20 pF.

Max 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 (475/475A only) — Connectors provide correct voltages for two optional P6201 FET Probes.

HORIZONTAL DEFLECTION

465

Time Base A — 0.05 $\mu s/div$ to 0.5 s/div (1-2-5 sequence). X10 mag extends max 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 max sweep rate to 5 ns/div.

475/475A

Time Base A and B — 0.01 μ s/div to 0.5 s/div (1-2-5 sequence). X10 mag extends max sweep rate to 1 ns/div.

Variable Time Control — Time Base A (465/475/475A 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
	465	475/475A	465	475/475A
Unmagnified	±2%	±1%	±3%	± 2%
Magnified	±3%	±2%	±4%	±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

465 — 0.2 to X10 delay time/div settings of 200/ns to 0.5 s (minimum delay time is 200 ns).

475/475A — 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	±1%
less than one major dial division	±0.01 major dial divisions

Jitter — 1 part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

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 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 -

		46	55	4	75	47	5A
C	Coupling	To 25 MHz	At 100 MHz	To 40 MHz	At 200 MHz	to 40 MHz	At 250 MHz
	Internal	0.3 div deflec- tion	1.5 div deflec- tion	0.3 div deflec- tion	1.5 div deflec- tion	0.3 div deflec- tion	2.0 div deflec- tion
Dc	External	SECT. 1500V.C.	150 mV	50 mV	250 mV	50 mV	250 mV
	External + 10	500 mV	1.5 V	500 mV	2.5 V	500 mV	2.5 V
Ac		Requirem	ents incre	ase below	60 Hz		AT .
Ac I	f Reject	Requirem	ents incre	ase below	v 50 kHz		
Ac I	Hf Reject	Requirem	ents incre e 50 kHz	ase below	v 60 Hz		

465 Jitter - 0.5 ns or less at 100 MHz and 5 ns/div.

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 approx 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 $\div 10$.

A Sources — Norm, Ch 1, Ch 2, line, external, and external \div 10.

 ${\bf B}$ Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 M Ω paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

465

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.

475, 475A

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert) — 2 mV/div to 5 V/div (475), 5 mV to 10 V/div (475A) accurate $\pm 3\%$. 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 without extra charge. 18 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

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.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .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 ½ 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°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — (465) Ch 1 vertical signal is dc to at least 50 MHz (-3 dB), and approx 25 mV/div terminated into 50 Ω , and approx 50 mV/div terminated into 1 M Ω . (475/475A) Ch 2 vertical signal is dc to at least 50 MHz (-3 dB), and approx 10 mV/div terminated into 50 Ω , and approx 20 mV/div terminated into 1 M Ω .

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 ±10%. 48 to 440 Hz, 75 watts (465) or 100 watts (475, 475A) max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

	Cab	inet	Racki	nount
Dimensions	in	cm	in	cm
Height	6.2	15.7	7.0	17.7
Width (with handle)	12.9	32.8	19.0	48.3
Depth (with panel cover)	18.1	46.0	18.0	45.7
Depth (handle extended)	20.3	51.6		
Weights (approx)	lb	kg	lb	kg
Net (without panel cover)	22.8	10.3	29.4	13.3
Net (with panel cover and accessories)	25.3	11.5		
Shipping	37.0	16.7	58.0	26.3

INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03) (465 only), two P6106 10X probes (010-6106-03) (475/475A only), blue accessory pouch (016-0535-02), 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 ¾-amp fuse (159-0042-00). Rack models also include mounting hardware and slide out assemblies, do not include accessory pouches.

ORDERING INFORMATION

465 Oscilloscope\$2295
475 Oscilloscope\$3195
475A Oscilloscope\$3555
R465 Oscilloscope\$2420
R475 Oscilloscope\$3320
R475A Oscilloscope
465 DM 44\$2740
475 DM 44\$3640
ATEA DM AA Jordon ATEA Ontion AA ago
475A DM 44 (order 475A Option 44, see below) INSTRUMENT OPTIONS
below)
Delow) INSTRUMENT OPTIONS Option 01, delete temperature probe on DM 44.
Delow) INSTRUMENT OPTIONS Option 01, delete temperature probe on DM 44. (for 475A order Option 45)Sub \$85

Modification kits for field conversion of existing 465s, 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 Field Engineer, Distributor, or Representative for information.

1106 Battery Pack (used with Option 07) . . Add \$585

Option 44, Built-in DMM (475A only) Add \$445

Option 78, P11 Phosphor......No charge

Option 45. Built-in DMM without temperature

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Band 465	width' 475	with 475A
P6063B 6 ft	1X Switchable	1 MΩ 105 pF	6 MHz	6 MHz	6 MHz
	10X	10 MΩ 14 pF	90 MHz	145 MHz	160 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ 2 pF	100 MHz	185 MHz	220 MHz
	100X Head	10 MΩ 2 pF	100 MHz	185 MHz	220 MHz
	Ac Head	10 MΩ 4 pF	100 MHz	185 MHz	220 MHz
Current Probe	Calibration	Insertion Impedance	Band 465	dwidth	with 475A
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	.03 Ω @ 1 MHz In- creasing to 0.2 Ω @ 120 MHz	85 MHz	125 MHz	160 MHz

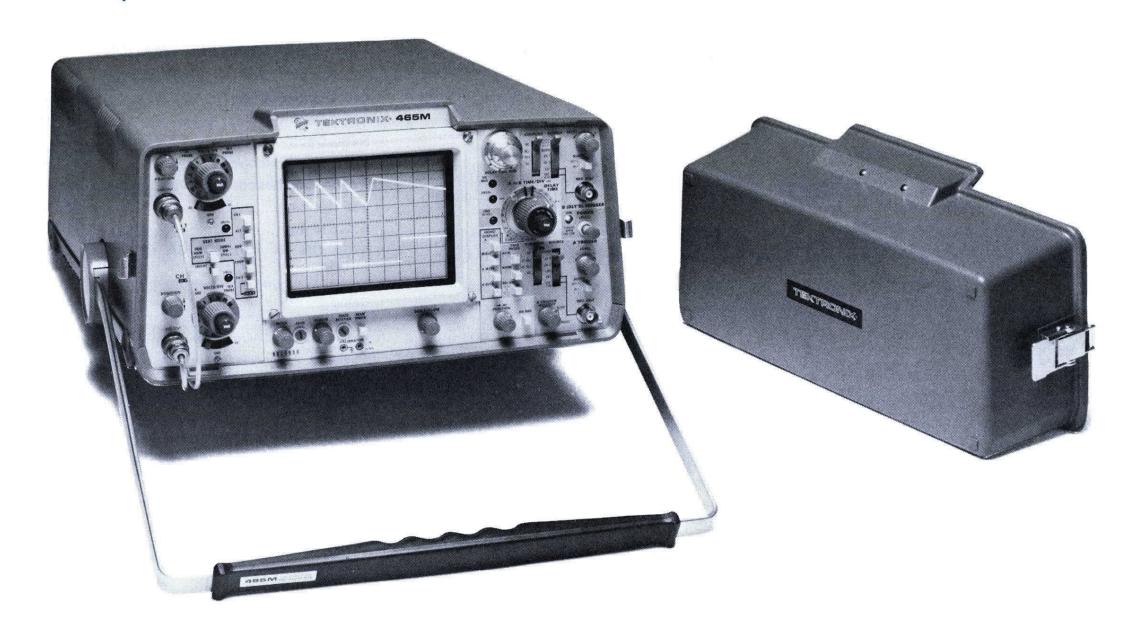
*Bandwidths are measured at the upper —3 dB and apply only to the cable length shown. Generally shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Folding Polarized Viewing Hood — Order 016-0180-00\$2	23
Collapsible Viewing Hood — Binocular Order 016-0566-00\$1	13
Protective Cover — Waterproof, blue vinyl Order 016-0554-00	15
Mesh Filter — Improves contrast and emc filtering Order 378-0726-01	30
SCOPE-MOBILE® Cart — Occupies less than 18 aisle space, has storage area in base	
Order 200C	
1105 Battery Power Supply\$84	
Rack Adapter — 016-0556-00\$16	

RECOMMENDED CAMERA

For further information see camera section.

100-MHz Oscilloscope



The Commercial Version of the AN/USM 425
Full Military Provisioning through the
Federal Supply System
100 MHz at 5 mV/div
Meets MIL-T-28800B, Type II, Class 4,
Style C

If you're in a civilian agency or work for a prime contractor, consider this new 100-MHz portable. The 465M is the commercial version of the triservice standard TEKTRONIX AN/USM 425. Both are designed and manufactured to meet MIL-T-28800B, Type II, Class 4, Style C Specifications.

The 465M retains the popular features of our other lab-quality 400-Series Portable Scopes — like dual trace, delayed sweep, graticule illumination and external trigger view. And it features a 100-MHz bandwidth at 5 mV/div sensitivity.

This 24 pound (10.9 kg) instrument is ideal for military applications. Modular design simplifies servicing and parts are fully provisioned in the Federal Supply System. Military manuals and documentation are available. The unit comes equipped with a cover to protect front panel controls during transit and a ruggedized case. For battery operation, the 1105 Power Supply is available.

Specify the new TEKTRONIX 465M as part of your test equipment package in your next government application.

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 $+55^{\circ}\text{C}$. 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: $\pm 2\%$ 0°C to 40°C; $\pm 3\%$ -15°C to 0°C, 40°C to 55°C. Uncalibrated, continuously variable between settings, and to at least 12.5 V/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 M Ω ±2%, approx 20 pF.

Max 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, approx 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 μ s/div in 22 steps (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Time Base B—50 ms/div to 0.05 μ s/div in 19 steps (1-2-5 sequence). X10 mag extends maximum sweep rate to 5 ns/div.

Accuracy-

	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 μ s 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 divisions: +15°C to +35°C 1% + .1% of full scale 0°C to +55°C additional 1% allowed.

Jitter—1 part or less in 20,000 (0.005%) of 10X the A TIME/DIV switch setting.

TRIGGERING A AND B

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 10X the TIME/DIV settings, except at .2 s and .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/div, -15° C to $+55^{\circ}$ C.

Trigger View—View external and internal trigger signals; Ext X1 100 mV/div, Ext ÷ 10 1 V/div.

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 $\pm 1.0 \text{ V}$ to $\pm 1.0 \text{ V}$ on either slope of the trigger signal.

A Sources—Ch 1, Ch 2, NORM (all display modes triggered by the combined waveforms from Ch 1 and 2), LINE, EXT, EXT \div 10.

B Sources—B starts after delay time; Ch 1, Ch 2, NORM, EXT, EXT \div 10.

X-Y OPERATION

Sensitivity—5 mV/div to 5V/div in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5 V/div.

X Axis Bandwidth-Dc to at least 4 MHz.

Y Axis Bandwidth-Dc to 100 MHz.

X-Y Phase—Less than 3° from dc to 50 kHz.

SIGNAL OUTPUTS

A Gate—Approx 5.0 V positive-going pulse.

B Gate—Approx 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 intensify) to +5 V (to blank). Continuous operation maximum input shall be ± 50 V (dc + peak ac).

ENVIRONMENTAL

EMI—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 $+55^{\circ}$ C. Non-operating: -62° C to $+85^{\circ}$ C.

Altitude—Operating: to 15,000 feet. Max operating temperature decreased 1° C/1,000 ft above 5,000 ft Non-operating: to 50,000 ft

Vibration—Operating: along each of the three major axes:

a. cycling 5 to 25 to 5 Hz for 10 min at 0.025 in p-p;

b. cycling 25 to 55 to 25 Hz for 5 min at 0.020 in p-p;c. dwelled at 55 Hz for 10 min at 0.020 in p-p.

Total vibration time 75 min.

Humidity—5 cycles (120 hours) referenced to MIL-E-16400F (operating and non-operating).

Shock—Operating: 30 g's, $\frac{1}{2}$ sine, 11 ms duration, 3 shocks each direction per axis for a total of 18 shocks.

OTHER CHARACTERISTICS

Calibrator Output Voltage—1.0 V $\pm 1.0\%$ -15°C to +55°C. Frequency approx 1 kHz.

Channel 2 Signal Output—Through main module Ch 2 OUT connector. Output voltage: approx 50 mV/div into 1 M Ω , approx 25 mV/div into 50 Ω . Output resistance: approx 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 watts at 115 V, 60 Hz.

Dimensions—	in	cm
Height (with feet)	7.05	17.91
Width (with handle)	13.65	34.67
Width (without handle)	12.50	31.75
Depth (including panel cover)	24.45	54.58
Depth (handle extended)	24.10	61.10
Weight (approx)	lbs	kg
Net (without cover and accessories)	24.0	10.9
Net (with panel cover, modules,	CS=CANDATO	303,650,600
and accessories)	27.0	12.2
Shipping	34.2	15.5

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 adapters (103-0015-00), two BNC male to UHF female adapters (103-0032-00), one T connector (103-0030-00), one BNC male to dual binding post adapter (103-0035-00), three probe tip adapters (103-0051-01), three banana tips (134-0013-00), three 6" lead 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	 \$2345
402141	loitable	Oscilloscope	 42040

OPTIONAL ACCESSORIES

Probe —P6022 Current Probe, 5 ft cable with termination.
Order 015-0135-01\$225
Folding Polarized Viewing Hood Order 016-0180-00\$23
Mesh Filter—Improves contrast and emi filtering. Order 378-0726-01\$30
SCOPE-MOBILE® Cart—Occupies less than 18 in of aisle space.
Order 200-C\$170
1105 Battery Power Supply— Provides 1.8 hours of battery operation.
Order 1105 Battery Power Supply\$845
Rack Adapter (Cradle Mount) Kit—Rack height 7 in, depth 18% in, width 19 in.
Order 040-0825-00\$200

RECOMMENDED CAMERA

C-30AP Option 01 General Purpose Camera—Includes
016-0301-00 mounting adapter/corrector lens.
Order C-30AP Option 01 Camera \$770



50 MHz at 5 mV/div 5 ns/div Sweep Rate Trigger View Dual-Trace, Delayed Sweep

The 455, the 400-Series value leader, is a rugged and economical portable that retains the high performance of the 400-Series.

Special features of the 455 let you check trigger signal presence and timing at the push of a button, without moving the probes. Errors in amplitude readings are minimized through lighted vertical deflection factor readout. 1X and 10X probes are automatically accounted for by the readout. If the 455's modular probes should become damaged, the probe tip, cable, or compensation unit can be quickly and inexpensively replaced. A large 8 x 10 cm display permits easy viewing, yet the control area remains uncrowded.

An important 455 option, adding to versatility, is the snap-on 1106 Battery Pack.

Modular design means easy serviceability. Vertical amplifier and time-base modules can be quickly removed for ready access to all components, making repairs faster and less costly.

Calibration time is reduced with the 455. A minimum number of adjustments, made possible by actively trimmed networks, simplifies procedures and saves calibration time.

The 455 is extremely easy to operate, thanks to well-laid-out, color-coded controls. This translates into minimum operator training

time, plus easier, faster, more error-free measurements.

The value leading 455 is an economy/performance, general-purpose oscilloscope. Though its price is moderate, it accommodates most measurements required in digital service.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth* and Rise Time — Bandwidth dc to at least 50 MHz and rise time 7.0 ns or less, at all deflection factors from $50-\Omega$ terminated source. Lower —3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

*Measured at -3 dB.

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 12.5 V/div. In cascade mode sensitivity is approx 1 mV/div. Cascaded bandwidth is at least 20 MHz, when signal out is terminated in 50 Ω .

Display Modes — Ch 1, Ch 2 (normal or inverted), alternate, chopped (250 kHz rate), X-Y.

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 automatically indicated by two lighted indicators beside 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 Ω ±2%, approx 20 pF.

Max 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)

HORIZONTAL DEFLECTION

Time Base A — 0.05 $\mu s/div$ to 0.5 s/div (1-2-5 sequence). X10 mag extends fastest 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 fastest 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 Cm -

	+20°C to +30°C	-15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes — A, A intensified by B, B delayed. B ends A for increased intensity in the delayed mode.

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 Settings	+15°C to +35°C
Over one or more major dial divisions	1.5%
Less than one major dial division	±0.015 major dial division

Jitter — 1 part or less in 20,000 (0.005%) of 10X the A sweep time/div setting.

TRIGGERING A AND B

A Trigger Modes — Normal Sweep (runs when triggered), single sweep (runs one time on the first triggering event after the single sweep pushbutton is pressed). Automatic (sweep free-runs in the absence of a trigger and for signals below 20 Hz). Lights indicate when single sweep is ready.

A Trigger Hold-off — 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, following the A sweep delay time, in each of these modes.

Time Base A and B Trigger Sensitivity and Coupling-

Coupling		To 10 MHz	At 50 MHz
Dc	Internal	0.4 div deflection	1.5 div deflection
	External	50 mV	250 mV
	External ÷ 10	500 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		

 $\mbox{\bf Jitter}$ — 0.5 ns or less at 50 MHz and 5 ns/div (X10 MAG on).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. Provides quick verification of external trigger and time comparison between external trigger and the displayed signal. Deflection factor approx 50 mV/div (0.5 V/div in external ÷ 10 mode).

Level and Slope — Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits triggering on any level between -2 V and +2 V (-20 V to +20 V for external \div 10).

A Sources — Norm, Ch 1, Ch 2, line, external, and external \div 10.

B Sources — Starts after delay, norm, Ch 1, Ch 2 and external.

External Inputs — R and C approx 1 M Ω paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

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 3 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, P11 phosphor optional without extra charge. 12 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses the display to within the graticule area and provides a visible display when pushed.

Z-axis Input — Dc coupled, positive-going signal decreases intensity: 5 V p-p signal causes noticeable modulation at normal intensity: dc to 20 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .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, $\frac{1}{2}$ sine, 11 ms duration, 2 shocks per axis each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V \pm 1%. Frequency approx 1 kHz.

Vertical Signal Output — Ch 2 vertical signal is dc to at least 20 MHz and approx 25 mV/div terminated into 50 Ω , and approx 50 mV/div terminated into 1 M Ω .

Gate Outputs — (approx 5 V) internally selectable from either A or B time base.

Power Requirements — Quick change line voltage selector provides two ranges: 100 V to 132 V, 200 V to 264 V, 48 Hz to 440 Hz. Power consumption 35 watts at 115 V, 60 Hz. Operation from 12 V or 24 V dc is available with Option 07.

Dimensions	in	cm
Height	9.0	22.9
Width (with handle)	13.7	34.7
Depth (with handle cover)	19.5	49.5
Depth (handle extended)	21.7	55.2
Weight (approx)	lb	kg
Net (without panel cover)	24.0	10.9
Net (with panel cover and accessories)	27.0	12.2
Shipping	34.2	15.5

INCLUDED ACCESSORIES

Two P6105 probes (010-6105-03), blue accessory pouch (016-0339-00), clear pouch (016-0537-00), clear crt filter (337-2122-01), adapter (134 0016-01), $\frac{1}{2}$ -A fuses (159-0025-00), two 2-A fuses (159-0021-00), one 1-A fuse (159-0022-00).

ORDERING INFORMATION

455/A2/B2 Portable Oscilloscope ...\$1850

INSTRUMENT OPTIONS

Option 04	Emc ModificationAdd \$125
Option 05	Tv Sync Separator Add \$185
Option 07	External Dc OperationAdd \$125
Option 78	P11 Phosphor

For more information on instrument options, see your Tektronix Field Engineer, Distributor, or Representative.

OPTIONAL ACCESSORIES

	OPTIONAL A	CCESSORIES	
Probes —			
Probe Type	Attenuation	Input Impedance	Bandwidth* with 455
P6062B 6 ft	1X Switchable	1 MΩ 105 pF	6.7 MHz
	10X	10 MΩ 14 pF	50 MHz
P6202	10X	10 MΩ 2 pF	50 MHz
FET probe	100X Head	10 MΩ 2 pF	
2 meter	Ac Head	10 MΩ 4 pF	
Current Probe	Calibration	Insertion Impedance	Bandwidth with 455
P6022	10 mA/mV 1 mA/mV	.03 Ω @ 1 MHz in- creasing to 0.2 Ω @ 120 MHz	47 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.

Rack Adapter (Cradle Mount) Kit — Includes hardware for converting standard 455 to 19 in rack installation. Cradle mount consists of a shelf and a mask to fit over regular instrument panel. Instrument can be slid out from rack. Rack height 7 in, depth 18¾ in, width 19 in.

Order 040-0825-00\$200
Protective Cover — Waterproof, blue vinyl.
Order 016-0344-00\$10
Folding Viewing Hood — Polarized
Order 016-0180-00\$23
Folding Viewing Hood — Binocular
Order 016-0566-00\$13
Scope-Mobile® Cart—Occupies less than 18 inches
of aisle space.
Order 200 C\$170

RECOMMENDED CAMERA





Dc to at Least 100 MHz Bandwidth

5 mV/div Vertical Sensitivity at Full Bandwidth

5 ns/div Sweep Speed

Variable Persistence and Fast Mesh Transfer Storage Modes

3000 div/ μ s Stored Writing Speed (466)

The 466 and 464 Portable Storage Oscilloscopes are both designed to display non-repetitive or slow moving signals. And with the exception of 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/ μ s (1350 cm/ μ s) making it the fastest portable storage oscilloscope available. The lower cost 464 doesn't offer a reduced scan mode and stores at 110 div/ μ s. Both instruments feature two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 cm 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. Of time-saving importance, you can easily view the trigger signal without disconnecting leads and re-setting controls.

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 464 and 466 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 Ω terminated source.

-15°C to +40°C	+40°C to +55°C	
Dc to 100 MHz. <3.5 ns	Dc to 85 MHz. <4.15 ns	

*Measured at —3 dB 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 bandwith is at least 50 MHz when signal out is terminated in 50 Ω .

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 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 Ω \pm 2% paralleled by approx 20 pF.

Max 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 μ s/div to 0.5 s/div (1-2-5 sequence). X10 mag 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 cm

	+20°C to +30°C	-15°C to +55°C
Unmagnified	± 2%	±3%
Magnified	±3%	±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
over one or more major dial div	±1%	± 2.5%
less than one major dial div	±0.01 major dial div	±0.025 major dial div

Jitter — 1 part or less in 50,000 (0.002%) of X10 the A sweep 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 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	
_	Int	0.3 div deflection	1.5 div deflection	
Dc	Ext	50 mV	150 mV	
	Ext ÷ 10	500 mV	1.5 V	
Ac	Ac Lf	Requirements inc	rease 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 mag).

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 ÷ 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 \div 10.

A Sources — Norm, Ch 1, Ch 2, line, external and external \div 10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 M Ω paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

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 in 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). 8.5 kV accelerating potential, normal mode, 10 kV reduced scan. P31 phosphor.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

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.

STORED WRITING SPEEDS

	466	464	Storage* View Time
Full Scan (Center 6 x 8 div; 0.9 cm/div)			
FAST	150 div/μs	110 div/μs	>15s
VARIABLE	0.5 div/μs	0.5 div/μs	>15s
PERSISTANCE			
Reduced Scan			
(Center 8 x 10 div;		Reduced	
0.45 cm/div)		Scan not	
FAST	3,000	available	
	div/μs	on 464	>15s
VARIABLE	3 div/μs		>15s
PERSISTANCE			

*These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in SAVE Display Mode.

ENVIRONMENTAL CAPABILITIES

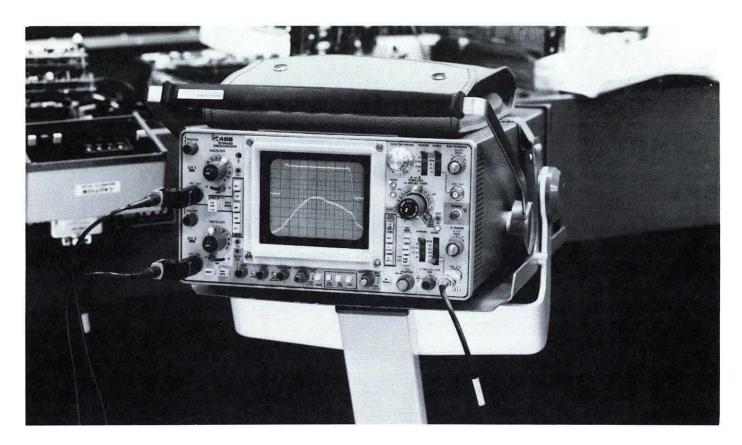
Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C. Forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .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, $\frac{1}{2}$ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.



OTHER CHARACTERISTICS

Amplitude Calib	rator —	
Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°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 Ω , and approx 50 mV/div terminated into 1 M Ω .

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 max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

Dimensions	in	cm
Height	6.2	15.9
Width (with handle)	13.0	33.0
Depth (with panel cover)	21.7	55.0
Depth (handle extended)	23.5	59.7
Weights (approx)	lb	kg
Net (without panel cover or accessories)	26.0	11.8
Net (with panel cover and accessories)	29.8	13.5
Shipping	41.5	18.8

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 $1\frac{1}{2}$ amp fuses (159-0016-00), one $\frac{3}{4}$ amp fuse (159-0042-00), adapter, ground wire (134-0016-01), viewing hood (016-0592-00).

ORDERING INFORMATION

466 Storage Oscilloscope	. \$4895
466 DM 44 Storage Oscilloscope/	
Multimeter	. \$5340
464 Storage Oscilloscope	.\$4120
464 DM 44 Storage Oscilloscope/	
Multimeter	. \$4565

INSTRUMENT OPTIONS

Option 01, delete DM 44 temperature probe
(466 DM 44, 464 DM 44 only)Sub \$85
Option 04, Emc EnvironmentalAdd \$125
Option 05, Tv Sync SeparatorAdd \$185
Option 07, Ext Dc Operation
(Option 07 cannot be ordered with DM 44) Add \$125

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 Field Engineer, Distributor, or Representative for information.

OPTIONAL ACCESSORIES

Probes —	OPTIONAL A	CCESSORIES	
Probe Type	Attenua- tion	Input Impedance	Bandwidth* with 464/466
P6063B 6 ft	1X Switchable 10X	1 MΩ 105 pF 10 MΩ 14 pF	6 MHz 90 MHz
P6202 FET Probe 2 Meter	10X 100X Head Ac Head	10 MΩ 2 pF 10 MΩ 2 pF 10 MΩ 4 pF	100 MHz
Current Probe	Calibra- tion	Insertion Impedance	Bandwidth with 464/466
P6022	1 mA/mV 10 mA/mV (Select- able)	0.03 Ω @ 1 MHz In- creasing to 0.2 Ω @ 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.

OPTIONAL ACCESSORIES

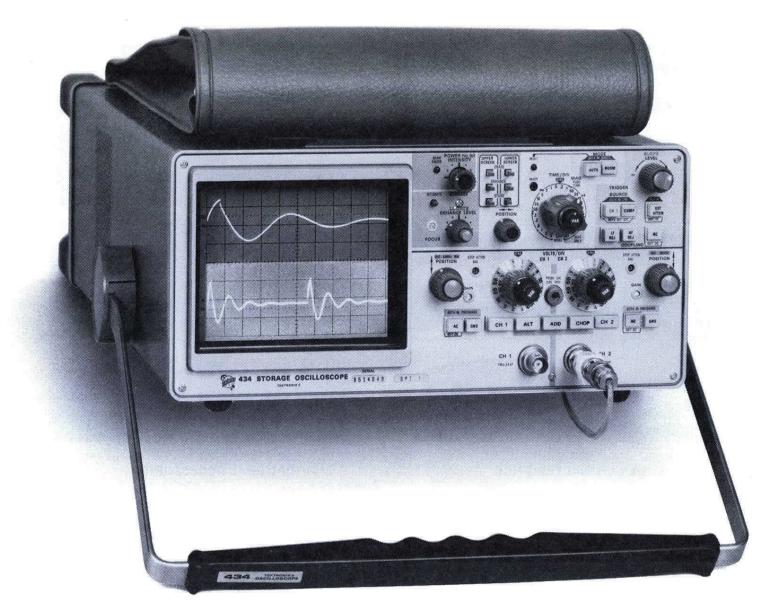
1106 Battery Pack (used with Option 07)\$585
1105 Battery Power Supply\$845
Mesh Filter — Improves display contrast in high ambient light. Order 378-0726-01
Protective Cover — Waterproof vinyl. For 464/466 Order 016-0365-00\$17
Folding Viewing Hood — Order 016-0592-00\$11.50
Folding Binocular Hood — Order 016-0566-00\$13
Polarized Collapsible Viewing Hood — Order 016-0180-00\$23
SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.
Order 200C\$170

RECOMMENDED CAMERA

C-30AP Option 01 General Pu	
cludes 016-0301-00 mounting ac	dapter/corrector lens.
Order C-30AP Option 01	\$770
Camera Adapter — Mounts C-30	OA Series Camera to
464/466 Oscilloscopes.	
Order 016-0301-00	

For further information see Camera section.

25-MHz Storage Oscilloscope



Deflection Factors to 1 mV/div Automatic Volts/div Readout Direct-Reading Wide-Range Magnifier Weighs 203/4 Lb

A bistable, split-screen storage oscilloscope with a 25 MHz bandwidth, the compact 434 fills many needs in the field as well as on a bench.

The 434's split screen operates in three modes: full-screen storage, or upper or lower screen storage, with the other half in a conventional mode.

Vertical scale-factor readout is provided by lighted knob skirts. You save time by not having to calculate the scale factor each time a measurement is made.

The 1105 Battery Power Supply powers the 434 for up to 1.8 hours. Take the 1105 along when required. Or forget it when line power is available.

TEKTRONIX 434's have been used for: maintaining display boards, video monitors, and automatic baggage handling systems for an airline; maintenance of X-ray systems in a hospital; monitoring air-conditioning and heating systems that are hooked into an alarm system in large buildings.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth and Rise Time — (from 50Ω 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 (less than 1 Hz with 10X probe).

Deflection Factor — 1 mV/div to 10 V/div, accurate $\pm 3\%$. Lighted knob skirts indicate correct deflection factor for either 1X or 10X probes. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes — Ch 1 only, Ch 2 only (normal or inverted), alternate, chopped (approx 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 automatically indicated by two lighted indicators beside 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 Ω ±2% paralleled by approx 24 pF.

Max Input Voltage — Dc coupled: 250 V (dc + peak ac); ac coupled: 500 V (dc + peak ac). In either mode the max 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 at temperatures above $\pm 30^{\circ}\text{C}$.

HORIZONTAL DEFLECTION

Time Base — 0.2 μ s/div to 5 s/div (1-2-5 sequence). X50 mag 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 div -

	+20°C to +30°C	-15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±4%	±5%

External Horizontal Input — Deflection factor is approx 0.5 V/div. Input resistance is approx 50 k Ω .

TRIGGER

Modes — Auto trigger (sweep free-runs in absence of triggering signal and provides bright baseline at all sweep rates), normal trigger, single sweep.

Trigger Sensitivity and Coupling —

Coupling		To 5 MHz	At 25 MHz
Dc	Internal	0.3 div deflection	1 div deflection
20000000	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 kHz		

Sources — Ch 1 only, composite line, external and external \div 10. External trigger level range is at least +2 V to -2 V or +20 V to -20 V.

Level and Slope — External trigger level range is at least ± 2 V or ± 20 V in external \div 10.

External Inputs — Input R approx 1 M Ω paralleled by 100 pF \div 1 or 70 pF \div 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; nonilluminated.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of 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 storage with 3 display modes: storage on either upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display on entire screen. Independent operation of both 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 — When the 434 is operated in the stored mode, the beam can be positioned to the left of the graticule area to determine the vertical position of the next sweep without disturbing a stored display.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .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, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.6 V \pm 1.0%, 1 kHz \pm 1.0% (\pm 20°C to \pm 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 max. Also operates from 220 V dc to 350 V dc.

	Cab	inet	Rack	mount
Dimensions	in	cm	in	cm
Height	5.6	14.2	5.3	13.3
Width (with handle)	13.0	33.0	19.0	48.3
Depth	18.7	47.5	18.0	45.7
Weights (approx)	lb	kg	lb	kg
Net	20.8	9.4	23.1	10.5
Shipping	30.0	13.6	49.0	22.2

INCLUDED ACCESSORIES

Two P6105 probes (010-6105-03), accessory pouch (016-0165-00). Rack models also include mounting hardware and slide out assemblies, do not include accessory pouch.

ORDERING INFORMATION

434 Storage Oscilloscope	\$3245
R434 Storage Oscilloscope Rackmo	
Model	\$3320

INSTRUMENT OPTIONS

Option 01 Increased Writing SpeedAdd \$50

For more information on instrument options, see your Tektronix Field Engineer, Distributor, or Representative.

OPTIONAL ACCESSORIES

Probes —

Probe	Attenuation	Input	Bandwidth*
Type		Impedance	with 434
P6062A	Switch- 1X	1 MΩ	6.7 MHz
6 ft	able	5 pF	
	10X	10 MΩ 14 pF	25 MHz
Current	Calibration	Insertion	Bandwidth
Probe		Impedance	with 434
P6022	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, longer ones decrease bandwidth.

1105 Battery Power Supply — Provides 1.8 hours of battery operation.

Order 1105 Battery Power Supply\$845

Mesh Filter — Improves contrast and emc filtering.

Order 378-0682-00\$22

Portable to Rackmount Assembly — Includes hardware for converting standard 434 to 19-inch rack installation.

Order 016-0272-00\$120

Folding Polarized Viewing Hood —
Order 016-0180-00\$23

Clear Plastic Crt Filter —

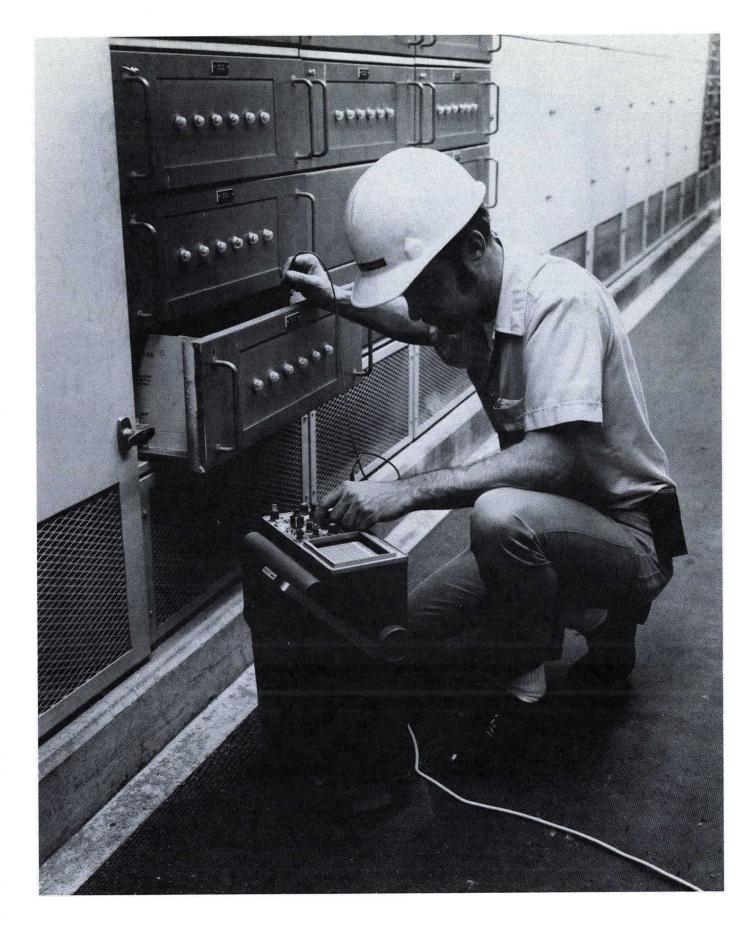
Order 378-0677-00\$2.50

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.

Order 200C\$170

RECOMMENDED CAMERA

For further information see Camera Section.



35-MHz Dual-Trace Delayed Sweep Oscilloscope



35 MHz, Dual-Trace, Delayed Sweep Small Size, Lightweight 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 lines at the inputs let you view 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 (\pm 11 to \pm 14 V or \pm 22 to \pm 28 V) assures that power can be obtained at nearly any location.

Rugged construction, plus environmental specifications that equal or better those of any portable scope, help the 335 withstand the wide range of temperature and humidity and rough handling it may encounter in field environments.

Color coding and functional layout of the front panel controls make the 335 easy to operate. Combined function controls and side mounting probes lead to small size and an uncluttered control panel.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth and Rise Time — Dc to at least 35 MHz, rise time 10 ns or less. For 1 mV/div to 5 mV/div bandwidth is at least 25 MHz, rise time 14 ns or less. 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 (approximately 300 kHz rate) added, X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Input R and C — 1 M Ω ±2% paralleled by approx 24 pF.

Max Input Voltage, ac or dc coupled, 300 V (dc \pm peak ac). 300 V p-p ac at 1 kHz or less.

 $\begin{tabular}{ll} \textbf{Delay Line} & -- \end{tabular} & \textbf{Permits viewing leading edge of displayed waveform.} \\ \end{tabular}$

HORIZONTAL DEFLECTION

Time Base A — 0.2 μ s/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 μ s/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. Warning light indicates uncalibrated settings.

Time Base A and B Accuracy, center 8 div -

	+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 μ s 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 divisions	±.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	0.35 div	1.5 div
Dc	External	70 mV	250 mV
	Ext ÷ 10	700 mV	2.5 V
Ac	above requi	rements increas	se below 60 Hz
Ac Hf Rej	requirement	s increase abov	ve 20 kHz
Ac Lf Rej	requirement	s increase belo	w 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 \div 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 approx 20 mV/div to approx 20 V/div. Dc to at least 500 kHz.

Input Impedance — Approx 1 $\mbox{M}\Omega$ 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 div per major 0.6 cm.

Z-axis Input — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 600 kHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Non-operating: -40° C to $+75^{\circ}$ C.

Altitude — Operating: to 15,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: to 50,000 ft max.

Vibration — Operating and nonoperating: 15 minutes along each of the three major axes, .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, $\frac{1}{2}$ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V ($\pm 1\%$) approx 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. Max power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a max current drain of 2A at +12 V or 1.0A at +24 V.

Dimensions	in	cm
Height	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	13.6	34.7
Depth (handle extended)	17.6	44.8
Weights (approx)	lb	kg
Net (without accessories)	10.5	4.7
Shipping	17.0	7.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case (016-0485-00), external dc cable assembly (012-0406-00), strap assembly (346-0131-00), two A-1 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).

ORDERING INFORMATION

335 Portable Oscilloscope\$1925

OPTIONAL ACCESSORIES

Viewing Hood — Order 016-0297-00\$6.50
Crt Filter — Light blue. Order 378-2016-00\$1.80
Crt Filter — Light amber. Order 378-0843-00\$1.80
Crt Mesh Filter — With frame and holder. Order 378-0063-00\$18

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.

RECOMMENDED CAMERA

C-30AP General Pu	irpose Camera	\$750
Camera Adapter —	mounts C-30A	to 335.
Order 016-0327-00		\$45

For further information see Camera section.





1 mV/div to 10 V/div Calibrated Deflection Factors

Compact Size — Weight < 13 Lb
5 MHz Bandwidth at 1 mV/div
Designed for Severe Environments

The 326 is an all solid-state, dual-channel, 10 MHz portable that can be operated from ac, dc, or internal rechargeable batteries.

Power consumption is extremely low... only 12 watts from an external dc source and 35 watts when powered from the ac line. The internal batteries will operate the 326 for 4 hours of continuous operation.

The portability/performance provided by the 326 Oscilloscope makes it most attractive for "on-site" applications such as maintaining remote computer terminals and on-board ship equipment.

VERTICAL DEFLECTION

Bandwidth and Rise Time — Dc to at least 10 MHz at 3 dB down, rise time 36 ns or less. Dc to at least 5 MHz, rise time 72 ns or less, at 3 dB down using X10 gain. For ac coupling, the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with the included 10X probes.

Deflection Factor — 10 mV/div to 10 V/div (1-2-5 sequence), accurate $\pm 3\%$; 1 mV/div to 1 V/div using X10 gain. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes — Ch 1, Ch 2 (normal or inverted), alternate, chopped (approx 110 kHz rate), added.

CMRR — Common-mode rejection ratio at least 20 dB at 2 MHz for common-mode signals of 8 div or less.

Input R and C — 1 M Ω ±2% paralleled by approx 47 pF.

Max Input Voltage — ac or dc coupled, 500 V (dc + peak ac).

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base — 1 μ s/div to 1 s/div (1-2-5 sequence); X10 mag extends sweep rate to 100 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps to approx 2.5 s/div.

Time Base Accuracy, center 8 div —

Unmagnified	1 μs/div to 0.2 s/div	±3%
	0.5 s/div to 1 s/div	±4%
Magnified	0.5 μs/div to 20 ms/div	±4%
	0.1 μs/div to 2 μs/div 50 ms/div and 0.1 s/div	±5%

TRIGGER

Modes — Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adujstments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Trigger Sensitivity and Coupling —

Coupling		To 1 MHz	At 10 MHz						
Dc	Internal	0.3 div deflection	1 div deflection						
	External	150 mV	500 mV						
Ac	(Int. only)	Requirements increase below 30 Hz							
Ac Lf Rej	(Int. only)	Requirements increase below 50 kHz							

Trigger Source — Internal Ch 1 or internal composite.

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both Ch 1 and Ch 2 provide vertical inputs.

X-axis Deflection Factors — Continuously variable from approx 15 mV/div to approx 15 V/div. Ac or dc coupled. Dc to at least 200 kHz at 3 dB down.

Input Impedance — Approx 1 M Ω paralleled by 62 pF.

DISPLAY

Crt — 8 x 10 div (0.6 cm/div) display. P31 phosphor normally supplied; P7 is optional without extra charge. 2 kV accelerating potential.

Graticule — Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

Z-axis Input — External blanking input require +5 V to +20 V (dc coupled); is usable from dc to at least 100 kHz. Max input voltage, 50 V (combined dc + peak ac).

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Charging: 0° C to $+40^{\circ}$ C. Nonoperating: -40° C to $+75^{\circ}$ C.

Altitude — Operating: 15,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 gs to 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-Std-202C, Method 106B, omit freezing and vibration, and allow a post-test drying period at $\pm 25^{\circ}$ C $\pm 5^{\circ}$ C at 20% to 80% relative humidity.

Shock — Operating and nonoperating: 30 g's, $\frac{1}{2}$ sine, 11 ms duration along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V (\pm 1%) at approx 1 kHz from \pm 20°C to \pm 30°C.

Power Sources — Internal NiCd batteries provide approximately 4 hours operation at max trace intensity. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Full recharge requires approximately 16 hours. A trickle charge mode prevents battery self-discharge when not in use. External dc source, 9 V to 32 V, 12 W.

Operates from an external ac source of 90 V to 136 V or 180 V to 272 V. 48 to 440 Hz, 35 W max at 136 V ac.

Dimensions	in	cm
Height	4.0	10.2
Width (with handle)	8.7	22.2
Depth (handle extended)		
(with charger)	15.0	38.1
(without charger)	12.2	31.0
Depth (handle extended)		
(with charger)	18.2	46.2
(without charger)	15.8	40.1
Weights (approx)	lb	kg
Net (without accessories)		
(with charger)	13	5.9
(without charger)	10	4.5
Shipping	19	8.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case (016-0532-00), strap assembly (346-0098-00), viewing hood (016-0297-00), blue light filter (426-0871-00), external dc cable assembly (012-0406-00), test lead (012-0039-00), three 0.4-A fuses (159-0097-00), two 1.6-A fuses (159-0098-00), three 0.2-A fuses (159-0100-00).

ORDERING INFORMATION

326 Oscillos													
including	power	pack	 ٠	٠	•	•	٠	•	٠	٠	٠	\$2180	

INSTRUMENT OPTION

Option 76, P7 phosphor......No Charge

OPTIONAL ACCESSORIES

Power Pack — Additional power pack for charging battery pack (not included).

Order 016-0528-00\$290

The SONY®/TEKTRONIX® 326 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 326 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

RECOMMENDED CAMERA

C-30AP — General Purpose Camera\$750

Camera Adapter — Mounts C-30A to 326.

Order 016-0327-00 Adapter\$45

For further information see Camera section.

300-Series SONY/TEKTRONIX Portable Oscilloscopes

4-MHz Single Channel Oscilloscope



1 mV/div to 20 V/div Calibrated Deflection Factors

Compact Size — Weight \simeq 7 Lb Operates to 7 Hours from Internal Batteries Designed for Severe Environments

The 323 Portable Oscilloscope features "heavyweight" performance in a lightweight package (approximately seven pounds).

With the 323 you have the option of using ac, dc, or internal rechargeable batteries for power. And like other 300-Series Oscilloscopes, power consumption is very low: typically 1.6 watts from an external dc source (maximum 4.5 watts), and 14 watts when powered from the ac line. Internal rechargeable batteries provide 7 hours of continuous operation, sufficient for a full working day.

The 323 has been purchased on its environmental specs alone...to withstand high shock conditions, and to tolerate extreme temperatures.

VERTICAL DEFLECTION

Bandwidth and Rise Time — Dc to at least 4 MHz at —3 dB down, rise time 90 ns or less. Dc to at least 2.75 MHz, rise time 130 ns or less, at lower —3 dB down using X10 gain. For ac coupling, the lower —3 dB point is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Deflection Factor — 10 mV/div to 20 V/div (1-2-5 sequence), accurate $\pm 3\%$ 1 mV/div to 2 V/div using X10 gain. Continuously variable between steps and to at least 50 V/div (uncalibrated).

Input R and C — 1 M Ω ±2% paralleled by approx 47 pF.

Max Input Voltage — ac or dc coupled, 500 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — 5 μ s/div to 1 s/div (1-2-5 sequence). X10 mag extends sweep rate to 0.5 μ s/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 2.5 s/div.

Time Base Accuracy, center 8 div

Unmagnified	
5 μs/div to 0.2 s/div	±3%
0.5 s/div to 1 s/div	±4%
Magnified	
2 μs/div to 20 ms/div	±4%
$0.5~\mu s/div$ to 1 $\mu s/div$ and 50 ms/div to 0.1 s/div	±5%

TRIGGER

Modes — Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Trigger Sensitivity and Coupling —

Coupling		to 400 kHz	at 4 MHz				
Dc	Internal	0.3 div	.75 div				
	External	190 mV					
Ac	requiremen	nts increase be	low 30 Hz				
Ac Lf Reject	requiremen	nts increase be	low 30 kHz				

Trigger Sources — Internal and external.

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Y-axis is from the vertical input.

X-axis Deflection Factors — Variable from approx 20 mV/div to approx 20 V/div, ac or dc coupled. Dc to at least 10 kHz at —3 dB down.

Input Impedance — Approx 1 ${\rm M}\Omega$ paralleled by 62 pF.

DISPLAY

Crt — 6 x 10 div (0.6 cm/div) display. P31 phosphor normally supplied; P7 is optional without extra charge. 2 kV accelerating potential.

Graticule — Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

Z-axis Input — External blanking input requires +5 V to +20 V (dc coupled), is usable from dc to at least 100 kHz. Max input voltage 150 V (combined dc + peak ac).

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Charging: 0° C to $+40^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C.

Altitude — Operating: to 30,000 ft; decrease max temperature by 1°C/1000 ft from 15,000 ft to 30,000 ft. Nonoperating: to 50,000 ft.

Vibration — Operating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 gs at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-Std-202C. Method 106B omit freezing and vibration, and allow a post-test drying period at $\pm 25^{\circ}$ C $\pm 5^{\circ}$ C at 20% to 80% relative humidity.

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, $(\pm 1\%)$ at approx 1 kHz from $+20^{\circ}$ C to $+30^{\circ}$ C, $(\pm 2\%)$ throughout the operating temperature range. Output resistance approx 10 k Ω . Output also switchable internally to vertical amplifier.

Power Source — Internal NiCd batteries provide approx 7 hours operation at max trace intensity. Max time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger charges the internal batteries when connected to the ac line, operating or nonoperating. Front-panel light indicates when internal batteries are low. Full recharge requires at least 16 hours. A trickle charge mode prevents battery self-discharge when not in use. External dc source, 6 V to 16 V, 4.5 W, (typically 1.6 W). External ac source; 90 to 136 V, or 180 to 272 V, 48 to 440 Hz, 14 W max at 115 V.

Dimensions	in	cm
Height (with accessory pouch)	4.3	10.8
Width (with handle)	8.5	21.6
Width (with ac power cord)	9.3	23.5
Depth (handle not extended)	10.6	27.0
Depth (handle extended)	13.0	33.0
Weights (approx)	lb	kg
Net (without accessories)	7	3.2
Shipping	14	6.3

INCLUDED ACCESSORIES

One P6149 10X probe (010-6149-03), patch cord (012-0089-00), accessory pouch (016-0113-03), viewing hood (016-0247-01), power cord (161-0043-02), panel cover (200-0812-00), strap assembly (346-0051-00), blue filter (426-0811-00).

ORDERING INFORMATION

323 Oscill	oscope									
(includes	power	pack)					٠		\$1445	

INSTRUMENT OPTION

OPTIONAL ACCESSORIES

Power Pack — Extra power pack, in addition to the one supplied with the 323, allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger. Order 016-0119-02\$220

Battery Set — Set of 6 NiCd cells, Order 146-0012-01\$30

The SONY®/TEKTRONIX® 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 323 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

10-MHz Dual-Trace, Long-Term Storage Oscilloscope



1 mV/div Sensitivity at 10 MHz

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, Light Weight

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 rise time, 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.

VERTICAL DEFLECTION

Bandwidth and Rise Time — Dc to at least 10 MHz. Rise time, 36 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 $\pm 3\%$. 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 M Ω paralleled by approx 47 pF.

Max Input Voltage — ac or dc coupled, 300 V (dc + peak ac).

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base — 1 $\mu s/div$ to 5 s/div. X10 mag 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 div

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%	
$0.5~\mu s/div$ 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.

Trigger Sensitivity and Coupling

Coupling		To 1 MHz	At 10 MHz
Dc	Internal	0.3 div deflection	1 div deflection
	External	150 mV	500 mV
Ac	requiremen	nts increase be	low 30 Hz
Ac Lf Reject	requiremen	nts increase be	low 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 M Ω ±2% paralleled by approx 62 pF.

DISPLAY

 ${\bf Crt}$ — 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. Max 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.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: -15° C to $+55^{\circ}$ C. Nonoperating: -40° C to $+75^{\circ}$ C.

Altitude — Operating: to 20,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 50,000 ft max.

Vibration — Operating: 15 minutes along each of the three major axes, .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 \pm 5°C and 20% to 80% relative humidity.

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 accurate $\pm 1\%$ from 20°C to 30°C, $\pm 2\%$ from -15°C to +55°C.

Power Sources — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 29 W at 115 V. External dc source, +11 V to +14 V or +22 V to +28 V with a max current drain of 1.6 A at +12 V or 0.8 A at +24 V.

Dimensions	in	cm
Height	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	13.6	34.7
Depth (handle extended)	17.6	44.8
Weights (approx)	lb	kg
Net (without accessories)	10.5	4.7
Shipping	17.0	7.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case (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\$2385

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-30AP General Purpose C	amera\$750
Camera Adapter-Mounts C-	
Order 016-0327-00	

For further information see camera section.



5-MHz, 5 mV/div to 100 V/div Internal Battery Pack

Integral 1 M Ω probe

The 221 miniscope weighs just 3.5 pounds and easily fits into a tool box or brief case; it measures only 3 x 5½ x 9½ 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 μ s/div sweep speed (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least three 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 M Ω 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 μ s/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μ s/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 highly accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, these 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.

VERTICAL DEFLECTION

Bandwidth — Dc to 5 MHz (-3 dB point) at all calibrated deflection factors. Lower -3 dB point ac coupled is approx 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 — Approx 1 ${\rm M}\Omega$ paralleled by approx 29 pF via attached signal acquisition probe.

Max Input Voltage — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL DEFLECTION

Time Base — 1 $\mu s/div$ to 200 ms/div, accurate $\pm 3\%$.

Magnifier — Increases all sweep speeds X10 with a max sweep speed of 0.1 μ s/div.

Variable Time Control — Extends minimum sweep rate to approx 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

Mode	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 $\pm 10\%$, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

Max 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 — Approx 0.5 M Ω paralleled by approx 30 pF.

DISPLAY

Crt — 6 x 10 div (0.5 cm/div) display. P31 phosphor normally supplied; P7 optional without extra charge. 1 kV accelerating potential.

Graticule — Internal, black line, non-illuminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only), -15° C to $+55^{\circ}$ C. Charging or operating from ac line: 0°C to $+40^{\circ}$ C. Nonoperating: -40° C to $+60^{\circ}$ C.

Altitude — Operating: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one minute cycles. Held for 3 min at 55 Hz.

Humidity — 5 days at +50°C, 95% humidity.

Shock — Operating and nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide at least 3 hours operation at max trace intensity for a charging and operating temperature between $+20^{\circ}$ C and $+30^{\circ}$ 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 approx 10 V to protect batteries against deep discharge. Full recharge requires approx 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.

in	cm
3.0	7.6
5.2	13.3
9.0	22.8
lb	kg
3.5	1.6
≃8.0	≃3.6
	3.0 5.2 9.0 Ib 3.5

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, including batteries and probe\$1025

INSTRUMENT OPTION

Option 76, P7 Phosphor......No Charge

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to % in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).

Order 015-0231-00\$13

Probe-tip to BNC Panel Connector Adapter

Power Cable Adapter 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\$5.00



DMM and Miniscope in One Unit

Compact and Lightweight

True Rms Voltage and Current Measurements

Internal Battery

Rugged Construction

The 213 combines a precision 31/2 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 easily fit into your briefcase or tool kit.

In operation the light weight 213 can be hand held, rested on the equipment being tested, or carried on a convenient neck-strap. Operating controls of the 213 are designed to be easily understood and to speed measurements.

The small size and internal battery power assures that the 213 can easily make measurements at many locations often inaccessible or impractical for other, larger instruments. Rugged construction equips the 213 to withstand hostile industrial or transportation environments. Battery operation and a double-insulated case aid the operator in isolating the 213 from ground or power line when making measurements at elevated voltage.

The 213, combining both oscilloscope and DMM functions, fits a multitude of on-site service applications. To pick just one, the 213 is used extensively for preventive maintenance on industrial control systems.

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 ($-3~\mathrm{dB}$ point) for 5 mV/div and 10 mV/div. Lower -3 dB point for ac coupling is approx 1 Hz.

Deflection Factor — 5 mV/div to 100 V/div (1-2-5 sequence), accurate $\pm 3\%$. Uncalibrated; continuously variable between steps to at least 250 V/div.

Input R and C — 10 $\mathrm{M}\Omega$ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Max Input Voltage

Input Condition	Max Input Voltage
Dc coupled, 5 mV/div	500 V (dc + peak ac)
to 1 V/div	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,	800 V (dc + peak ac)
2 V/div to 100 V/div	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 μ A/div and 10 μ A/div.

Deflection Factor — 5 μ A/div to 100 mA/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 mA/div.

Max Input Current - 2 A rms or 3 A peak for any range (fuse and diode protection).

HORIZONTAL DEFLECTION

Time Base — 2 μ s/div to 500 ms/div (1-2-5 sequence), accurate ±5%.

Variable Magnifier - Increases all sweep speeds to at least X5 with a max sweep speed of 0.4 μ s/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 -

Coupling		1 MHz
Ac	Internal (auto)	0.5 div
	Internal (normal)	0.5 div
Dc	External	1 V

DISPLAY

Crt - 6 x 10 div (0.52 cm/div) display. P43 phosphor is standard.

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 \pm 40°C. Nonoperating: \pm 40°C to \pm 60°C.

Altitude - Operating: to 25,000 ft, decrease max temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 40,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, .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 - 40°C or less, 80% or less relative humidity.

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 approx 3.5 hours operation at max 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 approx 16 hours. External power source, 90 to 136 V ac (48 to 62 Hz). Option 1 allows operation from an external 180 to 250 V ac (48 to 62 Hz) or dc supply. Power consumption, 8 watts 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.

Dimensions	in	cm
Height	3.0	7.6
Width	5.2	13.2
Depth	8.9	22.6
Weights (approx)	lb	kg
Net (without accessories)	3.7	1.7
Shipping	8.6	3.9

DMM

Provides true rms readings of voltage and current.

DC AND AC VOLTAGE

Range — 0.1 V to 1000 V full scale in 5 ranges.

Resolution — 100 μ V at 0.1 V full scale.

Accuracy in Dc Mode — For $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

Range (Full Scale)		
0.1 V	$\pm 0.1\%$ of reading ± 3 counts. Temp coef is ($\pm 0.015\%$ of reading $+$ 0.04% of full scale) per °C.	
1 V	$\pm 0.1\%$ of reading ± 1 count. Temp coef is ($\pm 0.01\%$ of reading $+$ 0.01% of full scale) per °C.	
10 V and 100 V	\pm 0.15% of reading \pm 1 count. Temp coef is (\pm 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 ($\pm 0.05\%$ of reading +0.1% of full scale) per °C.

Range Within	% of read	ing 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, and 100 V	2%	1%	1%
1000 V	2%	1%	2%

^{*}Accuracy limit increases linearly for crest factor greater than 2 up to twice indicated limit for crest factor of 5.

Input Resistance — 10 M Ω

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 sec to 0.1% of reading. RMS: 2 sec to 1% of reading.

Max Input Voltage —

Dc Coupled	
0.1 V to 10 V	100 V to 1000 V
500 V (dc + peak ac)	800 V (dc + peak ac)
Ac Coupled	
0.1 V to 10 V	
800 V (dc + peak ac)	

DC AND AC CURRENT

Range - 0.1 mA to 1000 mA full scale in 5 ranges.

Resolution - 100 nA at 0.1 mA full scale.

Accuracy in Dc Mode — For 25°C ±5°C.

Temperature Coef — (\pm 0.02% of reading \pm 0.04% of full scale) per °C. 0.1 mA \pm 0.5% \pm 3 counts. 1 mA to 1000 mA \pm 0.25% \pm 3 counts.

Accuracy in Ac Mode —

Range Withi	n % of reac	ling 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 greater than 2 up to twice the indicated limit for crest factor of 5.

Settling Time — 1.5 sec to 0.1% of reading.

Max Input Current — 2 A rms or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges — 1 k Ω to 10 M Ω full scale in 5 ranges.

 $\textbf{Resolution} - \textbf{1} \ \Omega \ \text{on} \ \textbf{1} \ \textbf{k} \Omega \ \text{scale}.$

Accuracy — For 25°C ±5°C.

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 k Ω to 1 M Ω	0.5% ± 1 count
10 ΜΩ	1% ±1 count

Settling Time — 2 seconds \pm 2 counts.

READOUT

Number of Digits — $3\frac{1}{2}$ digits plus decimal point and sign.

Display Size — 1 cm high by 4 cm wide (5 characters).

Overrange Capability — At least 200% of full scale.

Overrange Indication — Readout displays scrambled characters.

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), 2 test leads (alligator clip to banana jack) (red 012-0015-00) (black 012-0014-00), neck strap (346-0104-00), 2 power line fuses (159-0080-00), power line plug adapter (option 01 only) (161-0077-01), identification tag (334-2614-00), identification tag (000-7983-00).

ORDERING INFORMATION

213 Mi	n	is	36	3	o	0	e,	/	D	N	11	VI	į	n	C	l	u	di	in	Q	1	b	a	ti	te	r	ies	an	d
probe																											. \$	152	0

POWER OPTIONS

Option 01, 180 to 250 V ac (48 to 62 Hz) or dc (includes batteries and probe)......No charge

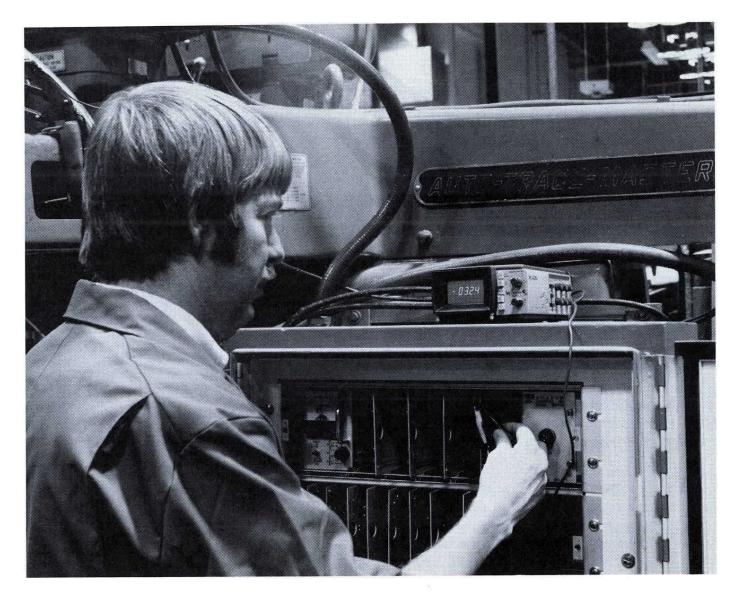
OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to 3% in) conductor. Incudes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).

Order 015-0231-00\$13	
Probe-tip to BNC Panel Connector Adapter	
Order 013-0084-01\$8	
Probe tip to BNC Cable Adapter	
Order 103-0096-00\$8	

Power Cable Adapter 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\$5





Storage (214)

Internal Battery Pack

500 kHz, 1 mV/div to 50 V/div

Integral 1 M Ω Probe

The 212 and 214 feature similar signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. Both are lightweight (only 3.5 pounds) and compact (3 x $5\frac{1}{4}$ x $9\frac{1}{2}$ inches). They differ in that the 214 offers storage capabilities. This is useful for viewing non-repetitive or slow moving signals.

Built of impact-resistant plastic and fully self-contained, these miniature portables are perfect for applications in severe environments. And they permit "floating" measurements since they are 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.

Both the 212 and 214 feature 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.

212 application examples: 1) Monitoring helicopter airframe stress, via transducers, plus monitoring other electrical signals inside the cockpit. 2) Measuring pulse widths for a manufacturer of pacemakers with variable pulse widths.

214 application examples: 1) Helping check out automobile seatbelt systems. 2) Measuring turn-off characteristics of elevator hoist motors. 3) Monitoring biomedical equipment and, via storage, viewing of low frequency physiological signals.

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 less than 2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence), accurate $\pm 5\%$. 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 (approx chop rate — 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μ s/div of time base.

Input R and C — Approx 1 $M\Omega$ paralleled by approx 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Max 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 μ s/div to 500 ms/div, accurate \pm 5%.

Variable Magnifier — Increases each sweep rate X5 with a max sweep speed of 1 $\mu s/div$.

External Horizontal Input — (Ch 1) 1 mV/div to 50 V/div \pm 10%; dc to 100 kHz: X-Y phasing to 5 kHz less than 3°. Input characteristics same as Ch 1.

Max External Horizontal Input Voltage — 50 V (dc + peak ac), 100 V (p-p).

Input Impedance — R and C, 1 M Ω paralleled by approx 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

Coupling		to 500 Hz
Dc	Internal (w/composite trigger source)	0.2 div
	Internal (w/ch 2 trigger source)	0.2 div
	External	1 V to 20 V p-p

Single Sweep — Sweep generator produces one sweep when trigger is received. (214 only)

DISPLAY

Crt — Bistable storage, 6 x 10 div (0.52 cm/div) display P44 Phosphor (214 only). P31 Phosphor (212 only).

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. Enhance is automatic from 0.1 ms to 5 μ s/div in single sweep.

Stored Luminance — At least 8 footlamberts.

Storage Viewing Time — Approx 1 hr.

ENVIRONMENTAL CAPABILITES

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: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles. Held for three minutes at 55 Hz.

Humidity — 5 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 approx 5 hours operation (approx 3.5 hours in 214 stored mode) at max 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 instruments turned off. Battery operation is automatically interrupted when battery voltage drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 10 min (5 min for the 214) 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.

Dimensions	in	cm
Height	3.0	7.6
Width	5.3	13.3
Depth	9.5	24.1
Weights (approx)	lb	kg
Net (without accessories)	3.5	1.6
Shipping	7.0	3.2

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

Oi	ADENING INFORMATION
	race Oscilloscope, including
	race Storage Oscilloscope, batteries\$1520
	POWER OPTIONS
Option 01 for batteries	220-250 V, (48 to 52 Hz) includes
	90 to 110 V, includes No Charge

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 M Ω , approx 20 pF) and higher max 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 adapter (206-0203-00).

Order	010-0378-01		30
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Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to % in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).

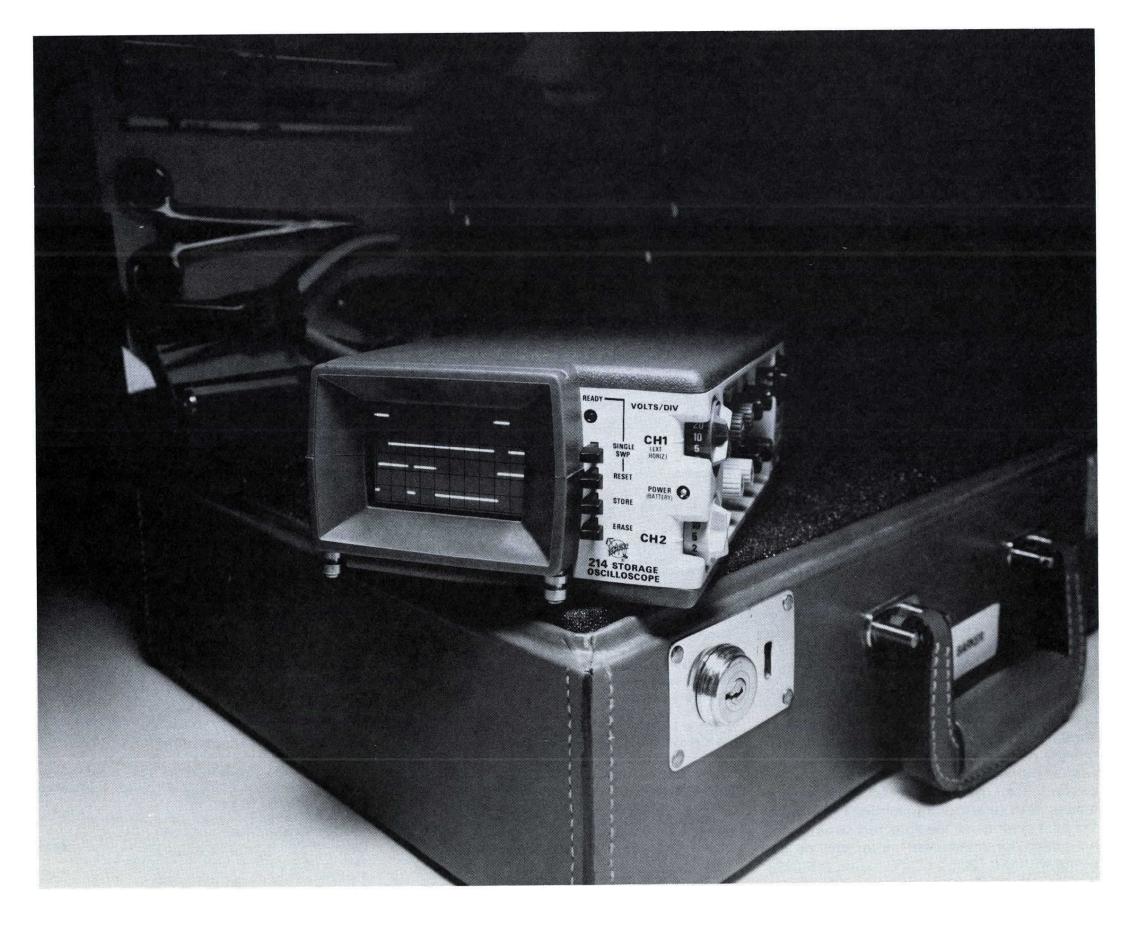
Order	015-0231-00								\$13
Oluei	013-0231-00	 	 	 		 	•		

Probe-tip to BNC F	anel Connector Adapter	
Order 013-0084-01		

Probe-tip to BNC Cable Adapter	
Order 103-0096-00	\$8

Power Cable Adapter 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.







T921 15 MHz Single-Trace Oscilloscope

Dc to 15 MHz at 2 mV/cm 20 ns/cm Sweep Rate with X10 Sweep Expander Bright (12 kV) Display Easy to Use Small and Lightweight **Regulated Power Supplies** Differential Input Option (T922 only)

The T921 (single-trace) and T922 (dualtrace) Oscilloscopes provide the basic functions of a general-purpose oscilloscope at the lowest price consistent with quality construction and reliable performance. Small and easy to operate, they are an excellent choice for the student's workbench in basic electricity, electronics, and physics classes. The same characteristics suit them well for production line applications wherever electronic components, circuits, or equipment must be tested or calibrated. In the manufacturing and servicing of consumer electronics the T921 and T922 are a cost-effective answer to most test and measurement requirements. As a signal processing, measurement and display device for dynamic transducer measurements, both oscilloscopes offer superior performance at a relatively low cost.

Although lightweight (15 lb) and small (7 x 10 x 19 inches), the T921 and T922 provide an especially bright, high resolution, 8 x 10 cm crt display. Even in high ambient light conditions, low-rep-rate signals are easily viewed. Their features shorten familiarization time and help make day-to-day measurements easier and more accurate. Functionally related controls are color coded for easy identification and grouped together for convenience. Chopped or alternate sweep modes are selected automatically to yield the best display for the selected sweep rate. An option for differential input may be ordered with the T922. In DIFF mode, the T922 displays the difference between Channel 1 and Channel 2 signals. The Channel 2 sig-



T922 15 MHz Dual-Trace Oscilloscope

nal is automatically inverted; the algebraic sum of the Channel 1 signal and the inverted Channel 2 signal is then displayed on the

Measurement accuracy of the T921 and T922 is superior to most similarly priced oscilloscopes. A twelve-step attenuator provides calibrated deflection factors ranging from 2 mV/cm to 10 V/cm. Both models offer 3% vertical amplitude and sweep timing accuracy, with minimal corner shift over a broad vertical dynamic range.

VERTICAL SYSTEM Mode Selections

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal (T922 only).

Dual Trace (T922 only) — 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 ≥ 1 ms/div, alternate for settings \leq 500 μ s/div. Trigger is derived from Ch 1 signal only.

Differential Input (T922 Option 01) - Adds Ch 1 and Ch 2 and automatically inverts Ch 2 for a differential display.

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).

Rise Time — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — ${\approx}250$

Input Resistance — \approx 1 M Ω .

Input Capacitance — \approx 30 pF.

Max 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

Delay Line - Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μ s/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 20 ns/div.

Accuracy —	Unmagnified	Magnified					
+20°C to +30°C	Within 3%	Within 5%					
0°C to +45°C	Within 4%	Within 6%					

TRIGGERING **Trigger Mode**

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.

Norm - 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. Triggers on tv line when SEC/DIV switch is set at 50 μ s 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 Norm — 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

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — \approx 1 M Ω . Input Capacitance — $\approx 30 \text{ pF}$.

X-Y OPERATION

Sensitivity, Variable Magnifier - \$\approx 100 mV/div (X10) mag), $\approx 1 \text{ V/div (X1 mag)}$.

X-Axis Bandwidth — Dc to at least 1 MHz (measured at -3 dB).

Input Resistance — \approx 1 M Ω .

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, internal graticule. Standard Phosphor - P31.

Beam Finder — Locates off screen display. Nominal Accelerating Potential — \approx 12 kV.

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 Ω .

POWER SOURCE (AC)

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 — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

ENVIRONMENTAL CAPABILITIES

Temperature Storage — -55° C to $+75^{\circ}$ C.

Operating — -0° C to $+45^{\circ}$ C.

Altitude Storage — To 15,200 meters; 50,000 feet.

Operating — To 4,500 meters; 15,000 feet max. Operating temperature decreased 1°C/304.8 meters (1,000 feet) above 1524 meters (5,000 feet).

PHYSICAL CHARACTERISTICS

Dimensions	in	cm
Height	10.0	25.4
Width	7.09	18.0
Depth	18.7	47.5
Weight (approx)	Ib	kg
Net (with panel cover)	15.5	7.0
Net (w/o panel cover)	15.0	6.8

ACCESSORIES

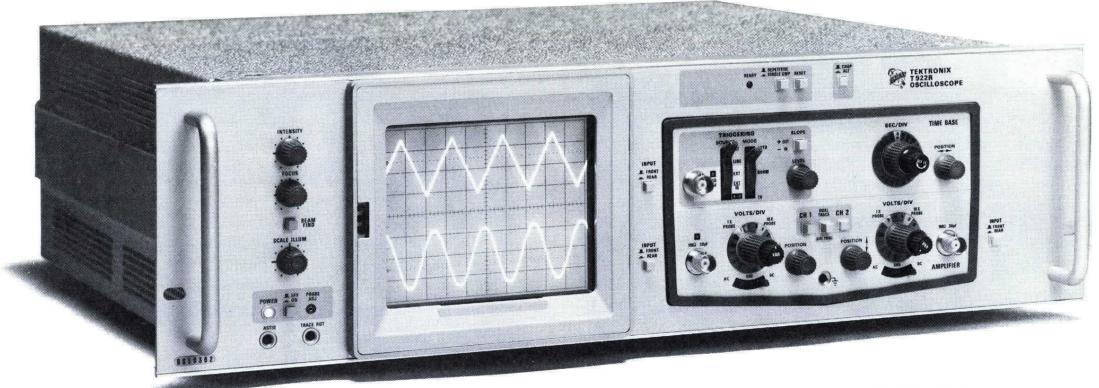
(Included as Standard Equipment)

Probe — P6006 general-purpose 10X voltage probe for each channel. Provides full bandwidth capabilities for either the T921 or the T922.

T921 - Dc to 15 MHz, Single-Trace, Mono Time Base Oscilloscope (Includes One 10X Probe)\$695

T922 — Dc to 15 MHz, Dual-Trace, Mono Time Base Oscilloscope (Includes

Two 10X Probes)\$850 Option 01, Differential Input for T922 add \$50



T922R 15 MHz Rackmount Oscilloscope

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
(51/4 x 19 x 17 in., 20 lb)
Single Sweep Operation

Bright (12kV) Display

The T922R Oscilloscope is our rackmountable version of the popular T922. In addition to standard features like its 15-MHz bandwidth at 2mV/div vertical sensitivity and its 20 ns/div maximum sweep rate with the X10 magnification control, we've added 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 19-inch (.48 m) rack and weighs only 20 pounds (9.1 kg). 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.

T922R SPECIFICATIONS

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 10V/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).

Rise Time - 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — $\simeq 250~\mathrm{kHz}.$

Input Resistance — \simeq 1 megohm.

Input Capacitance — 30 picofarads.

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 μ s/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.

TRIGGERING Trigger Mode

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.

Norm — 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 μ s 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 Norm — 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 — \simeq 1 megohm.

Input Capacitance — \simeq 30 picofarads.

X-Y OPERATION

Sensitivity, Variable Magnifier — \simeq 100 mV/div (X10 mag) \simeq 1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at -3 dB).

Input Resistance — \simeq 1 megohm.

Input Capacitance — \simeq 30 picofarads.

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 — \simeq 12 kV.

PROBE ADJUST

Output Voltage — \simeq 0.5 V.

Repetition Rate — \simeq 1 kHz.

OUTPUTS

Sweep/Gate Out — Output Voltage is \simeq 5 V positive going into 1M Ω , \simeq 50 mV into 50 Ω load.

Vertical Output — a composite of Ch 1 and Ch 2 with $\simeq 0.5$ V output per displayed division into a 1M Ω load. $\simeq 50$ mV with 50 Ω load. Bandwidth is at least 1 MHz.

POWER SOURCE (AC)

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 — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	in	cm			
Height	5.25	13.3			
Width	19	48.2			
Depth	17	43.2			
Weight	Ib	kg			
Net	20	9.1			

For environmental performance, see T922 information, page 122.

CAMERAS

T922R interfaces to all TEKTRONIX cameras.

ACCESSORIES

None included as standard equipment.

0

T922	R — D)c		to	0		1	5	I	VI	H	Z	٠,	1	D	u	al	-	T	ra	1	C	e	,	N	lo	n	0
Time	Base	٠	•	٠	•	٠	•	•	•	•	•	•	•	•	٠		•			•		•			\$1	12	20)

OPTIONAL ACCESSORIES

ackm	ount Hardware	Kit	
rder	016-0375-00		45

35 MHz Oscilloscopes



T932A 35 MHz Dual-Trace Oscilloscope



T932A 35 MHz Dual-Trace Oscilloscope with Delayed Sweep

Dc to 35 MHz at 2 mV/cm

Differential Display

Full Sensitivity X-Y

Ac and Dc Trigger Coupling

Composite, Ch 1 or Ch 2 Triggering

Selectable Chop/Alternate

Trigger Holdoff

Meet the two newest members of our T900 Oscilloscope Family — the T932A and the T935A. With these models we've added differential and full sensitivity X-Y capabilities, dc trigger coupling, a composite trigger and selectable chop/alternate display modes to the Tektronix line of low-cost portable oscilloscopes.

The T932A and T935A 35-MHz Dual-Trace Oscilloscopes are designed for cost-sensitive applications that require greater measurement capability than the T921/T922 oscilloscopes offer. Typical applications include design, production-line testing, and servicing of digital equipment such as computer peripherals, point-of-purchase data processors, numerical machine controls and consumer electronics.

Other T932A and T935A features seldom found in moderately-priced oscilloscopes include delayed sweep (the T935A) and trigger holdoff capabilites. Displayed signals that do not reveal sufficient detail on time base A sweep may be selectively expanded using the delayed sweep feature and dis-

played on the B sweep. The trigger hold-off function permits adjustment of the sweep repetition frequency without changing sweep time per centimeter. Both features are valuable measurement aids, especially in digital design and service applications.

When making measurements which require delayed sweep, the T935A is the logical choice. Except for this feature, it is identical to the T932A.

VERTICAL SYSTEM Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Chop — Displays Ch 1 and Ch 2 signals simultaneously (chop rate 250 kHz), triggers on Ch 1 or Ch 2 signal.

Alt — Displays Ch 1 and Ch 2 signals alternately, triggers on Ch 1 or Ch 2 signal.

Diff — Displays difference between Ch 1 and Ch 2 signal; Ch 2 automatically inverted, trigger signal automatically derived from the Crt display.

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 35 MHz (measured at -3 dB).

Rise Time — 10 ns or less.

Chopped Mode Repetition Rate — \approx 250 kHz.

Input Resistance — \approx 1 M Ω .

Input Capacitance — \approx 30 pF.

Max Input Voltage — Dc Coupled, 250 V (dc + peak ac) at 1 kHz or less. Ac Coupled, 250 V (dc + peak ac) at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM Calibrated Range

A Sweep — 0.5 s/div to 0.1 μ s/div in 21 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

B Sweep — (T935A only) 50 ms to 0.1 μ s/div in 16 steps in a 1-2-5 sequence. Varriable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

Delay Time Position Range — (T935A only) 0.5 to 10 div (uncalibrated).

Delay Time Jitter — (T935A only) One part or less in 10,000 (0.01%) of ten times the SEC/DIV switch setting.

TRIGGERING Trigger Mode

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.

Norm — 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. Triggers on tv line when SEC/DIV switch is set at 50 µs or faster.

 $\label{eq:Slope} \begin{array}{l} \textbf{Slope} \, + \, \textbf{Out} \, - \, \textbf{In} \, - \, \textbf{Sweep is triggered on the positive/negative-going slope of the triggering waveform.} \end{array}$

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Holdoff — Permits adjustment of time interval between end of sweep and next acceptable trigger to achieve stable displays of complex words.

more on next page.

Coupling

Ac (switch out) — Blocks dc (<60 Hz) component of triggering signal and allows triggering on ac portion of signal.

Dc (switch in) — Passes all components of triggering signal from dc to at least 35 MHz.

Trigger Source

Comp (composite) — Trigger signal is derived from the displayed vertical signal.

Ch 1/Ch 2 (internal) — Trigger signal is derived from either the Ch 1 or Ch 2 signal as described in the vertical mode section.

Line — Trigger signal is derived from the line voltage frequency.

Ext (external) — Trigger signal is derived from the signal applied to the external trigger input.

Ext/10 (external \div 10) — External signal is attenuated by a factor of 10.

X-Y — Permits X-Y displays when Ch 2 vertical button is depressed.

Trigger Sensitivity

Auto and Norm -

Ac — 0.5 div internal or 100 mV external from 60 Hz to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

Dc — 0.5 div internal or 100 mV external from dc to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

TV — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

 ${f Max\ Input-400\ V\ (dc\ +\ peak\ ac)\ 800\ V\ p-p\ ac\ at\ 1\ kHz\ or\ less.}$

Input Resistance — \approx 1 M Ω .

Input Capacitance — pprox 30 pF.

X-Y OPERATION

(Ch 1-X, Ch 2-Y)

Sensitivity - Same as Ch 1 and Ch 2.

Accuracy — 20 to 30°C—5%. 0 to 45°C—6%.

X-Axis Bandwidth — Dc to at least 2 MHz (measured at -3 dB).

Input Resistance — \approx 1 M Ω .

Input Capacitance — \approx 30 pF.

Phase Difference between X and Y Axis Amplifiers — Within 3° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, internal graticule.

Standard Phosphor - P31.

Beam Finder — Locates off-screen displays.

Nominal Accelerating Potential — \approx 12 kV.

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 Ω .

POWER SOURCE (AC)

Line Voltage Ranges — HI—LO range accessible externally; 110-120V, 220-240V 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 — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

For environmental performance, weights and dimensions, see T922 information on page 122.

ACCESSORIES

(Included as Standard Equipment)

Probes — 2 each. P6108 general-purpose 10X voltage probe provides full bandwidth capability for either the T932A or T935A.

ORDERING INFORMATION

T932A — Dc to 35 MHz, Dual Trace, Mono Time Base Oscilloscope (Includes Two 10X Probes).....\$1155

T935A — Dc to 35 MHz, Dual-Trace, Mono Time Base (with Delayed Sweep) Oscilloscope (Includes Two 10X Probes) \$1435 10 MHz Oscilloscope with Storage



T912 10 MHz Oscilloscope with Storage

250 cm/ms Stored Writing Speed Dc to 10 MHz at 2 mV/cm 50 ns/cm Sweep Rate (with X10 Sweep Expander) 8 x 10 cm Bistable Storage Crt **Small and Lightweight**

Differential Input Option

The T912 Storage Oscilloscope is wellsuited 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 chamber of an engine or the stressstrain 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 servomechanisms, shock and vibration analysis, and countless other transduceraided measurements.

Besides bistable storage, the T912 offers other features seldom found in economymodel oscilloscopes. These include a delay line, which allows you to view the leading edge of fast-rising signals; a 12step calibrated vertical attenuator; constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimeter; 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.

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 μ 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 0°C to +45°C

Within 3% 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).

Rise Time — 35 ns or less.

Chopped Mode Repetition Rate — \simeq 250 kHz.

Input Resistance — \simeq 1 M Ω .

Input Capacitance — \simeq 30 pF.

Max 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

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.5 μ s/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max 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%			

TRIGGERING Trigger Mode

Auto - Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "freeruns" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz.

Norm — 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

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Sensitivity

Auto and Norm - 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

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — \simeq 1 M Ω .

Input Capacitance — \simeq 30 pF.

POWER SOURCE (AC)

Line Voltage Ranges - 100-120 V, 220-240 V line voltage and HI/LO range are accessible extern-

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 - Watts (max) 65, amps (max) 0.6, at 120 V, 60 Hz.

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 — $\simeq 2.76$ kV.

PHYSICAL Weight

With Panel Cover and Accessories - 18.0 lb (8.2 kg).

Without Panel Cover and Accessories — 17.5 lb (7.9 kg).

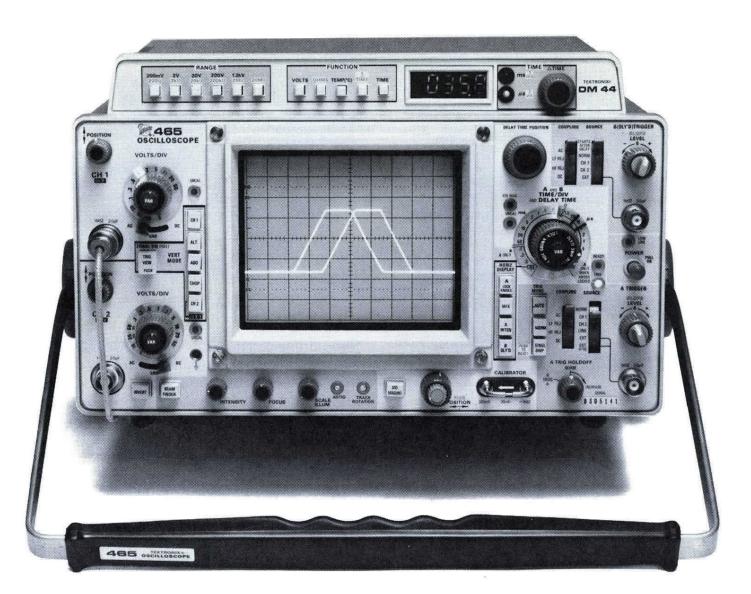
For X-Y operation, environmental performance and dimensions, see T922 information on page

ACCESSORIES

(Included as Standard Equipment)

Probes - 2 each. P6006 general-purpose 10X voltage probes. Provides full bandwidth capabilities for the T912.

T912 — Dc to 10 MHz, Dual-Trace, Single Time Base Storage Oscilloscope (Includes Two 10X Probes). \$1350 Option 01, Differential Inputadd \$50



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 31/2 digit LED screen. Simply use the Delay Time control and the Δ time dial to position intensified spots at the beginning and end of the interval you wish to measure(A). Next, switch to delayed sweep and use the Δ time dial to superimpose the end of the interval on the beginning (B). Then read its differential time or frequency on the LED panel (C). 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, 465, 466, 475 and 475A Portables. It adds Delta Delayed Sweep and independent DMM capabilities to these 400-Series Scopes. First, consider your bandwidth, sensitivty, 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 t	to +55°C
used with 464, 465, 466, 475, and 475A	used with 464, 465, 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 —	T COUNT	r count

1/Time Accuracy —		
+15°C to +35°C	-15°C	to +55°C
used with 464, 465, 466, 475, and 475A	used with 464, 465, 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 μ V.

Accuracy — Within 0.1% of reading \pm 1 count.

Input Resistance — 10 $M\Omega$ for all ranges. Removal of an internal strap increases resistance to approximately 1000 $M\Omega$ 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 — Approximately 3.3 measurements/s. Response Time — Within 0.5 s.

Maximum Safe Input Voltage — \pm 1200 V dc + peak ac between + and common inputs or between + and chassis. \pm 500 V (dc + peak ac) common floating voltage between common and chassis.

Resistance

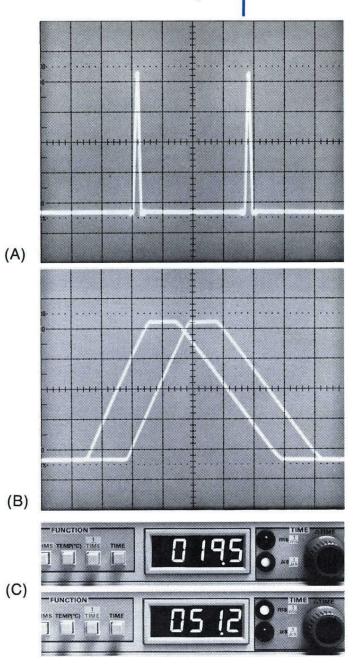
Ranges — 0-200 Ω , 0-2 k Ω , 0-20 k Ω , 0-200 k Ω , 0-2 M Ω and 0-20 M Ω .

Resolution — 0.1 Ω .

Accuracy —

Range	Accuracy
200 Ω	within 0.25% ± 1 count + probe resistance
2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω	within 0.25% \pm 1 count
20 ΜΩ	within 0.3% ±1 count

Recycle Rate — Approximately 3.3 measurements/s.



Response Time —

200 Ω through 200 k Ω ranges	within 1 s	
2 MΩ ranges	within 5 s	
20 M Ω ranges		

Maximum Safe Input Voltage — 120 V rms between + and common inputs.

Temperature Using P6430 Probe

Range — -55°C to +150°C

Accuracy —

		Accı	ıracy
DM 44 Temp	P6430 Tip Temp	probe calibrated to DM 44	probe not calibrated to DM 44
+15°C to +35°C	−55°C to +150°C	±2°C	±6°C
−15°C to	−55°C to +125°C	±3°C	±8°C
+55°C	+125°C to +150°C	±4°C	±8°C

ORDERING INFORMATION

465 DM 44		*********	. \$2740
475 DM 44			. \$3640
475A DM 44	(Order 4	75A Option 44)	. \$4000
466 DM 44 .		********	\$5340
464 DM 44 .			. \$4565

Option 01, delete temperature probe
(for 475A order Option 45)Subtract \$85

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 Field Engineer, Distributor, or Representative for information.



Battery Packs

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 - Square wave, 60 Hz ±10%.

Amplitude — Approx 108 V peak, operating from 24 V dc external or 22 V internal charge. Approx 137.5 V peak, operating from 28 V dc external or 30 V internal charge.

Amplitude (Option 01) — Approx 216 V peak, from 24 V dc external or 22 V internal charge. Approx 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 — Approx 140 VA hours.

Recommended Max Output Current — 0.9 amp.

Weight - 19.5 lb.

Order: 1105 Battery Power Supply....\$845
Option 01, 230 V Operation......No Charge



1106 BATTERY PACK

The 1106 is a convenient, snap-on battery power supply for TEKTRONIX 455, 464, 465, 466, 475 or 475A Oscilloscopes when the scope is ordered with Option 07

Output Power — 22 to 26 V dc; 140 watt-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 — 16 lb.

Order: 1106 Battery Pack......\$585

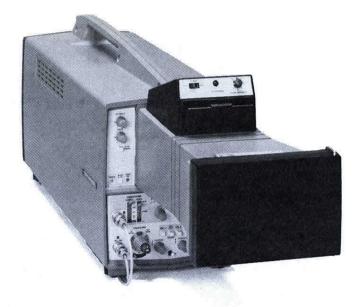
T900 Accessories

209 SCOPE STAND

Supports any benchtop T900 Oscilloscope at convenient angle for viewing and easy access to controls. Quickly disassembled, it forms a lightweight (3 lb) package that can be neatly attached to the bottom of the oscilloscope for easy carrying. Consists of a molded plastic base, support bracket, and a 15 in aluminum support column.

Order: 209 Scope Stand \$70





C-5B CAMERA

Recommended for all T900-Series Oscilloscopes, the C-5B attaches directly to the front panel without adapters and uses Polaroid pack film. A fixed f/16 lens aperture and an electric shutter with continuously variable speeds from .1 to 5 seconds combine to make the C-5B a rugged, low-cost scope camera. Bench model T900 Oscilloscopes use the C-5B 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-5B Option 01, without the Xenon flash. Batteries are not included for either version.

Order:	C-5B, Option	03.	 70.00		٠			. \$300
	C-5B. Option	01.	 	 				\$265

VIEWING HOOD

Provides for convenient viewing in high ambient light conditions.

Order: Viewing Hood (016-0377-00)...\$6.10

PROTECTIVE COVERS

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.

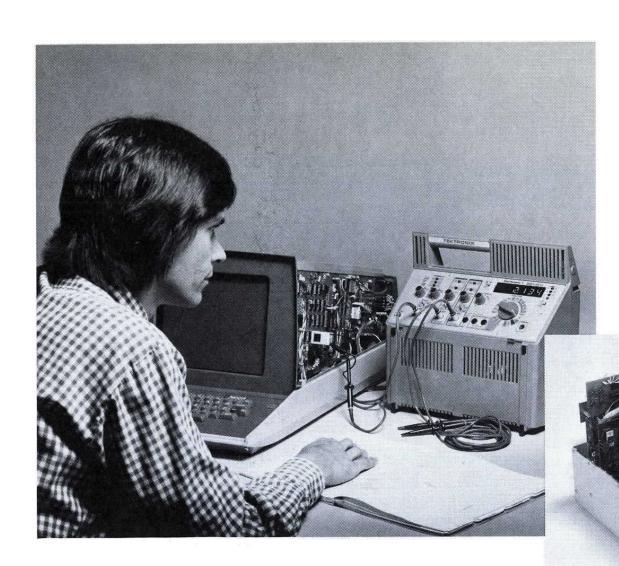
Order: Protective front cover (016-0340-00)\$18



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: Protect	IV	е	(C	O	/6	ì														
(016-0361-00)	•		٠	•		٠	•	•	•	•	٠	•	•	•	ě	•	•	ě		\$ 1	



Digital Service Instruments

New Concepts in Digital Service



Digital Service Instruments

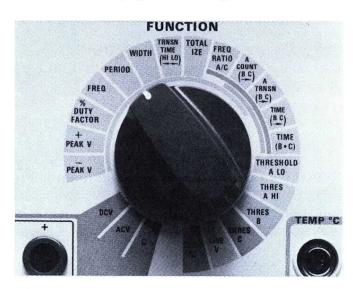
Designed for digital field service applications.

Single Knob Selects 22 Functions
Autoranging On All Functions
LED Display
Logic State Indicators for Each Channel
Built-in Self Test
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 13 pounds, 6 kg), 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.



Dial 22 different functions with the turn of this one knob.



851 DIGITAL TESTER FUNCTIONS

	PI DIGITAL TEOTER TOROTTO	.0
MEASUREMENTS	DIGITAL SIGNAL ANALYSIS	SELF TEST
VOLTAGE PEAK (10 ns to 25 ms) AC DC POWERLINE INPUT LOGIC THRESHOLDS RESISTANCE (0.1 Ω to 50 MΩ) TEMPERATURE TIME (20 ns to 10 s) PERIOD FREQUENCY PULSE WIDTH INTERVAL COINCIDENCE TRANSITION	LOGIC STATE INDICATORS HI, LO, INVALID, ACTIVE % DUTY FACTOR COUNTING FREQUENCY RATIO EVENTS BETWEEN START AND STOP PULSES TRANSITIONS BETWEEN START AND STOP PULSES TOTALIZE	TEST SIGNAL EXERCISE FUNCTIONS ADJUST PROBE READOUT TEST

All together, these functions allow you to:

measure system parameters.

check for signal activity.

correct synchronization problems in electro mechanical subsystems through adjustment or repair.

identify boards or component parts of the system in need of replacement.

It's easy. Just dial a function, probe the circuit being examined, and read the results directly from the five-digit LED display (4½ digits for DMM functions). All the functions are completely autoranging and the indicator lights tell you exactly what range is being used.

The capabilities of the 851 make it particularly suitable for servicing computer peripherals, small business systems, and industrial control equipment.

Electrical

Inputs

(ACV, DCV, Ω)

Resistance and Capacitance — 10 M Ω ±1% and approx 100 pF. Red to black terminal. (Volts only)

Max Safe Input Voltage (≤1 kHz) —

±500 V (peak) red terminal to ground.

±500 V (peak) black terminal to ground.

±500 V (peak) red to black terminal.

 \pm 250 V (peak) red to black terminal in Ω function.

Resistance

Ranges — 200 Ω , 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω , and 50 M Ω .

Accuracy -

200 Ω , 2 k Ω , 20 k Ω , 200 k Ω : $\pm 0.3\%$ of reading ± 4 counts (plus probe resistance).

2 M Ω : $\pm 0.5\%$ of reading ± 4 counts.

20 M Ω : $\pm 5\%$ of reading ± 10 counts.

50 M Ω : $\pm 10\%$ of reading ± 20 counts.

Extended temperature range: add 0.2% on 200 Ω through 2 M Ω and 5% on 20 M Ω and 50 M Ω ranges.

AC Volts

(Average responding RMS calibrated for sine wave.)

Ranges - 2 V, 20 V, 200 V, and 350 V.

Accuracy —

2 V and 20 V:

 $\pm 0.5\%$ or reading ± 4 counts, 40 Hz to 1 kHz. $\pm 2\%$ of reading ± 4 counts, 1 kHz to 25 kHz. > 9% full scale.

200 V and 350 V:

 $\pm 0.5\%$ of reading ± 4 counts, 40 Hz to 1 kHz. Extended temperature range: add $\pm 0.2\%$.

DC Volts

Ranges - 2 V, 20 V, 200 V, and 500 V.

Accuracy —

2 V, 20 V and 200 V: $\pm 0.1\%$ of reading ± 3 counts. 500 V: $\pm 0.15\%$ of reading ± 3 counts. Extended temperature range: add $\pm 0.05\%$.

Normal-Mode Rejection Ratio

(Dc volts) — \geq 60 dB at 50 to 60 Hz. For peak amplitude \leq 5X full scale.

Common-Mode Rejection Ratio

(Ac and Dc volts) — $\geq\!\!80$ dB at dc; $\geq\!\!60$ dB at 50 to 60 Hz; $\geq\!\!52$ dB on 350 V.

Line Voltage

Range — 90 to 132 V and 180 to 250 V.

Accuracy — $\pm 3\%$ of reading.

Temperature

Range — -55° to $+150^{\circ}$ C.

Accuracy — $\pm 2^{\circ}$ C (0.01° resolution). Extended temperature range: add $\pm 1^{\circ}$ C.

Inputs

(3 probes; one for each channel A, B, C.)

Resistance and Capacitance — 10 M Ω and approx 12 pF

Max safe input voltage — ± 500 V at probe tip (≤ 50 kHz)

Threshold Levels

Variable (4 controls) range: ± 30 V; settability ± 10 mV.

TTL (nominal, in detent position) — Input A LO \pm 0.7 V; HI \pm 2.1 V; Input B and C \pm 1.4 V.

Threshold Error — (Max difference between a displayed threshold voltage or TTL threshold voltage and the actual signal voltage at threshold crossing.) A Input (HI and LO THRESHOLDS): ± 100 mV $\pm 2\%$ of threshold voltage $\pm 3\%$ of the signal voltage (p-p) for pulses at least 14 ns wide at the threshold. B and C inputs: ± 100 mV $\pm 2\%$ of threshold voltage $\pm 8\%$ of the signal voltage (p-p) for pulses at least 14 ns wide at the threshold.

Extended temperature ranges: add ± 20 mV $\pm 2\%$ of signal voltage (p-p).

Input Filter

(Narrow pulse rejection) max input rep rate for pulse rejection = 20 MHz.

Range — off and 50 ns \pm 20% to >300 ns. Channel to channel delay mismatch: <100% of setting.

+, - Peak Volts

Range — $\pm 30 \text{ V}$.

Accuracy — $\pm 2\%$ of reading $\pm 3\%$ of p-p signal ± 90 mV. Max time between recurrent peaks, 25 ms. Peak amplitude must be maintained for at least 25 ns. Extended temperature range: add $\pm 1\%$ of reading $\pm 1\%$ of p-p signal ± 10 mV.

Frequency

 ${f Ranges}$ — 100 kHz (1 Hz resolution), 1 MHz, 10 MHz, and 35 MHz.

Accuracy — $\pm 0.005\%$ 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 — $\pm 0.005\%$ of reading ± 1 count \pm Trigger Error.

Trigger Error —

± Threshold Error

dv/dt of signal2 at time start threshold

threshold Error

dv/dt of signal2 at time stop threshold

Input filter setting

Counting

(Totalize, frequency ratio, events count, and transitions count.)

Range — 0 to 99,999

Max Input Frequency — 35 MHz (except 17.5 MHz for transition counting).

Accuracy — ± 1 count, $\pm A$ Input event or transition frequency multiplied by the Time Interval Trigger Error3.

Duty Factor

Range — 0 to 100%

Input Freq Range — 40 Hz to 10 MHz.

Min pulse width (HI and LO portions) - 50 ns.

Accuracy —

$$\pm 3\% \pm \frac{\text{Trigger Error}_3 \times 100}{\text{Pulse Period}}\%$$

$$\pm \frac{300 \text{ ns}}{\text{Pulse Width}}\%$$

Display

Readout

negative readings.

Type — 5 digits, fully buffered. 7 segment, 0.5" LEDs. Polarity Indication — + for positive readings. — for

Overrange Indication — Display flashes.

UP Ranging — Up ranging occurs at 100% of display range.

Down Ranging — Down ranging occurs at 9% of volts and ohms ranges, and 8% of time and frequency.

Range Indicators — LEDs show function ranges in Ω , $k\Omega$, $M\Omega$, MHz, kHz, ms, μ s 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).

Mechanical

Dimensions (approx)	cm	in
Width	33	13
Height	31	12
Depth	18	7
Weight	kg	lb
Net	6	13

Power Requirements

Line Voltage Range - 90 to 132 V or 180 to 250 V.

Frequency — 48 Hz to 440 Hz.

Power Consumption — 57 watts max.

Environmental Capabilities

Ambient Temperature — Operating: $+15^{\circ}$ C to $+40^{\circ}$ C. Nonoperating: -40° C to $+75^{\circ}$ C. Extended operating range: $+5^{\circ}$ C to $+50^{\circ}$ C.

Altitude — Operating: to 10,000 ft. Nonoperating: to 35,000 ft.

Vibration — Operating: 15 minutes along each of the 3 major axes, .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, ½ sine, 11 ms duration, each direction along each major axis. Total of 12 shocks.

EMI — Reference Mil Standard 461A-462 susceptibility as specified. Conducted emission, relax 10 dB. Radiated emission, relax 15 dB <100 MHz and relax 25 dB \geq 100 MHz.

See Threshold Error under Threshold Levels.

²Refer to the appropriate input (CH A, CH B, or CH C) for the measurement being made.

3See Trigger Error under Time Measurements.

INCLUDED ACCESSORIES

Three signal probes (010-0280-00), two DMM probes (012-0732-00).

ORDERING INFORMATION

851 Digital Tester\$2055

INSTRUMENT OPTION

Option 01 (with temperature probe)......Add \$125

OPTIONAL ACCESSORIES

Temperature Probe —
Order 010-6430-00\$125
Rain Jacket —
Order 016-0639-00\$15

Digital Service Instruments Literature Available

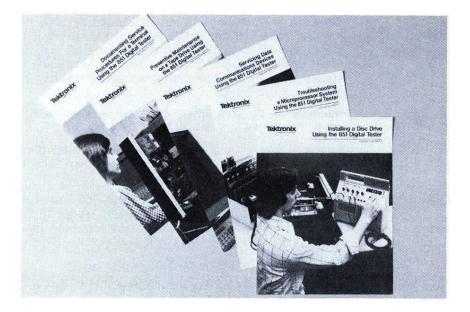


851 Digital Tester Brochure

The 851 Digital Tester is described in this 12-page color brochure. The multifunctional 851 Digital Tester is a new concept in service instruments and was developed to meet the needs of the digital service industry for a first-line tester. The brochure ranges from a discussion of the new concept and an overview of the benefits of the 851, to a more detailed description of the functions, features, and some typical applications. (Order A-3626 for U.S., X-3626 outside U.S.)

851 Digital Tester Applications Folder

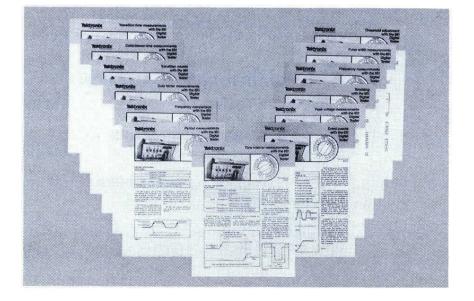
For more detailed information about the 851 Digital Tester, the Applications Folder contains a data sheet, pocket guide, 13 technique briefs, each explaining one of the 851 Digital Tester functions, and five applications notes. (Order A-3572-1 for U.S., X-3572-1 outside U.S.)



Application Notes

Five application notes are presently available to give you technical information about how to use the 851 Digital Tester. This packet contains the following notes:

- 1. Documenting Service Procedures for a Terminal Using the 851 Digital Tester.
- 2. Preventive Maintenance on a Tape Drive using the 851 Digital Tester.
- 3. Installing a Disc Drive Using the 851 Digital Tester.
- 4. Troubleshooting a Microprocessor System Using the 851 Digital Tester.
- 5. Servicing Data Communications Devices Using the 851 Digital Tester.



Technique Briefs

The 13 Technique Briefs explain how to make 13 different measurements with the 851 Digital Tester including period, pulse width, frequency, peak voltage, transition time, etc.

The briefs give detailed instructions on each measurement and how to set the controls on the 851 for a particular measurement.



Data Sheet and Pocket Guide

For complete specifications on the 851 Digital Tester, a detailed data sheet is included in the Applications Folder. (Order A-3571-1 for U.S., X-3571-1 outside U.S.)

The Pocket Guide includes an illustration of the front panel of the 851 Digital Tester. All the controls, connectors, and indicators are described.

Also, the 22 functions on the function knob are described in the Pocket Guide. (Order AX-3579-1)

To order any of the above literature, use the reply card at back of catalog or contact your local Tektronix Field Engineer or Representative.

TM 500

a complete family of test and measurement instruments

134-137 concepts 138-141 digital counters 142-143 digital multimeters 144-146 pulse generators 147-149 function generators audio/miscellaneous generators 150-151 152-153 calibration instruments 154-155 power supplies 156-158 signal processors 159-161 oscilloscopes digital delay & logic analyzer 162-163 164-165 mainframes and carts 165-169 accessories

TM 500 is a complete family of plug-in test and measurement instruments. Over forty modular instruments and six compact mainframes combine to make TM 500 a performance-packed, highly versatile family.

TM 500 functions run the gamut from DMMs to Word Recognizers. Yet all are related by their mechanical and electrical configurability and, since they are related, they share the same "family" name, TM 500.

They cover a wide range of general purpose and specialized applications, too. With TM 500 instruments and mainframes, multifunction packages can be created to encompass thousands of applications.

When it comes to talent, it's all in the TM 500

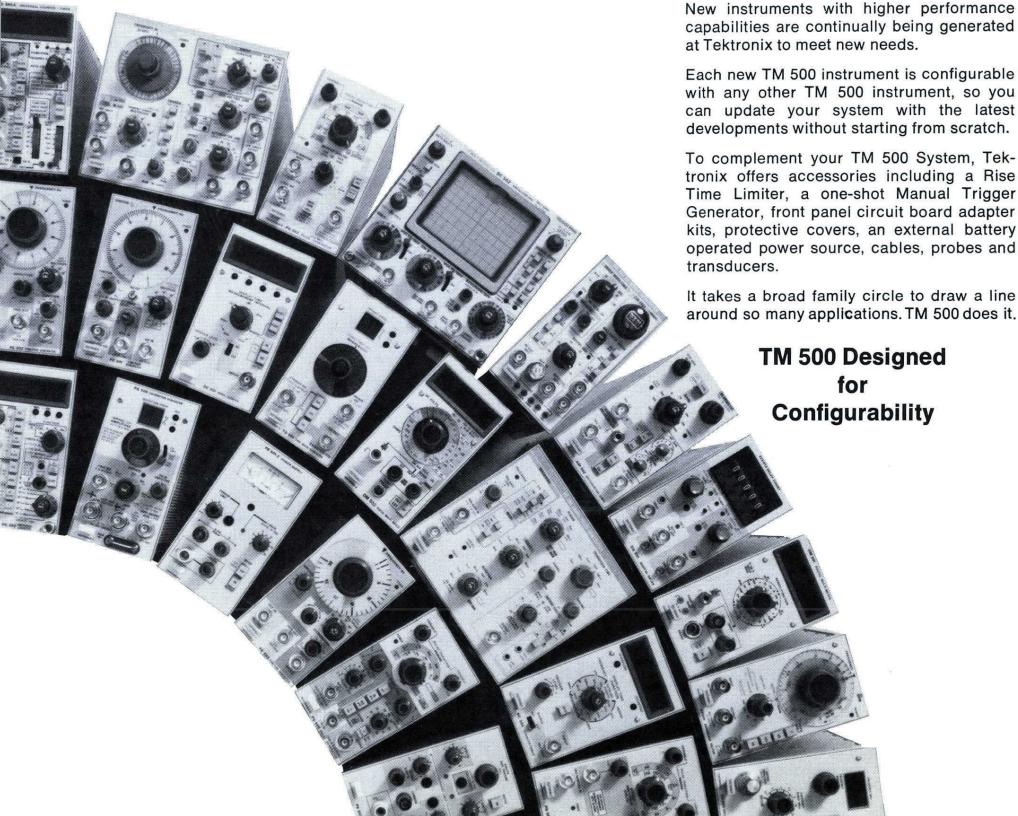
TM 500 is also a growing family.

New instruments with higher performance capabilities are continually being generated

Each new TM 500 instrument is configurable with any other TM 500 instrument, so you can update your system with the latest developments without starting from scratch.

tronix offers accessories including a Rise Time Limiter, a one-shot Manual Trigger Generator, front panel circuit board adapter kits, protective covers, an external battery operated power source, cables, probes and transducers.

It takes a broad family circle to draw a line around so many applications. TM 500 does it.



TM 500 Concepts

"Configurability" means a mouthful.

When the TM 500 approach to test and measurement instrumentation was developed, we combed the dictionary for one word that might describe it.

Though it was unique, it seemed like a simple concept: A variety of compact, interchangeable instruments that could easily function individually or in combination.

Several words came close to describing this idea. One was **modularity.** Each TM 500 instrument — whether a multimeter or power supply, oscilloscope or logic analyzer — is designed as a plug-in module to fit into TM 500 Mainframes. Instruments are interchangeable in seconds so you can slip together a system for one test, then rematch the set using other modules for a completely different application. Nearly 40 different TM 500 instruments are available.

But modularity didn't say enough.

Integrated seemed to get several ideas together. The back of each TM 500 Plug-in has connectors which slide into the connectors of the mainframe's "mother board." The "mother board" allows the user to interface the plug-ins with one another and with other devices external to the mainframe.

We also considered **flexibility.** TM 500 Mainframes can be racked, stacked or rolled around on TEKTRONIX Lab Carts. You can pack up to 5 instruments in a TM 515 Traveler Mainframe which looks (and fits under the seat) like a handsome carry-on flight case. But no single word captured the most popular features of the TM 500 concept, namely the ability to mix and match several mechanically and electrically interfaced instruments quickly and conveniently.

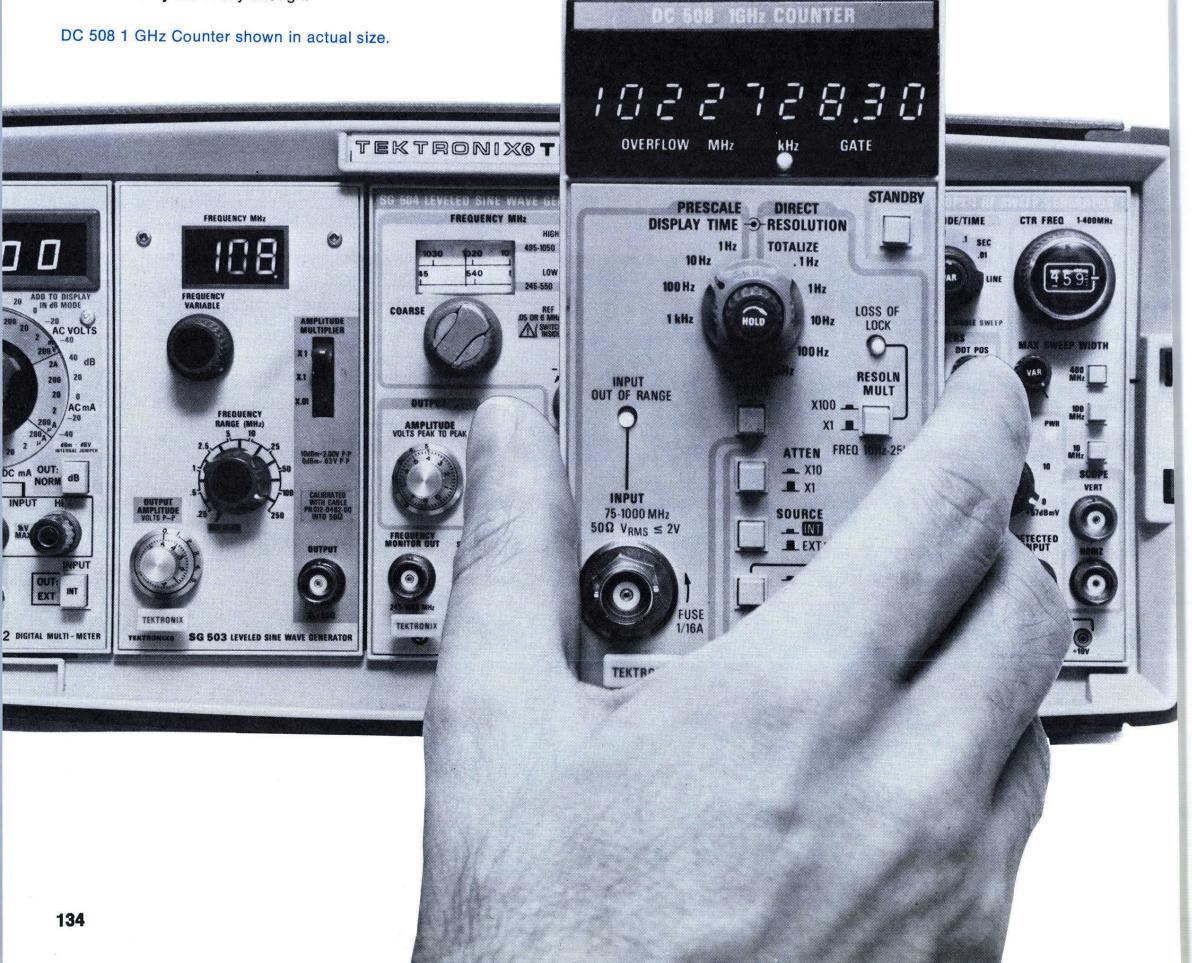
So, we forged our own word.

For testing and measuring, **configurability** means just about everything: A logic analyzer with digital delay. A plug-in oscilloscope with function generator, counter/timer and digital multimeter. You name it. The combinations run into the hundreds.

Exactly what configurability can mean to you is something to figure out for yourself.

At any rate, you might just add it to your vocabulary so the next time you get caught up in benchwork or run short of plugs on the floor, you'll be able to describe, in one word, exactly what you need.

TM 500 Configurability.



Lots of plug-ins, not a lot of plugs.

Let's start with your work bench.

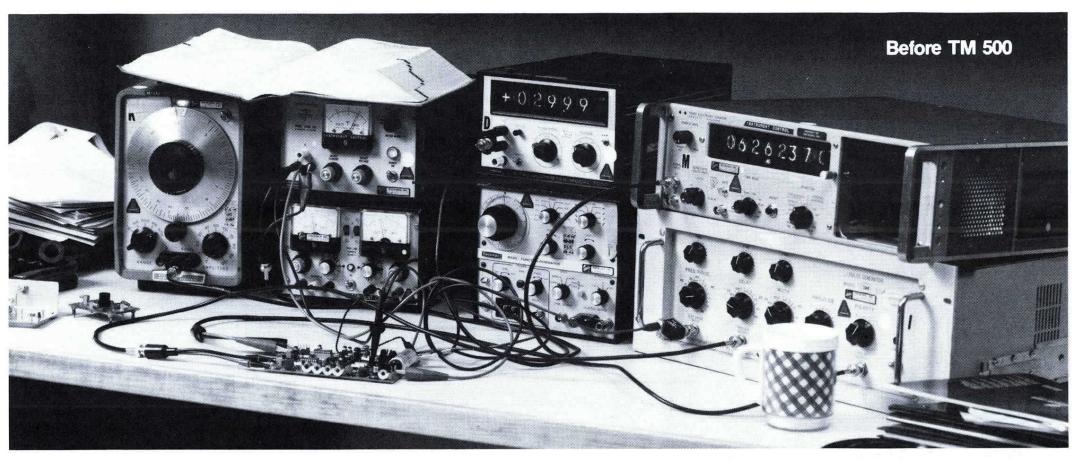
If you're plugging along with a bench-load of single-function instruments that necessitate picking your way through a maze of spaghetti to set up for a test, maybe it's time to do some spring cleaning.

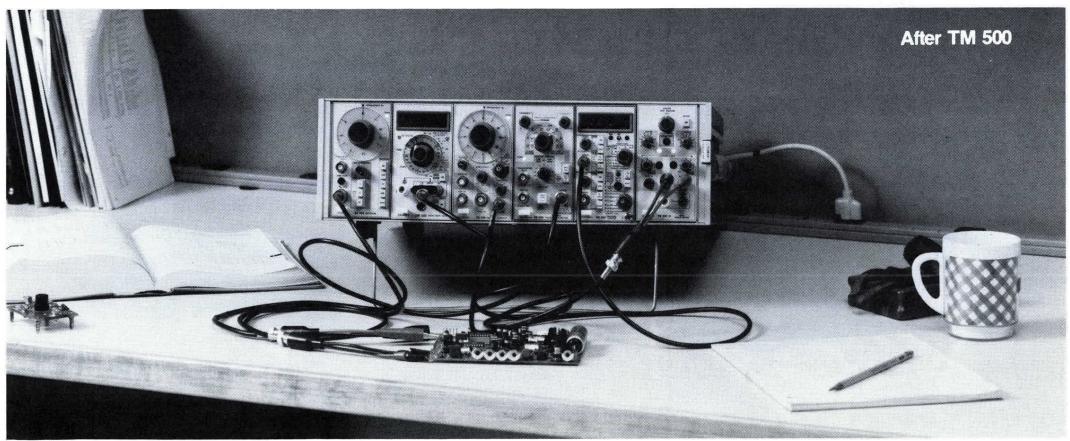
With the TM 500, you can load up to 6 modular instruments in a single mainframe and build a custom system of instrument interfacing. You can focus on the task to be performed, instead of getting sidetracked with set up.

You'll save time and clutter when you have the ability to configure, in seconds, a variety of systems for testing and measuring. You can combine everything from state-of-the-art function generators to workaday digital multimeters to oscilloscopes and word recognizers. And, if you're keeping a close measure on costs, remember that a significant part of the price of every single-function instrument is its power supply. But with TM 500, one power supply is shared by several instruments, so you can add on more performance capabilities for less money.

Through electrical configurability and mainframe interfacing, you can create an instrument more powerful than the sum of its parts, like combining two pulse generators with a digital delay module to create a logic system with self-contained burst generation. TM 500 configurability not only allows you to choose from nearly 40 ready-to-go, compact plug-ins for testing and measuring, but the mainframe also makes room for compatible custom plug-ins you assemble yourself with a TM 500 custom Plug-in Kit.

TM 500 electrical configurability is a neat idea in other ways, too. It gives you lots of plug-ins, not a lot of plugs.





TM 500 Concepts

Instrumentation a la carte

Whether your daily rounds include routine checks on the production floor, periodic R & D measurements at the bench, quality control inspection of in-coming components or on-site customer maintenance, there's a TM 500 Mainframe that gets all your instrumentation together and keeps it close at hand.

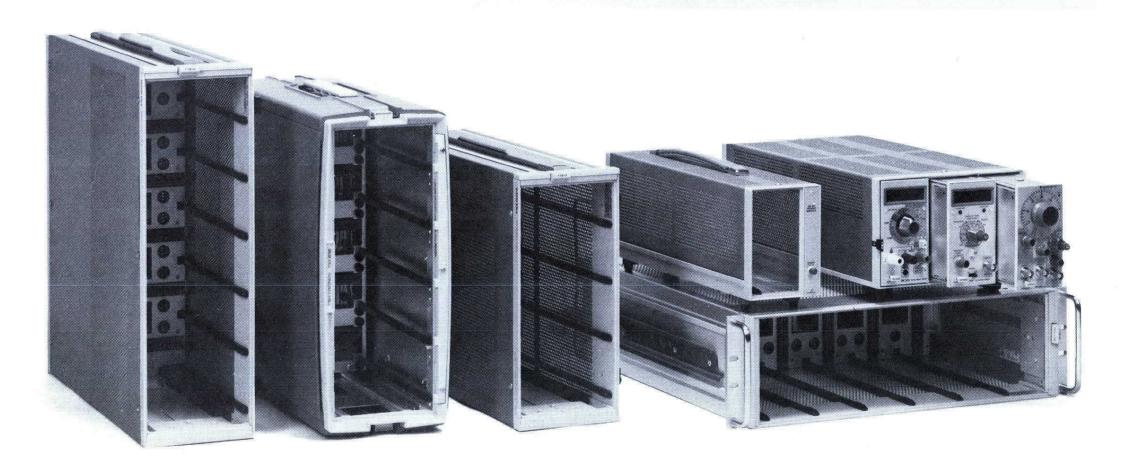
TM 500 instruments slide into any one of several power-module mainframes, available in six versions accepting one instrument or combinations of up to six.

Benchtop models, fitted with tilt bails and front panel switches, also sport a toughtested handle and cord-wrap feet, providing a fair amount of portability, especially if you pick up an optional protective front cover.

If you're set up with a rack or console arrangement, TM 500 Rackmount Mainframes feature a slide out assembly, lateral grips, and powerful ventilation fan.



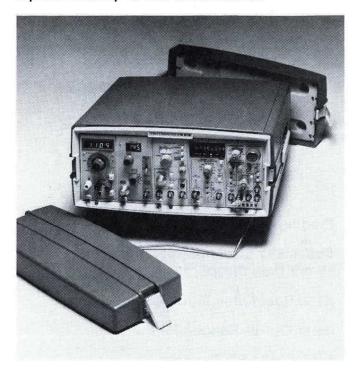


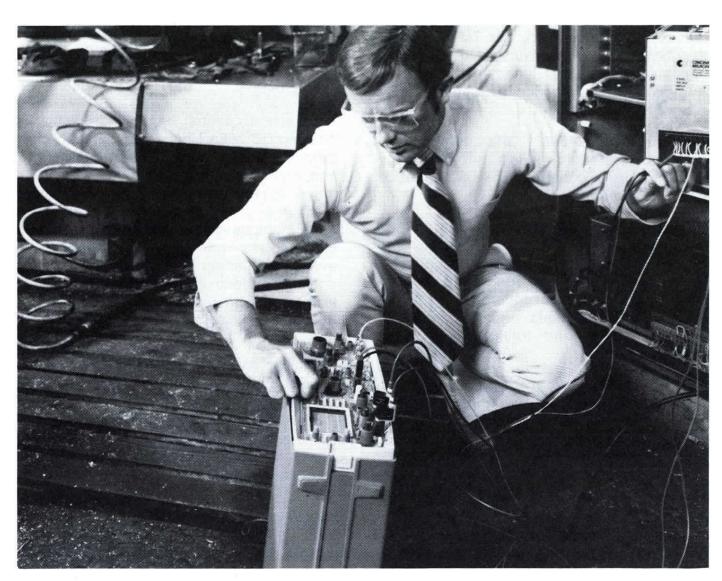


Ultimate Portability—TM 515

The ultimate in modular instrument portability is the TM 515. For on-site applications across town or across the country, you can't beat it. With the front and rear covers snapped in place, it looks like a carry-on flight case.

Pop the covers off and it acts like a benchtop lab with up to five instruments.



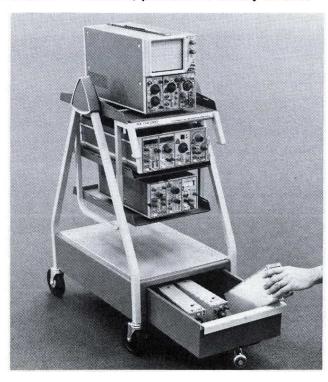


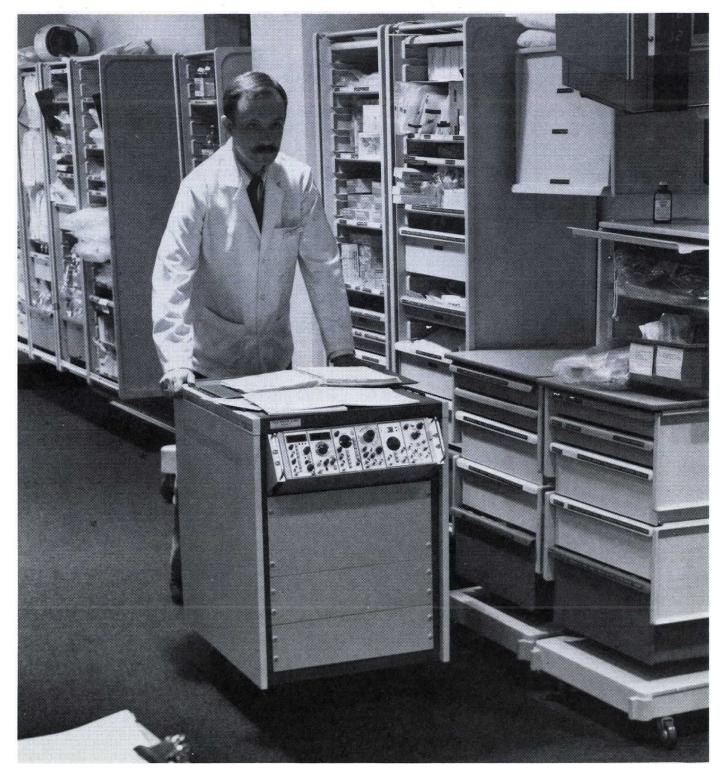
Instruments on wheels

You can set one or more benchtop mainframes in the mounting trays of a TEKTRONIX Lab Cart, combine them mechanically, even electrically, with monolithic instruments on the same cart and create an extremely versatile rollabout test laboratory. Fully loaded for a variety of applications, you can slip down crowded aisles, across the production floor or into tight quarters, like the confines of an X-ray booth, to deliver everything you need to solve the problem in one trip, not several.

There's even a TEKTRONIX Rackmount Rollcart. It has a flat-top surface to carry documents or to use as a work space for taking notes.

No matter where your work takes you, take TM 500 — racked, packed or ready to roll.





TM 500-Series Test and Measurement System

Comparison of Characteristics

When it comes to accurate time and frequency instrumentation, our TM 500 Counter/Timers always measure up. Their unique flexibility, compact size and easy readability are making testing and measuring more convenient and reliable.

Add our new DC 508 1 GHz counter to our four other versatile models, and you've got a full range of capabilities — a counter for virtually every application.

Our DC 501 and DC 508 Counters can measure frequencies and totalize events from low audio through 110 MHz to 1 GHz. The low-cost DC 504 has a period mode to improve resolution and accuracy of low frequency measurements. In addition to frequency, period and totalize, it has rpm capability.

For totalizing and frequency measuring plus single period, period averaging, frequency ratio and time interval capabilities, our Universal Counter/Timers, DC 503 and DC 505A, are the ones to watch. A sophisticated combination of features like the DC 503's time-manual (electronic stopwatch), and the

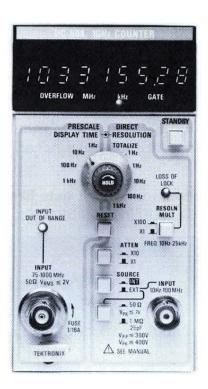
DC 505A's time interval averaging, direct pulse width measurements and unique events A-during-B mode can enhance your level of productivity while decreasing operator fatigue.

The second channel capabilities of the DC 503 and DC 505A Universal Counter/Timers permit measurement of frequency ratios and, more importantly, time intervals, in addition to the frequency and total events measures of single channel instruments. Time intervals are measured by the internal clock pulses which occur between a start event on channel A and a stop event on channel B. Resolution and accuracy are determined by the instrument's clock rate, and by whether time interval averaging is available.

Whatever the application from industrial control to research and communications—the TM 500 Counters are designed to cover most measurement needs. And they're built for maximum production with minimum downtime, since replacement is as simple as pulling a plug.

DIGITAL COUNTERS — COMPARISON OF CHARACTERISTICS

	DC 501	DC 503	DC 504	DC 505A	DC 508
Number of Digits	7	7	5	7	9
Frequency Range	110 MHz	100 MHz	80 MHz	225 MHz	1 GHz
Totalize	Yes	Yes	Yes	Yes	Yes
Period	No	Yes	Yes	Yes	No
Period Average	No	Yes	No	Yes	No
Time Interval	No	Yes; 1 μs maximum clock rate	No	Yes; 10 ns maximum clock rate	No
Time Interval Average	No	No	No	Yes	No
Ratio	No	Yes	No	Yes	No
Other	Option 01 FCC Type Approved	Time Manual Option 01	Rpm Option 01	Events A During B, single-jack pulse width, dc trigger level out Option 01	Option 01 Option 07
Price	\$675	\$795	\$450	\$1550	\$1100



DC 508 FREQUENCY COUNTER

Frequency up to 1 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

The DC 508 Counter, designed to operate in a TM 500-Series Power Module, measures frequency from 10 Hz to 1 GHz. A nine-digit LED display shows frequency or totalized events from 0 to 999,999,999. The prescaler input allows it to measure frequency from 75 MHz to 1 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 highstability time base, and Option 07 also includes an interface for the TR 502 Tracking Generator/Spectrum Analyzer. An audio frequency resolution multiplier multiplies the resolution by 100 to 25 kHz. This allows resolution of .01 Hz in 1 second.

DC 508 SPECIFICATIONS

DISPLAY

Nine-digit LED display, leading zero 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 $M\Omega$ paralleled by 25 pF.

Maximum Operating Input Voltage — For 50 Ω is ≤7 V peak. For 1 MΩ, X1 attenuation, V peak ≤400 V; V p-p ≤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 ≤10 V above 22 MHz; for a pulse, V peak ≤400 V and dV/dt ≤5 V/ns. For 1 MΩ, X10 attenuation, V peak ≤400 V; V p-p ≤300 V from 10 Hz to 1 MHz, V p-p ≤300/fMHz V from 1 MHz to 6 MHz, V p-p ≤100 V above 6 MHz.

Attenuation — X1, X10.

Resolution (without resolution multiplier) — $0.1~{\rm Hz}$ 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

Rear Interface Internal Input Impedance — 50 Ω .

Rear Interface Internal Input Maximum Safe 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 — 75 MHz to 1 GHz.

Sensitivity — 20 mV rms from 50 Ω source (-21 dBm).

Impedance — 50 Ω .

VSWR — ≤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

Input Protection Voltage — Input fuse opens at ≈ 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.

Accuracy — Temperature stability, 0°C to 50°C — $\pm 5 \times 10^{-6}$.

Aging Rate — 1 X 10-6 per year.

OPTION 01 TIME BASE

Frequency — 10 MHz.

Temperature stability, 0°C to 50°C after warmup — Within 0.2 parts in 106 after warmup.

Warmup Time — Within $\pm\,0.2$ ppm of final frequency in less than 10 minutes when cold-started at 25°C.

Aging Rate — \leq 1 x 10⁻⁸/day at time of shipping. \leq 4 x 10⁻⁸/week after a month of continuous operation. \leq 1 x 10⁻⁶/year after two months of continuous operation.

Setability — $\leq \pm 2 \times 10^8$

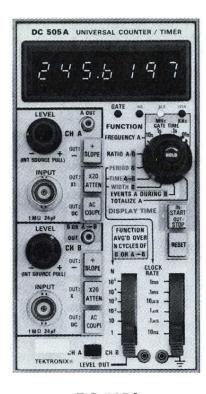
ACCURACY

The overall DC 508 accuracy is: Accuracy (% of reading) $=\pm$ (time base accuracy +

total displayed counts) x 100.

Time base accuracy $\leq \pm$ [calibration accuracy + temperature stability + (aging rate x time since calibration) + short-term stability].

DC 508 Frequency Counter \$1100
Option 01 (Time Base)add \$150
Option 07 (for use with TR 502 and
SW 503)add \$200



DC 505A UNIVERSAL COUNTER/TIMER

Dc Output for Accurate Trigger Level Setting with Companion DMM Direct Counting to 225 MHz

10 Nanosecond Clock Rate

Time Interval Averaging with Resolution to 100 Picoseconds

Two Equal Bandwidth Channels for Time Measurements on Narrow Pulses

Events A During B

The DC 505A is a high-performance universal counter featuring direct counting to 225 MHz. Both channels A and B, have equal response for ratio, time interval, and other measurements requiring two channels. The DC 505A provides dc trigger level output both at the front-panel jack and rear interface connector. Any TM 500 Digital Multimeter may be connected via the rear interface to read the DC 505A trigger level setting when the DMM input switch is pushed to the INT position. Alternately, an external voltmeter or oscilloscope may be connected to the front-panel jack to perform this function. The DC 505A can perform virtually any counting-timing function below 225 MHz.

Various functions include conventional frequency operation on channel A, ratio of channel A to B frequency, period of signal B, time interval from channel A start to B stop, width B, events A during B, and totalize. An averaging feature allows measurements to be averaged from 1 to 105 times as selected by front-panel controls with the resultant average displayed on the LED readout. Averaging factor and clock rate are independently selectable. Pulse width may be measured directly with single shot resolution to 10 ns. By use of maximum averaging on width or interval measurements of repetitive waveforms, resolution to better than 100 picoseconds is possible. Typical application of the DC 505A is in the design, development, or maintenance of logic circuitry in high speed digital computers. It is a highperformance counter for state-of-the-art design and measurements up to 225 MHz.

Display — 7 digits (7 segment LEDs).

Frequency (A input) — Range: 0-225 MHz, dc coupled. 10 Hz to 255 MHz, ac coupled. Gate Times: 0.01s, 0.1s, 1s, 10s.

Accuracy (A \longrightarrow B) — ± 1 count \pm time-base error.

Time Interval Resolution — Single event; 10 ns to 1 ms selectable. Repetitive Events: \leq 100 picoseconds with 10 ns clock and 10⁵ averaging. Clock rate selectable, 10 ns to 1 ms. Averaging factor independently selectable from 1 to 10⁵. 5 ns minimum pulse width in either channel.

Time Interval Accuracy — ± 1 count $\pm time$ base error \pm trigger error CH A* \pm trigger error CH B* \pm channel delay match error (2 ns max) \pm slew rate error*** +2 counts (10 ns clock rate only). Best absolute accuracy 3 ns.

Width (B input) — Single pulse: 10 ns to 1 ms, selectable. Repetitive pulses: \leq 100 picoseconds with 10 ns clock and 10⁵ averaging factor. Clock rate selectable 10 ns to 1 ms. Average factor independently selectable in decades from 1 to 10⁵. 2 ns minimum pulse width.

Width Accuracy — ± 1 count \pm time base error + hysteresis error** \pm slew rate error*** + 2 counts (10 ns clock rate only). Best absolute accuracy, 1.5

Period and Period Averaging (B input) — Resolution: From 10 ns to 1 ms for single period; to 0.1 picosecond max with 10 ns clock and 10^5 averaging. Accuracy: ± 1 count \pm time-base error \pm trigger error† ± 2 counts (10 ns clock rate only).

Ratio (A/B) — Averaged over 1 to 10^5 cycles of signal at B. Accuracy: ± 1 count FREQ A \pm trigger jitter CH B†.

Events A during B — Averaged over 1 to 1-5 occurrences of signal at B. Accuracy: ±1 count FREQ A + hysteresis error** ± slew rate error***.

Totalize (A) — 1 to 9,999,999 at max rate of 225 MHz. Front panel start, stop, reset control.

Input Frequency Range (A and B) — 0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled.

Sensitivity, A and B — 150 mV p-p (50 mV rms sine wave) below 150 MHz. 300 mV p-p (100 mV rms sine wave) from 150 to 225 MHz.

Impedance (A and B) — 1 $\mathrm{M}\Omega$ paralled by 24 pF.

Trigger Level (A and B) — Adjustable $\pm\,2.0$ V at X1 attenuation.

Max Input Voltage (A and B) — X1 Atten: 50 V at 10 kHz or less; derate —20 dB/decade to 100 kHz. 5 V from 100 kHz to 225 MHz. X20 Atten: 250 V at 1 MHz or less, derate —20 dB/decade to 50 MHz. 5 V from 50 MHz to 225 MHz.

Attenuation (A and B) — Selectable X1, X20.

Standard Time Base Accuracy — Temp stability, 0°C to 50°C after warm-up: ± 1 X 10-5 (0.001%). Long Term Drift: ± 1 X 10-5 per month (0.001%). Stability: Adjustable within 1 part in 10-7 (0.00001%).

Option 01 Time Base Accuracy — Temp Stability, 0°C to 50°C after warm-up: ± 5 X 10^{-7} (0.00005%). Long Term Drift: ± 1 X 10^{-7} (0.00001%). Setability: Adjustable within 5 parts in 10^9 (0.0000005%).

Rear Interface Input — Reset, external display scan clock, external time base.

Rear Interface Output — Bcd serial-by-digit plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

NOTES:

* =
$$\left(\frac{0.01 \text{ V}}{\text{dv/dt of triggering edge}}\right) / \sqrt{N}$$

** = $\left(\frac{0.1 \text{ V}}{\text{dv/dt stop edge}}\right) \pm \left(\frac{0.01 \text{ V}}{\text{dv/dt start edge}}\right) / \sqrt{N}$

***Input amplifier slew rate of 10 ns/volt will produce additional error in

 Time A → B mode if A and B level controls are not set for corresponding points on waveforms.

(2) Width B and Events A during B modes if B level control is not set at 50% of input pulse height.

$$\uparrow = \left(\frac{0.01 \text{ V}}{\text{dv/dt triggering edge}}\right) / \text{N}$$

NOTE 1: Accuracies with averaging are dependent on the laws of statistics in Time A

B, Width B, and Events A during B modes.

Additional information on following page.

Special Features — A out: Shaped output, after LEVEL and SLOPE selection, of signal into CH A. This output represents what goes into the display of FREQ A, RATIO A/B and TOTALIZE A. Propagation delay from CH A INPUT to A OUT is ≈ 15 ns.

B or A→B OUT — Shaped output, after LEVEL and SLOPE selection, of either CH B signal or A→B signal. This output represents the continuous signal used in generating the display gating for RATIO A/B, PERIOD B, TIME A→B, WIDTH B, AND EVENTS A DURING B. Logic levels out are the same as for A OUT. Propagation delays from the channel INPUTS TO B or A→B OUT are ≈15 ns.

Included Accessories — 1 cable assembly, RF:3.5 ft. (012-0532-00)

DC	505	Α	٠		•	٠	•	•	•		•					•					•	\$	15	550)
Opt	ion	01		(T	ir	n	e	В	a	S	е)		. 9			65 (ć	30	de	d	\$2	200)



DC 504 COUNTER/TIMER

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.

Display - 5 digits, LEDs.

Display Accuracy — ± 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 (Max 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 Source — Internal (rear connector interface) or external (front-panel BNC).

Max Input Voltage — (sine waves, dc + peak ac) ± 250 V at 500 kHz or less; derate -20 dB/decade to 25 MHz. ± 5 V from 25 MHz to 80 MHz.

Impedance — 1 M Ω paralleled by approx 20 pF.

Coupling - Dc or ac.

Internal Time Base

	Standard	Option 01						
Crystal Frequency	1 MHz	5 MHz tempera- ture compensate						
Stability (0°C to 50°C) after ½ hour warm-up	≤±1 x 10 ⁻⁵	≤±5 x 10 ⁻⁷						
Long-term Drift	≤±1 x 10 ⁻⁵	≤±1 x 10 ⁻⁷						
Setability	Adjustable to	Adjustable to						

Totalize Events (Resolution) - 1 count.

Period (Resolution) — mSec Position: 1 μ s and 10 μ s. Sec Position: 0.1 ms, 1 ms, and 10 ms.

Display Time — Variable from about 0.1 s to about 10 s. Detent position at cw position of DISPLAY TIME knob provides a HOLD mode.

Data Inputs and Outputs — Available at rear of plugin for intra-compartment routing in any TM 500 Power Module/Mainframe. Bcd serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

DC 504 Counter	r/Timer	N 200 W N 100	 \$450
Option 01 (Time	e Base)		 . add \$200

*This assumes that the transducer output is one pulse per revolution.



DC 503 UNIVERSAL COUNTER

Direct Counting to 100 MHz
Six Measurement Functions
Period and Ratio Averaging
Interval Measurement Capability

The DC 503 Universal Counter offers counting to 100 MHz and provides the versatility of six measurement functions: frequency, period, ratio, time A→B, time manual, and totalize. The two channels (A and B) have individual BNC inputs and separate trigger level, attenuator, and coupling mode controls. Seven-digit readout is via sevensegment light emitting diodes (LEDs) with automatically positioned decimal point; leading zeros are blanked. A flashing display indicates register overflow. The lowcost DC 503 offers high performance in a variety of applications. Its interval measurement capability with selectable clock rates is useful for digital equipment design and maintenance, particularly digital control and data communications work. The CH A frequency range of dc to 100 MHz serves in communication and rf use. High resolution measurements of low frequencies are available quickly in the period mode with averaging up to 1 million periods available. TIME MANUAL provides an electronic stop watch function with selectable clock rates. TOTAL-IZE counts and displays the total number of input events at rates from dc to 100 MHz.

Display - 7 digits (7 segment LEDs)

Frequency (A input) — Range: 0-100 MHz, dc coupled. 10 Hz to 100 MHz, ac coupled. Gate Times: 0.01 s, 0.1 s, 1 s, 10 s.

Accuracy — ± 1 count \pm time-base error.

Time Interval Resolution (A \longrightarrow B) — Single event: 1 μ s to 1 s, selectable. Accurate to ± 1 count \pm time-base error.

Width (B input) — Resolution, single pulse: Use "tee" connector and Time Interval A→B mode; see above specifications.

Period and Period Averaging (B input) — Resolution: from 1 μ s for single period to 1 pico-second with 106 averaging. Accurate to ± 1 count \pm time-base error \pm trigger error/N.

Ratio A/B — Averaged over 1 to 106 cycles of signal at R

Totalize A — 1 to 9,999,999 at max rate of 100 MHz. Front panel start, stop, reset control.

Time Manual — Electronic stopwatch; accumulates and displays time following activation of front panel start button. Clock rates selectable from 1 μ s to 1 s.

Input A, Freq. Range — 0 to 100 MHz, dc coupled. 10 Hz to 100 MHz, ac coupled.

Input B, Freq. Range — 0 to 10 MHz, dc coupled. 10 Hz to 10 MHz, ac coupled.

Input sensitivity (A and B) — 300 mV p-p (100 mV rms sinewave).

Impedance (A and B) — 1 $\mathrm{M}\Omega$ paralleled by 20 pF.

Trigger Level (A and B) — Adjustable \pm 1.5 V at X1 attenuation.

Max Input Voltage (A and B) — CH A XI Atten: 50 V at 2 kHz or less; derate $-20~\mathrm{dB/decade}$ to 10 kHz. 10 V from 10 kHz to 25 MHz; derate $-20~\mathrm{dB/decade}$ to 50 MHz. 5 V from 50 MHz to 100 MHz.

CH B X1 Atten: 50 V at 2 kHz or less; derate $-20~\mathrm{dB/decade}$ to 10 kHz. 10 V, from 10 kHz to 10 MHz.

CH A X10 and X100 Atten: 500 V at 2 MHz or less; derate $-20~\mathrm{dB/decade}$ to 100 MHz.

CH B X10 and X100 Atten: 500 V at 350 kHz or less; derate $-20~\mathrm{dB/decade}$ to 10 MHz.

Attenuation (A and B) — Selectable X1, X10, X100.

Standard Time Base Accuracy — Temp stability, 0°C to 50°C after warm-up: ± 1 X 10-5 (0.001%) Long Term Drift: \pm 1 x 10-5 per month (0.001%) Stability: Adjustable within 1 part in 107 (0.00001%).

Option 01 Time Base Accuracy — Temp Stability, 0°C to 50°C after warm-up: ± 5 X 10^{-7} (0.00005%). Long Term Drift: ± 1 X 10^{-7} per month (0.00001%). Setability: Adjustable within 5 parts in 10^9 (0.0000005%).

Rear Interface Input — Direct count input (50 Ω impedance, resistor may be removed for 1 M Ω input) reset, external display scan clock, external time base.

Rear Interface Output — Bcd serial-by-digit, plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

DC 503 Universal Counter \$795 Option 01 (Time Base) add \$200



DC 501 DIGITAL COUNTER

Direct Counting to 110 MHz
7-Digit LED Display
Manual Start/Stop (Totalize)
Auto Range and Time Base Options

The DC 501 Digital Counter directly measures frequency from 10 Hz to 110 MHz and totalizes (counts number of events) from 0 to 9,999,999 at a maximum rate of 110 MHz. Measurement readout is provided by sevensegment LEDs in a seven digit display. The decimal point is automatically positioned and leading zeros are blanked. Register overflow is indicated by a front-panel LED. Signals to be counted can be applied via a front-panel BNC connector into an impedance of 1 $M\Omega$ and 20 pF or via the rear connector into an impedance of 50 Ω and 20 pF. Four gate times of 0.01 s, 0.1 s, 1 s, and 10 s are provided. A standard internal 1 MHz time base is provided with 1 x 10⁻⁵ accuracy (0° to 50° C) and an aging rate of 1 x 10⁻⁵ per month. An optional time base with 5 x 10⁻⁷ accuracy (0° to 50°C) and an aging of 1 x 10-7 per month is available at extra cost. Input sensitivity is approximately 300 mV p-p (100 mV rms sine wave) below 110 MHz. An automatic measurement interval option, also at extra cost, automatically selects the gate time (up to 10 seconds) to obtain maximum resolution with any input signal.

Display — 7 digits (7 segment LED's) Storage, leading zero blanked. Overflow, gate open and kHz or MHz indicators.

DIRECT INPUT

Frequency range — 10 Hz to 110 MHz.

Sensitivity — 300 mV p-p (100 mV rms sinewave).

Impedance — 1 M Ω , paralled by 20 pF.

Triggering Level — Adjustable ±2 V.

Max Input Voltage — X1 Atten: 500 V at 80 Hz or less; derate — 20 dB/decade to 250 Hz. 150 V from 250 Hz to 300 kHz; derate — 20 dB/decade to 3MHz. 15 V from 3 MHz to 110 MHz.

X5 Atten: 500 V at 600 kHz or less; derate $-20~\mathrm{dB/decade}$ to 4 MHz. 75 V from 4 MHz to 110 MHz.

X10 and X50 Atten: 500 V at 1.2 MHz or less; derate -20 dB/decade to 8 MHz. 75 V from 8 MHz to 110 MHz

Attenuation - X1, X5, X10, or X50.

Resolution — 0.1 Hz with 10 s gate. 1 Hz with 1s gate, 10 Hz with 0.1 s gate, 100 Hz with 0.01 s gate.

STANDARD TIME BASE ACCURACY

Temp Stability, 0°C to 50°C after warm-up — $\pm 1~\mathrm{X}$ $10^{-5}~(0.001\%)$

Long Term Drift — ±1 X 10⁻⁵ per month (0.001%) Setability — Adjustable within 1 part in 10⁷ (0.00001%)

OPTION 01 TIME BASE ACCURACY

Temp Stability, 0°C to 50°C after warm-up — $\pm 1 \text{ X}$ $10^{-7} (0.00005\%)$

Long Term Drift — $\pm 1 \times 10^{-7}$ per month (0.00001%)

Totalize — Counts events from 1 to 9,999,999 at a max rate of 110 MHz. Start, stop, and reset commands via front-panel pushbuttons.

REAR INPUT

Direct count input (50 Ω impedance, resistor may be removed for 1 M Ω input) reset, external display scan clock, external time base.

REAR OUTPUTS

Bcd serial-by-digit, plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

OPTION 02

Automatically selects optimum measurement interval to fill the display, and displays appropriate kHz or MHz indication. Overflow is indicated for frequencies in excess of 99,99999 MHz.

DC 501 Digital Counter	\$675
Option 01 (Time Base)	add \$200
Option 02 (Auto Measur	rement) add \$65

TM 500-Series Test and Measurement System

Digital Multimeter

For multiple electronic test functions — voltage, resistance and current measurements — plus compact, easy portability, many engineers are looking to the TM 500 Digital Multimeters.

Our DM 501 and DM 502 Multimeters represent a vast improvement in accuracy, easy readability and simplified use over the traditional volt-ohm-milliammeters. Beyond the usual dc/ac voltage, resistance and dc/ac current functions, both meters offer optional temperature measurement capabilities. With your choice of Celsius or Fahrenheit digital readout, at temperatures from -55° C to $+150^{\circ}$ C.

Both models measure dc voltage, to 1000 volts (extendable to 40,000 volts with the accessory probe), and ac voltage to 500 volts dc and ac currents to 2 amps, and resistance to 20 megohms.

Our 3½ digit meter, the DM 502, provides a standard decibel (dB) measurement fea-

ture across all ac ranges. Its absolute reference may be selected by internal jumper, with a dynamic range from -60 dB to approximately +56 dB.

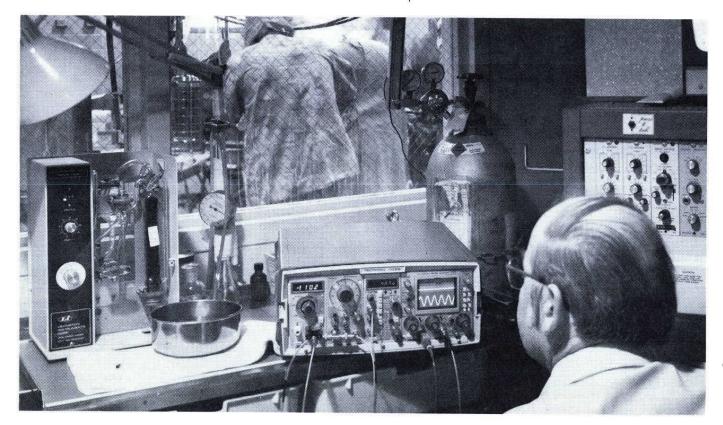
The DM 501, a 4½ digit meter, allows more precise readouts (up to six times better accuracy), while supplying a X10 better resolution. Beyond that, it can measure larger signals at any given resolution level.

For convenient compactability at the bench and unique portability in the field, our TM 500 Multimeters could well be the answer to all your electronic testing problems. Just plug them into our lightweight, luggage-type TM 515 Traveler Mainframe, and they'll follow you anywhere.

With full-scale precision measuring capabilities backed by Tektronix' design and engineering expertise, these multimeters are designed for most any test and measurement application.

DIGITAL MULTIMETERS—COMPARISON OF CHARACTERISTICS

	DM 501	DM 502							
Number of Digits	41/2	31/2							
Dc Volts — full scale	2 V to 1 kV	0.2 V to 1 kV							
Ac Volts — full scale	2 V to 500 V	0.2 V to 500 V							
Ac or Dc Current — full scale	2 mA to 2 A	200 μA to 2 A							
Resistance — full scale	2 kΩ to 20 MΩ	200 Ω to 20 M Ω							
Temperature Probe	Optional	Optional							
dB	No	$-60~\mathrm{dB}$ to $+56~\mathrm{dB}$							
Bcd (Output)	Full Floating	Nonfloating							
Input Impedance	10 ΜΩ	10 $M\Omega$ normal; FET input on 0.2 and 2 V scales by internal jumper							
Price	\$475	\$375							





DM 502 DIGITAL MULTIMETER

dB Readings from -60 dB to +56 dBSeven Functions Including Temperature and dB

0.1% Dc Voltage Accuracy Autopolarity DMM Prices Start at \$250

The DM 502 Digital Multimeter measures dc and ac voltage and current, dBm, dBV, resistance, and temperature. The ac functions are average responding and rms calibrated. A single front-panel control selects all ranges. Front-panel pushbuttons select dB readout of ac functions in lieu of ac voltage or current and front-panel or rear interface connector input. The dB is obtained by adding the selected dB scale value to the display reading. Readout in dBm or dBV is chosen by an internal jumper. An internal jumper also permits selection of FET input (>1000 $M\Omega)$ or 10 $M\Omega$ input impedance on the two lowest dc voltage ranges.

The readout is a 3½ digit display using seven-segment LEDs. The decimal point is automatically positioned by the RANGE/FUNCTION switch. Polarity indication is automatic. Maximum display at stated accuracy is 1999.

Nonfloating bcd output (referenced to the low input), is available at the rear interface connector if user wired.

DC VOLTAGE

Ranges — 0.2 V, 20 V, 200 V, 1000 V. Accuracy — Within $\pm 0.1\%$ of reading ± 1 count. Common-Mode Rejection — \geq 100 dB at dc, \geq 80 dB at 50 or 60 Hz with 1 k Ω imbalance.

Normal-Mode Rejection — ≥80 dB at 50 or 60 Hz.

Step Response Time — \leq 0.5 s.

Input R — 10 M Ω (jumper selectable for >1000 M Ω on 0.2 V and 2 V ranges).

AC VOLTAGE

Voltage Ranges — 0.2 V, 2 V, 20 V, 200 V, 500 V.

Accuracy — Within $\pm 0.5\%$ of reading ± 1 count from 40 Hz to 10 kHz. $\pm 1.0\%$ of reading ± 1 count, from 20 Hz to 40 Hz and 10 kHz to 20 kHz. Usable to 100 kHz. Typically <10% down between 40 mV and 500 V at 100 kHz.

Response Time — \leq 5 s.

Common-Mode Rejection — \geq 60 dB at 50 or 60 Hz. Input R — 10 M Ω paralleled by less than 60 pF.

dB VOLTS AND CURRENT

Scales — +40, +20, 0, -20, -40 dB. Reference is dBV (1 V) or dBm (1 mW dissipated in 600 Ω , 0.7746 V), selected by internal jumper.

Display - ±19.99 dB on any scale, except that the total dynamic range is limited to the range -60 dB to approx +56 dB by a 500 V max input specification.

Accuracy

Display Reading dB	Frequency Range	Max Error			
0 to +19.99	20 Hz to 20 kHz	0.5 dB			
0 to -10.00	20 Hz to 2 kHz 2 kHz to 20 kHz	0.5 dB 1.0 dB			
─10.00 to ─19.99	20 Hz to 2 kHz 2 kHz to 7.5 kHz 7.5 kHz to 20 kHz	0.5 dB 1.0 dB 2.0 dB			

Response Time — <5 s.

Common-Mode Rejection — \geq 60 dB at 50 or 60 Hz.

RESISTANCE

Ranges — 200 Ω , 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω .

Accuracy — 200 Ω range: $\pm 0.5\%$ of reading ± 1 count +0.1 Ω ; 2 k Ω through 2 M Ω range: $\pm 0.5\%$ of reading ± 1 count; 20 M Ω range: $\pm 1.0\%$ of reading ±1 count.

Response Time — \leq 0.5 s; 20 M Ω range, \leq 5 s.

Max Output Current and Voltage — 1 mA max; approx 12 V max.

AC & DC CURRENT

Ranges — 200 μ A, 2 mA, 20 mA, 200 mA, 2 A.

Accuracy — Dc current, $\pm 0.2\%$ of reading ± 1 count; ac current, $\pm 0.6\%$ of reading ± 1 count, 40 Hz to 10 kHz.

Response Time — $Dc \le 0.5 s$; $ac \le 5 s$.

Input Impedance — $\left(\frac{0.2 \text{ V}}{\text{Range Setting}} + 0.1\right) \Omega \left(\frac{2 \text{ k}\Omega \text{ with}}{200 \mu \text{A range}}\right)$

TEMPERATURE MEASUREMENT

Ranges — Celsius: -55°C to +150°C. Fahrenheit: -67°F to +200°F.

Accuracy — With probe shipped with instrument ±2°C (±3.6°F). With any P6430 probe prior to calibration with instrument, ±8°C (±14.4°F).

The temperature probe functions in all other modes in °C with analog signal out of 10 mV/° at rear interconnect.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate - 3.33 per second.

Inputs - The max input voltage is 1 kV. The frontpanel HI and LO connectors may be floated 1 kV max above ground, the rear inputs 350 V. Current measuring functions are fused at 2.5 A. Ohms functions protected to 120 V rms indefinitely, 250 V rms ½ hour. Ambient Temperature — Performance characteristics are valid over a temperature range of $+15^{\circ}\text{C}$ to +40°C.

Included Accessories — 1 pair Test Leads (003-0120-00), 1 P6430 Temp Probe (010-6430-00).

ORDERING INFORMATION

DM 502 Digital Multimeter \$375

and ProbeSub \$125

Option 02 without Temp Capability

Optional Accessories - Deluxe Test Lead with accessories including push-on spring-loaded hook tip and special IC package tip, high flexibility wire, red,

4 ft.															
Order (012-0426-00)		 •	•	•				•	•	 •		•	. \$1	0.0	00
As above except bla	ck														

Order (012-0426-01)\$10.00 Test lead with alligator clip, 4 ft, black.

Order (012-0425-00)\$5.50 High Voltage Probe to 40 kV

Order (010-0277-00)\$75



DM 501 **DIGITAL MULTIMETER**

0.1% Dc Voltage Accuracy

41/2 Digit LED Display

Autopolarity

Measures Volts, Current, Resistance, **Temperature**

Fully Isolated Serial Bcd Output

The DM 501 Digital Multimeter measures dc and ac voltage and current, resistance, and temperature. Dc voltage measurement accuracy is 0.1%. The ac functions are average responding and rms calibrated. A single front-panel control selects all functions and ranges. A pushbutton selects front-panel input or optional rear interface connector input. Temperature measurements are made using a TEKTRONIX P6058 Probe or other suitable sensing devices. Front-panel pin jacks provide external temperature readout, at 10 mV per degree, regardless of the position of the function switch. An internal switch selects calibration in degrees Celsius or Fahrenheit. Readout is a 41/2 digit stored display using seven segment LEDs. The decimal point is automatically positioned by the RANGE/FUNCTION switch and leading zeros are blanked. Polarity indication is automatic. A blinking display indicates overrange. Serial bcd output is available at the rear interface connector.

DC VOLTAGE

Ranges - 2 V, 20 V, 200 V, and 1 kV full scale (19999 max reading), accurate within 0.1% of reading ±2

Resolution — 100 μ V on 2 V range.

Common-Mode Rejection —≥ 100 dB at dc, 80 dB at 60 Hz with 1 k Ω imbalance.

Step Response Time -<1 s.

Normal-Mode Rejection — ≥30 dB at 60 Hz increasing 20 dB per decade.

Input R — 10 M Ω , constant.

AC VOLTAGE

Ranges - 2 V, 20 V, 200 V, and 500 V full scale (19999 max reading), average responding, rms calibrated.

Accuracy — Within 0.7% of reading ±2 counts from 40 Hz to 10 kHz; 1.2% of reading ± 2 counts from 20 Hz to 40 Hz and 10 kHz to 20 kHz. Usable to 100 kHz. Typically <5% down between 0.4 V and 500 V at 100 kHz.

Resolution — 100 μ V on 2 V range.

Response Time — <10 s.

Input R — 10 M Ω paralleled by <100 pF.

AC and DC CURRENT

Ranges — 2 mA, 20 mA, 200 mA, 2 A full scale (19999 max reading), ac rms calibrated, average responding.

Resolution — 100 nA on 2 mA range.

Accuracy — Dc amps, 0.2% of reading ±10 counts; ac amps, 0.6% of reading ±2 counts from 40 Hz to 1 kHz. $\pm 0.6\%$ of reading ± 10 counts from 1 kHz to 10 kHz. Usable to 100 kHz.

Input R —
$$\left(\frac{0.2 \text{ V}}{\text{Range Setting}} + 0.1\right)\Omega$$

RESISTANCE

Range — 2 k Ω , 20 k Ω , 200 k Ω , 2 M Ω , 20 M Ω full scale (19999 max reading).

Accuracy — Within 0.3% of reading ± 2 counts to 2 $M\Omega$, 0.5% of reading, ± 2 counts on 20 $M\Omega$ scale.

Resolution — 0.1 Ω on 2 k Ω range.

TEMPERATURE MEASUREMENT

Ranges — -55° C to $+150^{\circ}$ C (-67° F to $+302^{\circ}$ F selected by internal switch), using P6058 temperature probe. The temperature probe functions regardless of the DM 501 mode and provides a front-panel analog signal output of 10 mV/ $^{\circ}$ (into 2 k Ω or greater); thus temperature may be measured simultaneously with any other function. If temperature probe is not desired, order Option 01. If temperature capability is not desired, order Option 02; note: capability cannot be restored at a later date.

Accuracy - Within 1.5°C (2.7°F) from -55°C to +125°C and within 2.5°C (4.5°F) from +125°C to +150°C.

Resolution — 0.1°C.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 5 measurements/second.

Max Input Voltage - 1 kV. The front-panel HI and LO connectors may be floated 1.5 kV max above ground, the rear inputs 350 V max. Current measuring functions are fused at 3 A. Ohms ranges are fused at 1/16 A.

Ambient Temperature — Performance characteristics are valid over a temperature range of +15°C to +35°C.

Included Accessories - 1 Pair Test Leads (003-0120-00), 1 P6058 Temp Probe (010-0259-00).

ORDERING INFORMATION DM 501 Digital Multimeter \$475 Option 01 without P6058 Temp ProbeSub \$105 **Option 02 without Temp Capability** and Probe Sub \$125 Optional Accessories - Deluxe Test Lead with accessories including push-on spring-loaded hook tip

and special IC package tip, high flexibility wire, red, Order (012-0426-00)\$8.00

Order (012-0426-01)\$8.00	ĺ
Test lead with alligator clip, 4 ft, black.	
Order (012-0425-00)\$5.50	
High Voltage Probe to 40 kV	
Order (010-0277-00)\$75	Ü

As above except black.

Pulse Generators

TM 500-Series Test and Measurement System

Comparison of Characteristics

Today's complex logic systems require instrumentation equal to their diversified demands. The TM 500 Pulse Generators' highly configurable characteristics allow you to generate more waveforms for broader applications.

Whether you're testing wide-band systems, stimulating living tissue, driving a laser or simulating data transmission signals—these versatile, high-performance pulse generators can readily adapt to your specific needs.

For oscilloscope calibration, there's a specialized generator, the PG 506. For 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. And for ECL design and testing, the PG 502, with its 250 MHz repetition rate and pulse top and bottom level independent control, can handle even the most complex functions with ease.

PG 501

With plug-in adaptability on your bench or out in the field, our PG 508's accurate 50 Ω output impedance delivers clean signals into logic families (TTL, etc.) reactive loads or at the end of an unterminated cable.

The PG 508 is also designed for high-level performance on high impedance circuits (MOS, HTL and CMOS logic). This 50 MHz, multipurpose generator features a control error light, a trigger/gated light, selectable $1M\Omega$ or 50Ω trigger input impedance and an expanded trigger level range.

Used separately, or plugged into a powerful system, our TM 500 Pulse Generators offer a wide range of features that add up to unparalleled ease of operation, for even your toughest test and measurement problems.

PG 508

PG 508 Pulse Generator

5 Hz to 50 MHz Plus Custom Range Independently Variable Rise and Fall Times Delay and Double Pulse Capability 20 V Output in a \pm 20 V Window to Hi Z, 10 V to 50 Ω

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

3-State Trigger Light Indicates Proper External Triggering

Selectable 1 M Ω Trigger Input Impedance for Optimum Match to Circuitry — Lets You Use Your Scope Probe

PULSE GENERATORS — COMPARISON OF CHARACTERISTICS

PG 505

PG 502

		1 4 502	FG 303	FG 508			
Rep Rate Range	5 Hz to 50 MHz	10 Hz to 250 MHz	1 Hz to 100 kHz	5 Hz to 50 MHz			
Pulse Width Range	10 ns to 100 ms	2 ns to 50 ms	5 μs to 0.5 s	10 ns to 100 ms			
Rise and Fall times	Fixed, \leq 3.5 ns	Fixed, ≤ 1.0 ns	\leq 1 μ s to \geq 20 ms, Independently variable up to 20:1	5 ns to ≥ 50 ms, Independently variable up to 100:1			
Maximum Amplitude	\pm 5 volts across 50 Ω	80 volts behind 4 k Ω	20 volts in a \pm 20 volt window to Hi Z, 10 volts in a \pm 10 V window to 50 Ω				
Output Independent Independent portion top and pulse for + and - complement sy			Amplitude, inversion switch	Independent pulse top and pulse bottom, complement switch			
External Trigger and Ext Duration (width)	+1 V, $+$ Slope 50 Ω input Z	$+$ 1 V, $+$ Slope 50 Ω input Z	$+$ 0.5 V to $+$ 10 V, $+$ Slope, 10 k Ω input Z	-3 V to $+3$ V, $+$ or $-$ Slope, 1 M Ω or 50 Ω input Z			
Other	Simultaneous Pos and neg outputs, output LOCKED ON mode	Manual trig, Square-wave Mode, selectable internal 50 Ω Reverse Termination	Delay anywhere along 10-volt input ramp, custom timing positions	10 ns to 100 ms delay, double pulse, three-state trigger/gate light, control error light, manual trigger, manual gate, true 50 Ω output Z, custom timing positions, counted pulse burst with DD 501.			
Price	\$450	\$1595	\$450	\$1195			

Our PG 508 Pulse Generator combines state-of-the-art capabilities with TM 500 configurability. This means you can use its high-level performance and unique versatility for a broad range of test and measurement applications and for logic design functions in MOS, CMOS, TTL and ECL.

Few pulse generators on the market can match the PG 508 for hardworking control functions plus error-and-time reducing operational ease.

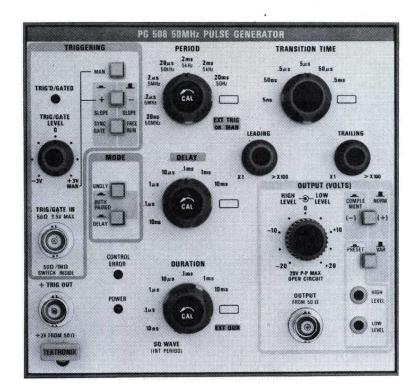
With an output of up to 20 V p-p, the PG 508 features independent controls for output period, delay, duration and transition times. More unusual features include selectable megohm/ 50Ω , trigger input impedance, a control error light, a 3-state trigger/gate light, and preset or external control of output voltage levels.

By simply pushing the preset button, you can change the output from variable top and bottom level controls to front panel screwdriver adjustments. Or track external supply voltages. So the time you usually spend on repeated setups of commonly used voltage levels, you can spend on your work, without worrying about accidental changes in output. With the power supply tracking mode of the PG 508, the CMOS logic circuits can withstand an accidental increase input of over 0.3 V, into the supply voltage.

The complement mode of the PG 508 allows an effective duty cycle range approaching 100%.

The PG 508's sophisticated array of control functions let you operate at maximum efficiency with minimum setup error. A control error light indicates improper switch or variable control settings.

Independent rise and fall time controls give you up to a 100:1 difference in rise and fall times. And the times aren't affected by output amplitude level changes.



PG 508 50 MHz PULSE GENERATOR

You can gate the PG 508 with a positive or negative going signal, or manually gate it 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.

Applications include simulating data of a given number of bits, or checking logic circuitry malfunctions. The MANUAL button and MAN position in PERIOD then let you add pulses, one by one.

And there's more. With the PG 508's trigger input switched to 1 megohm impedance, you can explore circuitry using a 1X or 10X scope. Or use the PG 508 as a pulse regenerator, logic level translator, or sine wave-to-pulse converter.

The PG 508 also has the output to drive MOS, CMOS, DTL, HTL, 1²L, T²L or ECL. And its transition time control lets you create a signal that accurately duplicates the circuit drive in most circuits under evaluation.

With control functions and features like these, no wonder the PG 508 is making more than its share of waves in the logic world. When you consider its independent output level controls, external trigger, delay and double pulse capabilities, you'll soon find the PG 508 generating pulses for radar, laser, rf switching and signal processing applications, too.

Pulse Period — \leq 20 ns to \geq 200 ms in seven decade steps plus variable, with overlap on all ranges. Periods longer than 200 ms can be obtained in custom range position. Jitter: < 0.1% + 50 ps.

Pulse Delay — (time between leading transitions in the paired pulse mode) \leq 10 ns to \geq 10 ms in seven decade steps plus variable, with overlap on all ranges. Delays longer than 100 ms can be obtained in custom range position. Duty Factor: delays to at least 70% of pulse periods for periods of 0.2 μ s or greater, decreasing to at least 50% for a 20 ns period. Jitter: \leq 0.1% + 50 ps.

Pulse Duration — \leq 10 ns to \geq 100 ms in seven decade steps plus variable, with overlap on all ranges. Durations longer than 100 ms can be obtained in custom range position. An additional position provides durations of approx 50% of the period setting for square wave output. Duty Factor: pulse durations to at least 70% of pulse periods for periods of \geq 0.2 μ s, decreasing to at least 50% for a 20 ns period. Jitter: \leq 0.1% + 50 ps.

Pulse Transition Times — Independently adjustable leading and trailing transition times from <5 ns typical (<7 ns at some offset and amplitude levels) to ≥50 ms, measured from the 10% point to the 90% point in six decade steps plus variable. Variable controls with 100:1 range (50:1 on 5 ns) provide overlap on all ranges. Transition times longer than 50 ms are obtainable in the custom range position.

Pulse-Transition Linearity — Deviation from straight line \leq 5% between the 10% and the 90% point for transition times greater than 10 ns.

Pulse Amplitude — Pulse high and low levels independently adjustable over a ± 20 V range from a 50 Ω low reactance source. Max pulse amplitude into a 50 Ω load is \geq 10 V p-p; minimum is \leq 0.5 V p-p. Max pulse amplitude into an open circuit is \geq 20 V p-p; minimum is \leq 1.0 V p-p. The preset level controls are adjustable over the same ranges.

Pulse Aberrations — \leq 5%, + 50 mV p-p for pulse levels between + and - 5 volts into a 50 Ω load. May increase to \leq 10%, +50 mV p-p for pulse levels outside this range.

Trigger Output — Amplitude $\geq +$ 2 V from 50 Ω . Source Impedance: 50 Ω . Duty Cycle: internal triggering, \simeq 50%; external triggering: determined by duty cycle of triggering signal.

Trigger/Gate Input — Sensitivity: 80 mV p-p to 10 MHz; 250 mV p-p to 50 MHz. Input impedance: internally selected, 50 Ω or 1 M Ω paralleled by \simeq 20 pF. Max input: \pm 5 V peak into 50 Ω , \pm 20 V peak into 1 M Ω . Minimum input pulse width: 10 ns. Trigger level range: \pm 3 V. Polarity: front panel selectable, + or — slope.

Trig'd Gated Light — Flashing: input triggered at greater than approx a 10 Hz repetition rate or following the input signal at slower repetition rates. On: (Logic True) TRIG/GATE IN input potential above TRIG/GATE LEVEL setting with + SLOPE selected or below TRIG/GATE LEVEL setting with — SLOPE selected. Off: (Logic False) TRIG/GATE IN input potential below TRIG/GATE LEVEL with + SLOPE selected or above TRIG/GATE LEVEL with — SLOPE selected.

Synchronous Gate — Rate generator starts synchronously with the gating signal and completes the last output pulse in progress when the gating signal ends.

Pulse Delay Modes—Undelayed, delayed, and paired. Paired pulse mode limited to 25 MHz. Minimum pulse separation governed by duration duty factor specification.

Fixed Delays — Trig/Gate Input to Trigger Out: \simeq 25 ns. Trigger Out to Pulse Out: \simeq 23 ns in SQ WAVE or EXT DUR modes, \simeq 35 ns in other modes.

Control Error Light — Steady On: indicates invalid operating mode, output is undefined. Flashing: timing control settings selected do not properly define the output pulse because valid limits have been exceeded. Steady Off: indicates valid operation for most control settings.

Counted Burst (with DD 501) — Max PG 508 repetition rate for exact count: 20 MHz. Usable to 50 MHz. Minimum time between bursts: 100 ns.

ORDERING INFORMATION

PG 508 50 MHz Pulse Generator \$1195

PG 508T 50 MHz Pulse Generator . . . \$1365 (includes PG 508, TM 503 Mainframe, and 016-0195-01 blank panel)

For Counted Burst, order the DD 501 Digital Delay (page 162) \$750

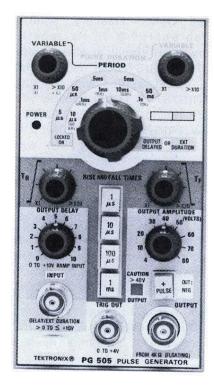
Suggested 10 in BNC 50 Ω cable (2 req) for interconnecting PG 508 and DD 501: 012-0208-00\$12.00

See Accessory Section for suitable probes. P6062B and P6105 are recommended.



TM 500-Series Test and Measurement System

100 kHz, 250 MHz, and 50 MHz Pulse Generators



PG 505 100 kHz PULSE GENERATOR

1 Hz to 100 kHz

Independently Variable Duration and Period 80 V Output

Variable Rise Time and Fall Time Delay Mode

The PG 505 Pulse Generator features: floating output; independently adjustable rise and fall times; external control of period or period and duration. A special position on the pulse period and pulse duration controls allows addition of an internal capacitor to custom-select pulse period and duration. When driven from an externally supplied 0 to 10 volt ramp, the delay control of the PG 505 permits the output pulse to occur at any selected voltage point on the ramp, thus providing controllable time delay to any set time along the ramp.

Pulse Period — 10 μ s or less to 100 ms (within 5%) in decade steps. Continuously variable between steps and to at least 1 s.

Pulse Duration — 5 μ s or less to 50 ms (5 μ s to 5 ms within 5%, 50 ms within 20%) in decade steps. Continuously variable between steps and to at least 0.5 s.

Duty Factor — (pulse duration/pulse period), 0 to 100%.

Pulse Rise Time and Fall Time — 1 μ s or less to 1 ms in decade steps with T_R or T_F controls set at (X1). T_R or T_F control extends time to at least 20 ms. Accurate within 5% with T_R or T_F set at (X1).

Aberrations — Within 5% at max p-p output into 4 k Ω , 20 pF load.

Pulse Amplitude — 4 V or less to at least 80 V from a 4 k Ω source. Polarity selectable for + or - output.

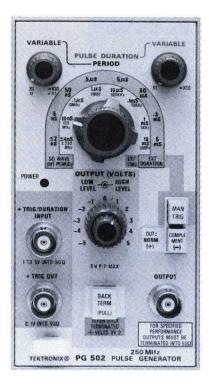
Isolation of Pulse from Ground — 200 V dc.

Trigger Output — 0 to +4 V into 50 Ω .

External Trigger/Duration Input — Accepts TTL level signals.

Delay Mode — Delay range (with respect to delay signal) 0 to 10 V within 5%.

PG 505 Pulse Generator.....\$450



PG 502 250 MHz PULSE GENERATOR

10 Hz to 250 MHz

1 ns Rise Time

5 V Output, ±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 rise and fall time; 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.

Pulse Period — 4 ns or less to 10 ms (within 5% in calibrated positions except 15% on 10 ms range) in decade steps. Continuously variable between steps and to at least 100 ms.

Pulse Duration — 2 ns or less to 5 ms (within 5% in calibrated positions except 15% on 5 ms range) in decade steps. Continuously variable between steps and to at least 50 ms. Square-wave mode approx 50% duty factor.

Duty Factor — At least 50% in normal mode, approx 100% in complement mode. Minimum off time is 2 ns.

Pulse Rise Time and Fall Time — Less than 1 ns.

Aberrations — Within $\pm 5\%$ at 5 V p-p amplitude, except negative transition aberrations may exceed 5% for durations less than 5 ns.

Pulse Top Flatness — Within 2%, beginning 10 ns after transition.

Pulse Amplitude — Pulse high and low levels independently adjustable over a -5 to +5 V range, with pulse amplitude limited between $\geq\!0.5$ V and $\leq\!5$ V. Complement switch inverts pulse between same two selected voltage levels. Front-panel selectable 50 Ω internal back termination divides output levels by two.

Offset — ± 5 V max, depends on amplitude setting.

Trigger Output — At least 1 V into 50 Ω , occurring approx 10 ns prior to pulse output. Duty cycle \simeq 50% when using internal period.

External Trigger/Duration Input — Trigger threshold less than 1 V; reset threshold greater than 0.1 V; max input 5 V. 50 Ω input impedance.

PG 502 Pulse Generator.....\$1595



PG 501 50 MHz PULSE GENERATOR

5 Hz to 50 MHz

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns into 50 Ω

Independent Period and Duration Controls

Trigger Out

Pulse Period — 20 ns or less to 20 ms (within 5% from 0.2 μ s to 2 ms and within 15% at 20 ms) in decade steps. Continuously variable between steps and to at least 0.2 s.

Pulse Duration — 10 ns or less to 10 ms (within 5% from 0.1 μ s to 10 ms) in decade steps. Continuously variable between steps and to at least 0.1 s.

Duty Factor — At least 70% for periods of 0.2 μ s or more. Duty factor decreases to 50% at 20 ns period. Minimum off time is 10 ns.

Pulse Rise Time and Fall Time — 3.5 ns or less.

Aberrations - With 3.5% at 5 V amplitude.

Pulse Amplitude — 0.5 V or less to at least 5 V into 50 Ω load.

Pulse Coincidence (+ and - outputs) — Leading edge of pulse outputs within 1 ns of each other (measured at 50% amplitude points).

Trigger Output — At least +1 V into 50 Ω load, occurring approx 8 ns prior to pulse output. Duty cycle \simeq 50% when using internal period.

External Trigger/Duration Input — At least +1 not to exceed +5 V (dc + peak ac). Trigger/Duration recognition level, + 1 V or less. Trigger/Duration reset level, +100 mV or less. Minimum on and off time is 10 ns. 50 Ω input impedance.

PG 501 Pulse Generator.....\$450

MANUAL (ONE-SHOT) TRIGGER GENERATOR

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, PG 505, and RG 501.

Order 016-0597-00\$45

Comparison of Characteristics

When your test and measurement problems require instrumentation capable of producing a wide variety of waveforms, our TM 500 function generators offer versatility at an affordable price.

Their high frequency coverage and plug-in portability are earning them top marks in communications industries — from audio, video and radio to telecommunications and beyond.

You can use their triangular waveforms with your oscilloscopes to determine the overload (clipping) point of amplifiers. Or use the square waveforms to simultaneously reveal low frequency response (by sag), high frequency response (by rise time), and transient response (by ringing and other aberrations) of amplifiers.

For electronics applications, sine waves display the full frequency response of innumerable devices. And for logic circuitry, pulses and square waves can be used as clock and signal sources.

Beyond that, ramps and triangles create time bases for both oscilloscopes and paper recorders, and test signals for voltage comparators. At the low frequency end of function generator capabilities, you can set them to work on biological, geophysical and mechanical simulations, or on servo systems, and that's just the beginning.

By applying an external ramp to the vcf (Voltage Controlled Frequency) input, all our function generators can double as sweep generators. With the FG 504, sweep capability is conveniently built-in.

For testing broadband amplifiers from subaudio to 40 MHz, these generators provide a full 1000:1 sweep frequency range. And, given the same vcf input fed from a lowlevel modulating signal, you can produce a frequency-modulated carrier.

For sweeping wide frequency ranges (1000:1 or greater), the FG 504 features logarithmic sweep. This means you can spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs

With the FG 501 and FG 504 in burst mode, you can control the starting phase of the output waveform. This gate or burst feature

is also highly efficient for testing tone-controlled systems, loud-speaker transient reresponse characteristics and Automatic Gain Control circuits.

If you're generating pulses or ramps, our FG 504's external trigger allows your signal to initiate one complete waveform. Beyond that, its phase lock feature permits an external repetitive signal to control its output frequency.

The FG 504's other high-performance features let you convert digital signals to high or low voltage sine waves, ramps or pulses. Or sine waves to digital signals.

And, you can reference its output frequency to your own frequency standard. Or turn it into a limited frequency synthesizer (locked to your reference frequency), by combining its capabilities with the DD 501's Digital Delay in the "divide by n" mode.

If more waveforms for more applications are what you're after consider the TM 500 Function Generators' high performance capabilities. At that point, we think you'll agree that they're setting measurement standards for the entire electronics industry.

FUNCTION GENERATORS—COMPARISON OF CHARACTERISTICS

· ·	FG 501	FG 502	FG 503	FG 504			
Vaveforms	Sine, Square, Trian	gle, Pulse, Ramp	Sine, Square, Triangle	Sine, Square, Triangle, Ramps & pulses with variable symmetry			
ariable Symmetry	no	no	no	7% to 93% duty cycle			
Frequency Range	0.001 Hz to 1 MHz	0.1 Hz to 11 MHz (pulse, ramp 1.1 MHz max)	1.0 Hz to 3 MHz (usable 0.01 Hz to 5 MHz)	0.001 Hz to 40 MHz 0.001 Hz to nominally 4 MHz with variable symmetry			
Custom Frequency Range	no	no	With user-installed capacitor	Shipped with capacitor for 20 Hz to 20 kHz range			
Dial Accuracy % of Full Scale)	Within 3%	Within 3% to 1 MHz Within 5% to 10 MHz	Within 5%	Within 3% to 4 MHz Within 6% to 40 MHz			
Amplitude Open Circuit	20 V p-p max	10 V p-p max	20 V p-p max	30 V p-p max			
Into 50 Ω	10 V p-p max	5 V p-p max	10 V p-p max	15 V p-p max			
Output Step Attenuator	no	no	no	0 to -50 dB in 10 dB steps			
Open Circuit							
Offset Voltage	±7.5 V dc	±5 V dc	±7.5 V dc	±7.5 V dc			
Peak Sig + Offset	± 15 V	±10 V	± 15 V	±20 V			
Into 50 Ω			1075 V 4	±2.75 V do			
Offset Voltage	±3.75 V dc	± 2.5 V dc	±3.75 V dc	±3.75 V dc			
Peak Sig + Offset	±6 V	±5 V	±6 V	± 11.25 V			
Output Impedance		50 ohms					
Amplitude Flatness Sine Wave ref 10 kHz	±1.5 dB, 0.001 Hz-1 MHz ±0.5 dB, 20 Hz to 20 kHz	±1.5 dB, 0.1 Hz-11 MHz ±0.5 dB, 20 Hz to 20 kHz	±2 dB, 0.1 Hz to 3 MHz ±0.5 dB, 20 Hz to 20 kHz	±0.5 dB, 0.001 Hz to 40 kHz ±2 dB, 40 kHz to 40 MHz Square wave ±0.5 dB to 20 MHz,			
Square, Triangle	±1 dB ref sine	±3 dB ref sine	±1 dB ref sine	±2 dB to 40 MHz			
Frequency Stability (% of Full Scale)		\leq 0.05% for 10 min, \leq 0.1% for 1 ho	our, \leq 0.5% for 24 hours				
Sine Wave Distortion	<0.5% 1 Hz to 20 kHz ≤1.0% 20 kHz to 100 kHz ≤2.5% 100 kHz to 1 MHz	\leq 0.5% 10 Hz to 50 kHz Harmonics: \leq $-$ 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	\leq 0.5% 20 Hz to 40 kHz Harmonics: \leq $-$ 30 dB 40 kHz to 1 MHz \leq $-$ 20 dB 1 MHz to 40 MHz			
Square Wave Response	<pre><100 ns rise and fall <5% total aberrations</pre>	≤20 ns rise and fall ≤3% total aberrations	≤60 ns rise and fall ≤3% total aberrations	≤6 ns fixed 10 ns to 100 ms variable ≤5% + 30 mV aberrations			
Triangle Linearity (10% to 90%)	Within 1% 0.001 Hz to 100 kHz Within 2% 100 kHz to 1 MHz	Within 1% 0.1 Hz to 100 kHz Within 3% 100 kHz to 1 MHz Within 5% 1 MHz to 11 MHz	Within 1% 1.0 Hz to 100 kHz Within 5% 100 kHz to 3.0 MHz	Within 1% 10 Hz to 400 kHz Within 5% 400 kHz to 40 MHz typ within 2% 0.001 Hz to 10 Hz			
Voltage Controlled Frequency	Up to 1000:1	frequency change with 10 V external	signal. Slew rate \geq 0.3 V/ μ s, typi	cally ≥0.5 V/μs.			
Burst/Gate	Input impedance, 1 k Ω . Control signal required $+2$ V; $+15$ V max. Bursts are synchronous with gate. Phase continuously variable from -90° to $+90^{\circ}$.	Input impedance, 1 k Ω . Control signal required, $+2$ V; $+15$ V max. Bursts are synchronous with gate.	Not applicable	Input impedance \geq 10 k Ω Trigger level -1 V to $+10$ V Sensitivity 1 V p-p Generator completes integral number of cycles $\pm 80^\circ$ phase control			
Triggered Mode	no	no	no	Single waveform with external or manual trigger			
Trigger Output	TTL compatible +2.5 V into 600 Ω	TTL compatible $+2.5$ V into 50 Ω	TTL compatible $+2.5$ V into 600 Ω	TTL compatible 0 to \geq 2 V, 50 Ω Output Z			
Phase Lock	no	no	no	100 Hz to 40 MHz			
Internal Sweep	no	no	no	Logarithmic or linear 0.1 ms to 100 second duration Separate start-stop frequency dials			
Amplitude Modulation	no	no	no	100% with 5 V p-p input			
Output Hold Mode	0.001 Hz to 10 Hz	no	no	0.001 Hz to 400 Hz			
	A CONTRACTOR OF THE CONTRACTOR	FG 502\$650	FG 503\$425	FG 504\$137			

TM 500-Series Test and Measurement System

40 MHz Function Generator

0.001 Hz to 40 MHz

Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Rise and Fall 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 DD501

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 sine waves, as well as adjust phase relationships. Post attenuator offset enables use of the full ± 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. (Contact your Tektronix Field Engineer for a data sheet discussing FG 504 applications in detail.)

Frequency Range — Sine, Triangle and Square Waveforms: 0.001 Hz to 40 MHz calibrated range. Ramps, pulses or waveforms requiring use of VARIABLE SYMMETRY control: 0.001 Hz to nominally 4 MHz. Multiplier switch has position for user-determined range by capacitor selection. Maximum frequency on this range is 400 kHz. A 5 μF capacitor provides a full scale frequency of 400 Hz. Instrument shipped from factory with capacitor installed for 20 Hz to 20 kHz range in 0.5 x 10³ position.

Frequency Resolution — 1 part in 106 of full scale setting using the FREQUENCY VERNIER control.

Frequency Stability — \leq 0.05% for 10 minutes, \leq 0.1% for 1 hour, \leq 0.5% for 24 hours. The FREQUENCY Hz dial must be on the calibrated portion. The instrument must be at a constant ambient temperature between 0°C and +50°C and checked after a 1 hour warmup.

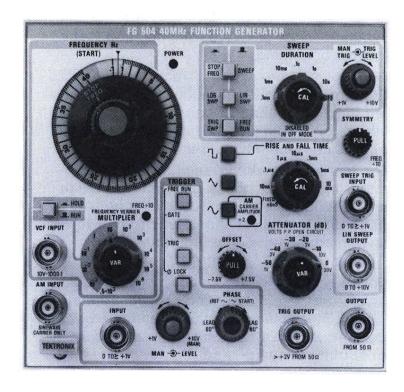
 $\textbf{Dial Calibration} \ - \ 1$ to 40 Hz calibrated, 0.1 to 1 Hz uncalibrated.

Dial Accuracy — $(+15^{\circ}\text{C} \text{ to } 35^{\circ}\text{C})$ Start Dial: Within $\pm 3\%$ of full scale from 0.001 Hz to 4 MHz. Within $\pm 6\%$ of full scale from 4 MHz to 40 MHz. Measurements made at $+25^{\circ}\text{C} \pm 10^{\circ}\text{C}$. Stop Frequency Dial: 5% of the difference between the start and stop frequencies plus the FREQUENCY Hz (START) dial error. Stop Dial uncalibrated on the 106 MULTIPLIER range.

Maximum Dial, VCF, and Sweep Range —

MULTIPLIER	FREQUENCY RATIO
106	500:1
105-102	1000:1
101, 1, 10-1, 10-2	100:1
10-3	40:1

Internal Sweep — Linear or Logarithmic. Accuracy: Limited by Start and Stop Frequency dial specifications. Can be set more accurately using an external



FG 504 40 MHz FUNCTION GENERATOR

frequency monitor. Sweep Duration: 100 s to 0.1 ms in six decades. Variable control overlaps decades. Stop Frequency to Swept Stop Frequency Error: Within 2% maximum from 100 s to 1 ms sweep duration. Within 10% maximum from 1 ms to 0.1 ms sweep duration. Linear Sweep Output: Amplitude: 0 V to \pm 10 V from 1 k Ω . Amplitude Accuracy: Within \pm 5% from 100 s to 1 ms, within \pm 10% from 1 ms to 0.1 ms. Sweep Trigger Input: Input Sensitivity: 1 V p-p. Trigger Level: 1 V through 10 V. Maximum Input: \pm 20 V. Manual Trigger: Front panel control.

Voltage Controlled Frequency Input — Nominal sensitivity (Hz/volt) = X 4 MULTIPLIER setting per volt. A positive-going voltage increases frequency. Maximum Frequency: X 40 MULTIPLIER setting. Minimum Frequency: Maximum frequency divided by vcf range of MULTIPLIER setting (see DIAL, VCF, and SWEEP RANGE). Slew Rate: 0.3 V/ μ s maximum. Input Impedance: 10 k Ω .

Output Amplitude — 30 V p-p into an open circuit, 15 V p-p into 50 Ω .

Amplitude Flatness — Sinewave (reference at 10 kHz): Within ± 0.5 dB from 0.001 Hz to 40 kHz. Within ± 2 dB from 40 kHz to 40 MHz. Typically within ± 0.5 dB to 40 MHz. Triangle (reference at 10 kHz): Within ± 0.5 dB from 0.001 Hz to 40 kHz. Within ± 2 dB from 40 kHz to 40 MHz. Squarewave (reference at 10 kHz): Within ± 0.5 dB from 0.001 Hz to 20 MHz. Within ± 2 dB from 20 MHz to 40 MHz. Sine, Triangle and Squarewave Amplitude Match: Within ± 1 dB at 10 kHz.

Output Attenuator — Open Circuit Voltages:

ATTENUATOR STEP	MAXIMUM OUTPUT VOLTAGE (p-p)
0 dB	30 V
-10 dB	9.5 V
-20 dB	3 V
-30 dB	950 mV
-40 dB	300 mV
-50 dB	95 mV

Variable -20 dB extends minimum signal amplitude to 10 mV. See square wave aberrations specification. Accuracy: ± 0.5 dB/decade.

Offset Range — ± 7.5 V into an open circuit, ± 3.75 V into 50 Ω . Maximum signal plus offset peak output amplitude of ± 20 V into an open circuit of ± 11.25 V into 50 Ω . Offset defeatable by front panel control.

Waveforms — Sine, Triangle and Square: Ramps and Pulses by use of the VARIABLE SYMMETRY control.

Variable Symmetry — Duty Cycle Range: 7% to 93%; 20% to 80% on triangle and sine waveforms above 1 MHz. Actuation of VARIABLE SYMMETRY control divides output frequency by approximately ten.

Triangle Symmetry — Within 1% from 10 Hz to 400 kHz, within 5% from 400 kHz to 40 MHz on calibrated portion of FREQUENCY Hz dial. Typically within 2% from 0.001 Hz to 10 Hz.

Triangle Linearity — Within 1% from 10 Hz to 400 kHz, within 2% from 400 kHz to 4 MHz, within 10% from 4 MHz to 40 MHz measured from the 20% to 80% points on the waveform Typically within 2% from 0.001 Hz to 10 Hz.

Sine-wave Distortion (Total Harmonic Distortion) — \leq 0.5% from 20 Hz to 40 kHz. Greatest harmonic at least 30 dB down from 40 kHz to 1 MHz and 20 dB down from 1 MHz to 40 MHz. Typically \leq 1% from 0.001 Hz to 20 Hz. Measured under the following conditions: terminated in 50 Ω , at 25°C \pm 10°C ambient, with zero offset, \leq 30 dB attenuation and with FREQUENCY Hz (START) dial set between 4 and 40.

Square wave — Rise and fall time (FIXED): \leq 6 ns. Aberrations: \leq 5% p-p + 30 mV into a 50 Ω load.

Variable Rise and Fall Time (Square and Pulse Waveforms) — Range: 10 ns to 100 ms in 7 steps measured from 10% to 90% points on waveform. Variable control has \geq 10 x range. Period of waveform must exceed combined rise and fall times by \geq 20%.

Amplitude Modulation Input — a 5 V p-p signal produces 100% modulation of a sine wave carrier from dc to 4 MHz with $<\!5\%$ distortion at 70% modulation when driven from a source impedance of $\leq\!600~\Omega.$ From 4 MHz to 40 MHz there is $<\!10\%$ distortion at 65% modulation. Distortion specifications valid for modulating frequencies from 20 Hz to 20 kHz. Modulation frequency bandwidth is dc to 100 kHz. A modulating source impedance of $\leq\!10~\mathrm{k}\Omega$ ensures proper modulation and divides the output amplitude by 2. Input Impedance: $>\!1~\mathrm{M}\Omega.$

External Trigger/Gate/Phase Lock Input - Input Impedance \geq 10 k Ω . Sensitivity: 1 V p-p. Maximum input Amplitude: +20 V. Trigger Mode: (for triggering a single cycle of main generator waveform). Trigger Level: -1 to 10 V. Minimum Period: 75 ns. Maximum Triggered Frequency: ≥20 MHz. Gate Mode: (for gating multiple-cycle bursts of main generator waveform). Minimum Period: 75 ns. Maximum Gated Frequency: ≥20 MHz. Duration of gate determines number of output cycles with integral number of cycles completed. Phase Lock Mode: Frequency Range: 100 Hz to 40 MHz. Capture Range: ±10 major dial divisions from 100 Hz to 4 MHz. ±8 major dial divisions from 4 MHz to 40 MHz. Lock Range: Generator will lock to a changing external signal, without readjusting the PHASE control, within ±10 major dial divisions from 100 Hz to 4 MHz and within ±1 MHz from 4 MHz to 40 MHz Phase Adjustment Range: ±80° from 100 Hz to 4 MHz.

Gate and Trigger Phase Control — Phase Adjustment Range: Triangle and sine waveforms only, $\pm 80^{\circ}$ from 0.001 Hz to 4 MHz.

Manual Trigger/Gate — Available at front panel.

Trigger Output — 0 V to \geq + 2 V from 50 Ω .

Hold Mode — Drift: \leq 10% of p-p output amplitude/hour. Range: 0.001 Hz to 400 Hz.

Power Consumption — 48 W from power line.

Power Dissipation — 24 W maximum in plug-in.

Performance Conditions — The electrical characteristics are valid if the FG 504 is calibrated at an ambient temperature between $+20^{\circ}$ C and $+30^{\circ}$ C, and operated between 0° C and $+50^{\circ}$ C, unless otherwise noted. Forced air circulation is required above $+40^{\circ}$ C (TM 515, TM 506, RTM 506 or equivalent).

FG 504 40 MHz Function Generator...\$1375

FG 504T 40 MHz Function Generator..\$1545 (includes FG 504, TM 503 Mainframe, and 016-0195-01 blank panel)

DD501 Digital Delay \$750

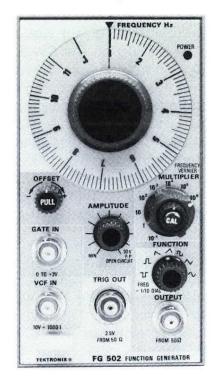


FG 503 3 MHz FUNCTION GENERATOR

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 p-p can be developed across a 50-ohm load (20 V p-p open circuit). Selectable offset up to 3.75 V dc across 50 ohms (7.5 V dc open circuit) is also featured.

FG 503 Function Generator \$425

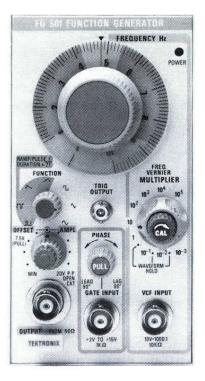


FG 502 11 MHz FUNCTION GENERATOR

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 wireline or radio remote control equipment and in certain phases of the telephane industry

FG 502 Function Generator\$650



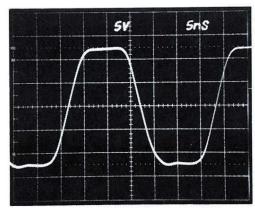
FG 501 1 MHz FUNCTION GENERATOR

0.001 Hz to 1 MHz Five Waveforms Vcf and Gated Burst Hold Mode

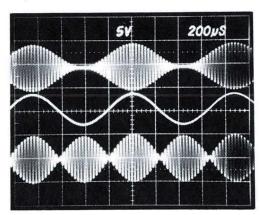
The FG 501 produces low-distortion sine, square, triangle, pulse, and ramp waveforms from 0.001 Hz to 1 MHz. An external vcf input permits control of the output frequency from an external voltage source. Frequency sweep up to 1000:1 ratio may be accomplished by applying a voltage ramp to the vcf input. A hold control allows the operation of the generator to be halted instantaneously at any point in its cycle. Release of the hold will then allow the operation to continue normally. A gate input is provided to allow "burst" or single cycle operation, with the phase of the generator output at the start of the burst controllable over a $\pm 90^{\circ}$ range. Output signal voltage is adjustable to 10 V p-p into a 50-ohm load, with dc offset also adjustable up to ± 3.75 V into 50 Ω .

FG 501 Function Generator \$525

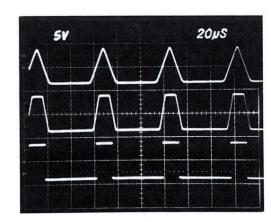
FG 504 OUTPUT WAVEFORMS



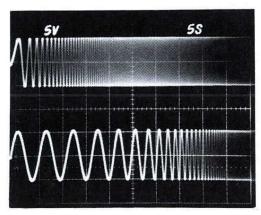
FG 504 30 volt output with 6 ns rise and fall times for superior pulse waveforms.



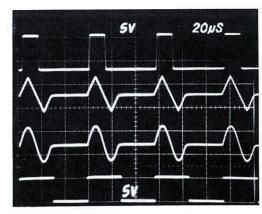
True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.



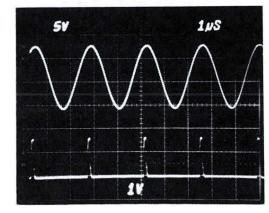
Variable rise and fall times increase pulse waveform flexibility.



FG 504 both linear or logarithmic sweep available for a wide range of sweep applications.



FG 504 completes one waveform when triggered from external signal on bottom trace.



Phase lock allows the FG 504 output (top trace) to lock to virtually any periodic input waveform.

Sweep, Audio, and Ramp Generators

For plug-in portability, compact size and state-of-the-art capabilities, many of today's broadcasting, computer time-sharing and telephonic communications specialists are turning to our TM 500 sweep, audio and ramp generators.

The SG 502 audio oscillator features extremely low sine wave distortion (less than 0.35% over a 20 Hz to 50 kHz audio range, and not more than 0.1% over its 5 Hz to 500 kHz coverage). Plus wide-range flat response for critical audio and communications systems and component testing.

Other high-performance features of the SG 502 include a flat output amplitude within ± 0.3 dB over the entire range, a 600 ohm output impedance, 70 dB amplitude control available in 10 dB steps, and 40 dB variable attenuator plus a simultaneous fixed amplitude square wave.

And, like the rest of our TM 500 Family, the SG 502 is highly configurable. When you add its capabilities to those of our DM 502 and DC 504, you get a compact, multifunction, audio frequency communications package.

The SW 503 Sweep Generator, with its 1 to 400 MHz range, built-in 1, 10 and 50 MHz markers and +10 dBm (+50 dBmV) output, offers the features of a larger sweep generator in a compact, portable plug-in.

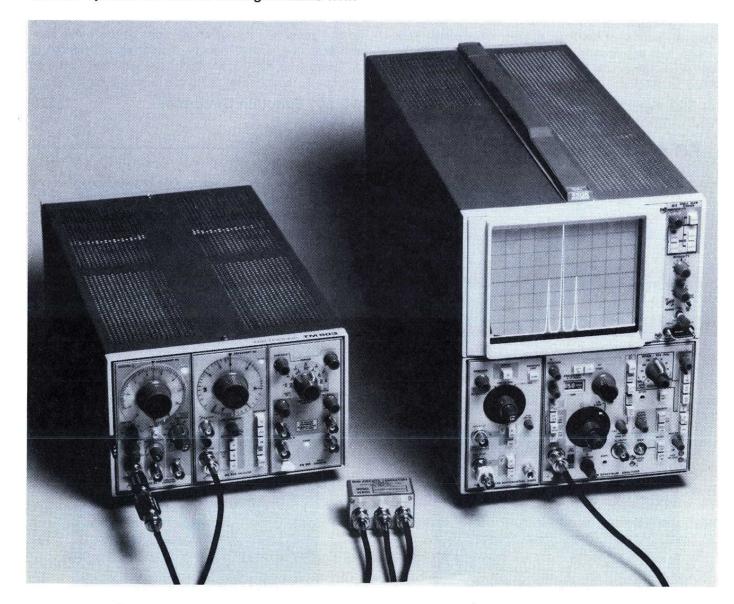
The SW 503 also features a bright dot marker system for use in configurations with

an oscilloscope. The bright dot marker is controlled by a knob on the SW 503's front panel. The dot marker can be accurately positioned at the frequency being measured and by adding a TM 500 Counter to this system the frequency at the marker dot on the scope will be digitally displayed on the counter. Packaging the SW 503, a TM 500 Counter and an oscilloscope in an Option 07 mainframe makes this unique performance capability possible.

The RG 501 Ramp Generator provides single or repetitive ramps of controllable amplitude and duration, excellent linearity, and short retrace time. And like the SG 502, the RG 501 can fit into several TM 500 packages when combined with our TM 500 function generators, the PG 505 Pulse Generator, crt monitors, or an X-Y recorder.

The RG 501's output provides an ideal time base for a monitor or recorder. Used with the PG 505, it permits a delayed pulse to be triggered at any selectable point along the ramp. And used with any of our function generators, where vcf (Voltage Controlled Frequency) input is fed by the RG 501's output, it generates a linear frequency sweep width of up to 1000:1.

As you can see, these generators offer high-level capabilities when used alone, and versatility when plugged into a powerful TM 500 system of your own design.





SW 503 SWEEP GENERATOR

1 to 400 MHz Range

1, 10, and 50 MHz Markers Built-in

Continuously Variable Dot Marker System

+10 dBm (+50 dBmV) Output

Remote Programming Capability

The SW 503 is a 1 to 400 MHz RF Sweep Generator with two marker systems built-in. Standard crystal comb markers at 1, 10, and 50 MHz intervals automatically adjust their width as the sweep width range is selected. Even more unique is the variable position dot marker whose frequency can be automatically displayed on a TEKTRONIX DC 508 Option 07 Counter. The counter will also monitor the frequency when using the SW 503 as a cw signal source.

The SW 503 can be amplitude modulated, frequency modulated, or remotely programmed with voltages to control amplitude, frequency, or sweep triggering.

The versatility and many features of the SW 503 make it an excellent choice for specialized sweep testing or for general laboratory use.

CHARACTERISTICS

Center Frequency Range — 1 to 400 MHz. Dial accuracy: ±8 MHz (note 1). Drift: 100 kHz/5 min — 2 MHz/8 hrs (note 2).

Swept Frequency Range — 1 to 400 MHz. Sweep width: 200 kHz min, 400 MHz max. Display linearity: \leq 2% @ 400 MHz position, \leq 3% @ 100 MHz and 10 MHz positions.

Signal Purity — Residual fm: \leq 10 kHz. Harmonic Spurious: \geq 30 dB below output from 10 to 400 MHz, \geq 25 dB below output from 3 to 10 MHz \geq 15 dB below output from 1 to 3 MHz. Non-harmonic Spurious: \geq 40 db below output.

Output — Impedance: Model SW 503, 50 Ω , Model SW 503, Option 01 75 Ω . Level: 0.7 VRMS MAX, SW 503 CALIBRATED —40 to \pm 10 dBm 50 Ω , SW 503, Option 01 CALIBRATED 0 to \pm 50 dBmV 75 Ω . Attenuation:

Step 50 dB in 10 dB steps, absolute accuracy 0.2 dB/ step referred to zero attenuation, vernier \geq 20 dB. Flatness: \pm 0.25 dB (measured at maximum output using precision detector \leq 1.15 vswr).

Blanking — Retrace blanking of the rf output provided for sweep operation, removed for cw operation.

Aux Rf Output — -2 dBm min. into 50 Ω .

Operating Modes — Repetitive sweep, single sweep, externally triggered sweep, line-lock sweep, manual sweep, cw.

Sweep Time — Continuously variable from 10 ms to 100 s in 4 decade steps, plus vernier.

Horizontal Output — 0.5 volts p-p (output symmetrical to ground reference).

Crystal Markers — Type: birdie-by-pass, comb markers. Marker comb frequency: 1, 10, and 50 MHz. Marker accuracy: 0.005%. Marker width: automatically changes from approx 400 kHz to 50 kHz as the sweep width range is selected. Marker size: adjustable from 1 mV to 1 V p-p. Rectified marker: internal switch removes the negative portion of the birdie for use with X-Y recorders. Size varies with detector's output impedance. Max marker size is over 0.5 V.

Variable (Dot) Marker (use in line or 10 ms rate) — When used in conjunction with the DC 508 Digital Counter with Option 07, the variable (dot) marker will stop the sweep wherever the marker is positioned. This in turn gates the counter on to read the frequency. At the end of the counter gate, the SW 503 resumes sweeping. The accuracy of the variable marker is limited to the counter accuracy and the display resolution, i.e.: reduced sweep width gives greater resolution.

Remote Programming — Front-panel jacks provide connections for the remote control of frequency, sweep width, and the 20 dB vernier output control. A jack is also provided to externally trigger the sweep circuit when the instrument is in a single sweep mode. Provisions are also available on the front panel for external frequency and amplitude modulation. External fm: the full frequency range can be modulated at rates up to 4 kHz. With reduced deviation and linearity, modulation rates to 100 kHz are possible. Modulation sensitivity is approx 50 MHz/ V. Input impedance 10 k Ω . External am: 90% modulation can be obtained at modulation frequencies up to 25 kHz. Note: the output level must be reduced at least 6 dB by the vernier output control to obtain 90% modulation. Modulation sensitivity is 1 volt p-p/ 10% am. Input impedance 10 k Ω .

Note 1. Increased accuracy can be obtained using the crystal markers or the variable (dot) marker in conjunction with the DC 508, Opt 07.

Note 2. After $\frac{1}{2}$ hour warm-up at a constant ambient, and allowing a 5 minute stabilization period after a frequency change.

Included Accessory — 50 $\,\Omega$ Termination 118-0065-00. Required for AUX RF output.

ORDERING INFORMATION

SW 503 RF Sweep Generator
(50 Ω Output)
Option 01 (75 Ω Output) No Charge
Needs external detector.

SUGGESTED ACCESSORIES

30ddE31ED ACCESCOTILES
TM 515 Option 07 Power Module\$350
DC 508 Option 07 1 GHz Freq Counter\$1300
DM 502 Digital Multimeter
SC 502 15 MHz Dual Trace Oscilloscope\$1325
50 Ω Precision Detector for SW 503
(118-0070-00)\$55
75 Ω Precision Detector for SW 503 Option 01
(118-0071-00)



SG 502 OSCILLATOR

5 Hz to 500 kHz Sine and Square Waves
Extremely Low Distortion Sine Wave
5 V Rms Open Circuit—600 Ω Source
0-40 dB Output Variable Plus 0-70 dB
in 10 dB Steps

SINE WAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to less than 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 2% for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to 40 dB.

Harmonic Distortion — Less than 0.035% from 20 Hz to 50 kHz. Less than 0.1% over the remaining frequency range.

Hum and Noise — Less than 0.1% of rated output.

Max Output Voltage — 5 V rms open circuit; 2.5 V rms into 600 Ω .

Output Impedance — 600 Ω , single ended.

SQUARE WAVE

Frequency Range — Same as sine wave. The square wave switches on the 0° phase of sine out.

Rise and Fall Time — 50 ns or less.

Amplitude — +5 V, fixed, open circuit.

Output Impedance — 600 Ω , single ended.

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 Ω .

Measurements made at rated output and terminated in 600 $\Omega.\,$



RG 501 RAMP GENERATOR

10 μs to 10 s Ramp Duration
 Plus or Minus Output
 10-V Amplitude
 Scope-type Trigger Functions
 Gate Out, TTL Compatible

RAMP

Ramp Duration — Decade ranges of 10 μ s to 1 s, extends to 10 s with 1-10 duration multiplier. Accurate within 3% when multiplier is at X1 (multiplier not calibrated).

Ramp Amplitude — Continuously variable from 50 mV or less to at least 10 V, either polarity. Dc level between ramps, 0 V within 20 mV.

Gate — From a low state of 0 V, within 100 mV, the ramp gate rises to +3 V, within 0.6 V, in 100 ns or less. Fall time is 100 ns or less. Gate source impedance is nominally 160 Ω .

Ramp Output Characteristics — Minimum load resistance, 3 k Ω ; max load capacitance, 300 pF.

TRIGGERING

Auto Triggering — Provides free-running signal in absence of trigger. Locks automatically to trigger with a frequency above 20 Hz and at least 200 mV amplitude.

External Triggering — Sensitivity is at least 200 mV p-p, dc to 100 kHz. Input impedance approx 9.5 k Ω . 50 V (dc + peak ac) max input.

Internal Triggering — Same as external except that the trigger source is via the rear interface.

Line Trigger — Triggers at line frequency.

Trigger Level Range — ±1 V.

RG 501 Ramp Generator.....\$295

Optional Accessory — Manual (One-Shot) Trigger Generator.

Order 016-0597-00\$45

Oscilloscope Calibration Instruments

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.

These TM 500 Oscilloscope Calibration instruments, offer the widest range of standard amplitude square waves, fastest rise times, lowest aberrations, fastest time marks and widest frequency range of leveled sine waves 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.

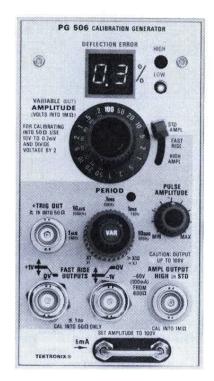
Our PG 506 calibration generator offers TM 500 portability plus state-of-the-art performance features. With the PG 506 in the amplitude calibration mode, you can generate a 1 kHz square wave and vary its amplitude around the calibrated level until the square wave aligns with your oscilloscope's vertical 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 sine wave generators, SG 503 and SG 504, round out a scope calibration and verification package. These generators provide leveled sine wave generator for bandwidth checks (-3dB points) and triggering performance checks.

The SG 503 is a general purpose leveled sine-wave 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 module, the SG 502 oscillator, could also benefit calibration applications where verification of low frequency roll off in ac modes and performance measurement of low frequency reject triggering modes is required.

For features that allow time and error reducing on-the-job oscilloscope evaluation, our TM 500 calibration instruments are the best value on the market today.



PG 506 CALIBRATION GENERATOR

Three Square-Wave Output Modes
10 Hz to 1 MHz

Direct Readout of Oscilloscope Deflection Error

The PG 506 is a calibration generator for oscilloscopes with three modes of squarewave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. For checking attenuator performance and transient response of oscilloscopes, simultaneous plus and minus low-level, fastrise (1.0 ns) square waves or high amplitude (60 volt), extremely clean square waves are available at frequencies from 10 Hz through 1 MHz. A 5 milliamp calibration current loop is useful for current probe calibration. In the amplitude calibration mode, a 1 kHz square wave is generated whose amplitude may be varied around the calibrated level until the square wave aligns with the oscilloscope vertical graticule divisions; scope deflection error is then read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

AMPLITUDE CALIBRATOR MODE

Period — Fixed at approx one millisecond or dc.

Amplitude — From 100 V p-p to 200 microvolts p-p in 1-2-5 sequence, accurate within $\pm 0.25\%$ into 1 M Ω . 5 V p-p to 100 microvolts p-p into 50 Ω .

Error Readout Range — ±7.5%.

Error Readout Resolution — 0.1%.

PULSE MODES

Period — One microsecond to 10 milliseconds (within 5%) in decade steps with the VARIABLE control in CAL position. VARIABLE extends period to at least 100 milliseconds.

Symmetry — Approx 50% duty cycle.

HIGH AMPLITUDE OUTPUT

Rise Time — Unterminated: 100 ns or less. Terminated into 50 Ω : 10 ns or less.

Amplitude Range — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω : 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω .

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST RISE OUTPUTS

Rise Time (Terminated into 50 Ω) — 1.0 ns or less.

Amplitude Range (Terminated into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — 2% or 10 mV p-p, 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 Ω within 3% at + and — output connectors.

Trigger Output (Terminated into 50 $\Omega)$ — Positivegoing signal of at least 1 V.

PG 506 Calibration Generator\$1495

TUNNEL DIODE PULSER

The Tunnel Diode Pulser (067-0681-01) 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 ohms, while rise time is \leq 125 ps; aberrations are <1% in a 1 GHz system.

Order 067-0681-01\$120

OSCILLOSCOPE CALIBRATION INSTRUMENTS CHART

	PG 506	TG 501	SG 503	SG 504
	Calibration Generator	Time Mark Generator	Signal Generator	Signal Generator
Primary	Amplitude calibration	Time-base calibration 1 ns to 5 s	Bandwidth calibration	Bandwidth calibration
functions	200 μV to 100 V		250 kHz to 250 MHz	245 MHz to 1050 MHz
Secondary functions	Rise time and transient response testing, attenuator compensation testing	Testing oscilloscope nonlinearity	General leveled rf signal source	General leveled rf signal source with frequency modulation capability

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 4 divisions when checking amplitude calibration from 20 μ V/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display 5 divisions of amplitude.

Input Z — 50 Ω with output load \geq 100 k Ω .

Max Input — ≤5 V rms.

Output — 0.4 x PG 506 Amplitude.

Voltage Accuracy — $\pm 0.4\%$.

Order 015-0265-00\$55



TG 501

TIME MARK GENERATOR

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 which 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.

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — \geq 1 V peak into 50 Ω on 5 s through 10 ns markers. \geq 750 mV p-p into 50 Ω on 5 ns and 2 ns markers. \geq 200 mV p-p into 50 Ω 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.

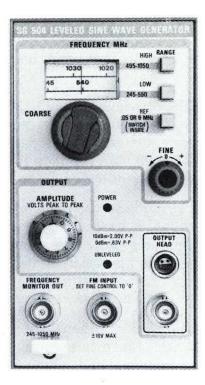
Internal Time Base	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz
Stability (0° to 50° C) after ½ hour warm-up	within 1 part in 10 ⁵	within 5 parts in 10 ⁷
Long-term Drift	1 part or less in 10 ⁵ per month	1 part or less in 10 ⁷ per month
Settability	adjustable to within 1 part in 10 ⁷	adjustable to within 5 parts in 109

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).

TG 501 Time Mark Generator \$1095 Option 01, 5 MHz Time Base Add \$200



SG 504

SIGNAL GENERATOR

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 ohms.

Frequency Range — Low band: 245 MHz to 550 MHz. Highband: 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: ± 9 V produces from $\pm 0.05\%$ to $\pm 0.4\%$ deviation of carrier, depending on output frequency.

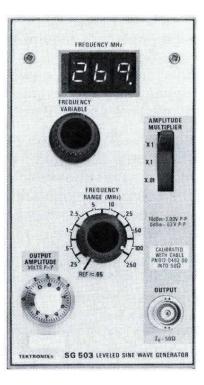
Frequency Monitor Output — $\geq\!\!0.3$ V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

Rear Card Edge Connections — Address fm input, frequency monitor output, and amplitude control.

SG 504 Signal Generator (Includes Leveling Head)\$1995

Replacement Leveling Head,
Order (015-0282-00)\$200





SG 503

SIGNAL GENERATOR

Leveled, Variable Output

250 kHz to 250 MHz

Digital Readout of Frequency

The SG 503 Signal Generator is a general-purpose leveled sine-wave oscillator. It provides a leveled output amplitude which 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 into 50 ohms is variable from 5 mV to 5.5 V peak-to-peak

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Accuracy — Within ± 0.7 of least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V p-p into 50 Ω 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 (X.01) range.

Flatness — (p-p) From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to $\pm 1.5\%$, $\pm 1.5\%$ 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.

Standard Accessory — Precision 50Ω cable 3 ft. long. (012-0482-00).

SG 503 Signal Generator.....\$1195

TM 500-Series Test and Measurement System

Power Supplies

R & D design engineers require power supplies that are flexible enough to equal their imagination . . . and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench.

Our TM 500 power supplies can do just that, and more. Beyond supplying voltages for experimental or breadboard circuits and devices, their unique modularity lets you add units as needed, to keep your instrumentation up to date.

To insure convenience in your test system TM 500 Digital Multimeters can be rear interfaced to provide a monitoring of any power supply voltage. The power supply voltage of the PS 501-1, PS 501-2 or PS 503A will be digitally displayed on the digital multimeter through this rear connector. A convenience when testing or measuring, the rear interface capability allows the engineer to accurately look at his voltage requirements. The TM 500 power supplies provide up to three independent voltages from one plug-in instrument. And each features a fixed 5-volt-at-1amp supply for logic circuits or indicators plus one or two variable supplies.

Other features that are standard with the PS 501-1 and PS 501-2 include a floating 0to-20 volt output and adjustable current limiting from 0 to 400 milliamps with constant current operation above the limiting setting.

For accurate setting and adjustment of the output voltage, our PS 501-1 precision supply features a multiturn potentiometer with mechanical digital readout. The PS 501-2 also features a meter giving analog readouts of voltage and current load on the panel front.

Our PS 503A provides a dual -20 to 0 and 0 to +20 volt variable supply plus a 5 volt 1A independent supply. And you can vary its -20 and +20 volt supplies in a tracked mode, or set each individually.

In the tracking mode, varying the plus and minus supplies in proportion to the voltage ratio set on their individual controls, is a simple, one-knob operation. In the nontracking mode, you can set each supply independently to any voltage — from 0 to 20 V.

In the high-power compartment of our TM 504 or TM 506, these two variable outputs can each supply up to 1 amp. And in any other compartment of a TM 500 Mainframe, they'll provide up to 400 mA.

Beyond that, since all three variable supply terminals are floating, you can ground any one of them. Or use the two outside terminals as a 0-to-40 volt supply. And both the positive and negative variable supplies have their own current limiting.

Since most active devices and transducers and many electromechanical components require direct current, you can well imagine that the application possibilities for these TM 500 power supplies are virtually unlimited. Their highly configurable characteristics and their compact, easy portability are enabling research and design engineers in their test and measurement work.

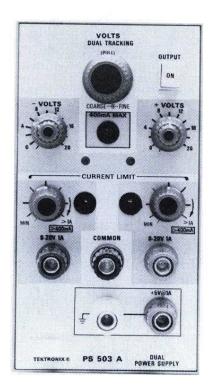
POWER SUPPLIES—COMPARISON OF CHARACTERISTICS

	PS 501-1	PS 501-2	PS 503A
Voltage/Current #1	+5 V @ 1 A	+5 V @ 1 A	+5 V @ 1 A
Voltage/Current #2	0-20 V @ 400 mA	0-20 V @ 400 mA	0 to +20 V @ 1 A*/400 mA**
Voltage/Current #3	No	No	0 to -20 V @ 1 A*/400 mA**
Current limit	<40-400 mA	<40-400 mA	<100 mA-1 A* 400 mA**
Min resolution	1.6 mV	10 mV	10 mV
Foldback current	No	No	No
Over voltage protection	No	No	Yes
Line regulation	<5 mV††	<5 mV††	<5 mV†††
Ripple & noise p-p	0.5 mV††	0.5 mV††	0.5 mV†††
Others	Multiturn pot with digital readout	Meter for voltage or current	+ — outputs independent, or dual tracking at ratio set by individual knobs
Price	\$250	\$250	\$350

^{*}In high-power (right-hand) compartment of TM 504 or TM 506.

**In any standard mainframe compartment.

†Refers to output #1 ††Refers to output #2 †††Refers to output #2 and #3



PS 503A TRIPLE POWER SUPPLY

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 +and -, 0 to 20 volt supplies.

±20 V FLOATING SUPPLIES

Output — 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.

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.

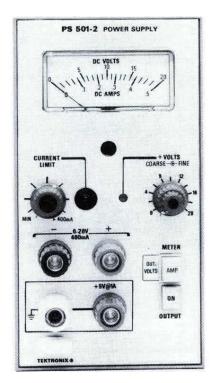
Current Limit - Adjustable from less than 100 mA to 1 A (high-power compartment) or less than 40 mA to 400 mA (standard compartment) on each supply.

Load Regulation - Within 3 mV for 1 A change (highpower 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. Non-high-power compartment (400 mA) indicator.

PS 503A Power Supply\$350



PS 501-2 POWER SUPPLY

Floating Output, 0-20 V
0 to 400 mA
Precise Regulation
Low Ripple and Noise
Fixed Output + 5 V @ 1A

Output — 0 to 20 V dc.

Current Limit — <40 mA to 400 mA.

Minimum Resolution — 10 mV.

Line Regulation — Within 5 mV for a $\pm 10\%$ line voltage change.

Load Regulation — Within 1 mV with a 400 mA load change.

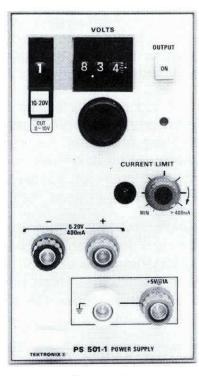
Ripple and Noise — $0.5\,$ mV p-p or less; $0.1\,$ mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Transient Recovery Time — 20 μ s or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400-mA change in output current.

Meter — Dual range, 0 to 500 mA or 0 to 20 V dc. Accuracy, $\pm 2\%$ of full scale.

PS 501-2 Power Supply \$250



PS 501-1 POWER SUPPLY

Floating Output, 0-20 V
0 to 400 mA
Precise Regulation
Low Ripple and Noise
Fixed Output + 5 V @ 1A

Output - 0 to 20 V dc.

Current Limit — <40 to 400 mA.

Line Regulation — Within 5 mV for a $\pm 10\%$ line voltage change.

Load Regulation — Within 1 mV with a 400 mV load change.

Ripple and Noise — 0.5~mV p-p or less; 0.1~mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Minimum Resolution — 1.6 mV.

Voltage is selectable within 0.5% by a 10 turn potentiometer with a 3 digit in-line dial and range switch.

Transient Recovery Time — 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400 mA change in output current.

PS 501-1 Power Supply \$250

PS 501-1, PS 501-2, PS 503A

20 V FLOATING SUPPLY

Primary Power Input — Determined by power module (TM 501, TM 503, etc).

Output — Floating, isolated from ground, 350 V dc + peak ac.

Stability — (0.1% +5 mV) or less drift in 8 hours at constant line, load, and temperature.

Indicator Lights - Voltage variation and current limit.

+5 V GROUND-REFERENCED SUPPLY

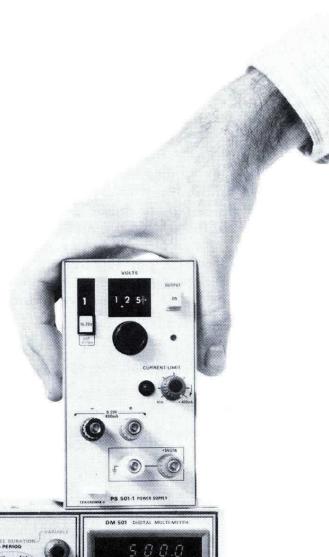
Output — 5 V nominal, ±0.2 V at 1 A (20°C to 30°C). Load Regulation — Within 100 mV with a 1 A load change.

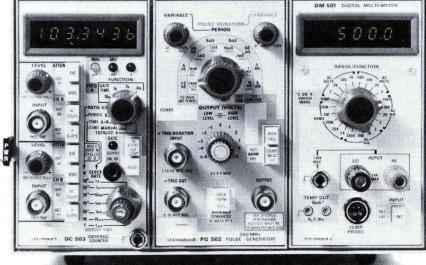
Line Regulation — Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A) — 5 mV p-p or less; 100 μ V rms or less.

Stability - 0.5% or less drift.

Overload Protection — Automatic current limiting and over-temperature shutdown.





Bandpass Filter/Amplifier

When it comes to solving electrical measurement and analysis problems at the critical design stage, our TM 500 signal processors are the best value on today's market. Their compact, plug-in portability and unique flexibility allow complete lab instrumentation setups to be built within stringent space and budget limitations.

You can put these versatile electrical signal alteration devices to work on a broad range of applications: preamplification of low-level signals and addition or removal of dc offset; filtering noise and signals outside your spectrum of interest; integration, differentiation and summing of multiple signals; and impedence transformation and post amplification (obtaining higher amplitude drive from low-amplitude signal sources).

Our AF 501 Bandpass Filter/Amplifier features a center frequency that's one-knob tunable over the entire audio range—from 3 Hz to 35 kHz. It's switch-selectable in broad (Q=5) and narrow (Q=15) bandwidths, and it provides sine-wave generation to 35 kHz and flat signal amplification to 50 kHz.

The AF 501's capabilities are extremely versatile. You can select amplification from 1 to 500 in a 1-2-5 sequence in both filter and flat modes. Or use its signal output pulse to drive counters and oscilloscopes or to trigger stroboscopic lamps. Or take advantage of its oscillator mode when you want the output frequency to equal the center-tuned frequency in the filter modes. And its selectivity can be put to work on individual analysis of fundamental and harmonic components of complex waveforms like vibration transducers' signals.

For most electronic and many electromechanical applications, the AM 501 operational amplifier's output power (± 40 volts and

±50 mA across 800 ohm loads) is more than adequate. This high-output unit features front-panel connectors that let you change configurations by selecting feedback components, quickly and easily.

So, the AM 501 is easily set up for differentiation, integration, summing and impedance transformation problems. Or, if you want a given configuration to be relatively permanent, you can hardwire its feedback components internally.

Our versatile AM 502 Differential Amplifier (for maximum rejection of common-mode noise signals) lets you control gain, dc offset, low-frequency and high-frequency response. You can also use the AM 502 with single-ended input.

The AM 502's adjustable dc offset allows high amplification even with low-level signals having a dc component up to one volt . . . its variable dc offset feature simply cancels the signals dc component. Another high-performance feature is the AM 502's dc-to-1 MHz bandwidth. Switch-selectable high-pass and low-pass filters can reduce the noise bandwidth when you don't need a full frequency range.

The AM 502 and AF 501 are commonly used in the conversion of a mechanically originated signal into an electrical signal or when eliminating noise in transducer measurements in order to concentrate on a particular signal.

The TM 500 signal processors are designed to be a unique combination of hard-working features, human engineering and compact portability. And these built-in capabilities really count when it comes to overcrowded classrooms, a design engineer's cramped quarters or to signal conversion in the world of physical mechanical measurements.

SIGNAL PROCESSORS—COMPARISON CHART

	AF 501 Tunable Bandpass Filter/Amplifier	AM 501 Operational Amplifier	AM 502 Differential Amplifier
Amplification range	1 to 500 in 1-2-5 steps	Depends on feedback components; open loop gain 10,000	1 to 100,000 in 1-2-5 steps
Input impedance	1 ΜΩ	Depends on feedback components	1 M Ω normal; FET input by internal jumper
Bandwidth control	Center frequency tunable 3 Hz to 35 kHz; Q=5 or 15	Depends on feedback components; max gain- bandwidth product 5 MHz	Independent switch-selected high-frequency and low- frequency filters
Maximum output	20 V p-p (Bandpass filter)	\pm 40 V, \pm 50 mA with 800 Ω load	\pm 5 V, \pm 20 mA, ouput resistance 5 Ω or less
Other features	Functions as audio oscillator, narrow or wide bandwidth tunable filter and flat audio amplifier	Use as inverting or noninverting amplifier, follower, summing amplifier, integrator, differentiator, etc, by appropriate feedback R and C	Coarse and fine control of up to ± 1 V of internal dc offset, ac or dc coupling, single-ended or differential input, 25 μ V equivalent input noise at full bandwidth
Price	\$550	\$350	\$725



AF 501 BANDPASS FILTER/AMPLIFIER

Tunable Bandpass Filtering to 35 kHz Signal Amplification to 50 kHz Sine-wave 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 sine-wave generator combined in a single TM 500-Series module. Used alone or in conjunction with other TM 500-Series 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. And, of course, the AF 501 can be used in any application calling for a conventional sine-wave generator, ac-coupled amplifier, or bandpass filter.

BANDPASS FILTER

Center Frequency Range — 3 Hz to 35 kHz in 4 decade steps.

Frequency Dial Error — <5% dial setting between 3-20, <10% dial setting between 20-30.

Frequency Multiplier — X1, X10, X100, X1 k.

Phase Shift — <10° at tuned frequency below 5 kHz.

Dial Range - 3 to 40 Hz/180-2400 cpm.

Max Filter Attenuation — >70 dB.

Filter Selectivity — Broad: $Q = 5 \pm 1$. Narrow: $Q = 15 \pm 5$.

Bandwidth at Half-power Points —

 $\Delta F_{-3 dB} = \frac{\text{center frequency}}{2}$

Gain Range — 1-500; 1-2-5 sequence.

Gain Accuracy — ± 3 dB (Broad), ± 5 dB (Narrow).

Input Impedance — 1 M Ω \pm 1% paralleled by \approx 47 pF.

Max Dc Input Voltage — \pm 100 V.

Output Voltage — 20 V p-p (max freq times amplitude = 400 V kHz).

Output Current—20 mA p-p max (at 20 V p-p). Output Impedance — <1 Ω .

AMPLIFIER

Gain — 1 to 500; 1-2-5 sequence.

Gain Accuracy — $\pm 3\%$.

Bandwidth — <0.5 Hz to >50 kHz (at 3 dB point).

Input Impedance — 1 M Ω ±1% paralleled by \approx 47 pF.

Noise — <25 mV rms (referred to output).

Output Voltage — 20 V p-p (max freq times amplitude = 400 V kHz).

OSCILLATOR

Sine Wave Out Range - 3 Hz to 35 kHz.

Dial Range - 3 to 40 Hz/180-2400 cpm.

Output Amplitude — 1, 2, or 5 V p-p \pm 20%, depending on gain position.

Waveform Distortion — <3%.

Output Current - Max 50 mA p-p.

Output Impedance — <1 Ω (within 50 mA output current limit).

TRIGGER OUTPUT

Pulse Amplitude — >10 V.

Pulse Duration — $10 \pm 5 \mu s$.

Min Signal Required — 500 mV, p-p

Rise and Fall Time — $<1 \mu s$.

Output Impedance — \approx 50 Ω .

AF 501 Bandpass Filter/Amplifier \$550



AM 511 PREAMPLIFIER

For Use with 7L12 or 7L13 Spectrum Analyzers

Reference Level Selectable in 1 dB or 10 dB Steps

30 to 890 MHz Frequency Range

The AM 511 is a plug-in preamplifier for use with the 7L12 or 7L13 Spectrum Analyzers. It plugs into a TM 500 Power Module to meet the need of those who require a preamplifier for use with the 7L13.

The AM 511 applications include signal to noise, radiation, and field intensity measurements to FCC specifications on CATV, television, and fm installations. It is also useful in servicing and making measurements on radio systems and increasing sensitivity for emi measurements within the 30 to 890 MHz frequency range.

Concentric selectors select the reference level in either 1 dB or 10 dB steps and indicate this level in dBmV via a readout window. This level is also the maximum signal input level for linear operation. A +30 dBmV signal source at the input connector provides -30 dBm (from 50 Ω) signal at the OUTPUT connector. (Reference level readout uses an output of -30 dBm as a reference; therefore the 7L12 or 7L13 Reference Level must be set and calibrated for -30 dBm.) The CAL OUT Connector provides an accurate +30 dBmV, 50 MHz signal source from 75 Ω . This signal provides an absolute reference on the display of the 7L12 or 7L13 to check dBmV readings and calibrate the REFERENCE LEVEL. Harmonics of the 50 MHz signal provide picket fence markers across the frequency span for accurate frequency and span calibration.

ELECTRICAL CHARACTERISTICS (with 7L12 or 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — (AM 511/7L12) ± 1.0 dB, with respect to the level at 50 MHz, over the frequency range of 50 MHz to 300 MHz and +2.0 dB, -2.5 dB over the full frequency range. (AM 511/7L13) +1.0 dB, -1.5 dB, with respect to the level at 50 MHz, over the frequency range of 50 MHz to 300 MHz and +2.0 dB, -2.5 dB, over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode. The following characteristics apply at 50 MHz.

Sensitivity	ty Resolution Bandwidth	
−90 dBmV	30 Hz	
$-80~\mathrm{dBmV}$	300 Hz	
-73 dBmV	3 kHz	
-65 dBmV	30 kHz	
$-55~\mathrm{dBmV}$	300 kHz	
-45 dBmV	3 MHz	

Noise figure for the AM 511 is no greater than 5 dB.

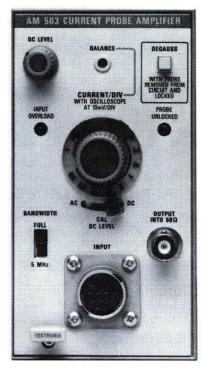
Intermodulation Distortion—(AM 511/7L12 or AM511/7L13) Imd products and harmonics from two signals within the frequency span of the AM 511 are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

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. Max deviation from this reference is 0.2 dBmV +0.01 dBmV per dB deviation from the +30 dBmV AM 511 reference level. This is equivalent to: \pm (0.2 dBmV \pm 0.01 [dBmV Ref LvI -30 dBmV]).

Input Impedance — 75 Ω with a vswr of 2:1 or better with 10 dB or more attenuation (between 50 MHz and 300 MHz).

Calibrator — 50 MHz $\pm 0.01\%$ with an absolute amplitude level of ± 30 dBmV ± 0.3 dB, from 75 Ω at 25°C.

AM 511 CATV Preamplifier\$625



AM 503 CURRENT PROBE AMPLIFIER

Displays Current/div Signals on an Oscilloscope

Current Range, Maximum Current, and Bandwidth Determined by the Probe Used

The AM 503 is a plug-in modular currentprobe amplifier that operates in TM 500 Mainframes. It allows display of current/division on any oscilloscope with 10 mV/div sensitivity, 50 ohm or 1 megohm input, and (for performance to full specifications) at least 75 MHz when using the P6302 or 50 MHz when using the P6303. 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.

ELECTRICAL CHARACTERISTICS

(AM 503 Current Probe Amplifier with P6302 Probe and P6303 Probe)

Maximum Input Current — 20 A (dc + peak ac) for P6302. 100 A (dc + peak ac) for P6303.

Maximum Voltage for Current Under Test (Bare Conductor) — 500 V (dc + peak ac) for P6302. 700 V (dc + peak ac) for P6303.

Bandwidth (-3 dB) — Dc to at least 50 MHz with P6302. DC to at least 15 MHz with P6303.

Rise Time (Full Bandwidth) — 7 ns or less with P6302. 23 ns or less with P6303.

Deflection Factor — 1 mA/div to 5 A/div for P6302.

20 mA/div to 50 A/div for P6303. In a 1, 2, 5 sequence for both probes.

Attenuator Accuracy — Within 3% of indicated CUR-RENT/DIV for both probes.

INCLUDED ACCESSORIES WITH AM 503

Refer to page 241 of this catalog for complete specifications on the AM 503 Current Probe Amplifier.

See probes on next page.



DC CURRENT PROBE

100 A Ac and Dc Current Measurements
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 new clamp around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip the P6303 can easily be clamped to cables up to 0.830 in. Other measurement parameters of the probe include: 100 amps continuous and 500 amps peak.

By combining an oscilloscope, such as our SC 504, with your P6303/AM503 Current Probe Amplifier in a TM 500 Mainframe you will have a convenient and compact high current amplification/measurement system.



1 mA to 20 A Current Measurement Range 50 A Peak Pulse Measurements Dc to 50 MHz Bandwidth

When a P6302 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 μ 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 — 5 inch ground lead (175-0124-01), 3 inch ground lead (175-0263-01), two alligator clips (364-0046-00).

P6302 Current Probe Order 010-6302-01\$315

For complete specifications and ordering information on the P6303 Current Probe and the P6302 Current Probe, please refer to page 241 in this catalog.



AM 502 DIFFERENTIAL AMPLIFIER

1-to-100,000 Gain
100 dB Cmrr
Selectable Upper and Lower —3 dB Points
Dc-to-1 MHz 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 ± 1 V is provided.

AMPLIFIER

Gain — 100 to 100,000, 1-2-5 sequence, accurate within 2%. 1X gain obtained by 100X attenuation.

Frequency Response — From dc (if ac coupled, 2 Hz or less at -3 dB point) to 1 MHz with GAIN set to 20 k or less. Upper -3 dB point reduces to 500 kHz at 50 k gain, 250 kHz at 100 k gain.

HF -3 **dB POINT** — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. (Also limited by frequency response at gains of 50 k and 100 k.)

 ${\it LF}$ -3 ${\it dB}$ POINT — Selectable in 6 steps from 0.1 Hz to 10 kHz.

Dc Offset — At least + or - 1 V to offset signal dc component. Normal Mode Cmrr — At least 100 dB, dc to 50 kHz,

 \div 100 Mode Cmrr — At least 50 dB, dc to 50 kHz range, \pm 50 V.

Max 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 Ω paralleled by approx 47 pF. Input impedance can be increased to FET input via a simple internal jumper change.

OUTPUT

Max Output — ± 5 V, ± 20 mA, output resistance is 5 Ω or less.

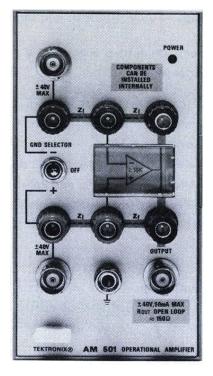
Min Load Impedance — 250 Ω .

Max Input Gate Current - 50 pA at 25°C.

Max Noise — 25 μ V or less (tangentially measured). Overrange — Front-panel lamp indicates most overrange conditions.

Max Voltage Drift — 100 μ V/°C.

AM 502 Differential Amplifier \$725



AM 501 OPERATIONAL AMPLIFIER

±40 V, 50 mA Output
Open Loop Gain 10,000
50 V/μs 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

OPERATIONAL AMPLIFIER

for teaching operational amplifier theory.

Open Loop Gain — At least 10,000 into 800 Ω load. Unity Gain Bandwidth — At least 5 MHz into 800 Ω load.

Common-Mode Rejection Ratio — At least 10,000 to 1 at 60 Hz.

Slew Rate — At least 50 V/ μ s into a 800 Ω load.

INPUT

Common-Mode Input Voltage Range — At least ± 40 V. Input Leakage Current — Less than 500 pA at 20°C. Equivalent Input Drift — Less than 100 μ V/°C. Equivalent Input Noise — Less than 10μ V rms. Max Differential Input Voltage — 80 V.

OUTPUT

AM 501 Operational Amplifier\$350

Voltage Range — At least ± 40 V. Current Limit — At least ± 50 mA. Open Loop Output R — Approx 150 Ω .

OPTIONAL ACCESSORY

 80 MHz Oscilloscope
Rear Interface Capability
5 mV/div Max Sensitivity
5 ns/div Max Calibrated Sweep Rate
Enhanced Automatic Triggering
True X-Y Capability

The TM 500 family of plug-ins welcomes a new 80-MHz oscilloscope to its membership. The addition of this plug-in scope makes many new configurations possible, especially for those applications demanding higher bandwidth capabilities. A double-wide plug-in, the new SC 504 is compatible with all existing TM 500 Plug-ins and multicompartment 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. The P6105 and P6062B are the TEKTRONIX Probes recommended for use with the SC 504.

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 0°C to 50°C.

Rise Time — 4.4 ns or less from 0° C to 35° C; 5 ns or less from 0° C to 50° C.

Ac Low Frequency Response (lower -3 dB point) — 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 — 5 mV to 10 V/div (15°C to 35°C) $\pm 2\%$, (0°C to 50°C) $\pm 3\%$; in CH 1-CH 2 (differential) mode, Channel 2 (15°C to 35°C) $\pm 3\%$, (0°C to 50°C) $\pm 4\%$. Uncalibrated Range — Continuously variable between calibrated steps. At least 2.5:1 range. Extends maximum attenuator steps 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 M Ω \pm 1% paralleled by approximately 20 pF.

Maximum Input Voltage — DC Coupled — 250 V (dc + peak ac). AC Coupled — 400 V (dc + peak ac). AC Component — 500 V p-p 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 6 divisions or less.

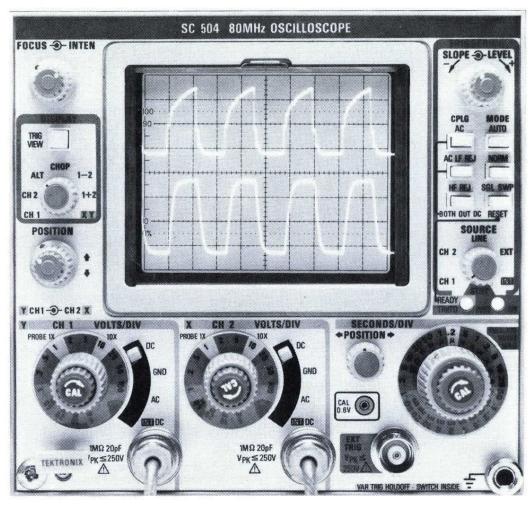
Channel Isolation — Display Related — At least 50:1 up to 20 MHz. Input Related — At least 80 dB up to 20 MHz between front panel inputs; at least 40 dB up to 20 MHz between rear interface inputs; at least 40 dB up to 20 MHz from front panel input to rear interface input (each channel); at least 80 dB up to 40 MHz from rear interface input to front panel input (each channel).

Position Range — ±6 div.

Signal Delay Between Channels — \leq 1 ns.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, $\pm 1\%$, approximately 1 kHz frequency.



SC 504 80 MHz OSCILLOSCOPE

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 to 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.

	15°C to 35°C		0°C to	50°C
	X1	X10	X1	X10
20 ms/div to 0.2 μ s/div	±2%	±3%	±3%	±4%
Linearity (any 2 div. portion within center 8 div.)	±5%	±6%	±6%	±7%
0.2 s/div to 50 ms/div	±3%	±4%	±4%	±5%
0.1 μs/div to 50 ns/div	±3%	±4%	±4%	±5%
Linearity (any 2 div portion within center 8 div.)	±6%	±7%	±7%	±8%

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, HF REJ, DC.

Triggering Sensitivity

		Minimum 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 35 mV	1.5 div 150 mV 80 mV
AC	Requirements increase below approx. 50 Hz		
AC LF REJ	Requirements increase below approx. 10 kHz		
HF REJ	Requirements increase above approx. 50 kHz		

External Triggering Level Range — $\geq \pm 1.4$ V.

External Triggering Input — Input R and C — 1 M Ω \pm 10% paralleled by approximately 24 pF. Maximum Input Voltage — 250 V (dc + peak ac); 250 V p-p 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 are as for normal sweep. When triggered, sweep generator produces one sweep only.

CRT

Phosphor — P31.

Acceleration Potential — Approximately 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 M Ω paralleled by approximately 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 M Ω paralleled by approximately 40 pF.

Z-Axis Input — Input Impedance: Approximately 1.5 k Ω . +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: $<\!50~\Omega.$

ENVIRONMENTAL CAPABILITIES

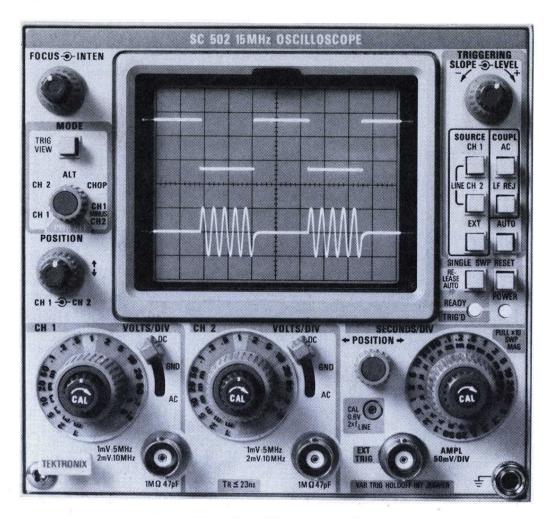
Temperature — Operating — 0°C to 45°C (to 50°C in mainframes equipped with fan). Non-operating — -40°C to +75°C.

 $\bf Altitude - \bf Operating - \bf To 15,000 feet. Non-operating - \bf To 50,000 feet.$

SC 504 Oscilloscope\$1900

TM 500-Series Test and Measurement System

15 MHz Dual-Trace Oscilloscope



SC 502 OSCILLOSCOPE

A Full-Featured 15 MHz Dual-Trace Oscilloscope in a Two-wide Plug-in 20 ns/div Max Calibrated Sweep Rate 1 mV/div Max 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 TM 500 Power Module/Mainframes. 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 disc 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 wellproven 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 instrumen-

tation suggests exceptional applicability to systems of built-in test equipment or rack-mounted installations. And the TM 515 Traveler Mainframe with the SC 502 form a nucleus for sophisticated, compact field service "packages."

TEKTRONIX probes P6062B and P6105 are recommended for use with the SC 502.

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.

Rise Time — 5 mV to 20 V/div, 23 ns or less.

Ac Low-Frequency Response (Lower -3 dB point) — 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 ($+15^{\circ}$ C to $+35^{\circ}$ C) within 2%, (0° to $+50^{\circ}$ 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 max 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.

Input Impedance — 1 $\mathrm{M}\Omega$ within 0.5% paralleled by approx 47 pF.

Max Input Voltage — 350 V (dc + peak ac).

Aberrations — Front corner \pm 2% or 3% p-p.

Common-Mode Rejection Ratio (CH 1 minus CH 2 mode) — At least 50:1 at 1 MHz when using same attenuator setting.

Channel Isolation — Input isolation: at least 80 dB up to 15 MHz; display related: at least 50:1 up to 15 MHz. Displayed Noise — 200 μ V or less of noise tangentially measured.

Position Range — ± 6 div.

Calibrator — Voltage, 0.6 V, $\pm 1\%$. Frequency, twice the power line frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.5 s to $0.2 \ \mu\text{s}/\text{div}$, 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 and within 5% magnified.

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 less than 50 Hz to at least 2 MHz. Deflection Factor, 50 mV/div within 5%. X and Y Amplifier Phase Difference, less than 3° at 50 kHz or less. Input Impedance, 1 M Ω within 2% paralleled by approx 47 pF. Max 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), SINGL SWP.

Trigger Sources — CH 1, CH 2, LINE, EXT.

Trigger Coupling — Dc, ac, ac low freq reject.

Trigger Sensitivity	dc to 5 MHz	5 MHz to 15 MHz
Internal		
dc	0.4 div	1.0 div
ac	0.4 div (from 50 Hz). Will trigger below 50 Hz with increased deflection.	1.0 div
LF REJ	0.4 div (from 5 kHz) Will trigger below 5 kHz with increased deflection.	1.0 div
External		
dc	60 mV	150 mV
ac	60 mV (from 50 Hz) Will trigger below 50 Hz with increased signal.	150 mV
LF REJ	60 mV (from 5 kHz) Will trigger below 5 kHz with increased signal.	150 mV

Triggering Level Range — Internal: at least + and -8 div. External: at least + and -1.2 V.

External Triggering Input — Input Impedance: 1 M Ω within 2% paralleled by approx 47 pF. Max 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 approx 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 — Approximately 12 kV.

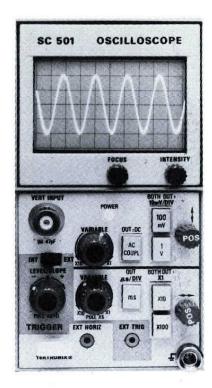
Graticule — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

ENVIRONMENTAL CAPABILITIES

Temperature — Operating, 0° C to $+50^{\circ}$ C. Nonoperative -40° C to $+75^{\circ}$ C.

Altitude — Operating, to 15,000 ft. Nonoperative to 50,000 ft.

SC 502 Oscilloscope \$1325



SC 501 OSCILLOSCOPE

5 MHz Bandwidth
Single Compartment Size
2½ in Crt
Versatile Operating Features

The SC 501 is a single-channel 5 MHz plugin unit oscilloscope with a 2.5 inch crt display which 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 μ s/div to 100 μ s/div (microsecond), 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 many auxiliary functions such as sweeping a voltage controlled frequency oscillator or obtaining variably delayed pulses from the PG 505 Pulse Generator.

The triggering circuits allow stable triggering from either internal or external sources. An AUTO triggering mode and manual LEV-EL/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.

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 Ω paralleled by 47 pF. Max Input Voltage — 350 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — Calibrated sweep rates: 1 μ 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 Ω paralleled by 25 pF. Max 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 max 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 in absence of trigger signal, or for trigger repetition rates below 10 Hz.

CRT

OSCILLOSCOPES COMPARISON CHART

	SC 504	SC 502	SC 501
Crt	8 x 10 div, 0.25 in/div P31 phosphor	8 x 10 div, 0.25 in/div P31 phosphor	6 x 10 div, 0.203 in/div P31 phosphor
Vertical (Y) axis	Dual Trace. 80 MHz, 5 mV per div to 10 V/div. Alt, chop, Ch 1 minus Ch 2, Ch 1 plus Ch 2, XY modes	Dual-trace, 15 MHz, 1 mV per div to 20 V/div (5 and 10 MHz bandwidth at 1 and 2 mV) alt, chop, and Ch 1 minus Ch 2 modes	5 MHz bandwidth, 10 mV/div to 10 V/div
Horizontal (X) axis	Triggered sweep 50 ns/div to 0.2 s/div with X10 magnifier. Enhanced auto trig, line ext/int trig, single sweep, external horizontal input, variable trigger hold off.	Triggered sweep 200 ns/div to 0.5 s/div with X10 magnifier, X2.5 variable, normal, enhanced auto, ext/int trig, single sweep, external horizontal input, variable trigger hold off	Triggered sweep 1 μs/div to 1 s/div with X5 magnifier to 200 ns/div, normal/auto trigger, internal/external-trigger, external horizontal input
Other features	Trigger view, switchable rear interface capability.	Trigger view, 12 kV accelerating potential	Compact Display
Price	\$1900	\$1325	\$775

Digital Events Delay



DD 501 DIGITAL DELAY

Digital Events Delay for Scope Trigger 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 plug-in unit. Separate external trigger signals connected to the EVENTS and START INPUT connectors allow up to 99,999 events to be counted. That is, the unit counts a predetermined number of events, from 0 to 99,999, selected by the front-panel thumb-wheel switches. The last event counted generates a trigger pulse to the DLY'D TRIG OUT connector on the front panel. Delay by event is particularly useful in troubleshooting asynchronous logic systems. The DD 501 can also function as a frequency divider when the same signal is applied to both inputs.

The DD 501 can be used in a "counted burst" mode with pulse or function generators that can be synchronously gated. This provides the ability to dial up the number of pulses you want in a burst for applications with shift registers, memories, data communications, process control, or any system requiring an exact number of pulses or waveforms. A jumper inside the DD 501 converts the DLY'D TRIG OUTPUT to a delay interval (gate) waveform for this application TEKTRONIX generators capable of being gated by the DD 501 are the FG 501, FG 502, FG 504, and the PG 508.

Other DD 501 applications include ranging for radar, sonar, ultrasonics, or laser. By using the proper frequency clock, the numbers dialed up can represent miles, yards, kilometers, etc. In systems requiring precision timing, several DD 501s and a reference clock can provide precise thumbwheelselectable repetition rates, delays, pulse width, or timing intervals.

EVENTS DELAY

Count — 1 to 99,999 events.

Max 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 in-

Input Impedance — 1 M Ω , 20 pF.

Slope — Either + or -, selectable.

Sensitivity — 85 mV p-p @ 30 MHz.

Frequency Response - Up to 65 MHz at 120 mV sensitivity.

Minimum Detectable Pulse Width - 5 ns.

Threshold Level Range — From -1.5 V to +1.5 V (-15 V to +15 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

Voltage Swing - + 0.8 V or less to at least + 2.0 V with 3 TTL loads (\sim 5 mA).

Light — Indicates output trigger.

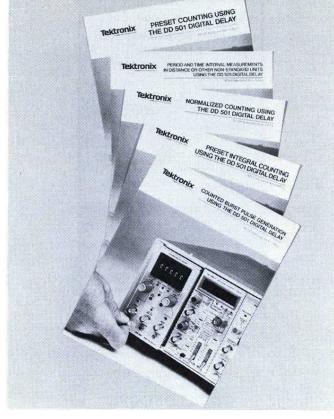
GENERAL

Temperature — Operating 0°C to +50°C. Non-operating: -40° C to $+75^{\circ}$ C.

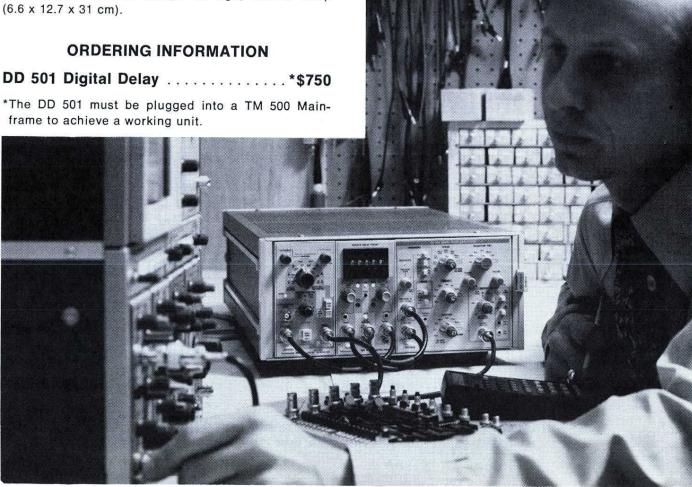
Altitude - Operating: to 15,000 ft.; Nonoperating to 50,000 ft.

Shipping Weight - 3 lb.

Dimensions — 2.6 in wide, 5 in high, 12.2 in deep (6.6 x 12.7 x 31 cm).



The digital delay, when combined with other TM 500 Instruments, adds significant power to many measurement or signal generation situations. A series of five TM 500 Application Notes explain various measurement techniques based on the versatile DD 501. These notes include application information. schematic and technical information for measurements such as preset counting, preset integral counting, normalized counting, period and time interval measurements in distance or other non standard units, and counted burst pulse generation, all using the DD 501. Ask your field engineer for copies of these and other notes in the TM 500 Series.







Captures Glitches as Narrow as 5 ns at Probe Tips

Allows Expansion of Information Time Frame

TM 500 Compatibility

The TEKTRONIX DL 502 Digital Latch extends the LA 501W 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.

SPECIFICATIONS

Minimum pulse width to initiate latch - 5 ns.

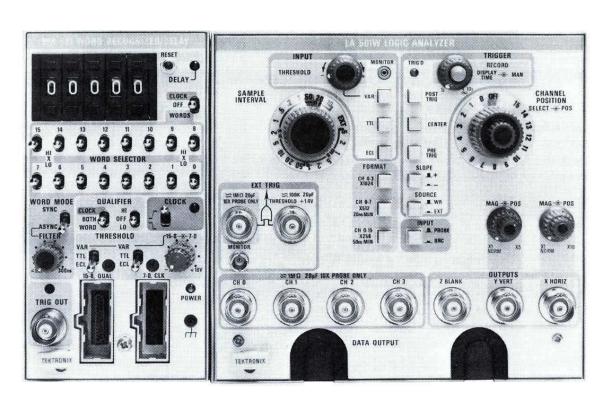
Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock — 20 ns.

DL 502 Digital Latch.....\$1350

Standard accessories include instruction manual, 6 inch BNC cable, and LA 501W Clock Cable Assembly.

The DL 502 and other analyzers are completely described beginning on page 15.



LA 501W LOGIC ANALYZER

Acquires 16 Channels Simultaneously
Captures Single-Shot Data
Stores 4096 Bits in 4, 8, or 16 Channel Format
Displays Data Preceding Trigger
16-Bit Parallel Word Recognizer with up
to 99,999 Word Delay
Active Probes Minimize Circuit Loading
Samples Data Synchronously and
Asynchronously

Selectable Trace Positioning

The LA 501W Logic Analyzer, made up of the LA 501 Logic Analyzer and WR 501 Word Recognizer plug-ins, operates in any 3, 4, 5, or 6-compartment TM 500-Series Power Module Mainframe. This combination complements virtually any oscilloscope or X-Y monitor to provide a versatile logic analysis system.

Tick Marks for Easy Timing Comparisons

4096 bits of storage may be formatted as 4 channels x 1024 bits, 8 channels x 512 bits, or 16 channels x 256 bits to best fit your application. With a selectable asynchronous sampling rate of up to 100 MHz (4-channel operation only), the LA 501 provides timing resolution to 15 ns. Data can also be synchronously (externally) clocked to 50 MHz. Pre, center, or post-trigger data can be recorded at a sample rate from 10 ns to 5 ms.

Two active P6451 Probes feature a high input impedance — 1 $M\Omega$ paralleled by 5 pF. They provide a total of 18 inputs to the WR 501 — 16 data input channels, one clock input, and one qualifier input. There are

separate threshold controls (TTL, ECL, and variable ± 10 V) for each probe.

The stored data is displayed as a timing diagram in groups of four. Each trace displays high and low logic states. Vertical and horizontal position and magnifier controls provide the capability to zoom in on any segment of the timing diagram. Biphase timing tick marks on each channel provide excellent visual resolution and also indicate whether an inactive line is high or low. Channel-to-channel timing comparisons are easy because any trace can be moved vertically and thus positioned next to any other.

The WR 501 16-bit parallel word recognizer with digital delay produces triggers when it recognizes a preselected parallel word. This gives you fast access to almost any location in the data stream. The WR 501 can be operated as an independent trigger source or interfaced with the LA 501.

The LA 501W Logic Analysis System may be combined with counters, pulse generators, multimeters, and oscilloscopes into a compact package using TM 500-Series Power Module/Mainframes. The TM 500 Series also offers you a choice of benchtop, rackmount, rollabout, or portable configurations to match your application.

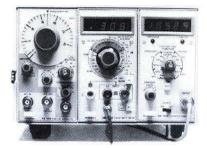
LA 501W Logic Analyzer

The LA 501W and other logic analyzers are completely described beginning on page 15.

Test and Measurement System

Mainframe Specifications





POWER REQUIREMENTS

Line Voltage Ranges — International Transformer: 100, 110, 120, 200, 220, 240 V ac, all within 10%; but not to exceed 250 V ac. Range changing for transformer accomplished with quick-change line-selector block.

Line Frequency Ranges — International Transformer: 48 Hz to 440 Hz.

NOTE: The ventilating fans on the TM 506 and TM 515 operate on 48-60 Hz only.

Power Consumption — Max primary power approx: 35 W for TM 501, 120 W for TM 503, 200 W for TM 504, 320 W for TM 506, and 240 W for TM 515. Actual power consumption depends on plug-in selection and operating modes.

SUPPLIES (UNREGULATED)

Shared by All Compartments — +33.5 V dc and -33.5V dc. TM 501 -500 mA max. TM 503 -1 A max. TM 504 -1.4 A max. TM 506 -2.1 A max. TM 515 -1.8 A max.

Low Power Compartments - Two 25 V ac windings, 500 mA each, supplied to each compartment, independently. 17.5 V ac and +11.5 V dc shared in any combination between these two supplies and among all low-power compartments. TM 501 -1 A max. TM 503 and TM 504 -3.6 A max. TM 506 -6.5 A max. TM 515 -6.5 A max.

High Power Compartments — (nearest to switch in TM 504 and TM 506): Two 25 V ac windings, 1 A each. 17.5 V ac and + 11.5 V dc, 4 A max, shared in any combination between these two supplies.

TEMPERATURE RANGE

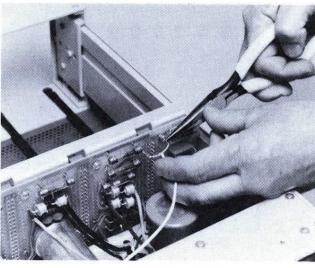
Operating — 0° C to $+50^{\circ}$ C. Nonoperating — -40° C to $+75^{\circ}$ C.

ALTITUDE RANGE

Operating — To 15,000 ft. Nonoperating — To 50,000 ft.



OPTIONAL INTERFACE



The TM 500 line is designed so that connections between modules and/or external equipment can be made by the mainframe rear interface board and optional rear-panel connectors.

Each plug-in has selected lines brought to its interface, some parallel to front-panel connections, others present only at the interface. Normally, these lines are left open, but they may be connected by the user to reduce front-panel clutter or to perform functions not otherwise available. For example, digital counters have serial bcd outputs which may be brought out for data logging or processing.

LINES AVAILABLE AT THE MODULE INTERFACE CONNECTOR **Digital Counters**

Bcd serial by digit

Reset

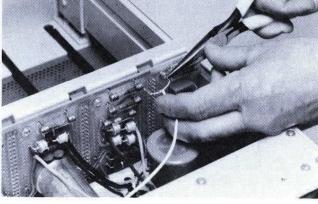
Range code

Time slot zero

Scan clock out

Data good

Scan clock in and internal scan disable Signal in (selected by front-panel switch)



These lines allow for external data logging and processing via the bcd output and associated signals. They also allow the external system to initiate the taking of a measurement, and control the rate at which the bcd data is scanned.

Digital Multimeters

Scan clock out

Most significant digit

Decimal point

Data transfer

Bcd serial by digit

Polarity

Least significant digit

Power Supplies

Supply output through rear connection Remote sense Remote analog voltage control Remote analog current limit control

Amplifiers

Signal Out, Signal In

Monitor

X, Y, and Z inputs

Oscilloscope

Ramp out, Gate out

NOTE: The Option 02 power modules are shipped with a rear-panel multipin connector, a mating cable connector, and one rear-panel BNC connector for each plug-in compartment. The user may wire these to the interface board as required. Option 02 is also supplied with square pin connectors on the rear interface board, and a supply of jumper wires with square pin receptacles.

The Option 05 TM 515 is supplied with the square pin connectors on the rear interface board and the prepared jumper wires.

Pin assignments are common for each "family" of modules (DMMs, generators, counters, etc). Each family has its own pattern of circuit board notches at the interface. Interface terminal barriers may be inserted in the mainframe so that it accepts only plug-ins of one family. A supply of barriers (and square-pin jumpers) is shipped with the power module if Option 02 is ordered.

A typical example of interface connection between modules is to connect the ramp output of the RG 501 to the vcf input of the FG 502 for frequency sweep. The output of a power supply can be measured with the interface feature of the DM 501 for voltage monitoring.

POWER MODULE DIMENSIONS & WEIGHTS (without Plug-ins)

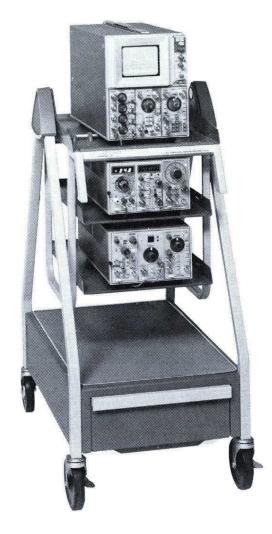
CABINET

	тм	501	ТМ	TM 503		504	ТМ	506	RTM	1 506	TM 515		
Dimensions	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	
Height	6.0	15.2	6.0	15.2	6.0	15.2	6.0	15.2	5.3	13.3	6.8	17.3	
Width	3.9	9.9	8.7	22.1	11.0	27.9	17.4	44.2	19.0	48.3	15.0	38.1	
Length	15.3	38.9	15.3	38.9	20.0	50.8	20.0	50.8	18.9	48.0	20.0	50.8	
Weight (approx)	lb	kg	Ib	kg	Ib	kg	Ib	kg	lb	kg	lb	kg	
Net	5.4	2.4	9.5	4.3	20.5	9.3	29.0	13.2	32.0	14.4	22.5	10.2	
Domestic Ship	13	5.9	17	7.7	26.0	11.8	41.0	18.6	46.0	21.0	30.0	13.6	

ORDERING INFORMATION (Plug-ins not Included)

TM 501 Power Module\$135
with Option 02 Interfaceadd \$55
TM 503 Power Module\$170
with Option 02 Interfaceadd \$75
TM 504 Power Module\$190
with Option 02 Interfaceadd \$100
TM 506 Power Module\$250
with Option 02 InterfaceAdd \$150
RTM 506 Power Module
(rackmount version)\$340
with Option 02 Interfaceadd \$150
TM 515 Traveler Mainframe\$325
with Option 05 Interfaceadd \$75
with Option 06 48-440 Hz fanadd \$150

TEK LAB CART MODEL 3



This Lab Cart is especially designed for rollabout configurations combining TM 500 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 TEK-TRONIX 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. Max 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 at rear underside of the top tray provides four power outlets and a 15foot line cord.

International modification (Option 01) deletes power distribution module.

TEK Lab Cart Model 3\$325
with Option 01 (International Modification)No Charge
Additional Lower Shelf, Order 436-0132-01\$25
Safety Belt to secure oscilloscopes or TM 500 to top tray or lower shelves (not needed for 5000 or 7000 Series on top tray)
Order 346-0136-01\$15

New! Tek Rack Cart Model 7

The TEKTRONIX Rack Cart Model 7 is a new versatile, general-purpose equipment cart. This rugged cart is designed to be used with standard 19-inch rackmounted systems and instruments.

The lightweight, aluminum Rack Cart Model 7 is designed and UL listed to carry up to 300 pounds of equipment (200 lbs inside and 100 lbs on top). The Model 7 may be shipped with 200 lbs of equipment mounted inside. To meet UL specifications for slidemounted equipment, an optional stablizer may be purchased. Also, blank panels and other rackmount accessories are available.

A special hardware package enables you to slide an RTM 506 Rackmount Mainframe into the front of the cart. The RTM 506, holding up to six TM 500 Plug-ins, fits snugly into the cart and conveniently tilts upward for easy dial tuning and reading.

Rack Cart Model 7 — Net weight 60 pounds,
shipping weight 77 pounds,
Order Model 7
Hardware Package for RTM 506
Order 016-0390-00\$35

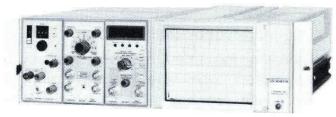


ADAPTER KITS FOR EARLIER SCOPE-MOBILE® CARTS

TM 504 Adapter Kits - Includes hardware to attach

TM 503 Adapter Kits — Includes hardware to attach TM 503 to 203 or 204 SCOPE-MOBILE® Cart.

CABINET-TO-RACKMOUNT CONVERSION KITS AND MONITORS



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\$69

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 utilized.

Order 040-0617-02\$110

Rackmount - to - cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.

Order 040-0618-01\$45

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\$70

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to convert a TM 506 (cabinet style) to an RTM 506.

Order 040-0761-03\$80

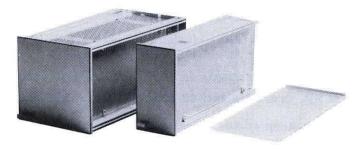
Rackmount - to - cabinet conversion kit equipped to convert an RTM 506 to cabinet style TM 506.

Order 040-0762-00\$55

MONITOR ORDERING INFORMATION

A broad range of display monitors may be rackmounted. These include two storage monitors, the 603A Bistable Monitor, and the 607A Variable Persistence Monitor. Non-storage monitors include the 604A (low cost), 606A (high resolution), the 608 (high brightness) and the 624 (good performance—low cost). See page 217 for more information.

TM 500 CUSTOM PLUG-IN KITS



Single and double compartment sizes

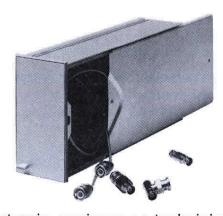
A complete test and measurement set-up for many typical jobs requires at least one nonstandard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, 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 exceed 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 which 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 IC's can be used to provide exact voltages for most individual power supply requirements. The finished specialpurpose circuitry or instrument is physically compatible with the other TM 500 instrumentation.

New! Single Compartment with Power Supply

Now a blank plug-in kit complete with power supply parts and circuit board layout is available. A single-wide compartment, this plug-in kit saves set up time and build time as the power supply circuitry is designed and kitted for you.

PLUG-IN STORAGE COMPARTMENT



An electronic engineer or technician away from his 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, stuff in 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 9% in L x 2 in W x 41/4 in D.

Order Number 016-0362-00 \$27

TM 500 BLANK PANEL



When operating the TM 500 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 016-0195-01\$11

50 Ω 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 Ω coaxial cable into a 50 Ω load.

50 Ω Cable, Order 012-0482-00.....\$22

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 23½ inches long by 8½ inches thick by 15½ inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam insert 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 which will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 24 inches long by 8½ inches thick by 17½ inches high and weighs approximately 14 pounds empty.

TM 503 Carrying Case,
Order 016-0565-00\$140
TM 504 Carrying Case,
Order 016-0608-00\$150

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. While particularly valuable when the TM 503 or TM 504 (full of instruments) is carried into the field or in a vehicle, the cover is also good insurance against damage to instrument knobs and jacks during normal handling in the lab, or when a mainframe full of instruments is stored. The cover adds 1¾ inches to the length of the TM 503, TM 504, and TM 506 Mainframes, and clears the longest knob projections on any of the instruments.

M 503 Front Panel Cover,	
order 200-1566-00\$1	0
M 504 Front Panel Cover,	
Order 200-1727-00	1
M 506 Front Panel Cover,	
order 200-1728-00	0

ACCESSORY POUCH



While the TM 501, TM 503, TM 504, and TM 506 Mainframes were optimized 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 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 91/4 in L x 53/4 in W x 2 in D.

Order Number 016-0351-00.....\$14.50

RAIN COVERS



These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 packages of instrumentation, 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.

TM 503 Rain Cover											
Order 016-0620-00	•		•		•				•	٠	\$25
TM 504 Rain Cover											
Order 016-0621-00		٠									\$30

P6058 TEMPERATURE PROBE





The P6058 Temperature Probe is used with the DM 501 for sensing temperature from -55° C to $+150^{\circ}$ C. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being measured. P6058 probes are interchangeable among all DM 501's without requiring recalibration since probes and DM 501's are held to tight tolerances. Besides measuring temperature, the P6058 can function as an electrical probe for resistance, current, and voltage measurements to 500 V. To obtain the full probe kit with ground lead and pushon electrical contact tip, order 010-0260-00 below. A simple modification of the DM 501 is also required. For temperature-only measurements, order 010-0259-00.

The temperature probe consists of the temperature sensor, a four-foot, 4-wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 501. The unit weighs approximately five ounces.

P6430 TEMPERATURE PROBE



The P6430 Temperature Probe is used with the DM 502 for sensing temperature from -55°C to $+150^{\circ}\text{C}$. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being mea-

sured. The probe can be immersed vertically, approximately two inches in a liquid, for temperature sensing and still retain water tightness.

The temperature probe consists of the temperature sensor, a six-foot, 2-wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 502. The unit weighs approximately five ounces.

To meet full accuracy specifications a specific P6430 and DM 502 multimeter must be calibrated as a pair.

P6430 Temperature Probe,
Order 010-6430-00\$125

HIGH VOLTAGE PROBE FOR USE WITH DMMs



The High Voltage Probe will measure dc voltages from 1 kV to 40,000 volts with an accuracy of 1% at 25,000 volts. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes.

This probe plugs directly into the front end of either multimeter.

CHARACTERISTICS

Voltage range 1 kV to 40 kV dc 1000 M Ω Input resistance Division ratio 1000:1 Overall accuracy 20 kV to 30 kV 2% Upper limit Changes linear from accuracy 2% at 30 kV to 4% at 40 kV Lower limit Changes linear from accuracy 2% at 20 kV to 4% at 1 kV Input Z at meter 10 MΩ required

Order 010-0277-00\$75

Type 1105 Battery Power Supply



TM 500 instruments may be operated with the Type 1105 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.

Optio	n 01	, :	2	3	0	1	1	O	p)6	er	a	t	ic	r	1			•			N	0 (ch	ar	ge
1105																										
TM	515		×		¥	×	•	×				·		•	×						1	.4	h	οu	ırs	
TM	506			(*)	•		()	٠		٠	٠								•	W.	1	.2	h	οι	ırs	
TM	504	٠	•	•	•	•	٠	ě		٠		٠		٠	•			•			1	.8	h	οι	ırs	
TM	503	٠	٠	٠	•	٠	•											٠			2	2.3	h	οι	ırs	
TM	501		•		*	•	٠	•	*	٠	•					•	•		(*)	•	7	'.0	h	οι	ırs	

TM 500 FLEXIBLE EXTENDER CABLE



Designed to couple a TM 500 Plug-in with the mainframe rear interface board connection. It provides a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

Extender Cable, Order 067-0645-02 \$70

RISE TIME LIMITER



For use with the PG 502 Pulse Generator which has a pulse rise and fall time of less

than one nanosecond. In some applications, such as TTL logic where slower rise time is needed, this fast pulse can be limited to six nanoseconds by using the rise time limiter.

Rise Time Limiter, Order 015-0249-00...\$48

MANUAL (ONE SHOT) TRIGGER GENERATOR

RG 501, PG 501, AND PG 505



The Manual (one shot) Trigger Generator is a self-contained, battery-operated, handheld device for manually generating a single pulse. This adapter is used to start a pulse, ramp, sweep, or complete sequence of events on instruments which do not have a manual trigger button or where a remote operation capability is desired, such as some oscilloscopes and the PG 501, PG 505, and RG 501.

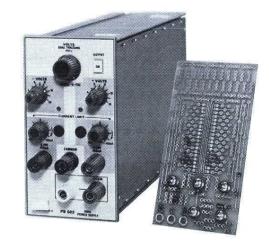
The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally two milliseconds in width and three volts in amplitude with a rapid rise and fall. Output impedance is low (50 Ω); the pulse amplitude drops from about 3.6 to 1.8 volts when changed from a high impedance to a 50 Ω termination. Both voltages decrease with battery aging. The battery is a 5.4 V dry cell.

Applications for the trigger generator also include stepping or sequencing of digital systems, analog control systems, mechanical devices, as well as obtaining "single shot" operation from many types and brands of instruments. Biological and physical experiments, where manual triggering is required as a part of the stimuli, are also common applications.

Order Number 016-0597-00.....\$45

FRONT-PANEL CIRCUIT BOARD ADAPTER 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 adapter are as a device tester (test fixture), educational demonstrator (especially IC's), and in temporary systems functions, e.g., OR'ing and AND'ing two signals. This adapter will supplement the blank plug-in kit for simple or temporary applications.

The adapter 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 adapter 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 adapter kit is 2½ inches wide.

Order Number 013-0152-00 \$12

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 approximately 2½ inches square. The kit is a pc board which has six terminal studs for attachment to the amplifier's banana jacks. 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 Number 013-0146-00 \$12



250-ps Rise Time Pulses Alternate Pulses of Equal or Different Time Duration

0-55 V Calibrated Variable Amplitude Selectable Polarity

The 109 is intended for use with fast-rise sampling or conventional oscilloscopes that generate their own internal sweep trigger. The 109 is transistorized and requires no warmup time before operating.

PULSE CHARACTERISTICS

Characteristics Performance
Rise time Less than 250 ps

Amplitude Adjustable from 0 through 50 V

Repetition Rate Preset between 550 p/s and 720 p/s (using two charge lines)

Pulse Duration 0.5 ns to max of 100 ns at full rep rate; 300 ns at half rep rate

Decay approx 10% in 300 ns
Polarity Positive or negative

Output Impedance 50 Ω

Charge Lines — Either one or two charge lines can be used to provide alternate equal or unequal pulses as desired. Equal charge lines produce a repetition rate of 550 pulses per second to 720 pulses per second.

External Dc Charge Voltage Inputs — Use of external charge voltages allows alternate pulses to be of different amplitude and polarity. Maximum external charge voltage is 600 volts. With up to 100-volt input, the output amplitude will be half the external input amplitude. At voltage inputs over 100 volts, the output amplitude will be less than half the input amplitude. At pulse outputs over 50 volts, irregularities may occur.

Power Requirement — Wired for 105 to 125 V, may be ordered with the taps connected for 210 to 250 V. 50 to 800 Hz, 60 watts maximum.

Dimensions and Weights		
Height	≈8 in	19.7 cm
Width	≈5 in	12.2 cm
Length	≈12 in	30.2 cm
Net weight	≈8 lb	3.8 kg
Shipping weight	≈13 lb	≈5.9 kg

Included Accessories — Charge network (017-0067-00); three 5-ns 50- Ω RG123 cables (017-0502-00); 3-conductor power cable (161-0010-03).

109 Pulse Generator\$1025



Pulse Output With 70-ps or Less Rise Time Sinewave and Squarewave Outputs Compact, Solid-State Design

The 284 Pulse Generator provides the facility for verifying the performance of Sampling Oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the rise time, vertical deflection factors, and horizontal sweep rates. A pretrigger output is also provided.

In addition to checking the transient response of sampling oscilloscopes, the fast-rise step of the pulse output is an excellent 50- Ω signal source for TDR measurements. The 284 is available in a cabinet version, or modified for rackmounting in a standard 19-inch rack using the optional Rack Adapter.

OUTPUT CHARACTERISTICS

Pulse Output — 70 ps or less rise time with a pulse width of more than 1 μ s and a repetition rate of approx 50 kHz. Aberrations immediately following positive-going transitions are less than $\pm 3\%$, 3% total peak-to-peak; after 2 ns less than $\pm 2\%$, 2% total peak-to-peak. Pulse amplitude is more than ± 200 mV into 50 Ω . Source resistance is 50 Ω .

Squarewave Output — Periods of 10 μ s, 1 μ s, or 100 ns. Output amplitude is 10 mV, 100 mV, or 1 V into 50 Ω .

Sinewave Output — Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω .

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 ± 5 ns, or 75 ns ± 5 ns ahead of the main pulse. Rise time is 3 ns or less; pulse width is 10 ns or greater.

Timing and Amplitude Accuracy

_		Timing	Amplitude Accuracy										
Output	Period	Accuracy	1 V	100 mV	10 mV								
Pulse	20 μs	± 10%											
Square- wave	10 μs 1 μs	±0.5%	±0.5%	±1%	±1.5%								
	100 ns	±0.05%*	±2%†	±2.5%†	±3%†								
Sine- wave	10 ns 1 ns	±1%		± 20%									

* crystal controlled

† 20 ns after transition

OTHER CHARACTERISTICS

Operating Temperature — Instrument operating specifications are valid over an ambient temperature range of 0° C to $+50^{\circ}$ C.

Power Requirements — 6.5 watts, 48 Hz to 440 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

Dimensions and Weights	1	1
Height	6 in	15.3 cm
Width	≈5 in	11.4 cm
Depth	15 in	38.1 cm
Net weight	8 lb	3.6 kg
Shipping weight	≈14 lb	≈6.3 kg

INCLUDED ACCESSORIES

 $50-\Omega$, BNC coaxial cable (012-0057-01); right angle, 3-conductor power cable (161-0024-03) standard; (161-0031-00) with Option 01.

284 Pulse Generator	\$1525
Option 01	Sub \$25
(less cabinet, for mounting	in rack adapter listed on
page 254)	

Portable—Battery Powered, Self-Contained, Light (18 pounds), Small (5 x 12½ x 18½ in)

Rugged—Designed to MIL-T-28800, Type II, Class 2, Style A

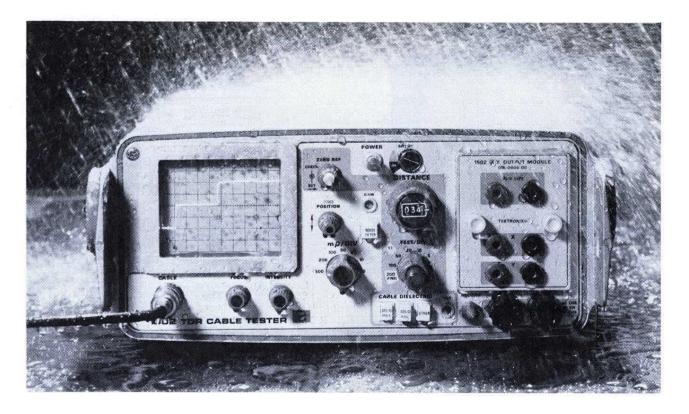
Versatile—Test Any Type Cable

Easy to Use—Produces Results with Minimum Operator Training

The small, portable, rugged, batterypowered 1502 and 1503 TDR Cable Testers are very simple to operate and will test any type cable, from lamp cord to coax, under virtually any conditions, from dust to rain, from desert to sea to mountain top. The high resolution (to a fraction of an inch), moderate range (to 2000 feet) 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The long range (to 50,000 feet), moderate resolution (to 3 feet) 1503 is appropriate for testing long runs of coax or twisted-pair cables in telephone and other communications applications.

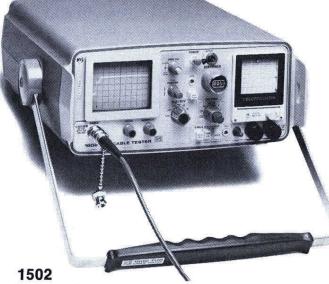
These units use Time Domain Reflectometry (TDR), a simple, proven, wellestablished technique, to identify and precisely locate cable faults.





These testers are designed to be field maintenance tools. For carrying ease and operation in tight spaces, the 1502 and 1503 offer an ideal combination of small size, light weight, and portability. Either tester is capable of operation for more than five hours on the internal batteries before recharging is required.

Since permanent records are extremely useful in cable maintenance, the optional plug-in Y-T Chart Recorder is available for self-contained hard copy capability. The standard plug-in X-Y Output Module can drive an external X-Y recorder.



This unit has the high-resolution capability of a laboratory time domain reflectometer. It is directly calibrated in reflection coefficient (rho) and distance and is thus very simple to operate. The 1502 uses ultra-fast (110-picosecond), steptype excitation signals, and provides fault resolution to 0.6 inch. The 1502 performs excellently at distances to 2000 feet, even though rise time and resolution typically degrade with increasing cable length. The 1502 is matched to 50-ohm cables, but may be used on other cables by adjusting the front-panel GAIN control or using optional impedance adapters.



1503

The limited bandwidth and relatively high losses common to long cables (particularly twisted pair) require special high-energy, controlled-bandwidth test signals. For these applications, the 1503 provides 10-volt, ½-sine-shaped pulses and is calibrated in decibels for direct reading of return loss. Range of the 1503, dependent upon cable type, is up to 50,000 feet; resolution capability provides for resolving faults as close together as 3 feet. Impedance levels of 50, 75, 93, and 125 ohms are selectable with the press of a button.

1503 Option 1

1503 Option 01 has calibration controls that make it more convenient for fault location in a variety of cables. The 1503 is more convenient for coax. Other changes allow easier operation by craft people.

DISTANCE CAL switches are set for the particular type of cable to be tested. When the 1503 Option 01 has been calibrated for each cable before trouble occurs, and records have been kept, finding the damage is quick work. DISTANCE CAL switches can be set exactly and damage location can begin immediately.

NOTE: When specifications are different for the metric version, Option 05 (in many cases, the metric specification is not a direct conversion from English measure), or where conversion to metric is appropriate, the metric specifications are shown in italics and are set in brackets.

1502 Characteristics

TEST SIGNAL

System Reflected Rise — \leq 0.07 ft [\leq 2.1 cm] (\leq 140 ps).

Aberrations— $\pm 5\%$ during 1st 10 ft [300 cm] after rise. $\pm 0.5\%$ peak beyond 10 ft [300 cm] NOISE FILTER "out." $\pm 0.2\%$ peak beyond 10 ft [300 cm] NOISE FILTER "in."

Jitter— \leq 0.02 ft [0.6 cm] (\leq 40 ps) for X.1. \leq 0.1 ft [\leq 3 cm] (\leq 200 ps) for X1.

Termination — 50 Ω , within 2%.

Pulse Amplitude — 225 mV nominal (into $50-\Omega$ load).

Test Connector —

Type: BNC.
Coupling: dc.

Max Input: DO NOT APPLY EXTERNAL VOLTAGE.

VERTICAL SYSTEM

Deflection Factor — 5 m ρ /div to 500 m ρ /div.

Accuracy: ±3%.

Gain: >3.5:1 from calibrated point.

Displayed Noise — ± 5 m ρ or less, NOISE FILTER switch "out."

Low Noise Operation — ± 2 m ρ or less, NOISE FILTER switch "in."

HORIZONTAL SYSTEM

Distance Controls —

Distance Dial:

Range — 0 to 100 ft [0 to 25 m] for X.1. 0 to 1000 ft [0 to 250 m] for X1.

Accuracy—within $\pm 2\%$ of reading ± 0.05 ft [$\pm 2\%$ ± 0.05 m] for X.1. Within $\pm 2\%$ of reading ± 0.5 ft [$\pm 2\%$ ± 0.5 m] for X1.

FEET/DIV Control:

Range — 0.1 to 20 ft/div [0.025 to 5 m/div] for X.1. 1 to 200 ft/div [0.25 to 50 m/div] for X1. Accuracy — with 2% of full crt screen.

CABLE DIELECTRIC Scales (V_P/V_{air}) — 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 — 35 ± 5 Hz with NOISE FILTER switch "out." 4 Hz within $\pm 20\%$ with NOISE FILTER switch "in."

1502 Included Accessories — Watertight front cover, TDR Slide Rule (003-0700-00); $50-\Omega$ BNC Terminator (011-0123-00); Precision $50-\Omega$ Cable (012-0482-00); Viewing Hood (016-0297-00); X-Y Output Module (016-0606-00); Replacement Fuses (for front panel) 117 V ac (159-0032-00) or 234 V ac (159-0029-01); Power Cord (161-0066-00); Mesh Filter (CRT) (378-0055-00); BNC Female-to-Female Adapter (103-0028-00).

1503 Characteristics

TEST SIGNAL

Duration — 10 ns, 100 ns, 1000 ns $\pm 20\%$ at half amplitude.

Amplitude — 10 V \pm 20% unterminated. 5 V \pm 20% terminated.

Shape — $\frac{1}{2}$ sine $\pm 20\%$.

Termination — 50 Ω , 75 Ω , and 93 Ω , with 1%; 125 Ω within 3%.

Jitter — 0.2 div max.

Test Connector —

Type: BNC.
Coupling: ac.

Max Input: $\pm 400 \text{ V}$ (dc + peak ac at max frequency of 440 Hz).

VERTICAL SYSTEM

Display -

Range: +6 to -18 dB from reference.

Accuracy: ±3%.

Display Reference —

Range: 0 to 60 dB, 7 steps, 10 dB per step.

Accuracy: ±0.1 dB.

Variable: 0 to 18 dB additive to steps.

Displayed Noise —

Aberrations: -30 dB p-p. Random: -80 dB rms.

Low-Noise Operation — 86 dB rms, random.

HORIZONTAL SYSTEM

Distance Controls —

Distance Dial:

Range — 0 to 2,500 ft at X10 [0 to 500 m at X1]. 0 to 25,000 ft at X100 [0 to 15,000 m at X10].

Accuracy — 2% of reading + 1 digit on dial.

FEET/DIV Control:

Range — 5 to 500 ft/div at X10 [1 to 100 m/div at X1]. 50 to 5000 ft/div at X100 [10 to 1000 m/div at X10].

Accuracy — Within 2% of full crt screen.

CABLE DIELECTRIC Scales (V_P/V_{air}) — 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 (V_P/V_{air}) — Selectable from 0.2 to 1.0 in .01 increments.

Sweep Repetition — 35 ± 5 Hz with NOISE FILTER switch "out." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder).

1503 Included Accessories — Watertight front cover, Replacement Fuses (for front panel) 117 V ac (159-0032-00) or 234 V ac (159-0029-01); Power Cord (161-0066-00); Viewing Hood (016-0297-00); $50-\Omega$ 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 (012-0671-00).

Common Characteristics

POWER SYSTEM

Line Voltage — 117 V ac $\pm 20\%$, 48 to 410 Hz, 234 V ac $\pm 20\%$, 48 to 410 Hz.

Battery Pack —

Operation: At least 5 hr $(\pm 20^{\circ}\text{C})$ to $\pm 25^{\circ}\text{C}$ charge and discharge temperature) including 20 chart recordings.

Full Charge Time: 16 hr.

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/div, source impedance is 10 k Ω .

Vertical — 0.09 to 0.13 V/div (adjustable), source impedance is 10 k Ω .

PHYSICAL CHARACTERISTICS

Weight — 18 lb $[8.2 \ kg]$ with front cover and standard accessories. 16 lb $[7.3 \ kg]$ without front cover and accessories.

Domestic Shipping Weight — 24.4 lb [11.1 kg].

Export Shipping Weight — Approx 36 lb [16.3 kg].

Height - 5.0 in [12.7 cm].

Width — 12.4 in [31.5 cm] with handle. 11.8 in [30 cm] without handle.

Depth — 16.5 in [41.9 cm] including front cover, handle not extended. 18.7 in [47.5 cm] handle extended.

ORDERING INFORMATION

1502 TDR Cable Tester\$3550
Option 04 (with recorder)add \$650
Option 05 (metric version)no extra charge
Option 06 (234-V version)no extra charge

Option 76 (P7 phosphor)no extra charge

1502 Optional Accessories

Also available is a modified 1503 TDR Cable Tester with calibrated pushbutton selection for telephone L-carrier cablesrequest quote

1503 Optional Accessories	
Chart Recorder — 016-0506-03	\$650
Chart Paper (roll) 006-1658-01	\$4.90
Chart Paper (100-roll case) 006-1658-02	\$350
Isolation Network (for balanced lines) — 013-0169-00	\$140
Adapter Cables (BNC-to-Clips) —	
9-foot — 012-0671-00	\$38
30-foot — 012-0671-01	\$53
Accessory Pouch — 016-0351-00	

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

Digital Photometer/Radiometer

J16 Photometer/Radiometer (Fig 1) 3½-Digit Light-Emitting Diode Readout Portability and Versatility

Complete Probe Interchangeability without Recalibration

Available with Metric Readout

The J16 is a portable photometer/radiometer that is equally at home in the lab or in the field. It weighs 3.3 lb, measures $2.4 \times 4.6 \times 8$ inches, and comes with a shoulder strap and rechargeable nickel-cadmium batteries. The J16 has excellent long-term calibration stability. It is environmentalized to operate from -15° C to $+40^{\circ}$ C and meet MIL specs for humidity.

Available for the J16 are eight quickly interchangeable, precalibrated silicon probes, an ac power supply, probe cable (for separate operation of the probes), and analog and bcd outputs.

All J16 Probes

Rugged, Stable Silicon Sensor and Glass Spectral-Correction Filter

Hold Switch to Store Reading

Calibration Accuracy of Reading 5% \pm One Digit

No Fatigue or Saturation Effects Excellent Calibration Stability

J6511 Illuminance Probe (Fig 2)

Accurate Photopic (Color) Correction Accurate Cosine Correction (180° Field of View)

Measures 0.001 to 1999 Footcandles (0.01 to 19,999 Lux*)

Resolution 0.0001 Footcandles (0.001 Lux*) 5% Accuracy Even with Low-Pressure

25-Ft Cable Attached

Sodium Lighting

Built-in Bubble Level

Use for OSHA Standards, Office Lighting, Highway Lighting, Automotive Lighting, Medical Lighting

J6523 1° Luminance Probe (Fig 3)

1° Acceptance Angle

199,900 Nits*)

Optical Sighting and Viewing System
Accurate Photopic (Color) Correction
Measures 0.1 to 19,990 Footlamberts (1 to

Resolution 0.01 Footlamberts (0.1 Nits*)

Measures a Spot as Small as 0.23 Inches at 18-In Distance (0.035" with Commercially Available Standard Photographic Close-up Lenses)

Focus Range of 18 Inches to Infinity 5% Accuracy Even with Low-Pressure Sodium Lighting

Use for Highway Lighting, Television, Photographic Equipment, Cathode-Ray Tubes

*Metric version.



Fig 1

Fig 2

Fig 3

Fig 4

Fig 5

J6502 Irradiance Probe (Fig 4)

Flat Spectral Response within $\pm 7\%$ from 450 to 950 nm

Measures 1 nW/cm^2 to 1.999 mW/cm^2 (0.01 to 19,900 mW/M^2*)

Resolution 0.1 nW/cm^2 (0.001 mW/M^{2*})

1-cm 2 Sensor Allows Direct Reading of Laser Power in μW with Detector Underfilled by Beam

Acceptance Angle Approximately 120°
Use for Lasers, Environmental Research,
Tv Monitor Color Temperature Adjustment,
Ir LED's

J6503 8° Luminance Probe (Fig 4)

Accurate Photopic (Color) Correction Measures 0.1 to 199,900 Footlamberts (1 to 1,999,000 Nits*)

Resolution 0.01 Footlamberts (0.1 Nits*) Use for Television, Illumination, Photographic Equipment, Cathode-Ray Tubes

J6501 Illuminance Probe (Fig 4)

Same Characteristics as J6511 Except No Cosine Correction; Construction Similar to J6502. (When Using 014-0047-00 LED Adapter, the Ranges are the Same as Those for the J6505.)

Use for Green and Yellow LED's, Lamp Testing, and Other Point Light Sources

J6505 Red LED Probe (Fig 4 and 5)

Accurately Matches Photopic Curve from 600 to 710 nm

Measures 0.01 Millicandela to 199.9 Candelas at 3.8 Inches (Higher at Greater Distances)

Resolution 0.01 Millicandela

Includes Snap-on LED Adapter to Position LED and Exclude Room Light

Use for Red LED's, Red Automotive, and Aircraft Lights

J6512 Irradiance Probe (Similar to Fig 2)

Same Characteristics as J6502; Construction Similar to J6511

Use for Lasers, Medical, Environmental Research

J6504 Uncorrected Probe (Fig 4)

Spectral Response: Uv-Enhanced Silicon Curve (250 to 1200 nm)

Highest Sensitivity (No Filters Are Used to Modify Spectral Response)

Relative Reading Only

Use for Periodic Tests of Photoresist Exposure Equipment, Uv Light Sources

ORDERING INFORMATION

Photometer/Radiometer without Probes

Read- out Units	Power Source	Voltage	Order Informa- tion†	Price
US	Battery	115 V, 50-60 Hz bat- tery charger	J16	\$790
		230 V, 50-60 Hz bat- tery charger	Opt 01	No Charge
US	S Ac 115 V, 50-400 Hz		Opt 03	No Charge
US	JS Ac 230 V, 50-400 Hz		Opt 04	No Charge

Analog and digital outputs available on special order.

†For a J16 with metric readout, specify Option 02 in addition to above ordering information. No additional charge.

Option 02 probes must be used with Option 02 J16.

PROBES

J6511 Illuminance Probe	\$380
J6523 1° Luminance Probe\$	1090
J6502 Irradiance Probe	\$380
J6503 8° Luminance Probe	\$380
J6501 Illuminance Probe	\$380
J6505 Red LED Probe	\$460
J6512 Irradiance Probe	\$420
J6504 Uncorrected Probe	\$380

For probes for metric J16, specify Option 02 at no additional charge.

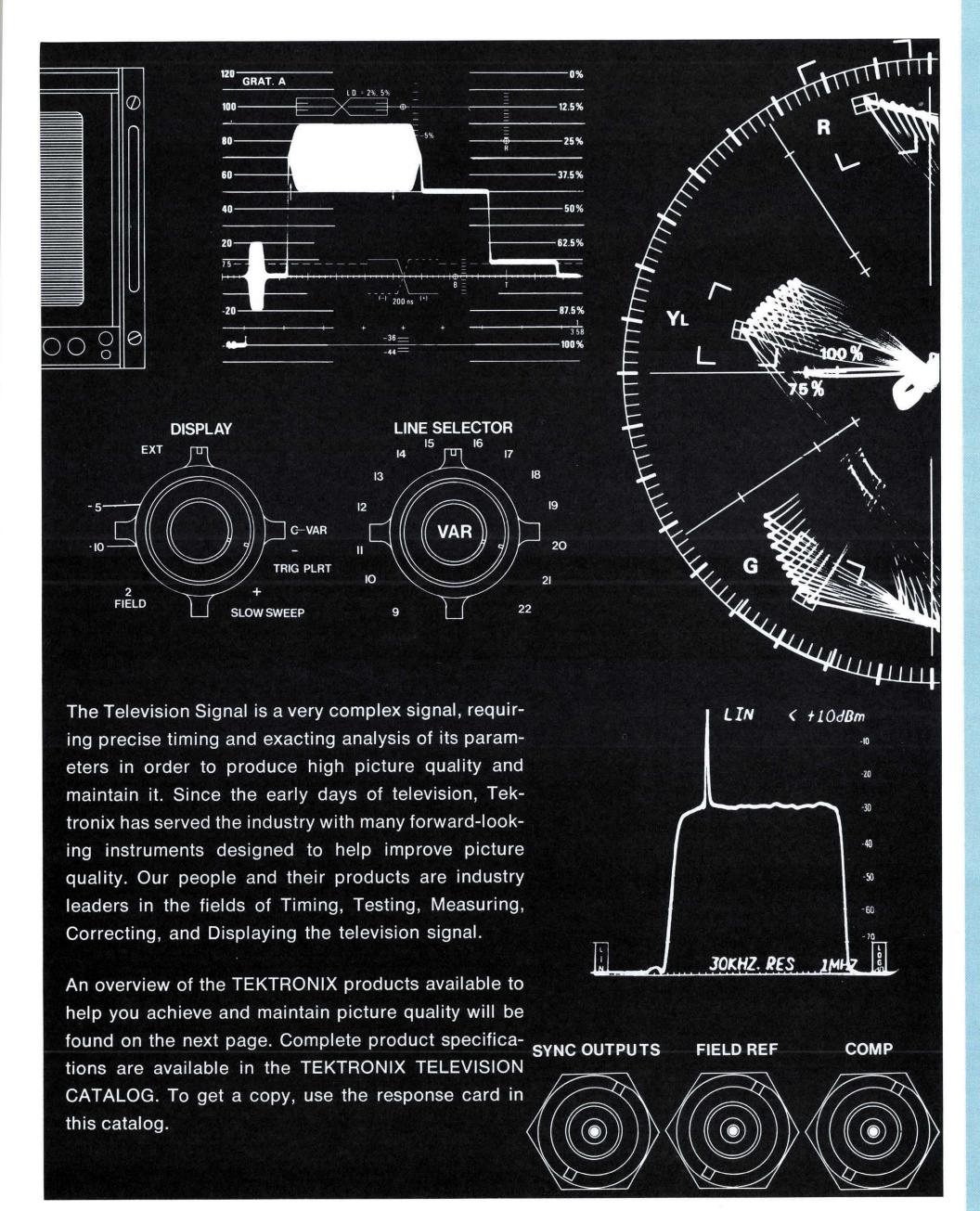
ACCESSORIES

42-in Probe Extension Cable for J6501, J6502, J6503, J6504, and J6505. Order 012-0414-02 (Longer on Special Order)\$60
Light Occluder (for Color Tv Monitor Setup). Order 016-0305-00\$18
Filter Holder — Mounts 1-in Diameter Filters to J6501, J6502, J6503, J6504, and J6505. Order 016-0527-00\$18
Filter Holder — Mounts 2-in Diameter Filters to J6512. Order 352-0380-00\$3
Tripod, Order 016-0253-00\$55
Ac Power Supply, 115 V, 50-400 Hz. Order 119-0404-00\$150
Ac Power Supply, 230 V, 50-400 Hz. Order 119-0404-01\$160
LED Adapter (included with J6505). Order 014-0047-00\$62

For a complete brochure and application notes on the J16, please return the reply card attached to the catalog or see your Tektronix field representative.

11

Television Products



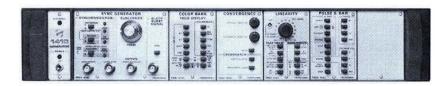
TEKTRONIX Television Products time, test, measure, correct, and display the television signal.



New Product

Demodulators — System M

The TEKTRONIX 1450 Demodulator measures the quality of the transmitted signal and performance of the television transmitter. It does not introduce any distortion into the measurement as a result of the demodulation process. Either envelope or synchronous detection is provided. Technological advances in the 1450, such as a Tektronix-developed surface wave filter, make it one of the most advanced demodulators available. Request our brochure number AX-3466-1 for details on the TEKTRONIX 1450 Demodulator.



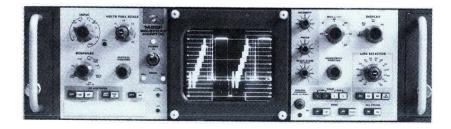
Generators—Sync and test signal for NTSC, SECAM, PAL and PAL-M systems

All of the many signals needed to time and accurately test broadcast and closed-circuit color video equipment are provided by TEKTRONIX Television Signal Generators for NTSC, SECAM, PAL, and PAL-M systems. Most TEKTRONIX Generators provide many signals, rather than just one or two, through an arrangement of fully or partially independent controls.



Correctors—NTSC and PAL

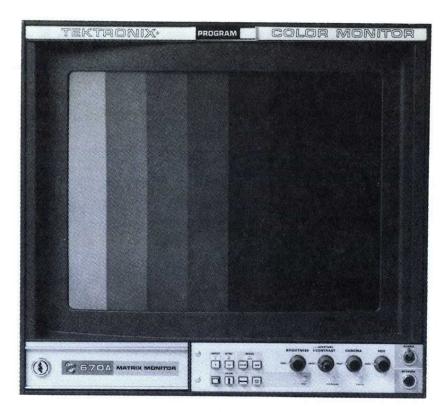
TEKTRONIX Automatic Video Correctors use a reference signal located in the vertical-blanking interval to correct the video signal. The Corrector samples the parameters of the reference signal in the vertical interval and automatically changes its operating characteristics until correct values for the reference signal are achieved. The full field signal is simultaneously corrected by the same automatic changes that correct the reference signal.



Waveform Monitors — NTSC, PAL, PAL-M, SECAM

The waveform monitor is a specialized oscilloscope designed for the measurement of the composite video signal.

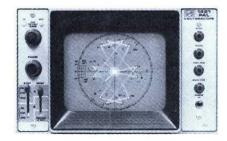
Characterized with sync-selective triggering and precise vertical characteristics, TEKTRONIX Waveform Monitors are designed for quick and accurate measurement of the components of the composite-video signal. There is a selection of TEKTRONIX Waveform Monitors for 525/60 and 625/50 scanning standards and for full-or fractional-width rack installation. Cabinet-style units are also available.



Picture Monitors—SECAM, PAL, PAL-M and NTSC

Picture monitors used in television production and transmission facilities are required to present program material and test patterns for critical evaluation by both engineering and production people. Therefore, consistent high-quality color reproduction is an important requirement. In addition to having stable, consistent color characteristics, TEKTRONIX Color Picture Monitors provide underscan and vertical and horizontal delay functions for detailed examination of the entire picture.

TEKTRONIX Monitors are sized to fit the critical space requirements of your installations. The Trinitron kinescope makes both the 650 Series and the 670 Series simple to converge and contributes to the color stability of both series.



Vectorscopes — NTSC, PAL and PAL-M

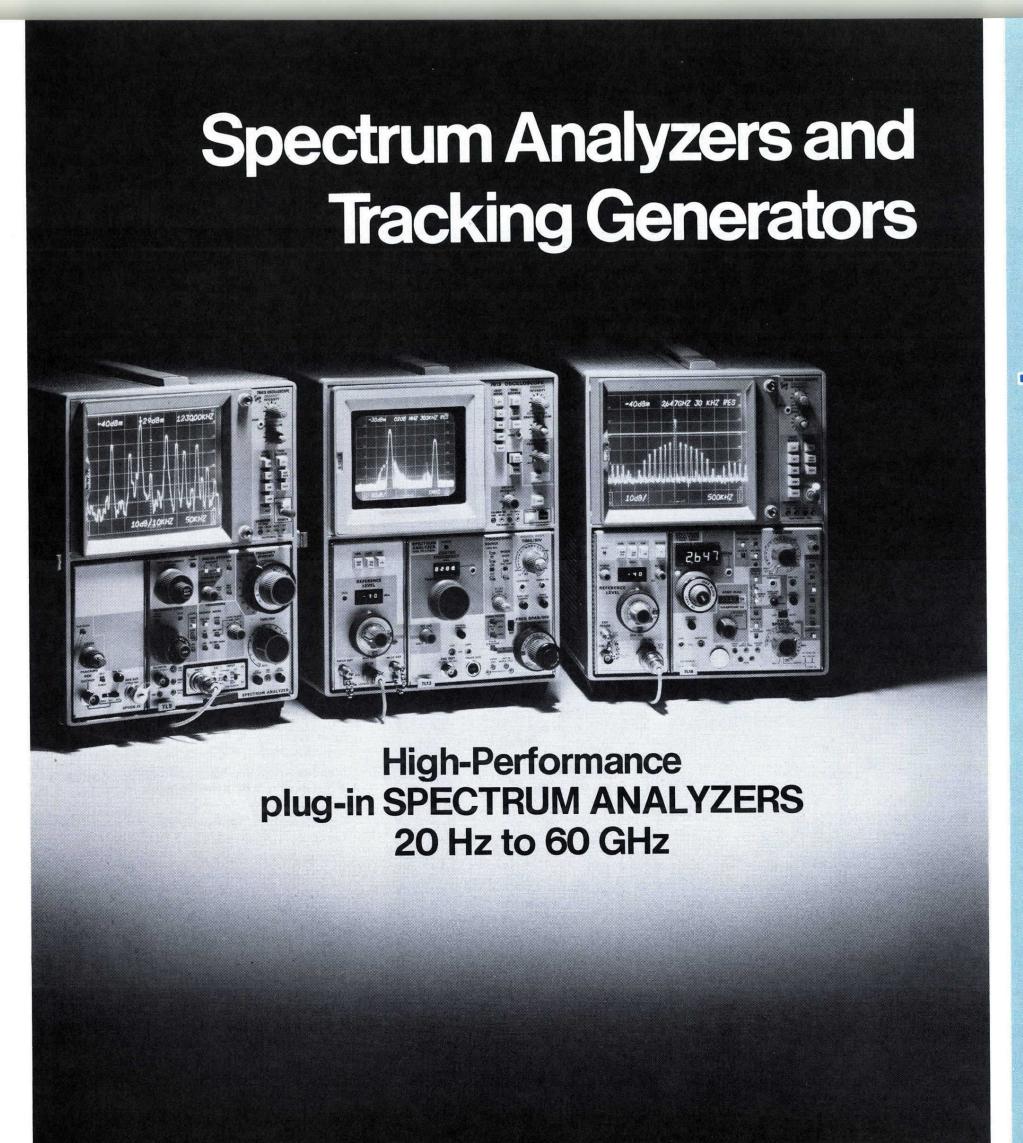
Vectorscopes are used to display and examine the chrominance signal. Some Vectorscopes offer linear time-base displays in addition to vector displays. Luminance amplitude, chrominance phase, chrominance amplitude, differential phase, and differential gain are included in the wide variety of specialized measurements for which vectorscopes are used.



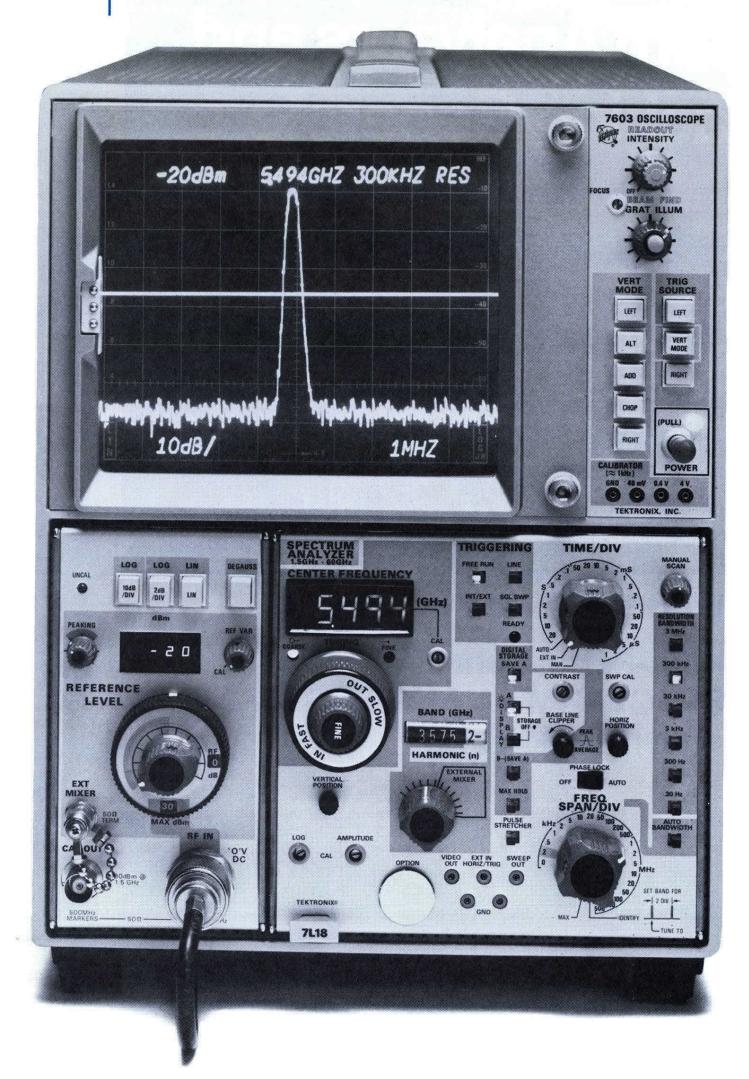
Sideband Analyzers and Other Products for Television

Check this catalog for other products used in the video communications industry: sideband analyzers, spectrum analyzers, scopes with sync separation features, and the TM 500 Modular instruments.

The complete reference for data on TEKTRONIX Television Products is the TEKTRONIX Television Catalog. To get it, see the response card in this catalog.



The 7000 Series family of high performance plug-in spectrum analyzers includes the 7L18, 7L13, and 7L5. Read about these and other spectrum analyzer products in the next 17 pages.



7L18 Spectrum Analyzer in a 7603 Option 06 mainframe with internal spectrum analyzer graticule.

30 Hz Resolution to 12 GHz

Microprocessor-aided Front Panel Controls

Digital Display and Signal Processing (Max Hold, Save A, Split and Comparison Features, and Algebraic Addition)

Calibrated Reference Level Includes Internal Preselector

60 GHz with Optional Waveguide Mixers

Transportable—Just 48 Pounds Including 7603 Mainframe

Preselected for Freedom from Spurious Responses

80 dB Display Dynamic Range

≤ 10 Hz Residual FM (Fundamental Mixing)

Fits all 7000 Series mainframes including USM-281C

7L18 SPECIFICATIONS

FREQUENCY RELATED

Frequency Range—1.5 GHz to 60.5 GHz

Tuning Range—

With internal mixer: 1.5 GHz to 18 GHz. With external mixer: 12.5 GHz to 60.5 GHz.

Frequency Span—Per Division: 20 calibrated span widths from 200 Hz/div to 500 MHz/div in a 1-2-5 sequence. Max Span: Depends on mixing mode. Span width = N x 2 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: Non sweeping tunable receiver mode.

Tracking Preselector—Internal and automatic 1.5 to 18 GHz. Rejection of harmonic mixing, image and multiple responses > 70 dB.

Frequency Bands—

With internal mixer	$(\dot{N} = mixing mode)$
1.5 GHz to 3.5 GHz	N = 1 -
2.5 GHz to 4.5 GHz	N = 1 +
3.5 GHz to 7.5 GHz	$\dot{N} = 2-$
6.5 GHz to 12.5 GHz	N = 3 +
9.5 GHz to 18.0 GHz	N = 5 -
With external mixer	(N = mixing mode)
12.5 GHz to 24.5 GHz	N = 6+
14.5 GHz to 28.5 GHz	N = 7 +
16.5 GHz to 32.5 GHz	N = 8 +
TOTO WITE TO OLLO WITE	

Frequency Accuracy—

Dial Accuracy: (5 MHz \pm 20% of frequency span/div) x N [typically (1 MHz) x N with degauss activated].

Span accuracy—5% over center 8 horizontal divisions (typically 3%).

Stability—Residual fm stabilized 10 Hz peak-to-peak x N (typically 2 Hz peak-to-peak x N).

Frequency Drift—

Long term drift: (at fixed center frequency after 2 hr warm up).

Stabilized: 2 kHz/hr x N. Unstabilized: 50 kHz/hr x N.

Setability-

Within 1 MHz for 1.5 GHz to 18 GHz (after 2 hr warm up).

Within 10 MHz with external mixers (after 2 hr warm up).

Resolution-

Bandwidth range: Selectable 6 dB bandwidths from 30 Hz to 3 MHz in decade steps plus auto.

Shape factor: 4:1, 60 db to 6 dB points, 300 Hz to 3 MHz, 12:1, 60 dB to 6 dB points, 30 Hz. Bandwidth accuracy: 6 dB points, 20%.

Phase Noise Sidebands — When phase locked, for fundamental (N=1) conversion: -70 dBc min at frequency offsets $\geq 20X$ resolution bandwidth settings.

AMPLITUDE RELATED

MEASUREMENT RANGE

Log Reference Level— -110 dBm to +40 dBm (+30 dBm max safe input level).

Log Display Dynamic Range—80 dB.

Linear—8 divisions with calibrated reference levels.

Rf Attenuation Range—6 steps @ 10 dB/step.

If Gain Range—9 steps @ 10 dB/step -20 dBm to -110 dBm (with zero rf attenuation) (-20 dBm is reduced noise position).

Sensitivity and Frequency Response—See tables 1 and 2, and figure 1.

Amplitude Accuracy—

If gain variation with different resolution bandwidths (at 25°C).

Log: ± 0.5 dB.

Reference level variation due to band switching: $\pm 1.0 \; \mathrm{dB}$.

Table 1

Sensitivity and Frequency Response with Internal Mixers—(Average noise level specified for 300 Hz resolution bandwidth. Frequency Response with 10 dB input attenuator setting.)

Frequency Range (GHz)	Mixing Mode	Average Noise Level (dBm Max)	*Frequency Response Optimum Peaking (dB Max)
1.5—3.5	1-	-119	±1.5
2.5—4.5	1+	-119	±1.5
3.5—7.5	2-	-109	± 2.0
6.5—12.5	3+	— 107	±2.5
9.5—18.0	5—	-92	± 3.0

^{*}Includes mixer frequency response, rf attenuator frequency response, internal preselector frequency response, mixing mode gain variation, rf input VSWR.

Table 3

Optional Waveguide Mixers: Economy General Purpose

Frequency Range (GHz)	Sensitivity† (dBm Typical)	Part Number	
12.5—18.0	-85	119-0097-00	
18.0—26.5	-80	119-0098-00	
26.5—40	-70	119-0099-00	

[†]Average noise in 3 kHz resolution bandwidth (typical). Required cable for above mixers 012-0748-00.

Table 2

Sensitivity and Frequency Response with External Mixers—(Average noise level specified for 3 kHz resolution bandwidth.)

Frequency Range (GHz)	Mixing Mode	Average Noise Level (dBm Max)	Frequency Response (dB Max)
12.5—18.0	6+	-85	-
**18.0-26.5	7+	-90	±3
**26.5—40	10+	-85	±3
**40—60.5	15+	-75	±3

^{**}High Performance Mixer Line.

Table 4

Optional Waveguide Mixers: High Performance

Frequency Range (GHz)	Sensitivity‡ (dBm Max)	Frequency Response (dB)	Part Number	
18.0—26.5	-90	±3	016-0631-00	
26.5—40.0	-85	±3	016-0632-00	
40.0—60.5	-75	± 3	016-0634-00	

‡Average noise in 3 kHz resolution bandwidth. Required cable for above mixers 012-0649-00.

Log 10 dB/div: ± 1.0 dB/10dB to a maximum of 2.0 dB. Log 2 dB/div: ± 0.4 dB/2 dB to a maximum of 1.0 dB. Linear: ±10%.

If gain: ± 1.0 dB/10 dB, ± 2 dB max.

Rf attenuator: \pm 0.3 dB/10 dB to a maximum of \pm 0.7

Calibrator output: Amplitude -30 dBm ± 0.5 dB, frequency 2.0 GHz $\pm 0.01\%$.

Absolute Calibration Accuracy 1.5 to 18 GHz: Overall accuracy is a function of measurement technique and includes the following parameters: Amplitude calibrator + band switching error + if gain switching + rf attenuator switching + logging error + flatness + digital quantizing error (if digital storage is used). With appropriate technique, absolute accuracy of ± 2.5 dB is usually achievable (1.5 to 18 GHz).

INPUT CHARACTERISTICS

Input Impedance—50 ohms nominal (1.5 to 18 GHz).

Connector—Type "N" female.

VSWR— \leq 1.35 for attenuator settings of \geq 10 dB.

Maximum Input Level—1 watt (+30 dBm).

Optimum Input level— \leq -30 dBm with zero rf attenuation.

Input Compression Point — \geq -22 dBm from 1.5 to 1.8 GHz. \geq -18 dBm from 1.8 to 18 GHz. (Both with zero rf attenuation.)

L.O. Emission—-80 dBm, 1.5 to 18 GHz (10 dB input attenuator setting).

SPURIOUS RESPONSES

Residual-(No signal present at input) with input attenuation at 0 dB, ≤ -110 dBm.

Intermodulation Distortion-Third order down 70 dB or more from any two full screen signals, when if gain is not set to red zone (reduced noise position).

Mixed-All harmonic mixing, image and multiple responses down 70 dBc to 18 GHz.

DIGITAL STORAGE AND SIGNAL PROCESSING

Multiple memory display storage (A & B memory). Save "A".

Digital display averaging.

Max hold.

B minus "Save A".

Disable for non-storage viewing.

GENERAL

Sweep Characteristics—1 μ s/div to 20 sec/div in a 1, 2, 5 sequence plus auto, manual, and external. Accuracy ±5%.

Triggering modes-Internal, external, free run, single sweep. Triggering source line, internal, external. Sensitivity: 1 div internal, 0.5 volt external (50 volts max). Frequency Range: 15 Hz to 1 MHz.

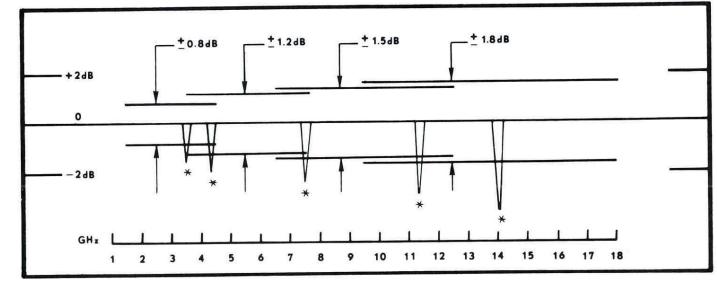


Figure 1. Typical Frequency Response Limits.

Video Output—500 mV $\pm 5\%$ /div of display.

Pulse Stretcher-Enhances pulsed rf measurements.

Degauss—Improves frequency measurement accuracy.

X, Y Output-Front panel pin jacks.

Uncal Light-Provides indication of uncalibrated display amplitude.

Peaking-Optimizes sensitivity and frequency response.

ACCESSORIES

Included—	Part Number
1 Spectrum Analyzer Graticule	337-1439-01
1 Spectrum Analyzer Graticule	337-1159-02
1 50 ohm coaxial cable, 10 in.	012-0208-00
1 Adapter, BNC female to N male	103-0045-00
Plug-in to Mainframe Securing Kit	016-0637-00

Optional-

Waveguide mixers: See tables 3 and 4.

General	Purpose Wave	g	u	ic	le	1	M	i	(6	r	s												
Set 016-	0640-00													•			٠		•	•			\$449
Mixer	119-0097-00	0.00	1200												٠					٠			125
	119-0098-00																						
Mixer	119-0099-00							•				٠	•								•		190
Cable	012-0748-00			٠					•							٠	•	•			٠	٠	15
Coco	004 1651 00																						35

High Performance Waveguide Mixers

\$2605	•	٠	٠	٠		٠	•			•				(1)							016-0641-00	Set
800					٠		٠											٠			ixer 016-0631-00	M
800					٠			٠	•		٠	•	٠	•	•						ixer 016-0632-00	M
950					•	٠										•			,	٠.	ixer 016-0634-00	M
20	•	•				٠	٠										٠	٠	٠		able 012-0649-00	C
35			•		•			•	100	•						•					ase 004-1651-00	C

Carrying Case: Protective aluminum case with hinged
latchable front cover and carrying handle.
016-0626-00\$175

ORDERING INFORMATION

7L18 Spectrum Analyzer \$12,600
*7603 Oscilloscope\$2050
R7603 Oscilloscope (Rackmount)\$2350
Option 06 Internal S A Graticule+50
Option 08 Protective Front Cover (Cabinet Only)Add \$100

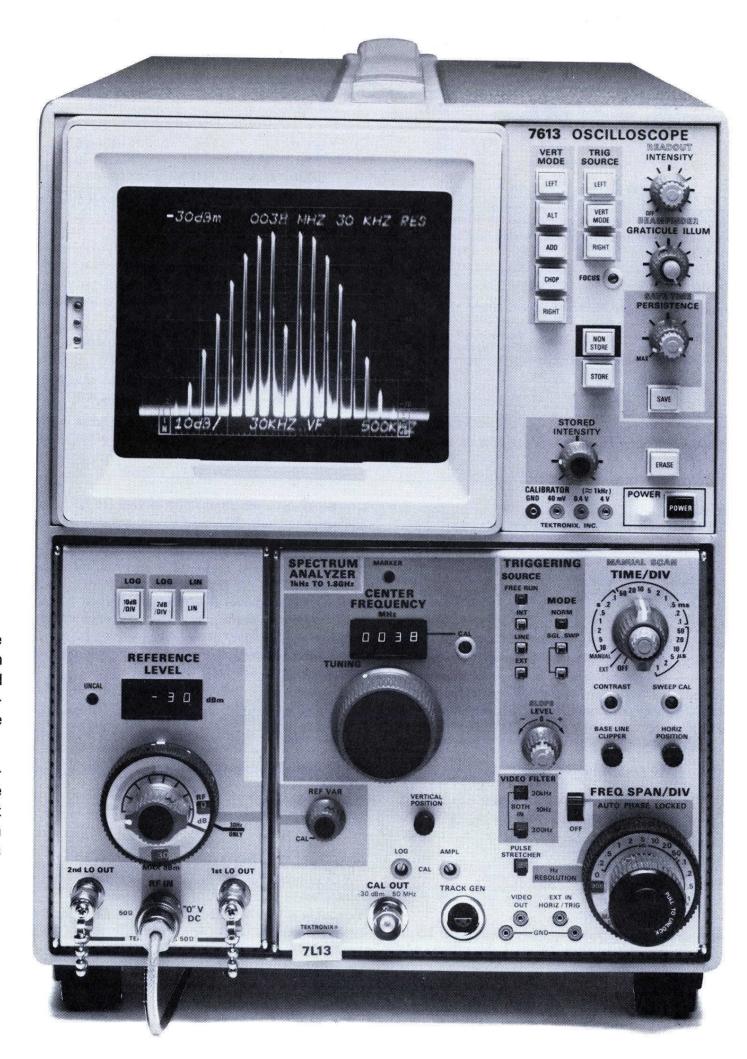
*Suggested Mainframe: 7603 Opt 08/Opt 06 for maximum transportability. Has protective front cover (Opt 08) and Spectrum Analyzer Graticule (Opt 06). See 7000 Series pages for oscilloscope specifications and options.

^{*}Aberrations at approximately 3.5 GHz, 4.5 GHz, 7.5 GHz, 11.5 GHz, and 14 GHz are within worst case maximum frequency response.

1 kHz to 1800 MHz in One Display
Fully Calibrated Displays
30 Hz to 3 MHz Resolution
4:1 Resolution Bandwidth Shape Factor
70 dB On-screen Dynamic Range
IM Distortion 70 dB below Full Screen
Spurious Free Operation
Automatic Phase Lock
—128 dBm Sensitivity

The 7L13 Spectrum Analyzer represents the highest performance possible today in an instrument of this frequency range and price. The fm stability is 10 Hz, making 30-Hz resolution possible across the entire frequency range.

This analyzer is a high quality laboratory instrument. In addition to incorporating the standard features of the 7L12, it has crt readout of the center frequency, and an UNCAL light to indicate incorrect settings of the sweep rate or resolution controls.



7L13 in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.

7L13 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 1 kHz to 1.8 GHz.

Resolution Bandwidth — Resolution bandwidth selections from 30 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 12:1 or better for 30 Hz resolution and 4:1 or better for 300 Hz to 3 MHz resolution.

Stability — After a 2 hour warm-up, within 2 kHz, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — -10 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from -110 dBm to +30 dBm, within ± 2 dB. An UNCAL indicator shows when excessive sweep speeds are selected.

Log 10 dB/div:

 $-70~\mathrm{dB}$ dynamic range. Accuracy $\pm 0.1~\mathrm{dB/dB}$ to a max of 1.5 dB.

Log 2 dB/div:

-14 dB dynamic range. Accuracy ± 0.4 dB/2 dB to a max of 1.0 dB.

Linear:

- Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode) -128 dBm at 30 Hz, -115 dBm at 300 Hz, -108 dBm at 3 kHz, -100 dBm at 30 kHz, -90 dBm at 0.3 MHz, -80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — +1 dB, -2 dB over any frequency span.

Spurious Responses —

Residual — (No signal present at input) with input attenuation at 0 dB, \leq -100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from two -30 dBm signals within any frequency span. Second order down 70 dB or more from two -40 dBm signals.

Mixed — All image, harmonic related, and out-of-band mixing responses are \geq 70 dB down from a level of -30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 80 dB when operating with 30 Hz resolution bandwidth. 70 dB with 300 Hz to 3 MHz resolution bandwidth. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

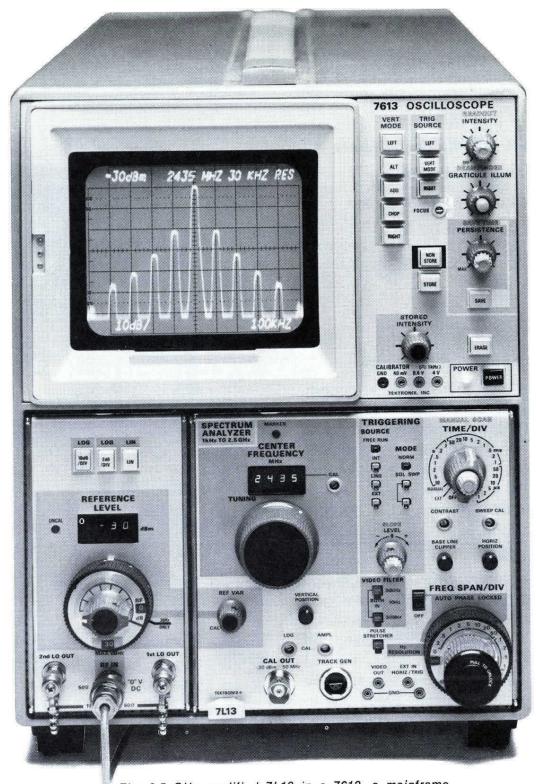
Impedance — 50 Ω , nominal.

SWEEP CHARACTERISTICS

Frequency Span — Calibrated steps in 1-2-5 sequence from 200 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — Selection of an external sweep source, manual sweep, or calibrated time base, 10 s/div to 1 μ s/div.

Triggering — Trigger signal source can be external, internal, or line voltage.



The 2.5 GHz modified 7L13 in a 7613, a mainframe featuring variable persistence. Variable persistence is recommended for maximum utilization of the capabilities of the 7L13. Information is available upon request.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, -30 dBm at 50 Ω .

Video Out - Approx 2 V full screen.

Horiz In - (and Trig) For use with chart recorder.

Tracking Gen (Logic) — For use with tracking generator (5 V TTL).

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO - For use with tracking generator.

ACCESSORIES

Included — 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; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

CONTROL MATERIAL CONTROL CONTR
7L13 Spectrum Analyzer \$8850
7603 Mainframe\$2050
Option 08 Protective Front CoverAdd \$100
Option 77 P7 Phosphor and Internal S A Graticule
7613 Variable Persistence
Mainframe\$3150
Option 06 Internal S A Graticule\$50
Option 08 Protective Front CoverAdd \$100

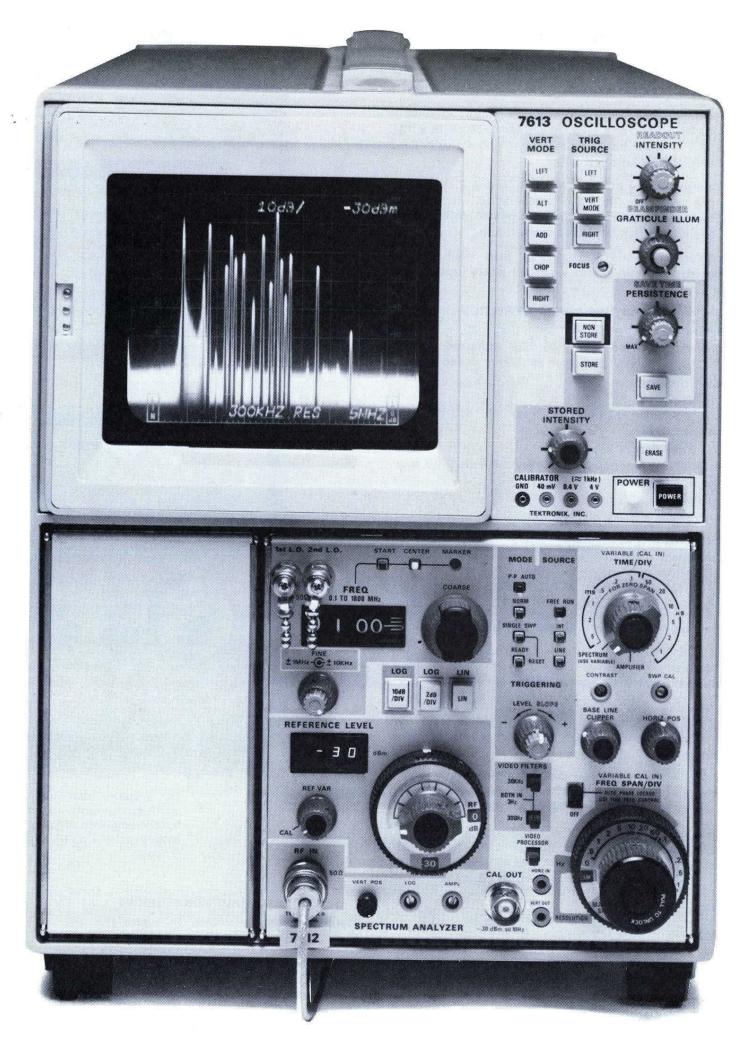
Extended Frequency Range to 2.5 GHz. Ask about the modified 7L13.

100 kHz to 1800 MHz in One Display
Fully Calibrated Displays
300 Hz to 3 MHz Resolution
4:1 Resolution Bandwidth Shape Factor
70 dB On-screen Dynamic Range
IM Distortion 70 dB below Full Screen
Spurious Free Operation
Automatic Phase Lock
—115 dBm Sensitivity

The 7L12 Spectrum Analyzer is a modern, high-performance, swept front-end type of analyzer covering the frequency range up to 1.8 GHz. The unit employs phase lock stability and an ample selection of resolution bandwidths in an economical field or laboratory instrument.

The unit has a 3 MHz resolution mode for accurate measurement of pulse phenomena; the zero-span mode may be used to present a demodulated display of a signal for time domain measurements. A 4:1 resolution bandwidth shape filter introduced by Tektronix permits close-in measurements not possible with conventional filters. Noise measurements are also easily made due to the high sensitivity, video filters, and equivalent resolution and noise power bandwidth of the instrument.

The 7L12 fills two holes in any 3- or 4-hole 7000-Series Mainframe and features a complete time base so that other oscilloscope or time domain plug-ins may be used simultaneously. As with all 7000-Series Plug-ins, CRT READOUT will display the major parameters. For the 7L12, these include: reference level, dB/div, frequency span, and resolution.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.

7L12 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 100 kHz to 1.8 GHz. (Usable below 100 kHz with degraded performance.)

Resolution Bandwidth — Resolution bandwidth selections from 300 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 4:1 or better.

Stability — After 2 hour warm-up, within 50 kHz, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — 200 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from -100 dBm to +30 dBm, within ± 2 dB.

Log 10 dB/div:

-70 dB dynamic range. Accuracy $\pm\,0.1$ dB/dB to a max of 1.5 dB.

Log 2 dB/div:

-14 dB dynamic range. Accuracy ± 0.4 dB/2 dB to a max of 1.0 dB.

Linear:

- Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode). —115 dBm at 300 Hz, —108 dBm at 3 kHz, —100 dBm at 30 kHz, —90 dBm at 0.3 MHz, —80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — ±1.5 dB over any frequency span.

Spurious Responses -

Residual — (No signal present at input) with input attenuation at 0 dB, \leq -100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from two -30 dBm signals within any frequency span. Second order down 70 dB or more from two -40 dBm signals.

Mixed — All image, harmonic related, and out-of-band mixing responses are \geq 70 dB down from a level of -30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 70 dB. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

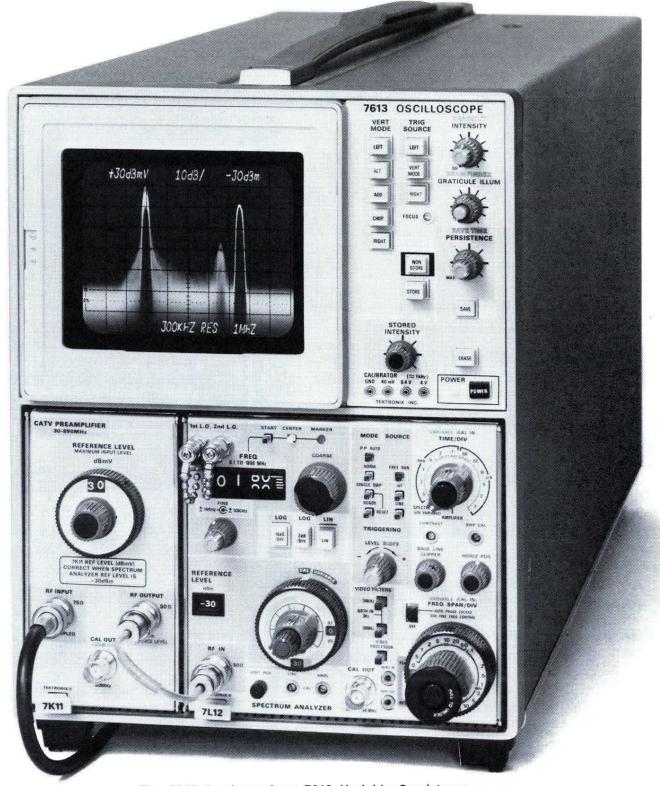
Impedance — 50 Ω , nominal.

SWEEP CHARACTERISTICS

Frequency Span — 500 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate - 10 ms/div to 1 μ s/div.

Triggering — Trigger signal source can be external, internal, or line voltage.



The 7L12 is shown in a 7613 Variable Persistence Mainframe with 7K11 Preamplifier for extra sensitivity.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, —30 dBm at 50 Ω .

Vert Out - Approx 2 V full screen.

Horiz In — For use with chart recorder.

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO - For use with tracking generator.

ACCESSORIES

Included — 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 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

7L12 Spectrum Analyzer\$6150
7603 Mainframe\$2050
Option 08 Protective Front CoverAdd \$100
Option 77 P7 Phosphor and Internal S A Graticule
7613 Variable Persistence
Mainframe\$3150
Option 06 Internal S A Graticule
Option 08 Protective Front CoverAdd \$100
7K11 CATV Preamplifier\$625

Extended Frequency Range to 2.5 GHz. Ask about the modified 7L12.

THREE-KNOB OPERATION makes the 7L5 the world's easiest-to-use spectrum analyzer.

SYNTHESIZER STABILITY for six-digit accuracy of center frequency setting with virtually no drift.

DIGITAL STORAGE & AVERAGING of display signals.

REFERENCE LEVEL SELECTION in 1 dB steps.

ABSOLUTE CALIBRATION in dBm, dBV or volts/div.

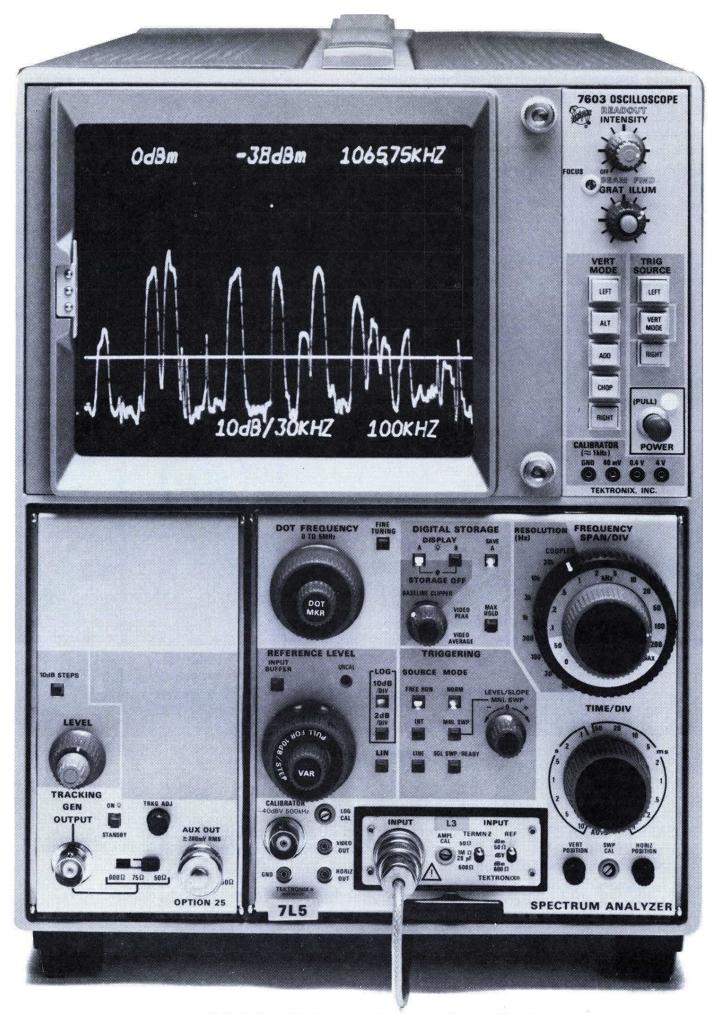
TRACKING GENERATOR option for swept component measurements.

CHANGEABLE INPUT IMPEDANCE MOD-ULES to accommodate any impedance requirement.

WIDE DYNAMIC RANGE and nanovolt sensitivity.

PRESET REFERENCE LEVEL for extra input protection.

CRT READOUT of all major parameters.



7L5 Option 25 Spectrum Analyzer with L3 Plug-in Module in a 7603 Option 06 Mainframe with internal spectrum analyzer graticule.

The 7L5 is an audio/baseband spectrum analyzer plug-in that provides exceptional frequency accuracy and operator convenience through a combination of frequency synthesizer and digital technology.

The center frequency can be set with 6 digit accuracy immediately after turn-on. A built-in micro-computer decodes control settings, processes frequency span and reference level information, and optimizes sweep time and resolution for the span chosen.

To accommodate a wide variety of user preferences, the 7L5 uses changeable plug-in input modules providing a variety of input impedances such as 50, 75, 600, or 1 megohm. The built-in computer automatically adjusts the calibrator to provide the correct reference level for the impedance chosen.

Digital storage, in addition to providing clean, easy-to-interpret displays, also makes special functions possible, such as digital averaging and peak detection. The display is stored electronically and updated during

each sweep. Two complete displays can be held in memory for comparison. A max hold function stores the maximum signal level over long periods of time to measure amplitude and frequency drift.

Crt readout displays the center frequency, reference level, resolution bandwidth, dB per division, and frequency span.



Changeable modules permit the 7L5 user to adapt to new measurement requirements. Modules now available are the 50 Ω L1, 75 Ω L2, and 1 M Ω L3. The probe-compatible L3 offers selectable internal 50 Ω , 1 M Ω , or 600 Ω impedance, while the L3-1 offers 75 Ω , 1 M Ω , or 600 Ω . The module you select calibrates displays for the impedance in use.

7L5 Options

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 10 Hz to 5.0 MHz.

7L5 Option 21 Logarithmic Frequency Display

The 7L5 Option 21 is a three-wide version of the normally two-wide 7L5 7000 Series plugin spectrum analyzer. The additional compartment houses circuitry that generates a logarithmic frequency display covering all 21 proportional bandwidth IRIG telemetry channels. The nominal frequency range is 200 Hz to 200 kHz.

7L5 Option 28 Front Panel Readout

The 7L5 Option 28 provides LED front panel readout of center frequency and reference level. Option 28 is recommended for 7000 Series Mainframes that have no provision for CRT readout such as 7603N11s.

Combined Options

All three options 21, 25, and 28 can be combined in one instrument. Options 21 and 25 can be combined, as can Options 25 and 28. Option 25 is available separately as a field modification kit to be attached to an existing 7L5. Options 21 and 28 can only be installed at the factory.

7L5 CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer and its options. They are applicable over the environmental specification criteria for the 7000-Series mainframe.

FREQUENCY CHARACTERISTICS

Range — Input frequency range is 20 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 250 Hz steps. Dot accuracy: 0° C to 50° C $\pm (20 \text{ Hz} + 10^{-5} \text{ of dot frequency})$; 20° C to 30° C $\pm (5 \text{ Hz} + 2 \text{ X} 10^{-6} \text{ of dot frequency})$.

Drift — Frequency drift is \leq 5 Hz/hour.

Residual Incidental Fm — Residual fm is \leq 1 Hz (p-p) for frequency spans of 50 Hz/div to 2 kHz/div. Residual fm is \leq 40 Hz (p-p) for frequency spans of 5 kHz/div to 500 kHz/div.

Resolution Bandwidth — 8 resolution bandwidths range from 30 kHz to 10 Hz. COUPLED switch position electronically couples resolution to span/div selection so that both are controlled by the same knob. Bandwidth accuracy @ 6 dB down is within 20% of selected resolution. Shape factor (60:6 dB ratio) is 10:1 or better for 10 Hz to 1 kHz and 5:1 or better from 3 kHz to 30 kHz. Amplitude change between resolution bandwidths is \leq 0.5 dB for 30 kHz to 100 Hz and \leq 2.0 dB for 30 kHz to 10 Hz.

SWEEP CHARACTERISTICS

Frequency Span—Provides calibrated frequency spans from 50 Hz/div to max (500 kHz/div) within 4% in 1-2-5 sequence.

Horizontal linearity is within 4% over the entire 10 div display.

A 0-Hz/div position is provided for time domain operation

Sweep Rate — Time per div is selectable from 10 s/div to 0.1 ms/div in 1-2-5 sequence. An AUTO position permits automatic selection of optimum time/div depending on resolution and span/div settings.

Sweep rate accuracy is within 5% of the rate selected.

Triggering — Provides two triggering sources, INT (internal) and LINE, in addition to a FREE-RUN position

When INT is selected, ac coupled signal components from the mainframe trigger source (left or right vertical amplifiers) are used.

When LINE is selected, ac coupled sample of main-frame ac line voltage is used.

Three triggering modes are NORM (normal), SGL SWP/READY (single sweep), and MNL SWEEP (manual sweep).

Trigger level is \geq 1.0 div of internal signal for both NORM and SGL SWP modes over the approx frequency range of 30 Hz to 500 kHz.

OUTPUT CONNECTORS

Video Out — Front-panel pin jack connector supplies the video (vertical) output signal at an amplitude of 50 mV/div +5% (about the crt vertical center) with source impedance of 1 k Ω . (Analog signal prior to digitization for storage).

Horiz Out — A front-panel pin jack connector supplies horizontal output signal (negative-going sawtooth that varies from about 0 to about -6 V dc with a source impedance of 5 k Ω).

Calibrator — Front-panel BNC connector supplies a calibrated 500 kHz square wave output signal (derived from the analyzer's time base). Output amplitude is within ± 0.15 dB of -40 dBV into the plug-in impedance.

OPTION 25 TRACKING GENERATOR 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 — (Max Output calibrated at 500 kHz.) 50 Ω , 0 dBm \pm 0.25 dBm 75 Ω , -6 dBm + 0.4, -0.2 dBm 600 Ω , -17 dBm + 0.5, -0.1 dBm

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 Peak-to-Peak. 600 Ω : Within 1.0 dB Peak-to-Peak. Total System Flatness (7L5 with Option 25) 50 Ω and 75 Ω : Within 1.0 dB Peak-to-Peak. 600 Ω : Within 1.25 dB Peak-to-Peak.

Dynamic Range (7L5 with Option 25) — \geq 110 dB.

Residual FM (peak-to-peak) —

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/hr maximum after 1 hour.

Spurious Suppression, 10 Hz to 5.0 MHz (Harmonic and non-harmonic) — 40 dB or more with respect to the carrier.

Auxiliary Output — \geq 200 mV rms into 50 Ω .

OPTION 21 LOG SWEEP (IRIG) CHARACTERISTICS

Logarithmic Display Frequency Range — 250 Hz to 222.25 kHz consisting of three combined linear sweeps.

Combined Linear Sweeps — 250 Hz to 2250 Hz, 2.25 kHz to 22.25 kHz, 22.25 kHz to 222.25 kHz, each displayed over one third the crt.

Nominal Resolution Bandwidth — 10 Hz @ 250 Hz input, increasing to 3 kHz @ 40 kHz to 222.25 kHz input.

Signal Acquisition Time for Full Screen Log Display—2.5 sec max.

Stability — Drift and incidental fm same as ordinary 7L5 at each frequency.

Dot Frequency Display — Continually changing as linear sweep segments cycle through. The dot feature is not operational.

7L5 Controls — All except the vertical reference and MAX HOLD controls are disabled.

Option 21 Controls —

220 kHz IRIG (On-Off) — Normal 7L5 when "off", log frequency display when "on".

SWP INHIBIT — When "on", the instrument will finish the three linear sweeps to form a log display. Data will stay in memory to provide the equivalent of a single sweep function.

OPTION 28 FRONT PANEL READOUT CHARACTERISTICS

Provides front panel LED display of frequency and reference level when operating in a non-readout mainframe. LED display shuts off automatically when operating in a mainframe with crt readout.

CHARACTERISTICS WITH PLUG-IN INPUT IMPEDANCE MODULE

INPUT CHARACTERIST	ICC	L1	L2	L3	L3-1
	ics			1 MO	/28 pF
Input Impedance — Input Power — Max input power for reference lev	vels:	50 Ω	75 Ω	(also 50Ω and 600Ω)	TOTAL COLUMN TOTAL
	above 0 dBm below 0 dBm		dBm dBm		dBm dBm
				100 V (peak	ac + dc) @ input z
AMPLITUDE CHARACTERI				1 10122	input 2
Residual Response — Internally generated spinput).		130 dBm or125 dBm forharmonics	less, r calibrator and	-143 dBV or -138 dBV for harmonics	less calibrator and
Sensitivity — Equivalent input noise for each r is measured in VIDEO AVERAGE mode with 10 s	esolution bandwidth setting s/div sweep rate and INPUT	, armomos		Harmonics	
BUFFER control off. Equivalent input noise for re-	solution bandwidth of:	*(equal to o	r better than)	*(equal to o	better than)
	10 Hz	AND COLUMN TO SERVICE STATE OF THE SERVICE STATE OF	5 dBm	N 10 10 10 10 10 10 10 10 10 10 10 10 10	B dBV
	30 Hz		3 dBm	N AND	6 dBV
	100 Hz	N. Carrier) dBm	N 1000	3 dBV
	300 Hz		dBm	V4 1962	dBV dBV
	1 kHz) dBm	— 133 — 133	
	3 kHz	-115	dBm		dBV
	10 kHz	-110) dBm	—123	
	30 kHz	-105	dBm	-118	
Sensitivity is further degraded 8 dB with INPU increases approx 10 dB operating in VIDEO PEAK	T BUFFER on. Noise level mode.				457
Intermodulation Distortion — Within any frequence	y span, intermodulation				
products for two, on screen, signals of any input level:			S SUNDS IN		
	3rd order products 2nd order products	at least 75 at least 72		at least 75 at least 72	STATE OF STATE OF STATE OF
of any input level up to $-53 \mathrm{dBv/} -40 \mathrm{dBm} (50 \Omega)$:	2nd and 3rd order products	at least 80	dB down	at least 80	dB down
of any input level with INPUT BUFFER on:	2nd and 3rd order products	at least 80	dB down	at least 80	dB down
Display Flatness — Peak-to-peak display variation	over any frequency span	0.5 dE) may	0.5.40	
Tank to peak alopiny fariation	over any frequency spain.	(Add 0.5% quan digital storage)	2. 1010/07/11/03/07	0.5 dB max (20 0.75 dB max (20 (Add 0.5% quant	Hz to 5 MHz)
On-screen Dynamic Range —		80 dB (fu	ıll 8 div)	digital storage) 80 dB (fu	II 8 div)
Reference Level** - In LOG mode, reference le	vel refers to top horizontal				
graticule line. Calibrated in dB steps.	POR N	1-dB and 1	0-dB stens	1-dB and 10	AR stone
Range —	LOG 10 dB/div mode		o +21 dBm	-83 dBV t	
	LOG 2 dB/div mode	—128 dBm t	DA THE STATE STATE STATE OF THE	—141 dBV t	
	LIN mode	20 nV/div to 200 m in 1-2-5 sequence	204 M. (2009) M. (24 Private MARCA)	20 nV/div to 200 m in 1-2-5 sequence	
Accuracy—When calibrated @ -40 dBV in LOG n	node.	Within 0.2 dB/dB db/10 dB change i	to max of 0.25 n reference level	Within 0.2 dB/dB, db/10 dB change i	to max of 0.25 n reference level
Display Dynamic Range Accuracy—	LOG 10 dB/div mode	.05 dB per dB to	2 dB max for 80	.05 dB per dB to dB full screen	
	LOG 2 dB/div mode	0.1 dB per dB to db full screen	1 dB max for 16	0.1 dB per dB to db full screen	1 dB max for 16
	LIN mode	±5	%	±5°	%
*Note: dBm = dBV $-10 \text{ Log Z} + 30 \text{ where Z} = \text{Example: dBV} = [dBm (600 \Omega) - 2.22]$	impedance				
200 200 200 200 200 200 200 200 200 200		We the stage of the second			
**Note: A > sign is displayed by the reference le the reference variable is out of its detent.	evel readout when the reference	level is not calibrate	d and the UNCAL	light is on. A $<$ sign i	s displayed when

ORD	ERING	G INFO	RMAT	ION
		M 1141 C	I I I I I I I I	1014

7L5 Spectrum Analyzer\$5700
(Spectrum Analyzer Requires L Plug-in Module.)
Option 21 with Logarithmic Frequency
Display Add \$750
Option 25 with Tracking GeneratorAdd \$1000 For a separate tracking generator, (One-wide field modification to be attached to an existing 7L5) order 040-0810-00\$1025
Option 28 with Front-Panel Readout Add \$500
Option 30 combines Options 21 and 25 Add \$1400 Option 32 combines Options 25 and 28 Add \$1300 Option 33 combines Options 21, 25 and 28 Add \$1800
Included Accessories — Graticule, Spectrum Analyzer 337-1159-00 (7000 Series), and 337-1439-01 (7603). Filter, light blue 378-0684-00.
L1 Plug-in Module (50 Ω) \$500 L2 Plug-in Module (75 Ω) \$500

L3 Plug-in Module $(1M\Omega, 50\Omega, 600\Omega)$. \$850 L3 Plug-in Module Option 01 $(1 M\Omega, 75\Omega, 600\Omega)$ No Charge †7603 Oscilloscope \$2050 †R7603 Oscilloscope (Rackmount) \$2350 Option 06 Internal S A Graticule +50 Option 08 Protective Front Cover (Cabinet Only)	
†7603 Oscilloscope \$2050 †R7603 Oscilloscope (Rackmount) \$2350 Option 06 Internal S A Graticule +50 Option 08 Protective Front Cover (Cabinet Only) Add \$100 †7704A Oscilloscope \$3325 †R7704 Oscilloscope \$4275 Option 06 Internal S A Graticule +50 †Suggested Mainframe. See 7000 Series pages for	L3 Plug-in Module (1M Ω , 50 Ω , 600 Ω) \$850
†7603 Oscilloscope \$2050 †R7603 Oscilloscope (Rackmount) \$2350 Option 06 Internal S A Graticule +50 Option 08 Protective Front Cover (Cabinet Only) Add \$100 †7704A Oscilloscope \$3325 †R7704 Oscilloscope \$4275 Option 06 Internal S A Graticule +50 †Suggested Mainframe. See 7000 Series pages for	L3 Plug-in Module Option 01 (1 M Ω , 75 Ω , 600 Ω)
Option 06 Internal S A Graticule	
Option 08 Protective Front Cover (Cabinet Only)	†R7603 Oscilloscope (Rackmount)\$2350
Only) Add \$100 †7704A Oscilloscope \$3325 †R7704 Oscilloscope \$4275 Option 06 Internal S A Graticule +50 †Suggested Mainframe. See 7000 Series pages for	Option 06 Internal S A Graticule+50
†7704A Oscilloscope	№ 2. (1) (2)
Option 06 Internal S A Graticule+50 †Suggested Mainframe. See 7000 Series pages for	
†Suggested Mainframe. See 7000 Series pages for	†R7704 Oscilloscope\$4275
†Suggested Mainframe. See 7000 Series pages for oscilloscope specifications and options.	Option 06 Internal S A Graticule+50
	†Suggested Mainframe. See 7000 Series pages for oscilloscope specifications and options.

OPTIONAL ACCESSORIES

Tracking Generator, one wide field modification kit, to
be attached to an existing 7L5 040-0810-00\$1025
2701 50 Ω Step Attenuator\$290

2703 75 Ω Step Attenuator\$330
75 Ω to 50 Ω Min Loss Attenuator (Ac Coupled) 011-0112-00
P6105 10X Probe, (2m) 010-6105-03\$70

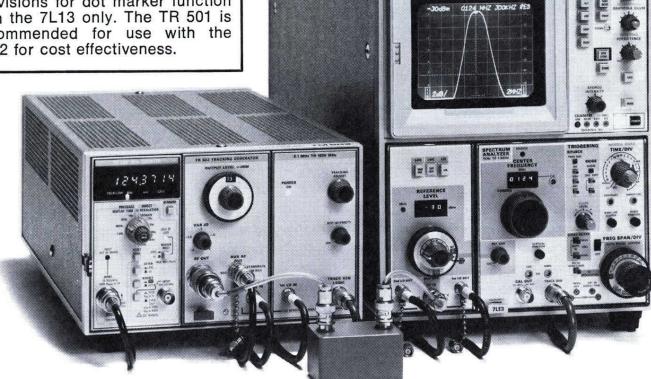
BALANCED INPUT TRANSFORMER
Frequency Range — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.
Flatness — 0.25 dB peak-to-peak maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.
Common Mode Rejection — 25 dB minimum (50 kHz to 3 MHz).

Connectors — WECO (0.37" with 0.090 center) on 0.625" spacing for balanced input. BNC for single-ended output.

Balanced Input Transformer 013-0182-00\$120

The TR 501 or TR 502 are capable of the same performance with either the 7L12 or 7L13 Spectrum Analyzer.

The TR 502 is recommended for use with the 7L13 because of the provisions for dot marker function with the 7L13 only. The TR 501 is recommended for use with the 7L12 for cost effectiveness.



For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DC 508 Option 07 Digital Counter, in TM 503 Option 07 Power Module, with a 7L13 Spectrum Analyzer in 7613 Option 06 Mainframe.

Wide Frequency Range — 100 kHz to 1.8 GHz

System Stability 10 Hz (TR 502 w/7L13) 200 Hz (TR 501 w/7L12)

Flatness — \pm 0.5 dB \pm 2.0 dB (TR 502/7L13) \pm 3.0 dB (TR 501/7L12)

Resolution 30 Hz (TR 502 w/7L13) 300 Hz (TR 501 w/7L12)

Plus — TR 502 Has Automatic Counter Dot Marker When Used with DC 508 Option 07 and 7L13

The TR 502 and TR 501 Tracking Generators work with either the 7L13 or 7L12 Spectrum Analyzers to provide constant level, calibrated rf sources for swept frequency tests to 1800 MHz.

When used as a cw source, with the analyzer in a zero span (nonswept) mode, the TR 502/ 7L13 system has 10 Hz stability. (The TR 501/7L12 system has 200 Hz stability.) This exceptional stability enhances the dynamic range capability of the analyzer/ tracking generator combination.

The Tracking Generator AUX RF OUTput may be used to drive a frequency counter. Frequencies up to 1800 MHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer. TR 502/7L13 sensitivity is -128 dBm at 30 Hz resolution bandwidth.

(TR 501/7L12 sensitivity is -115 dBm at 300 Hz resolution bandwidth.) When the TR 502 is used with the 1 GHz DC 508 Option 07 Frequency Counter the spectrum display center frequency, indicated by a bright dot, is automatically counted.

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.

The Tracking Generator is a two-wide unit compatible with the TM 500 Modular Instrument Series. When powered by a TM 503, there is room for a 1 GHz DC 508 or other counter.

CHARACTERISTICS

Apply to both TR 502/7L13 and TR 501/7L12 except where noted.

FREQUENCY CHARACTERISTICS

Range — 0.1 MHz to 1800 MHz.

Resolution Bandwidth - 30 Hz to 3 MHz (TR 502/7L13). 300 Hz to 3 MHz (TR 501/7L12).

Stability — 10 Hz p-p (TR 502/7L13). 200 Hz p-p (TR 501/7L12).

AMPLITUDE CHARACTERISTICS

Rf Output Amplitude - 0 dBm to -59 dBm in 10 and 1 dB steps plus 2 dB vernier (TR 502). 0 dBm to -11dBm in 1 dB steps plus 2 dB vernier (TR 501).

Auxiliary Output Level — 0.1 rms in 50 Ω .

Flatness — ± 0.5 dB (Tracking Generator only). ± 2.0 dB (TR 502/7L13). ± 3.0 dB (TR 501/7L12).

Spurious Output -

Harmonic: >20 dB below carrier. Nonharmonic: >40 dB below carrier.

Dynamic Range -> 110 dB (TR 502/7L13). > 100 dB (TR 501/7L12).

SWEEP CHARACTERISTICS

Frequency Span - 200 Hz/div to 180 MHz/div (TR 502/7L13). 500 Hz/div to 180 MHz/div (TR 501/7L12).

OUTPUT CONNECTORS

Rf Out — 50 Ω nominal impedance, vswr 2:1 or less. Aux Rf Out — For use with frequency counter.

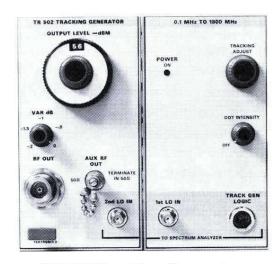
Included Accessories — Two 50 Ω coaxial cables 012-0649-00, logic interface cable (TR 502 only) 012-0648-00, adapter N male to BNC female 103-0045-00, retainer plug-in 343-0604-00 fixed 10 dB attenuator

with 3 mm fittings 307-0553-00 (TR 501 only).

ORDERING INFORMATION

TR 502 Tracking Generator\$4650
Suggested Complementary Items
TM 503 Option 07 Power Module\$195
DC 508 Option 07 Digital Counter\$1300
TR 501 Tracking Generator \$3900
Suggested Complementary Items
TM 503 Power Module\$170
DC 508 Digital Counter
or
Blank Panel 016-0195-01\$11
14 dB, 3 mm attenuator 015-1002-00
(used in the 2nd L.O. input line to improve TR 501/
7L12 isolation)\$120

Note: Existing 7L12 Spectrum Analyzers, if not already factory equipped for use with the TR 501, may be modified. Further information may be obtained from your local Tektronix office or representative.



TR 502 Tracking Generator.



TR 501 Tracking Generator.

TV Sideband Adapter



1405/7L12 Sideband Analyzer

Response of Transmitter under Test within $\pm 0.2~\mathrm{dB}$

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 is used with a Spectrum Analyzer, such as the 7L12 or 7L13. The 1405 generates a composite video signal, the "picture" portion of which is a constant-amplitude sinusoidal signal that sweeps 15-0-15 MHz. This signal is applied as modulation to a television transmitter; the output is then displayed on the spectrum analyzer, and appears as the response curve of the transmitter under test. The 1405/ spectrum analyzer combination will display the frequency response characteristics of rf and if circuits for transmitters with frequencies to 1 GHz. Video circuits (zero frequency offset) can also be analyzed.

Complete specifications and prices are available in the Television Products Catalog.

ORDERING INFORMATION 1405 TV Sideband Adapter (525/60 Markers)\$3050 Option 01 TV Sideband Adapter (625/50 Markers)Add \$100

OPTIONAL ACCESSORIES

Rackmount-conversion kit for mounting 1405 or 1405 Option 01 in std. 19 inch rack. 016-0489-00.....\$120



600 Ω Attenuator. 51 dB in 1 dB steps 011-0093-00\$190 2701, 2703 7K11, AM 511

Step Attenuators and Preamplifiers



The 2701 and 2703 Step Attenuators are laboratory quality, bench top instruments for attenuation of large value radio frequency signals. The 2701 50 Ω Attenuator is particularly useful in making receiver sensitivity and distortion measurements. The range of attenuation is 0 to 79 dB, selected in 1 dB steps with tens and units cam switches. A front-panel switch selects DC, AC, or DC TERM (a 50 Ω precision termination).

The 2703 75 Ω Step Attenuator is tailored for

television, CATV, telephone, and radio applications. A front-panel switch extends the range to 109 dB, making the attenuator an ideal accessory for wide-range measurements such as cross modulation, signal-to-noise and receiver sensitivity. A dc block has been incorporated for both rear-panel ports to protect the attenuator against accidental burnout from high dc offsets or ac power on center conductors.

The board assemblies and thick-film hybrid attenuation chips used in both instruments are mounted in a sturdy metal housing; solid top and bottom plates provide excellent mechanical and electrical stability. The two cam switches which select individual chips operate through gold-plated switch contacts. Held on a four-layer circuit board with spring clips, the chip substrates can be replaced easily in the field.

The attenuators may be used for frequencies up to 2 GHz, with slight degradation of the attenuation accuracy and vswr characteristics specified at 1 GHz.

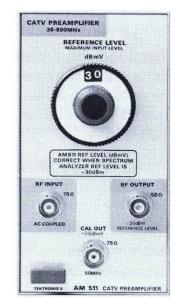
CHARACTERISTICS	2701	2703
Attenuation	0 to 79 dB in 1 dB steps	0 to 109 dB in dB steps (Including extra 30 dB range)
Impedance	50 ohms nominal	75 ohms nominal
Frequency	Dc to 1 GHz	3 kHz to 1 GHz*
Max Average Input Power	1.5 W to 65°C	1.5 W to 65°C
Signal Coupling	Dc, ac, and dc terminated at one port only	Ac only both PORTS*
Size	7½ in lg x 4½ in w x 2½ in h	7½ in lg x 4½ in w x 2½ in h
Connector	Type BNC Female 50 ohm	Type BNC Female 75 ohm

^{*}Blocking capacitors may be removed for specialized applications.

ORDERING INFORMATION

2701 50 Ω Step Attenuator......\$290 2703 75 Ω Step Attenuator.....\$330





7K11

AM 511

These plug-in preamplifiers are designed for Spectrum Analyzer applications where extra sensitivity is required. The 7K11 is a 7000-Series Plug-in while the AM 511 fits into the TM 500 Modular Series power supplies.

The amplifiers are tailored to the CATV and field intensity measurement markets providing a 75 Ω input impedance and calibration in dBmV. The low noise figure makes the preamplifiers well-suited for signal-to-noise and low-level radiation measurements.

CHARACTERISTICS

(with 7L12 and 7L13)

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 greater than 5 dB.

Intermodulation Distortion (with 7L12 or 7L13) — 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.

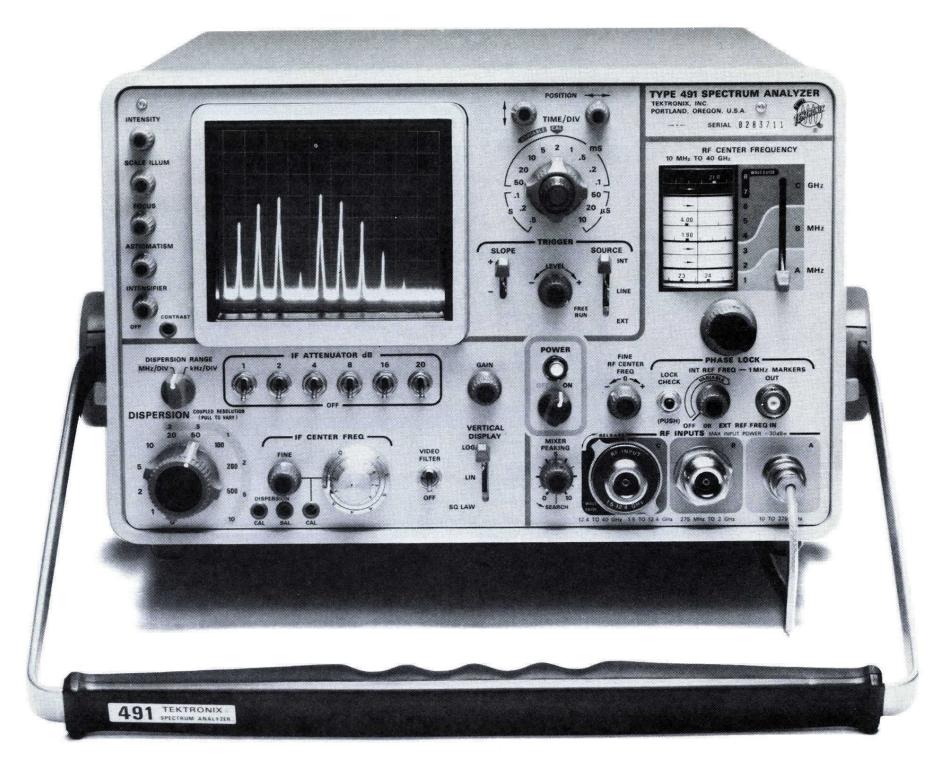
Input Impedance — 75 Ω .

Calibrator — 50 MHz $\pm 0.01\%$ with an absolute amplitude level of + 30 dBmV ± 0.3 dB, from 75 $\Omega.$

Accessories — BNC to BNC 50 Ω Cable, 5½ inch: 012-0057-01; BNC to F Adapter: 013-0126-00; BNC to BNC 75 Ω Cable, 42 inch: 012-0074-00.

ORDERING INFORMATION

7K11 CATV Preamplifier		\$625
AM 511 CATV Preamplifier		\$625
TM 501 Power Module for AM 51	1.	\$135



10 MHz to 40 GHz with 491 10 MHz to 2 GHz with 491 Option 01 1.5 GHz to 40 GHz with 491 Option 02

The 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is easy to carry, weighing less than 40 pounds complete with accessories. The R491 is electrically identical and requires only 7 inches of rack height.

FREQUENCY CHARACTERISTICS

Range

10 MHz to 40 GHz
Option 01
10 MHz to 2 GHz
Option 02
1.5 GHz to 40 GHz

Resolution — 1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

Frequency Stability — ±200 kHz after 1 minute.

Incidental Fm — Less than 300 Hz at fundamental, with Phase Lock.

AMPLITUDE CHARACTERISTICS

Display Flatness — Max amplitude variation over 100 MHz dispersions up to 12.4 GHz is 3 dB or less, except over 50 MHz dispersion in Band 1. Above 12.4 GHz the max amplitude variation (100 MHz dispersion) is 6 dB or less.

Max Input Power — -30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

Vertical Display (8 Div) — Log — \geq 40 dB dynamic range. Linear. Square Law — \geq 13 dB dynamic range.

If Attenuator — 51 dB in 1 dB steps, ±0.1 dB/dB.

If Gain Control — > 50 dB range.

Sensitivity — Greater than — 100 dBm to 8.2 GHz Greater than — 90 dBm to 18 GHz Greater than — 70 dBm to 40 GHz

INPUT CHARACTERISTICS

50 Ω Input

SWEEP CHARACTERISTICS

Sweep Range — The 491 uses a complete triggered oscilloscope type time base with 15 calibrated steps from 10 μ s/div to 0.5 s/div.

Calibrated Dispersion — 1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div and MHz/div).

CRT AND DISPLAY FEATURES

 $Crt - 8 \times 10$ div display area (each div = 0.8 cm); P7 phosphor.

ENVIRONMENTAL CAPABILITIES

The 491 meets MIL-I-6181D specs for EMI, operates up to 15,000 ft with temperatures from $-15^{\circ}\mathrm{C}$ to $+55^{\circ}\mathrm{C}$ and can stand a 30 g shock.

Weight — Rackmount 41 lb 18.6 kg
Portable 30 lb 13.6 kg

O. DERING INFORMATION

Additional specifications are available through your local Tektronix Field Office.

50 or 75 Ω Input

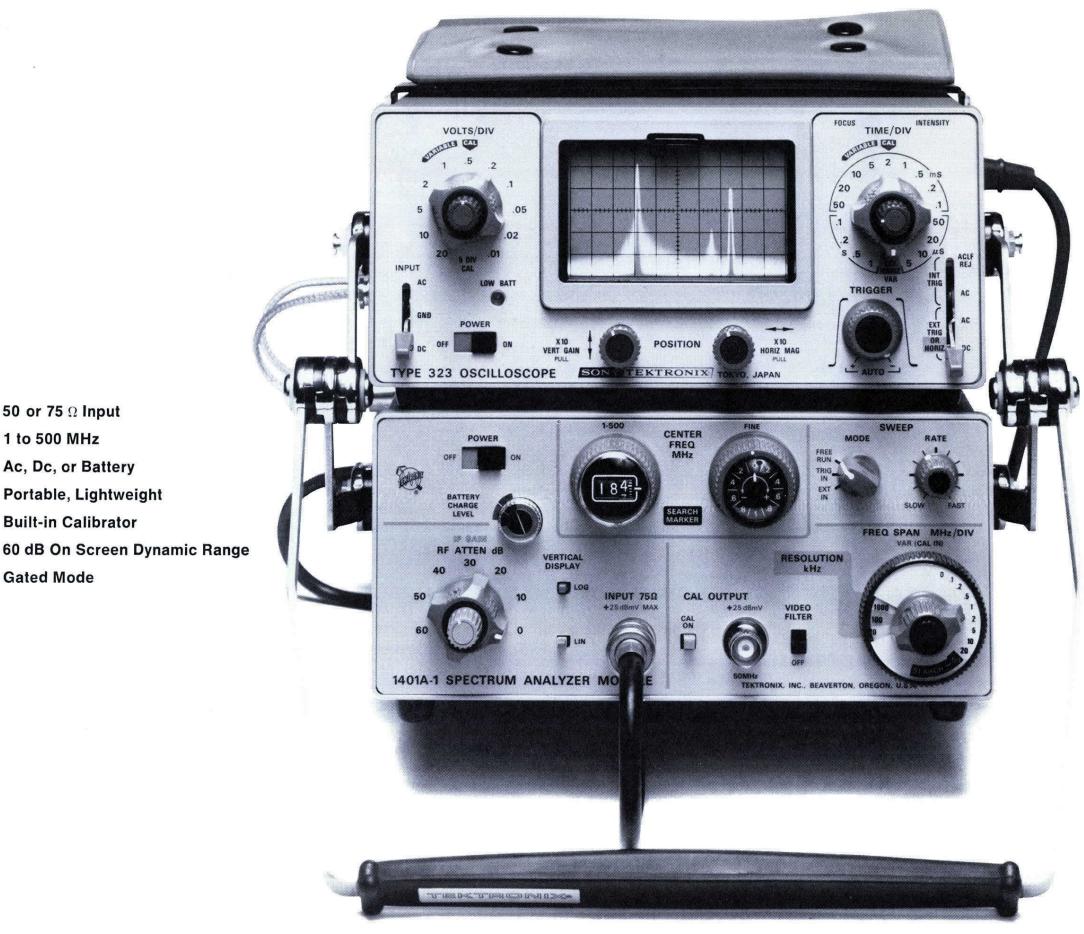
Ac, Dc, or Battery

Built-in Calibrator

Portable, Lightweight

1 to 500 MHz

Gated Mode



1401A-1/323 Spectrum Analyzer System

The 1401A and 1401A-1 Spectrum Analyzer Modules are used with the SONY/TEK-TRONIX battery-operated scope for measurements in the 1 to 500 MHz frequency range.

Because of its battery operation, the 1401A is popular with persons engaged in remote site studies, field maintenance, and applications where power is not convenient. The unit may be used for surveillance measurements by law enforcement officials and for displays and measurements important to radio, TV, and CATV operators, medical personnel, aircraft equipment personnel, shop owners, and others. In addition, the 1401A Module may be connected to any inexpensive scope to form an economical 500 MHz analyzer.

FREQUENCY CHARACTERISTICS

Range — Continuously selectable with 10-turn digital frequency readout control, 1 to 500 MHz. Absolute accuracy within ± 5 MHz (+5% of dial reading). Fine control provides a calibrated variation of up to ± 1 MHz, within 10%.

Resolution - 10, 100, 1000 kHz Gaussian-shaped

Frequency Stability - Within 100 kHz over any 5 minute interval after 25 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient $= 0.5 \text{ MHz/}^{\circ}\text{C}$ or less.

Incidental Fm - 20 kHz or less.

AMPLITUDE CHARACTERISTICS

Rf Attenuator - 0 to 60 dB in 10 dB steps (accurate within $+0.2 \, dB + 1\%$ of dB reading).

If Gain Control — At least 30 dB range.

Vertical Display - Linear and log.

Cw Sensitivity	1401A	1401A-1
10 kHz Resolution	$\geq -95~\mathrm{dBm}$	$\geq -$ 40 dBmV
100 kHz Resolution	$\geq -85~\mathrm{dBm}$	$\geq -$ 30 dBmV
1000 kHz Resolution	$\geq -78~\mathrm{dBm}$	$\geq -$ 23 dBmV

Display Flatness — Measured with respect to the level at 50 MHz, ±0.75 dB to 200 MHz and within +0 dB to -3 dB from 200 MHz to 500 MHz.

Intermodulation Distortion - 1401A at least 55 dB down with two signals at -30 dBm (+25 dBmV 1401A-1), 1 MHz apart; 60 dB down with signals at -40 dBm (+15 dBmV 1401A-1).

Dynamic Range — At least 60 dB in log mode at 10 dB/div.

INPUT CHARACTERISTICS

Impedance — 1401A 50 Ω nominally. 1401A-1 75 Ω nominally.

SWEEP CHARACTERISTICS

Sweep Rate — Continuously variable from one sweep per second or less to at least 100 sweeps per second.

Frequency Span (Dispersion) — 50 MHz/div to 100 kHz/div in 9 steps (1-2-5 sequence), accurate within 10% over a 10 div display, plus 0-Hz span. Frequency span can be continuously varied (uncalibrated) from any calibrated value toward zero.

OTHER CHARACTERISTICS

Calibrator — -30 dBm 1401A. +25 dBmV 1401A-1. Accuracy 0.3 dB at 25°C

Power Source - 6 size C NiCd cells for 31/2 hours of operation. External dc source: operates from an external dc source of 6 V to 16 V, requires 4.8 W. External ac source: operates from an external ac source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 14 W max 115 V ac.

Weight - 1401A or 1401A-1 and 323 Oscilloscope 15 lb 6.8 kg.

ORDERING INFORMATION

1401A Included Accessories — 8 ft power cable assembly (161-0043-02); panel cover (200-0812-00); blue filter (378-0670-01); amber filter (378-0670-02); three $5\frac{1}{2}$ inch, 50 Ω BNC to BNC cable assemblies (012-0113-00); screwdriver (003-0672-00); strap assembly (346-0051-00).

1401A-1 Included Accessories - Same as for 1401A except: two BNC to F adapters (013-0126-00). Delete 6 ft. 50 Ω cable; add 6 ft 75 Ω BNC to BNC cable assembly (012-0113-01).

1401A-1\$3600

1401A/323 (P7 Phosphor) Included Accessories - Includes accessories for both the 1401A, 323, and a two-instrument handle conversion kit (040-0563-00).

1401A/323P7, Order 1401A-3.....\$4945 1401A-1/323P7, Order 1401A-1-3 \$5045

OPTIONAL ACCESSORIES

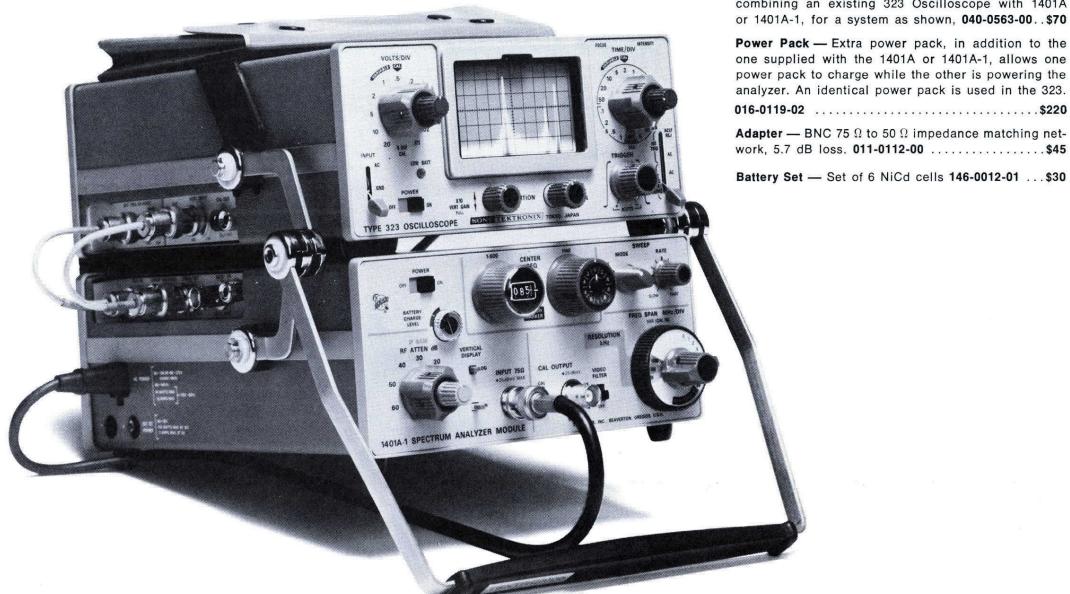
Protective Cover — Waterproof blue vinyl, 016-0112-00\$15

Handle Conversion Kit (for Two Instruments) - For combining an existing 323 Oscilloscope with 1401A or 1401A-1, for a system as shown, 040-0563-00..\$70

one supplied with the 1401A or 1401A-1, allows one power pack to charge while the other is powering the analyzer. An identical power pack is used in the 323. 016-0119-02\$220

Adapter — BNC 75 Ω to 50 Ω impedance matching net-

Battery Set — Set of 6 NiCd cells 146-0012-01 ...\$30



1401 A-1/323 Spectrum Analyzer System

20 Hz to 100 kHz

Selectable Impedance

Calibrated Appropriate to Impedance
Selected

Single-Ended Input

Differential (Balanced) Input

On Screen Dynamic Range 80 dB (Full 8 div)

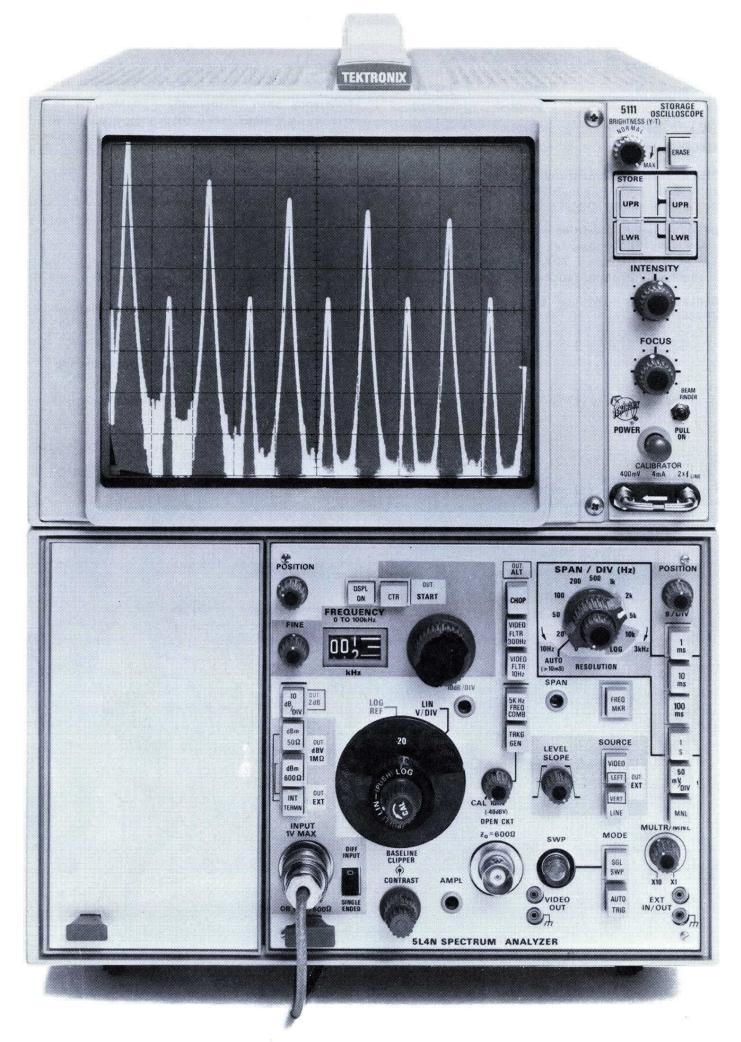
Intermod >70 dB Down

Resolution Bandwidth 10 Hz to 3 kHz

Auto Resolution

Built-in Tracking Generator

20 Hz to 20 kHz Log Sweep*



*100 Hz to 100 kHz also available.

5L4N Spectrum Analyzer with 016-0195-00 Blank Plug-in Panel in a 5111 Storage Oscilloscope.

The 5L4N is a 20 Hz to 100-kHz spectrum analyzer that offers both high performance and economy. The analyzer features selectable input impedances. 80 dB of dynamic range, and a built-in tracking generator.

This analyzer is especially suited for noise and distortion studies in the audio range and comes equipped for 20 Hz to 20 kHz log sweeps.

Many educators prefer this economical analyzer to teach frequency-related theory and demonstrate practical application in the areas of speech, sound, music, vibration, audio, broadcasting, and many others.

The 5L4N can be used with any 5000-Series Oscilloscope Mainframe. Only two compartments are occupied by the analyzer so that, with the addition of a vertical plug-in, basic oscilloscope functions may be obtained. We recommend the use of a 5111 Storage Oscilloscope for maximum utilization of the analyzer.

FREQUENCY CHARACTERISTICS

Range — 20 Hz to 100 kHz. Accuracy ± 3 kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Resolution Bandwidth — The resolution bandwidth is continuously variable from 3 kHz to 10 Hz. An AUTO mode provides the best resolution for the frequency scan and sweep rate selected. Signal level change over the resolution bandwidth range is 2 dB or less. Line frequency modulation of 50 Hz or more can be resolved up to 70 dB below the signal level. In the log sweep mode the resolution bandwidth changes with frequency giving an effect similar to octave bandwidth sweeps.

Stability — Within 30 Hz over a 10 min period, at a fixed ambient temperature.

Incidental Fm — 2 Hz (p-p) or less.

AMPLITUDE CHARACTERISTICS

Reference Level Range -

Log 10 dB/div:

from -10 dBm/dBV to -70 dBm/dBV, within 0.4 dB/ 10 dB to max of 1 dB at -70 dBm/dBV.

Log 2 dB/div

from -10 dBm/dBV to -130 dBm/dBV within 0.4 dB/ 10 dB to max of 1 dB at -70 dBm/dBV and 2 dB at -130 dBm/dBV.

Linear:

from 50 mV/div to 20 nV/div within 5% decade.

Cw Sensitivity (Signal Level + Noise = 2X Noise) — The following characteristics are applicable with the input internally terminated, or with a 600 Ω or less source impedance.

Resolution Bandwidth

Display Mode	3 kHz	10 Hz	
dBV	—123 dBV	—147 dBV	
dBm 50 Ω	-110 dBm	-134 dBm	
dBm 600 Ω	-121 dBm	—145 dBm	
LINEAR	680 nV	45 nV	

Flatness (20 Hz-100 kHz) — Flatness remains within ± 0.2 dB, over any selected frequency span, with respect to the level of -40 dBV signal at 5 kHz. Intermodulation Distortion — with two signals, within any frequency span, that are less than or equal to the reference level:

-10 dBm/dBV $\geq 70 \text{ dB down}$ < -20 dBm/dBV $\geq 75 \text{ dB down}$

Internal Spurious Signals — Equal to or less than —130 dBm/dBV referred to the input. Line related spurii less than —120dBm/dBV.

Dynamic Range - 80 dB (8 div).

INPUT CHARACTERISTICS

Selectable Impedance — 1 M Ω /47 pF or 600 Ω or 50 Ω (single-ended or differential).

Differential Input Characteristics — Full screen limit is approx 300 mV to 400 mV. Common-mode rejection ratio is 70 dB or more.

Single Ended Input Characteristics — Max single input for linear operation: $-10 \, \mathrm{dBm/dBV}$ or 0.316 V rms.

SWEEP CHARACTERISTICS

Linear Frequency Span — 20 Hz/div to 10 kHz/div, 1-2-5 sequence. 4% accuracy.

Log Frequency Span — 100 Hz to 100 kHz internally reprogrammable from 20 Hz to 20 kHz.

Zero Frequency Span — Analyzer operates as a fixed tuned receiver for time-domain displays.

Internal Sweep Sources — Time base 1 s/div to 1 ms/div (increased up to X10 with multiplier).

Triggering — Internal at least 0.1 div, External at least 250 mV. Slope and level selection are provided. Auto Trigger provides a sweep baseline when a trigger signal is absent. Single sweep provided.

Manual Sweep --- Provided.

External Sweep — Requires 0 V to 500 mV \pm 50 mV; from a 1 k Ω or less source to sweep the full span.

OUTPUT CONNECTIONS

Tracking Generator — 600 Ω source. Calibrated output level is —40 dBV ± 0.2 dB (10 mV) open circuit, or —46 dBV when terminated into 600 Ω . Output level can be varied from approximately 0.001 V to 0.1 V open circuit.

5 kHz Freq Comb — 600 Ω source of 5 kHz $\pm 0.005\%$ markers for span calibration.

Video Out — Provides 250 mV $\pm 5\%$ of video signal per display div (0 V to 2 V). Source impedance is about 1.0 k Ω .

Ext In/Out — Provides 500 mV ± 25 mV, per div of span, from 0 to 5 V, when using internal or manual sweep.

INCLUDED ACCESSORIES

013-0156-00 Adapter, Floating BNC to Dual BNC. 175-1178-00 BNC to Pin Jack Adapter Cable. 331-0429-00 Log Graticule (20 Hz-20 kHz).

ORDERING INFORMATION

5L4N Spectrum Analyzer \$2850
We recommend that the Plug-in 5L4N be ordered with a storage mainframe.
5111 Storage Oscilloscope (Cabinet)
R5111 Storage Oscilloscope (Rackmount)
OPTIONAL PLUG-INS FOR TIME DOMAIN USE 5A15N Single Trace Amplifier\$190

OPTIONAL ACCESSORIES
010-0160-00 10X Probe P6006 (6 ft.)\$50
016-0195-00 Blank Plug-in Panel\$7.50
2701 Step Attenuator (50 Ω)\$290
011-0093-00 Step Attenuator (600 Ω)\$190

5B10N Time Base Amplifier\$290

Spectrum Analyzer Accessories

Pads and Adapters 75 Ω to 50 Ω Minimum Loss Attenuator with dc block, 5.7 dB loss 011-0112-00\$45 75 Ω to 50 Ω Minimum Loss Attenuator with 11.25 dB conversion factor from dBm to dBmV 011-0118-00\$55 Fixed 10 dB attenuator with 3 mm fittings for use with TR 501/TR 502 with 7L12 307-0553-00\$25 Dc Block BNC to BNC max dc potential 50 volts 015-0221-00\$70 "F" Female to BNC Male Adapter 013-0126-00....\$10 BNC Female to "F" Male 103-0158-00\$8.50 Calibrator Jumper 50 Ω BNC to BNC 51/2 in 012-0214-00\$26 Jumper Cable BNC to BNC 50 Ω , 42 in 012-0057-01\$15 Jumper Cable BNC to BNC 75 Ω , 42 in 012-0074-00\$15 "N" Female to BNC Male 103-0058-00\$6.75



Protective Vinyl Covers

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe or instruments.

7000-Series 3 Hole Mainframe Cover 016-0192-01\$12
7000-Series 4 Hole Mainframe Cover
016-0531-00\$12
5000-Series Mainframe Cover 016-0544-00 \$12
491 Analyzer Cover 016-0074-01\$16
1401A-323 Protective Cover 016-0112-00\$15

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 Main-
frames:
Blue, 040-0835-00\$75
Gray, 040-0628-00\$75
491 Spectrum Analyzer — cover supplied, no charge with instrument.

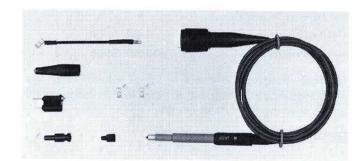
1401A and 3	23 Analyzer Combination (2 required)	
200-0812-00	22 1 1 1 2 2 1 1 1 2 2 2 1 1 1 2 2 2 2	\$8

Graticules, Filters

Graticules, Filters
Plastic Implosion Shield and S A Graticule 7613 and
7623 Mainframes 378-0625-07\$4
Plastic Implosion Shield and S A Graticule 7403 and
7603 Mainframes 337-1439-01\$3
Plastic Implesion Shield and C. A. Cresianta

Plastic Implosion Shield and S A Graticule
All other 7000-Series Mainframes 337-1159-02...\$3.50
(Internal graticules are available with most 7000-Series Mainframes)

EMI Metal Screen Mesh Filter for 7500-, 7700-Series instruments 378-0603-00
EMI Metal Screen Mesh Filter for 7400-Series instruments 378-0696-00
Audio 20-20 kHz Log Graticule for 5000-Series instruments — 331-0429-00\$2.50
IRIG Log Graticule for 7L5 331-0421-00\$1
Complete selection of colored filters is available in the accessories section.



Probes

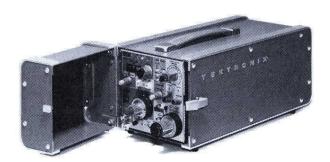
A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L12, 7L13, and 1401A Spectrum Analyzers:

, and the openium rulary zero.
FET Probe P6201 to 900 MHz 010-6201-01\$700
FET Probe P6202 to 500 MHz 010-6202-01\$390
Conventional Probe P6056 Dc to 3.5 GHz 6 ft. 010-6056-03
Conventional Probe P6057 Dc to 1.4 GHz with Adapter 010-6057-03\$110
Current Probe P6022 to 150 MHz 015-0135-00\$225
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- and 7000-Series instruments are:

Polaroid Film Back C-59P\$730
Polaroid Film Back C-5B\$285
Complete specifications on all cameras are available
in the cameras, probes, and accessories section.



Carrying Cases and Mounts

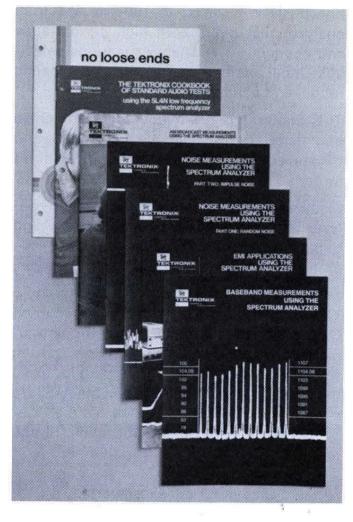
Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L12 or 7L13 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

3-wide Carrying Case for 7L13, 7L5 Option 25, etc.
016-0626-00\$175 2-wide Carrying Case for 7L12, 7L5, etc.
016-0625-00\$175
Luggage-type Carrying Case for 7603 Opt 08, 7613 Opt 08 016-0628-00 (Analyzer must have
016-0637-00 Securing Kit)\$250

Your local field 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, EMI, am, fm, and television measurements, cable television proof of performance, 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 Field Office or Representative.



Option 08 protective front cover is shown on 7613 Mainframe.

SPS – the Digital Alternative for your Measurement Needs

Signal Processing Systems presents a line of waveform digitizing instruments specifically designed to be used as acquisition components in your test and measurement systems.

Digitizers presently available are the **new** 7912AD Programmable Transient Digitizer, the **updated** DPO Digitizing Oscilloscope and the still viable R7912 Transient Digitizer.

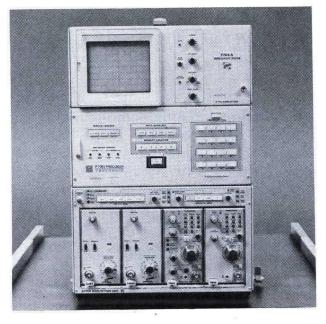
These waveform digitizers each use Tektronix unique 7000 Series packaging system and are fully compatible with 7000-Series Plug-ins, including amplifiers, time bases and spectrum analyzers. In addition, SPS introduces two new **programmable** plug-ins, 7A16P Programmable Amplifier Plug-in and 7B90P Programmable Time Base Plug-in which at present can be used only in the 7912AD.

The SPS waveform digitizers form the basis for the WP series of waveform processing systems presented on the following page.



The 7912AD Programmable Waveform Digitizer

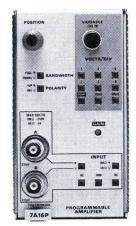
A fully programmable waveform acquisition and digitizing instrument based on the proven scan conversion technique. This model is useful for, recording fast transients (up to 350 ps rise time with direct access plug-in), providing automatic or remote signal aquisition capability (fully programmable to 200 MHz) and for various other high speed waveform digitizing tasks. The instrument uses the ubiquitous GPIB for control and signal interfacing with a variety of instrumentation controllers.

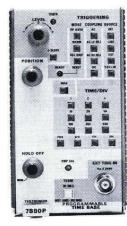


The DPO Digitizing Oscilloscope

The DPO is the combination of a 7704A Oscilloscope and a P7001 Digitizer with a local memory (4 channels) making it the most versatile digitizing oscilloscope available. It is compatible with most 7000-Series Plug-ins including amplifiers to 175 MHz, samplers to 14 GHz, and a wide range of time base and spectrum analyzer plug-ins.

It offers a variety of controller interfaces including the GPIB (IEEE 488). Program control of the A/D section offers significant capabilities for automatic test equipment.





The 7A16P Programmable Amplifier Plug-In

A 225 MHz fully programmable amplifier for use in the 7912AD programmable digitizer. Calibrated sensitivities range from 10mV/div to 5V/div. The input impedance is switchable between 50Ω and $1M\Omega$, and input coupling may be ac, do or ground for reference all under program control if required. NOTE: THIS AMPLIFIER WILL NOT FUNCTION IN NON-PROGRAMMABLE 7000-SERIES MAINFRAMES.

The 7B90P Programmable Time Base Plug-In

A programmable time base for use with the 7912AD programmable waveform digitizer. Calibrated sweep rates may be selected in a 1-2-5 sequence from 500ps/div to 500 ms/div. NOTE: THIS TIME BASE WILL NOT FUNCTION IN NON-PROGRAMMABLE 7000-SERIES MAIN-FRAMES.

In addition to its line of waveform digitizers, TEKTRONIX SPS offers a variety of instrumentation controllers and the powerful waveform processing software, TEK SPS BASIC!

Controllers

CP4165 — A test and measurement controller designed for use with waveform processing systems and compatible with TEK SPS BASIC, a powerful, high-level instrument control and signal processing software. Can be interfaced with either Q bus or GPIB.

4051 — A powerful desktop programmable calculator with complete instrument control capability and graphics, using the GPIB and BASIC software.

The line of waveform digitizers is also compatible with various other instrumentation controllers using the GPIB or other interfaces, including the Digital Equipment Corp PDP 11 series of mini-computers.

TEK SPS BASIC—See following page.

WP Systems

WP Systems

A WP system is a waveform processing system using either a DPO, 7912AD, or an R7912 waveform digitizers. Various interfaces, controllers and software options are available. The following is a list of standard WP systems available.

WP1020—DPO controller compatible system.

WP1110—DPO calculator based system.

WP1200—DPO controller based system.

WP2010—R7912 viewing system.

WP2020—R7912 controller compatible system.

WP2200—R7912 controller based system.

WP2050—7912AD controller compatible system.

WP2250—7912AD controller based system.



Non-destructive testing of ductile iron components.

The WP1100AC system using a DPO and a programmable calculator makes possible the production line testing of many key automotive components.

Fusion Research

The 7912 Series of transient digitizers have been used extensively to characterize events in pulsed laser fusion energy research.

Avionics ATE

The DPO key is a component in avionics test systems where simplicity and repeatability of a test are at a premium.

Laboratory Research

SPS instruments have found applications in the laboratory for time of flight mass spectrometry, nuclear magnetic resonance, fluorescence decay, power supply design and transfer function analysis.

List Of Application Notes

A library of Application Notes is maintained to disseminate technical information about the use of SPS instrumentation. This library



contains notes on specific techniques used in operating SPS instrumentation as well as descriptions of market oriented instrument applications. A sample of notes presently

DPO Program Library Techniques (DPO Note 45F1.0)

Mechanical Measurements Using the DPO (DPO Note 45A1.1)

R7912 Transient Digitizer...a Solution to Pulsed **Laser Measurement Problems** (WDI Note 47N1.0)

Pulsed Laser Measurements Using the R7912 Transient Digitizer (WDI Note 47N1.1)

Real-Time Metals Analysis Using the DPO (DPO Note 45N1.1)

Windowing to Control FFT Leakage (SPS Note 47L1.0)

"Measuring Transistor Switching Times with the DPO" (DPO App Note 45K1.1)

"TDR Difference Testing with TEK Signal Processing Systems"

(App Note 4711.1)

"Automatic Swept RF Measurements" (DPO App Note 45K2.5)

available includes:

SPS Specialist

If you wish further information concerning WP Systems contact the SPS Specialist in these Tektronix Field Offices:

Woodland Hills, CA (213) 999-1171 Santa Clara, CA (408) 249-5500 Norcross, GA (404) 449-4770 Albuquerque, NM (505) 265-5541 Dayton, Ohio (513) 859-3681 Rockville, MD (301) 948-7151

Springfield, NJ (201) 379-1670 Chicago, IL (312) 259-7580 Boston, MA (617) 861-6800 or Beaverton, OR SPS Marketing (503) 645-6464 Ext. 1163

TEK SPS BASIC Software

A new generation of software for signal processing and instrument control systems. Primary features include array and waveform operations, character string processing, program text editing, and file manipulations. The software is interactive, allowing minimally experienced users to quickly develop programs, and is modular, allowing the user to select only those features necessary for a particular application, thus preserving the maximum amount of controller memory for program data.

Functions of TEK SPS BASIC provide for determination of mean, minimum, maximum, and rms values, and also contain single word commands for integrate, differentiate, and cross (the point at which array values cross a level). Fast Fourier Transform and its inverse are included as single word commands. The sytem also allows the user to write transfer function algorithms for describing the response characteristics of a system, and includes capabilities for averaging and correlation as well as auto correlation.

Semiconductor Device Test Systems 14



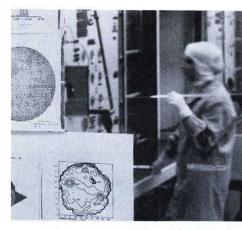


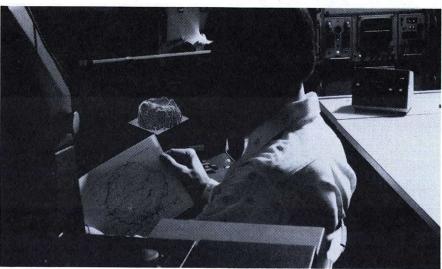




S-3260 Series

Respected around the world as the comprehensive LSI testing solution











Today the TEKTRONIX S-3260 Automated IC Test System is respected around the world as the comprehensive LSI-IC testing solution. The S-3260 also enjoys the reputation as the comprehensive testing solution for digital and digital/analog hybrids. When LSI devices graduate from the lab, they are characterized with an S-3260; when samples are received by device users, they are evaluated with an S-3260. When an LSI device first goes into production, production testing is often performed with an S-3260, just as device users will often use an S-3260 for receiving inspection.

Over the last several years the electronics industry has seen an explosion in IC technology. Throughout this explosion, the S-3260's architecture has allowed the system to pace IC developments. That is why S-3260 configurations have always offered testing capability a step ahead of the testing requirements.

The S-3260 is perhaps the most versatile automated IC test system available today. One of the guiding concepts behind the design of the S-3260 was to design a test and measurement package that could be configured to perform all test and measurements required by the customer. However, the S-3260 is more than a test system. It is also a data processing system—a totally integrated package that both acquires and processes test and measurement data. In such a system, software is perhaps more important than the hardware.

The S-3260's Operating System was written to specifically answer device testing problems. Besides a full set of test program writing, editing, and debugging utilities, the operating system allows data logging, data reduction, and test program development to occur without interrupting the testing. TEKTEST III™, the S-3260's programming language, is a procedure oriented, English-like language that facilitates quick interaction between the test engineer and the system.

For the whole story please use the reply card inside the back cover and request more information on the TEK-TRONIX S-3260; or, for faster action, call your local Tektronix Field Office and ask for the Sales Engineer specializing in automatic IC test systems.

Linear device testing via waveform digitizing is what the S-3000 Series is all about. The waveform digitizing capability in the S-3000 Series can be used to dynamically test such complex linears as audio, IF, and RF devices. Waveform parameters measured include frequency, period, pulse width, rise time, amplitude, and distortion. With a computer and WAFORM™ Software, a Fast Fourier Transform may be used to calculate the bandpass of a device from its impulse response. If THD is important, WAFORM™ Software can calculate Total Harmonic Distortion.

The S-3000 Series includes the S-3003 Waveform Digitizer and the S-3030 Automated Test System. The S-3003 is a complete measurement block that interfaces to your computer. It is also available separately for integration into your custom-built system. The S-3030 is a complete automated test system for linear devices, hybrids, modules, and circuit boards.





S-3003

The S-3003 Waveform Digitizer consists of a 568 Readout Oscilloscope, 3S6 and 3T6 Plug-in Units, and a 1340 Data Coupler. The 1340 also includes interface circuit cards for the 568 Oscilloscope, the Waveform Digitizer, and accommodates the interface to your computer. (See page 200).

Signals to be digitized are acquired by the 568 using the appropriate sampling heads with the 3S6. Then, the Waveform Digitizer processes the 568's 10-division displayed waveform into a series of 1000 10-bit words. One word is generated for each displayed dot on the 568. These completed words are sent to the computer where the binary image of the waveform can now be processed and measurements made through WA-FORMTM Software.

WAFORM I[™] Software runs on both DEC and HP minicomputers. When used with a DEC PDP 11, WAFORM I[™] runs under DEC DOS with FORTRAN; when interfaced to an HP2100, WAFORM I[™] Software runs under HP DOSM with FORTRAN.

S-3030

The TEKTRONIX S-3030 Automated Test System is particularly well suited for dynamic testing of audio, IF, and RF devices. Built using the S-3003 measurement block, the S-3030 is configured using TEKTRONIX 1140A Programmable Power Supplies (see page 200); 1840D Test Fixture; CP 1162 Controller (PDP 11/35 minicomputer); a selection of programmable DVM's, Pulse Generators, Counters, and Function Generators; and TEKTRONIX Graphic Computer Display Terminals.

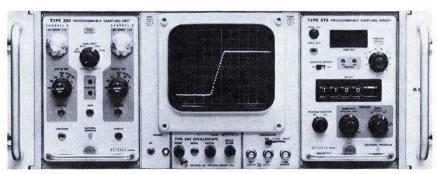
Typically an S-3030 configuration uses a CP1162 Controller and CP110 (RK05 DEC Pack Disk). For software, the S-3030 uses the TEKTEST II™ Software Operating System, WAFORM II™ Software, and FFT and THD programs.

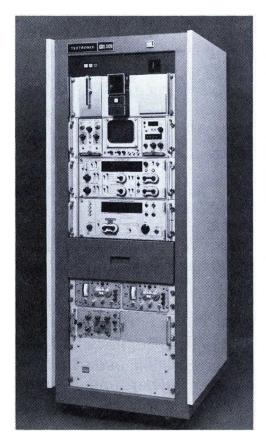
TEKTEST II™ is a procedures oriented, English-like programming language that facilitates quick interaction between the test engineer and the system. Besides a full set of test program writing, editing, and debugging utilities, the operating system allows data logging, data reduction, and test program development to occur without interrupting the testing. TEKTEST II™ also facilitates the writing of custom software for complex waveform analysis.

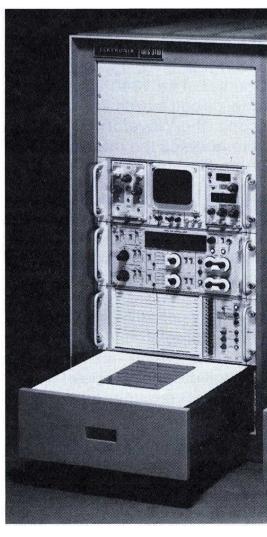
For the whole story please use the reply card inside the back cover and request more information on the TEKTRONIX S-3030; or for faster action, call your local Tektronix Field Office and ask for the Sales Engineer specializing in automatic IC test systems.

S-3100 Series









The distinctive feature of the TEK-TRONIX S-3100 Series is automatic high speed time measurements such as rise time, propagation delay, time to voltage level, etc. High speed time measurements have become very important now that we are seeing device switching times in the 2 ns to 10 ns area — even some as fast as 800 ps. The S-3100 Series meets the challenge by using sampling techniques that can measure events as fast as 25 ps with 1 ps resolution.

Like the S-3000 Series, S-3100 configurations are based around the 568 Readout Oscilloscope, which may include either a 3T5 or 3T6 Plug-in Unit and a 3S5 or 3S6 Plug-in Unit, plus appropriate sampling heads.

The key to the S-3100's measurement capability is sampling. The concept behind sampling is illustrated in Figure 1.

A repetitive signal, such as the input pulse to a logic gate, is sampled — one sample per pulse. Each sample is taken slightly later in time than the previous sample. The time interval between samples is set by the sweep rate and the number of samples per crt division. As the sample is taken, the amplitude of the signal is measured and recorded in sample-and-hold memory. The resulting display is a series of dots on the 568's crt where the vertical position of each dot represents the amplitude of the signal at that instant in time (an equivalent time display).

The unit that allows time measurements to be made automatically is the 230 Digital Unit. The Digital Unit can be programmed to start and stop counting samples based on programmable start and stop points known as preset zones. As an example, to make a rise time measurement the Digital Unit automatically finds the zero and 100% points on the leading edge of the acquired pulse and then starts counting samples at the first preset zone (10%) and stops counting at the second preset zone (90%). The 230 then multiplies the number of samples counted times the time interval between samples. The result is displayed on the Digital Unit's front panel. This measurement value is also available to a programmable calculator or minicomputer via the 1340 Data Coupler which links the 230 to the systems controller.

The S-3100 Series is a collection of "building block" components which may be configured to form a standalone automatic measurement instrument, a measurement sub-system, or a complete automatic test system. There are four S-3100 configurations to choose from.

S-3101

The S-3101 is a stand-alone automatic measurement instrument that automatically calculates and displays time measurements. Easy to read digital readout frees the operator from potentially difficult analog display interpretation. The configuration consists of a 568 Readout Oscilloscope, a 3S5 or 3S6 Plug-in Unit, a 3T5 or 3T6 Plug-in Unit, appropriate Sampling Heads, and a 230 Digital Unit.

S-3105

The S-3105 is a measurement sub-system designed to perform as the measurement block in a custom built automated test system. Besides the components found in a S-3101, the S-3105 includes a 1340 Data Coupler. Since the Data Coupler provides a variety of interfaces, the S-3105 may be programmed by a variety of controllers. The Data Coupler may also eliminate the need to develop special interfaces for coupling other programmable instrumentation to the system.

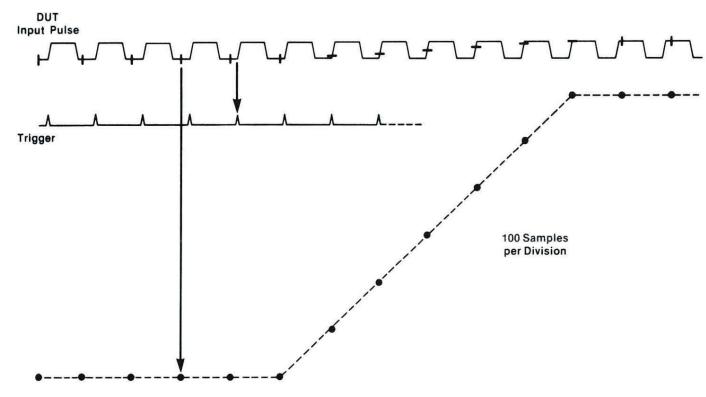
S-3110

The S-3110 is a diode programmed automatic test system. Besides the components found in the S-3101, the S-3110 includes a 241 Programmer, 1840 Fixture Drawer, Dual Probe Choppers and a cabinet. The 241 (see page 200) will sequence up to 15 measurements in less than 150 ms. Each measurement is programmed by inserting diodes into one of the cards in the 241 and a special tool is provided to make the diodes easy to insert and remove.

S-3120

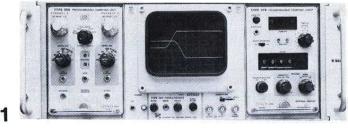
The S-3120 is an automatic test system programmed by the 240 Program Control Unit (see page 200). Besides the components found in an S-3101, the S-3120 includes a 240 Program Control Unit, Disc Memory, Paper Tape Reader/Punch, Dual Probe Choppers, and a cabinet with fixture drawer. Stimulus instruments may also be added and programmed by the 240. The S-3120 can randomly access from 1600 individual tests at rates up to 100 tests per second.



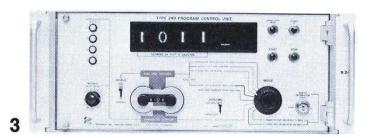


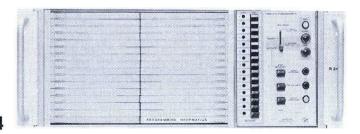
For the whole story please use the reply card inside the back cover and request more information on the S-3100 Series; or for faster action, call your local Tektronix Field Office and ask for the Sales Engineer specializing in automatic IC test systems.

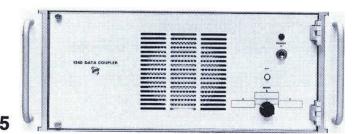
S-3000/S-3100 Components



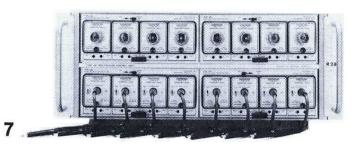
















Both S-3100 and S-3000 systems are assembled with "building block" components. The following is a brief description of each component and the interfaces between components. For complete descriptions and specifications contact the Tektronix Sales Engineer specializing in automatic IC test systems.

- 1. The R568 Readout Oscilloscope performs the signal acquisition function in S-3100 and S-3000 Series systems. In S-3100 systems the R568 is interfaced to the R230 Digital Unit. In an S-3000 Series system the R568 is interfaced to a R1340 Data Coupler.
- **8. The 3S5 and 3S6** are plug-in, dual trace, sampling units for the R568 Readout Oscilloscope. These units allow the R568 to be programmed for deflection factor (2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence), dc offset (range + 1V to -1V programmable between +995 mV and -995 mV in 5 mV steps), and smoothing. A variety of sampling heads are available for the 3S5 and 3S6 to meet various measurement requirements.

Sam- pling Head	Rise Time	Input	Minimum Deflection Factor	Dis- played Noise		
S-1	350 ps	50 Ω, GR874	2 mV/div	≤2 mV		
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV		
S-3A	350 ps	100 Ω, 2.3 pF	2 mV/div	≤3 mV		
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV		
S-5	1 ns	1 MΩ, 15 pF	2 mV/div	≤500 μV		
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV		

See descriptions on pages 78, 79.

External programming of 3S5 is accomplished by either a front or rear panel connector. Signal inputs are on the front. The 3S6 has both its program and signal inputs on the rear.

- 9. The 3T5 and 3T6 are programmable time base units for the R568. These units may be controlled manually using front panel controls. Real-time sampling is from 1 ms/div to 500 ms/div. Equivalent-time sampling is from 1 μ s/div to 100 ps/div. Sampling rate is 100 samples/div.
- 2. The R230 Digital Unit performs time and voltage measurements on signals acquired by the R568 in S-3100 Series systems. The R230 may be programmed by the R240 Program Control Unit, a R241 Programmer, or (with a R1340 Data Coupler) the unit may be programmed by a computer or programmable calculator. The R230 also has manual front panel controls. Measurement data displayed on the R230 front panel is transmitted to the controller or data coupler via data output connectors.

- 5. The R1340 Data Coupler is a multipurpose interface unit for S-3100 and S-3000 Series systems. The R1340 can accommodate up to 12 interface cards and 18 interconnecting cables. A common TTL bus within the R1340 allows data and control information to flow between the interfaced controller and test system instruments. A wide variety of controller and instrument interfaces are available.
- 4. The R241 Programmer uses diode programming to sequence the programmable functions of the R568 and R230. Also included are 14 lines to program other equipment. Each program card controls one measurement. A special tool is provided to make insertion and removal of diodes quick and easy. Up to 15 programmed measurements may be selected manually, sequenced manually, or sequenced automatically under external program control.
- 3. The R240 Program Control Unit controls the programmable functions on the R568 and R230. Using disc memory the R240 can randomly access up to 1600 independent tests. Test programs may be originated manually with front panel controls or written externally and then loaded into the R240 and data disc with a punched paper tape reader. The R240 can execute measurements at rates in excess of 100 measurements per second and random access of the tests allows program branching for sorting, classifying, and diagnostic routines.
- 6. The 1140A Programmable Power Supply provides stimulus voltage and current in S-3000 Series systems. The supply provides one current and four voltage outputs, each independently programmable. The 1140A is programmed via an interface card in the R1340 Data Coupler.
- 7. Sampling Head Multiplexers allow signals from as many as 64 test points to be measured by the two-input 3S5 or 3S6 plugin. Signals sensed by each sampling head are electronically switched (multiplexed) into the sampling plug-in, two signals at a time. The 286 is the basic unit of a sampling head multiplexer system and can operate four sampling heads. The R287 controls up to four 286's, allowing 16 heads to be multiplexed. The R288 controls up to four R287's multiplexing up to 64 sampling heads.

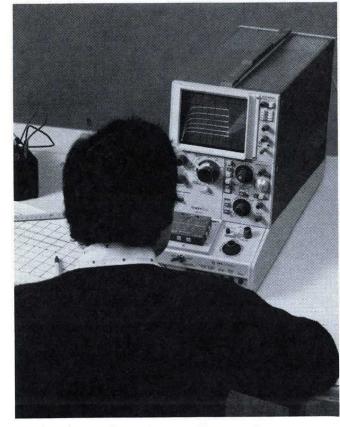
TEKTRONIX CURVE TRACERS

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.

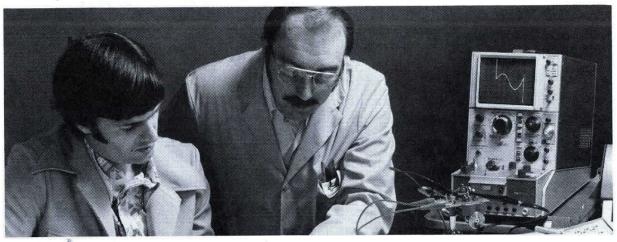
These versatile measurement tools give you more than pinpointed parameters. A curve tracer can show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

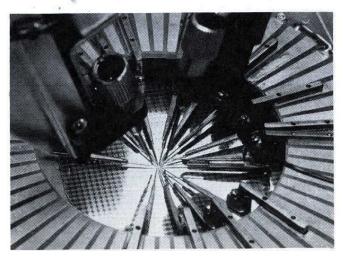
If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions (p 202-212) helpful in choosing the system that best meets your requirements. If you would like to receive a brochure, application notes, and other materials to learn more about Curve Tracers and their measurement capabilities, please use the reply card on the inside back cover; or, for faster action, contact a Tektronix Field Engineer at the Field Office nearest you.

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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 (described on p 204), and the 176 Pulsed High-Current Fixture (described on p 205). The 576 is an excellent general-purpose curve tracer system that performs well in applications where high current testing is required.

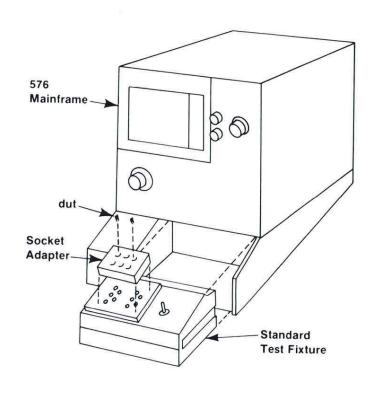
With the Standard Test Fixture, the collector supply of the 576 delivers up to 220 watts peak to the dut. The step generators can deliver up to 2 A in both its current and voltage modes of operation. Of course, with the 176, the 576 is capable of pulsed collector operation up to 200 amps peak.



One of the features that sets the 576 apart from the 577 is the display area READ-OUT. Adjacent to the 576's crt are alphanumeric indicators of vertical and horizontal deflection factor, step amplitude, and Beta/div or gm/div. The Beta or gm readout saves the operator from the arithmetic usually necessary to arrive at these parameters. The READ-OUT also provides 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 are: adjustable current limiting in the step generator, either 300 μs or 80 μs pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and illuminated graticule.



CHARACTERISTICS COLLECTOR SUPPLY

Modes — NORM: positive or negative full wave rectified ac (line frequency); dc: positive or negative dc; 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 is from 0.3 Ω to 6.5 M Ω 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/step (with X0.1 MULT) to 200 mA/step, 1-2-5 sequence. Max 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. Max 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. Max 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. Max voltage (steps and aiding offset) is X20 AMPLITUDE switch setting, 40 V max. Max 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 \pm 100%, \pm 0%; 2 A \pm 50%, \pm 0%. Max opposing offset voltage; X10 AMPLITUDE switch setting. Max opposing current; limited at 5 mA to 20 mA.

Accuracy — Incremental; within 5% between steps, within 10% with X0.1 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 — Approx 80 μ s or 300 μ s width, at NORM or X0.5 rates.

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 1 and 10.

DEFLECTION CONTROLS

Display Accuracies — As percentage of highest on-

		M/ with (FSET and AGNIFIE CENTER LUE from	D
NORM and DC MODES	NOR- MAL	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%
LEAKAGE MODE Vert Emitter Current/div:				
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:				
<u>≥</u> 1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/ vert div	NOT	APPLIC	ABLE
200, 20, or 2 nA	3% plus 50 mV/ vert div			
500, 50, or 5 nA	3% plus 125 mV/ vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

Vertical Deflection Factor — Collector current is 1 μ A/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μ A/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 μΑ	1 μΑ	2 μΑ	5 μΑ		
Vertical—Emitter	1 nA	1 nA	2 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

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 — 6½ 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 g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT.

STANDARD TEST FIXTURE

Description — A plug-in fixture with two sets of 5-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 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KEL-VIN contacts.

OTHER CHARACTERISTICS

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. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of $+10^{\circ}$ C to $+40^{\circ}$ C.

Dimensions and Weights		
	in	cm
Height	15.0	38.1
Width	11.5	29.2
Depth	23.0	58.4
	lb	kg
Net Weight	70.5	32.0
Shipping Weight	≈107	≈48.5

INCLUDED ACCESSORIES

Transistor adapter (013-0098-02), FET adapter (013-0099-02). TO3 adapter (013-0100-01), TO66 adapter (013-0101-00), axial lead diode adapter (013-0111-00), stud diode adapter (013-0110-00), Kelvin sensors for large and small plastic transistors (013-0138-01), and protective cover (337-1194-00).

ORDERING INFORMATION

576 Curve Tracer with Standard

Test Fixture	
The 576 Option 01 deletes the parameter readout module but maintains provisions for insertion of the module $\#$ (020-0031-00) at any time.	
Order Option 01Sub \$500	
Auto Scale-Factor Readout Module Order 020-0031-00\$765	

OPTIONAL ACCESSORIES

 Order 070-0970-01
 \$6.50

 172 Test Fixture
 See page 204

 176 Test Fixture
 See page 205

 Socket Adapters
 See page 210

Programmable Test Fixture for the 576

The 172 Programmable Test Fixture, when used with the TEK-TRONIX 576 Curve Tracer, permits the operator to program a sequence of tests of J FET's, transistors, and diodes.

The 172 can greatly reduce total test time in applications where 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 for the operator to set the test sequence at a rate which is best for him. A new operator requires more time per test, but with experience he 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 — Test 1 and 2 (Collector or Emitter Current): 1c, 1 μA to 2 A/div in 20 steps. Test 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): $1\mu A$ to 0.5 A/div in 18 steps. Test 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1, 2, 5 sequence.

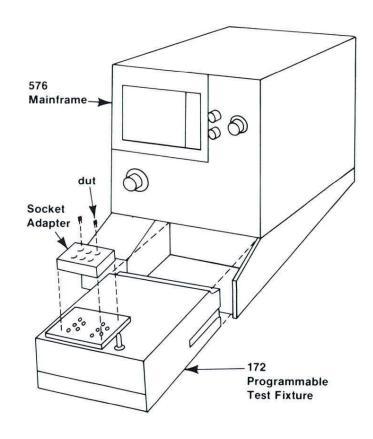
Horizontal Deflection Factor — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/ div to 2 V/div in 5 steps. Input Z for test 2, at least 100 MHz at 100 mV/div and 200 mV/div. 1 $M\Omega$ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Test 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.



	S THAT C		PROGRAMMABLE					
Test	Xstr	J FETs	Diodes	CAPABILITIES				
1*	HFE, VCE ^(sat)	V P	VF	PEAK CURRENT up to 10 A PEAK VOLTS up to 350 V.				
2	VBE			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).				
3	HFE, VCE(sat)	Ipss, Rps(on)		Base Drive: 100 nA to 110 mA. When testing J FET's 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 _{CER} exte	or Ices, with ernal sho esistor		Voltage Supply: 1 V to 500 V dc. Leakage current measure-ments to 0.5 mA. The most sensitive deflection factor is nA/div.				
6	ICBO	less		Same as #5.				
7	I _{EBO}		IR	Same as #5.				
8	V(BR)CEO C V(BR)CER W external r	ith	VF	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(BR)CES			Same as #8.				
10	V(BR)CBO	BVGSS		Same as #8.				
11	V(BR)EBO		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 for 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 tests the only 576 controls that are functional are the Polarity and crt controls such as INTENSITY, FOCUS, DISPLAY OFFSET.



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 μA 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 μA (from 0.1 μ A to 11 μ A), 1 μ A (from 10 μ A to 110 μ A), 10 μA (from 100 μA to 1.1 mA), 100 μA (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.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of $+10^{\circ}\mathrm{C}$ to +40°C.

Dimensions and Weights

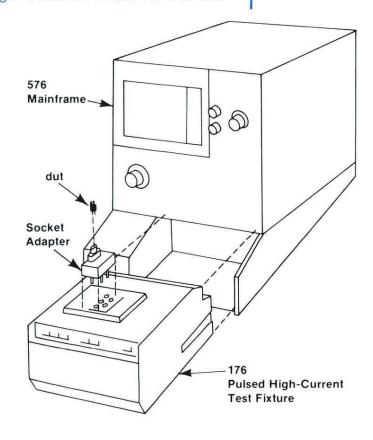
	in	cm
Height w/cover	6.5	16.5
Width	7.8	19.8
Depth	12.4	31.5
	lb	kg
Net weight	11.5	5.2
Shipping weight	≈18.0	≈8.2

Included Accessories - One protective cover, five programming cards, 250 programming card pins, five crt overlay limit cards.

ORDERING INFORMATION 172 Programmable Test Fixture\$2350

OPTIONAL ACCESSORIES
Programming Cards — Package of 25 programming cards without pins or limit cards. Order 016-0198-01
Crt Limit Cards — Package of 25 limit cards without programming cards or pins. Order 016-0510-01\$30
Programming Pins — Package of 1000 programming pins without programming or limit cards. Order 016-0519-01
Foot Switch — For manually sequencing the programmed test. Order 260-1189-01\$27
Programming Accessories Package — Includes one programming card, one crt limit card, and 50 programming card pins. Order 016-0518-00
Program Set-up Charts — Package of 250. Order 062-1615-00





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. The step offset, when selected, 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 over dissipation. 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 depressing the 300 μ s or 80 μ s pushbutton on the 576 mainframe (usually, 300 μs should be selected). The rep rate is automatically set when the 176 is inserted in the mainframe. Rep rate is also dependent on power-line frequency. The five highest VERTICAL CUR-RENT/DIV (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 μ s or 80 μ 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.

Max Peak Watts — Three illuminated pushbuttons select 10, 100, 1000 W max 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. Max Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Max 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 μ s or 80 μ 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.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over a temperature range of 0°C to +40°C.

Dimensions and Weights

	in	cm
Height	4.6	11.7
Width	7.9	20.1
Depth	11.4	29.0
	lb	kg
Net weight	12.8	5.8
Shipping weight	18.0	8.2

Included Accessories — TO36 adapter (013-0112-00); stud diode adapter (013-0110-00); protective shield (337-1194-00).

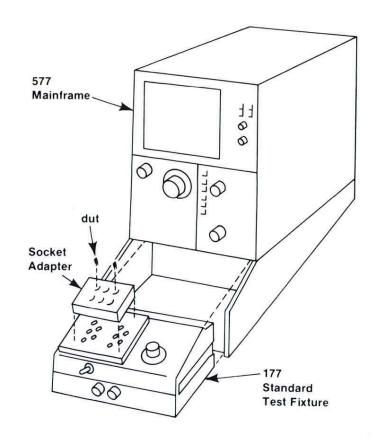
ORDERING INFORMATION

Order 1	7	6	1	Pı	ul	S	е	d	1	Н	i	gl	h.	-(Ci	ul	rr	е	n	t			
Fixture									770 * 21						:::: <u>:</u> :::					•			. \$2600

Curve Tracers

General-Purpose System with Storage Display Available





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 storage and the emphasis on low current measurements.



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 IC's such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see page 208).

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 A 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 max 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 M Ω . Coupling of series resistance and voltage controls maintains max peak power to the device-under-test when changing voltage ranges.

Safety Interlock — Protects operator from 100-, 400-, and 1600-volt 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 1X (SLOW), 2X (NORM), or 4X (FAST) line frequency.

Pulsed Steps — Steps can be gated for a duration of approx 300 μ s 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. Max 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 approx 95 steps when using STEP X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies — As a percentage of highest onscreen 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 6½ 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.

177 TEST FIXTURE

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 volts.

Left-Right Switch — Selects left or right test connections. Off in center position. Test connection area accepts all TEKTRONIX Curve Tracer adapters and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation — Reduces display loops due to test adapter capacitance and some device capacitance.

Variable Voltage Supply — Continuously variable bias supply from -12 V to +12 V. Source resistance is 10 k Ω or less.

OTHER CHARACTERISTICS

Power Requirements — 100, 110, 120 V ac or 200, 220, 240 V ac all within $\pm 10\%$. 50 to 60 Hz, 155 W max at 110 V ac and 60 Hz.

Ambient Temperature — Performance characteristics are valid over an ambient temperature of $+10^{\circ}\text{C}$ to $+40^{\circ}\text{C}$.

Dimensions and Weights

	577/D1 or 577/D2		1	77
	in	cm	in	cm
Height	19.8	50.3	4.0	10.2
Width	8.8	22.4	7.9	20.1
Depth	23.0	58.4	6.0	15.2
114610 M2V	Ib	kg	Ib	kg
Net Weight	40	18.1	2.5	1.1
Shipping Weight	50	22.7	6	2.7

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic \simeq 53 lb or \simeq 24 kg.

INCLUDED ACCESSORIES

Transistor adapter for most bipolar-transistors and some MOS FET's (013-0098-02), axial lead diode adapter with Kelvin sensing terminals (013-0111-00), protective shield for test connection area (337-1194-00).

ORDERING INFORMATION

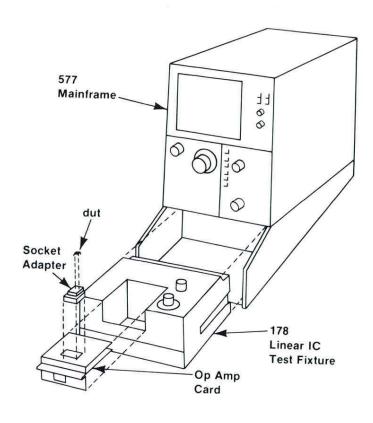
577D1 Storage Curve Tracer
Mainframe\$3150
577D2 Nonstorage Curve Tracer
Mainframe\$2700
Option 10, 10 x 10 cm Graticule; available with either storage or nonstorage mainframeAdd \$45
177 Standard Test Fixture\$600

storage or nonstorage mainframe
177 Standard Test Fixture \$600
OPTIONAL ACCESSORIES
178 Linear Test Fixture; see following page for complete description\$1595
Camera — C-5B, see pg 234 for complete description\$300
Cart — Tek Lab Cart, Model 3 (see pg 256) Order Model 3\$325
Test Set-up Chart — package of 250 Order 070-1639-00\$7.50
Device Adapter Sockets: see pages 210 and 211 for

Device Adapter Sockets: see pages 210 and 211 for complete description.

Tests Single, Dual, or Quad:
Operational Amplifiers
Comparators
Differential Amplifiers
Regulators
and More





Since linear IC's 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 accurate low current measurement capability, test cards set up the measurement function, and the 577's storage crt allows the operator to transform



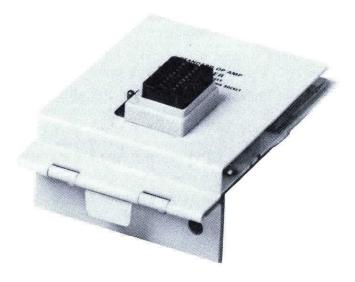
the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the crt while in the Storage Mode.

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 adapter (see page 210 & 211) 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

There are three types of op amp cards: the Standard Op Amp Card, Hardwire Card, and the Multiple Op Amp Card.



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 section of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

Socket Adapters for Op Amp Cards — The device-under-test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adapters using the Amphenol-Barnes adapter system. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on page 211.



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 Adapters for Regulator Cards—Socket adapters for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adapters used on the standard curve tracer (see next page).

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CHARACTERISTICS

NORMAL	MAGNIFIED	
10 μV/div	1 μV/div	
to 50 mV/div	to 5 mV/div	
3%	4%	
50 pA/div	5 pA/div	
to 0.2 mA/div	to 20 μA/div	
3% ±50 pA	4% ±50 pA	
0.1 μA/div	10 nA/div	
to 50 mA/div	to 5 mA/div	
3% ±0.1 μA	4% ±0.1 μA	
1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div 4% ±1 nA	
	10 μV/div to 50 mV/div 3% 50 pA/div to 0.2 mA/div 3% ±50 pA 0.1 μA/div to 50 mA/div 3% ±0.1 μA	

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 2% ±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 — Four input resistor pairs selectable, 50 Ω , 10 k Ω , 20 k Ω , and 50 k Ω , 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 Ω greater.

Load Resistance — Six selectable load resistors, 100 Ω , 1 k Ω , 2 k Ω , 5 k Ω , 10 k Ω , 20 k Ω , and 50 k Ω , 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 Δ 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 $\pm 2\%$ ± 200 mV of dial setting, and 0-60 V is within $\pm 2.5\%$ ± 300 mV of dial setting.

REGULATION — Within 200 mV.

INPUT SWEPT FREQUENCY — Dc to 1 kHz. 300 μ 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	300 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.

OTHER CHARACTERISTICS

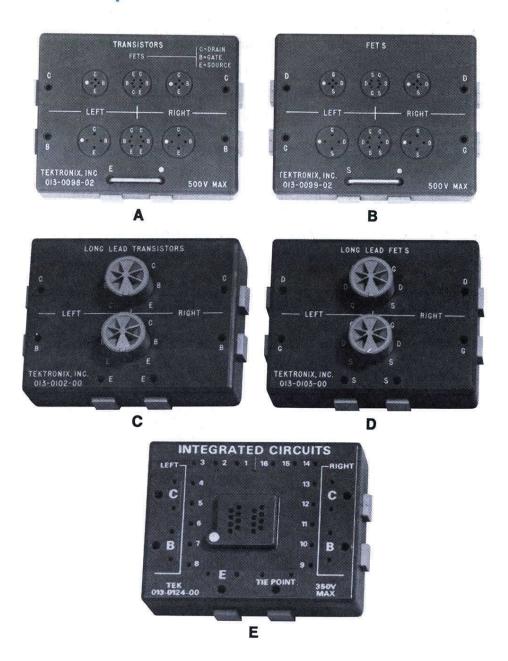
Dimensions and Weights

	in	cm
Height	4.5	11.4
Width	7.9	20.1
Depth	7.8	19.8
	lb	kg
Net Weight	3.3	1.5
Shipping Weight	8	3.6

Included Accessories — Dual-in-line 16 pin IC socket (136-0442-00). Standard Op Amp Card with cover and ten patch cords (013-0149-01), interchangeable nomenclature panel for function switch (333-1770-00).

ORDERING INFORMATION

Socket Adapters





The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

B. FET Adapter — Useful for most single and dual FET's.

Order (013-0099-02)\$80

C. Long Lead Transistor Adapter — Accepts dual or single transistors with untrimmed leads.

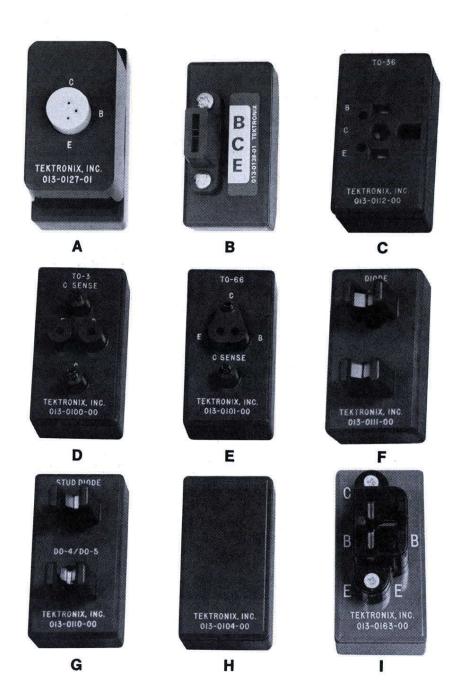
Order (013-0102-00)\$65

D. Long Lead FET Adapter — Accepts dual or single FET's with untrimmed leads.

Order (013-0103-00)\$65

E. Integrated Circuit Adapter — Allows connection to multipin device packages. The appropriate multilead socket is plugged into the integrated circuits adapter. 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 (013-0124-01) Includes 8 each 4-inch test leads \$125



KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

A. Transistor Adapter — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.

Order (013-0127-01)\$40

B. In-Line Adapter — Accepts large and small transistors with inline leads. The adapter will accept devices with approx spacing between terminals of 0.06 inchs up to 0.18 inchs. 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)\$42

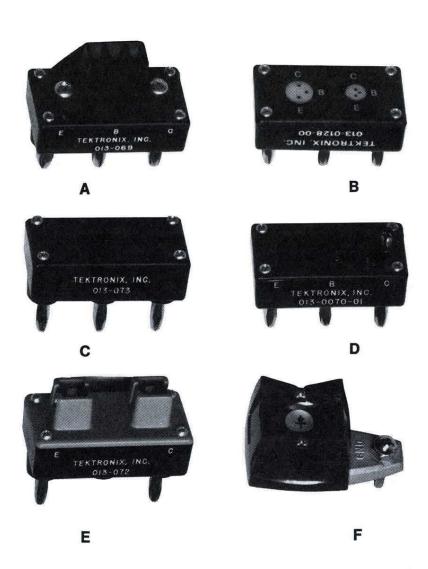
C. TO36 Adapter — Order (013-0112-00)\$35

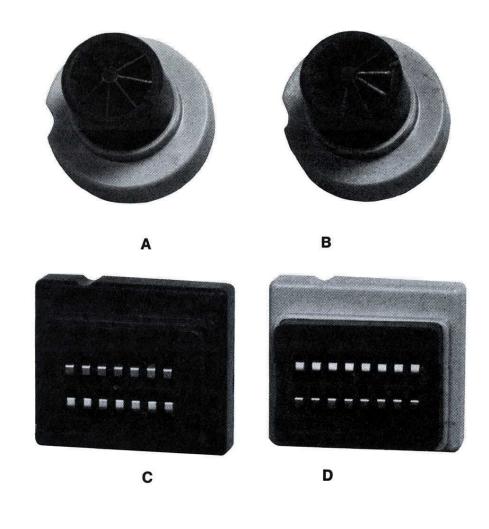
D. TO3 Adapter — Can be rewired to accommodate nonstandard configurations.

H. Blank Adapter — For mounting special sockets.

Order (013-0104-00)\$18

Socket Adapters





3 PIN ADAPTERS

The following accessories may be used with any of the TEK-TRONIX Curve Tracer products. They do not have Kelvin sensing contacts.

A. Long Lead Transistor Adapter — Order (013-0069-00)\$15						
B. TO5 or TO18 Transistor Adapter — Order (013-0128-00) \$17.50						
C. Blank Adapter — For mounting special sockets. Order (013-0073-00)						
D. TO3 or TO66 Transistor Adapter — Order (013-0070-01)\$18						
E. Diode Test Adapter — Holds axial-lead diodes. Order (013-0072-00)						
F. Diode Test Adapter — Magnetically holds steel axial-lead diodes.						
Order (013-0079-00)\$85						

MULTILEAD SOCKETS

These sockets are used with the Integrated Circuits Adapter (013-0124-01) listed under Dual Width Adapters, and with the 178 Test Fixture.

A. 8 lead TO package — Order (136-0444-00)	
B. 10 lead TO Package — Order (136-044-00) \$25	
C. 14 lead dual-in-line package — Order (136-0443-00) \$17	
D. 16 lead dual-in-line package — Order (136-0442-00) \$21	

(These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Amphenol Sales Division, 2875 South 25th Avenue, Broadview, Illinois 60153, OR from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.)

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

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

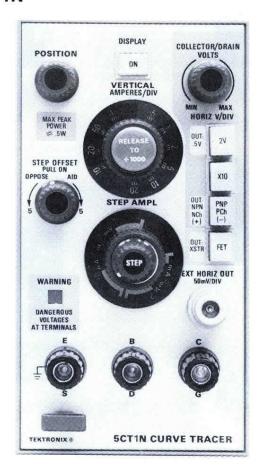
	X	1	X10		
Horizontal Volts/Div	0.5	2	5	20	
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V	
Maximum Current	240 mA	60 mA	24 mA	6 mA	

Max Open Circuit Voltage — Within ±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.

5CT1N



7CT1N



STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μ A/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 Ω \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 μ A/div with the \div 1000 control activated. 10 μ A/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ± 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 Plugins) 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 Plugins) 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.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid from 0°C to +50°C.

	5C	Γ1N	7CT1N		
Dimensions	in	cm	in	cm	
Length	12.0	30.5	14.5	36.8	
Width	2.6	6.6	2.8	7.1	
Height	5.0	12.7	5.0	12.7	
Weight	lb	kg	lb	kg	
Net	1.8	0.8	2.5	1.1	
Shipping	4	1.8	6	2.7	

Included Accessories — Test Adapter (013-0128-00) with two sets of test terminals, one with TO5 basing and the other with TO18 basing.

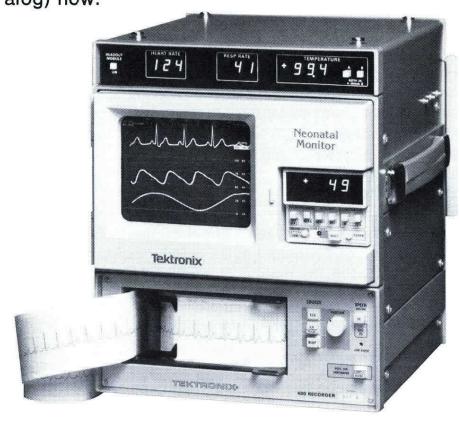
Order 5CT1N	Curve	Tracer	•	•	٠	٠	٠	•	٠	٠	. \$510	
Order 7CT1N	Curve	Tracer									. \$825	

For optional accessories see 3 pin adapters on page

Patient Monitors

Tektronix physiological monitors provide the medical professional with a full range of vital signs monitoring in one compact package. From simple ECG to pulse, respiration, temperature (including temperature from two body areas) and pressure, with systolic/diastolic or mean blood pressure (our 414 Option 21 even displays dual pressure) readout — the TEKTRONIX Monitors offer exceptional capabilities. Our 401 Series digital readout modules provide additional LED readouts and 400 Series recorders deliver hard copies (both trace and alphanumerics) for a permanent record. Units are line or battery powered, easy-to-operate and completely self-contained.

As an additional feature, the TEKTRONIX Patient Monitor can be serviced by trained professionals at more than 30 U.S. service centers. Find out how Tektronix can provide a better solution to your monitoring needs. Simply check the appropriate box on the attached reply card (in the back of this catalog) now.



413 Neonatal Monitor—

(Shown above with 400 Series Recorder and 401 Series Digital Readout Module). Simultaneously displays ECG, respiration, and blood pressure or pulse waveform. A digital readout shows heart rate, respiration rate, systolic/diastolic pressures, mean blood pressure, two temperatures, or temperature difference. Ac or battery operation.

413 Option 20 Neonatal Monitor-

Identical to the standard 413 Neonatal Monitor, except it provides neither blood pressure waveform, nor pressure related digital readouts. Ac or battery operation.

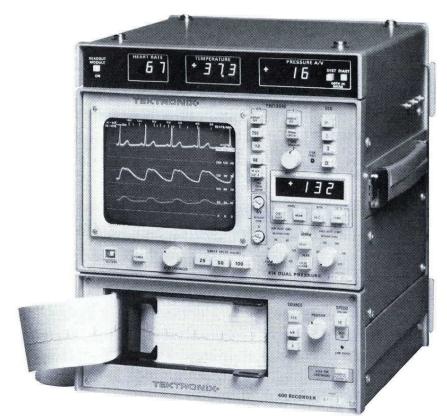
413 Option 22 Patient Monitor-

Provides same features as the standard 413, except designed for adult measurement. Ac or battery operation.

Tektronix Offers Varied Service Agreements and Leasing Plans.

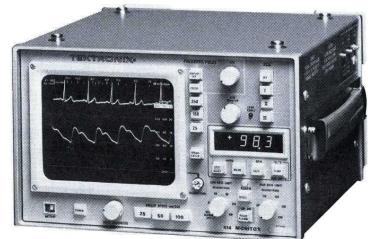
- Service Agreements covering TEKTRONIX Portable Patient Monitors vary in duration and cost according to service and use requirements.
- The basic Tektronix lease agreement covers periods of one to three years in six month increments and offers low cost renewal for one year periods. An option to purchase plan is also available.

For complete information, see your local Tektronix representative.



414 Option 21 Patient Monitor—

(Shown above with 400 Series Recorder and 401 Series Digital Readout Module)—This three-trace instrument offers simultaneous crt display of ECG and two blood pressure waveforms. First pressure channel is Arterial/Venous with three pressure ranges; second channel is Arterial dedicated to 250 mm Hg. Digital readout displays systolic/diastolic and mean blood pressures from either pressure channel, heart rate, and temperature. Ac or battery operation. Options include full lead select.

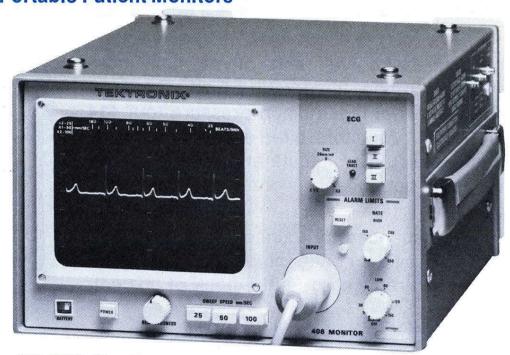


414 Patient Monitor—

This dual trace instrument displays ECG and blood pressure or peripheral pulse, and provides a digital readout of heart rate, systolic/diastolic pressures, mean blood pressure, or temperature. The standard monitor features three-lead selection plus pressure and heart rate alarm limits, selectable sweep speeds, and ac or internal battery operation. Options include full-lead selection and dual pressure display.

Standard 414 Monitor\$2900

Portable Patient Monitors



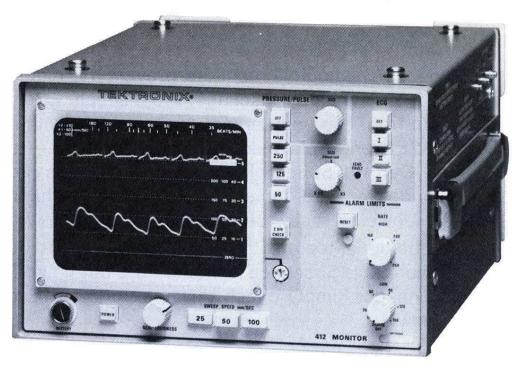
408 ECG Monitor—

This low cost, single-trace instrument is designed for applications requiring ECG measurements only. It features three-lead selection, variable heart rate alarm limits, three selectable sweep speeds, and ac or internal battery operation. Full lead selection is optional.

401 Series Digital Readout Modules For TEKTRONIX 413, 414 and 414 Option 21—

Each module provides three digital readouts in addition to the monitor readout. On the 413: ECG, respiration rate, and temperature (select between one of two temperature channels or the difference between temperatures). On both the 414 and 414 Option 21: ECG, temperature and blood pressure (select either systolic, diastolic or mean pressure) the module for the 414 Option 21 (dual pressure) is dedicated to the arterial/venous pressure channel. Modules are light weight (2 lbs. 4 oz.-1.02 kg) and only 1% inches (3.5 cm) high. Line or battery power is supplied by the monitor. No external cables are required.

401 Digital Readout Module\$950



412 Portable Monitor—

Standard model offers dual-trace, three-lead selectable ECG and blood pressure or peripheral pulse display. It also provides variable heart rate alarm limits, three sweep speeds, and ac or internal battery operation.

400 Series Recorders—

These six-pound hard copy units attach directly to TEKTRONIX Patient Monitors and provide thermal printout records of ECG, blood pressure, or peripheral pulse waveforms. As well as alphanumeric printout in the margin of all digital information processed by the monitor.

Standard 400 Recorder (for 408 Monitor)	0
Model 400, Option 01 (for 412)\$130	0
Model 400, Option 02 (for 414 Series—except Opt. 21) \$230	0(
Model 400, Option 03 (for 414, Opt. 21)\$230	00
Model 400, Option 04 (for 413 Series) \$200	10

408, 412, 413, 414 Accessories

			PATIENT	CABLES
Torso	Cable	(3	electrodes)-	-

(012-0445-00)\$35
Torso Cable for 413 (3 electrodes)— (012-0739-00)
Limb Cable (3 electrodes)—With No. 4-40 tapped fittings (012-0459-00)\$60
Electrode Wires for Patient Cables 18 inch wires with snap fittings for disposable electrodes, set of three. (012-0502-00)
18 inch wires with No. 4-40 tapped fittings— White (RA) (012-0449-00)
ELECTRODE ADAPTERS
All equipped with No. 4-40 thread to mate with limb cable or related electrode wires.
Snap Adapter—(103-0110-00)\$2.50

Plate Adapter—(103-0079-00)\$
ELECTRODES
Electrode—Re-usable, Ag/AgCI, with No.
4-40 thread (119-0197-00)\$10
Attachment Rings—(006-1099-00)
Electrode Paste—(006-1098-00)\$3.50
Disposable Electrodes—Snap-fit adult monitoring electrodes. Pre-gelled; foam adhesive pad. Box of 30

(119-0353-01)
PULSE SENSORS Finger—(015-0236-01)\$85
Radial—Best sensor for infants. May also be used for finger, toe, etc. (015-0237-01)
TRANSDUCERS
Statham P23 1d—(015-0233-00)\$525
Trantec 800—(015-0234-00)\$525 Bell & Howell—4327-I (015-0235-00)\$525
bell & nowell—4327-1 (015-0235-00)\$525
TEMPERATURE PROBE
YSI 701 —For use with 413 or 414. (118-0256-00)\$35
MOUNTING FIXTURES
Mounting Kit —Mounts monitor at five foot level. Attached to vertical pipes or surfaces of anesthesia machines or similar devices.
(016-0110-00)\$180
Support—The upper-most portion of the mounting stand is available separately. (407-1767-00)
Mounting Adapter—Attaches to instrument.
(014-0054-00) \$11
Pole Clamp —Used to mount monitor models 408, 412, 413, 414 on poles ½ inch to 1¼ inch in diameter. (014-0053-00)

(in sealed envelopes of three each).

ORDERING INFORMATION

401 Series Digital Readout Modules

Modules only interface with the 413, 414 or 414 Option 21. Modules may be ordered two ways: 1) with the monitor being purchased or 2) to retrofit to an already-purchased monitor.

Designed for These Monitors	When Ordered with New Monitors, Specify	To Retrofit, Specify		
413	401, Standard	040-0849-00		
414	401, Option 01	040-0850-00		
414 Option 21	401, Option 02	040-0851-00		

Price for each of the above is \$950

Retrofit modules should be installed at your local Tektronix Service Center (nominal charge for installation).

MISCELLANEOUS

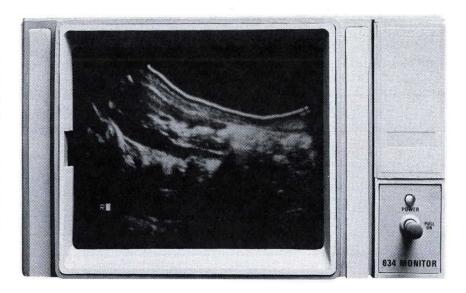
MISCELLANEOUS
Replacement "D" Cell Battery Set— (119-0441-01)\$100
Replacement "F" Cell Battery Set— (119-0443-01)
Accessory Pouch—(016-0560-00)\$15
Servicing Extender Set —408 and 412 only. (020-0078-00)
Servicing Extender Set for 414— (020-0188-00)
Repair Kit—For No. 4-40 ends on limb cables and electrode wires. (040-0696-01)

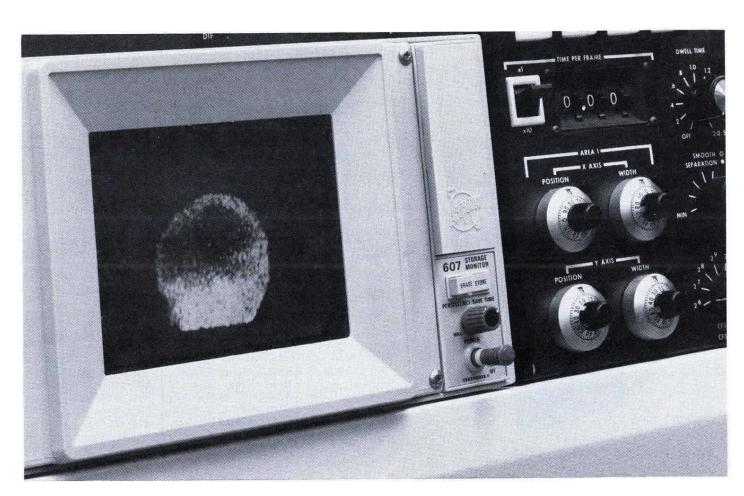
Display Components

The Tektronix OEM Commitment . . .

... means that we understand your needs as an original equipment manufacturer and that we'll help you be as competitive as possible in your market place. That's why we provide in-depth applications assistance... discount pricing to qualified OEMs... U.L. 544 Listing and Component Recognition on most instruments.

What's more, we've inaugurated a program that lets you select from a wider-than-ever range of options for each instrument. You start with a basic display, then add on just the options you need. This lets you customize to meet your system's more exact price/performance requirements. (This new program explains the addition of the letter "A" to the nomenclature of the 603, 604, 606 and 607).





Applications assistance . . . as near as . . .

... your local Tektronix Field Engineer. He'll help you select those instruments and options that most closely match your price/performance requirements. He can also show you how one of our many cameras extends your system's capability still further.

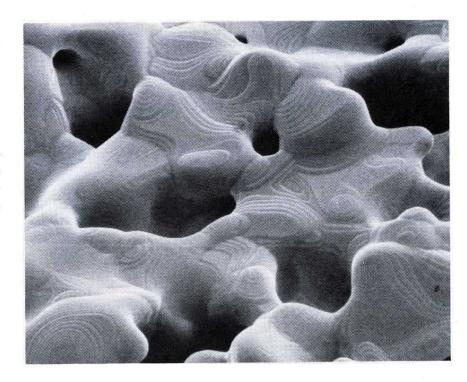
If you need additional assistance, a Tektronix Applications Engineer will work with you to achieve optimum interface between our component and your system. Instrument and visual mods are just some of the ways he can help.

Service . . . as near as . . .

... the worldwide Tektronix service network (35 centers in the U.S. alone). We're equipped to handle your customers' needs quickly and expertly.

Find out now how we can help you.

For additional product information, applications assistance, or demonstration of Tektronix OEM products, simply complete and return the postpaid card at the back of this catalog. If you need even faster service, please contact your local Tektronix Field Office today. See page 271 for listing.



OEM Display Components and Accessories—at a glance

New to the 1978 catalog: the 608 High Brightness Monitor, the 624 Display Monitor and the 634 Video Monitor. Now—all of our products have a new OEM tailored pricing structure for both basic unit and options.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

For full details, see your Tektronix Field Engineer or Representative.

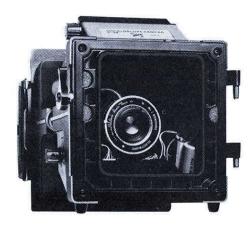
For complete specification	ns, including th	ose of the 63	34 Video Mo	nitor, see in	dividual produ	ct pages.	
	608	624	604A	606A	607A	603A	602
Spot size ¹	0.26 mm 10 mils	0.30 mm 12 mils	0.36 mm 14 mils	0.13 mm 5 mils	0.25 mm 10 mils	0.25 mm 10 mils	0.20 mm 8 mils
Display size	9.8 x 12.2 cm	9.8 x 12.2 cm	10.2 x 12.7 cm	8 x 10 cm	7.2 x 9 cm	10.2 x 12.7 cm	8 x 10 cm
Acceleration Potential	22.5 kV	≃18 kV	3.5 kV	5.6 kV	12 kV	3.5 kV	4 kV
Bandwidth, X-Y ²	≥5 MHz	≥3 MHz	≥2 MHz	≥3 MHz	≥3 MHz	≥2 MHz	≥1 MHz
Bandwidth, Z ²	≥10 MHz	≥5 MHz	≥5 MHz	≥10 MHz	≥5 MHz	≥5 MHz	≥1 MHz
Rise Time	≤35 ns	≤70 ns	≤70 ns	≤35 ns	≤70 ns	≤70 ns	≤200 ns
Type of Storage					Variable Persistence	Bistable	
Writing Speed ^{3, 4,}					0.8 div/μs	20 div/ ms	
Dot Writing Time ⁵					0.5 μs/15 sec /μs/3 min	4 μs	
Viewing Time ⁶					5 to 50 min	1-10 hrs	

- 1. Measured at $0.5\mu A$, except for the 606A, measured at $0.1\mu A$.
- 2. Full spec would read: "Dc to . . . " appropriate figure.
- 3. Option 02 on 603A is 200 div/ms.
- 4. Option 08 on 607A offers Fast Writing Speed of 200ns/div.
- 5. Option 02 on 603A is $0.5\mu s$.
- 6. 603A: variable brightness control required for 10 hour viewing.
- 607A: greater than 5 minutes at reduced writing speed. Extended up to 10 times in the save mode.

Extend component usefulness with these system-oriented accessories.

Cameras Priced for the OEM

For complete information on the C-28, the C-5B and other Tektronix cameras, see pages 225-234. For OEM purchasing information, please contact your local Field Engineer or Representative.



The High Performance C-28 Camera

Features changeable magnification (1:0.67 to 1:0.85), remotely controllable electric shutter, and rigid body design that eliminates trapezoidal distortion. F-stops from f/2.8 to f/16, and 8 shutter speeds (from 1/50 to 2 seconds, plus "bulb" and "open") handle a broad variety of exposure variables. Comes with a combination Graflok'/Polaroid² film back for 3¼" x 4¼" Polaroid film or user's choice of Graflok-compatible accessories such as 70 or 90 mm roll film backs. Three other object-to-image ratio lens mounts are also available.

T.M., Singer Education Systems.

²T.M., Polaroid Corporation.



The Low-Cost C-5B Camera

The C-5B is a light weight, easy-to-use camera that quickly attaches and removes from the display. It features changeable magnification ratios to accommodate both 8 x 10 and 10 x 12 cm displays, an exceptionally reliable electric shutter, and an f16 lens that requires no focusing.

Integrated Instrument Package Options



The modular mechanical package options provide attractive, full-rack width (horizontal) or double-height (vertical) instrument packages for your custom circuit designs. System power (ac) is obtained by a single ac power cord. The single top cover and handle add to the integrated appearance. Included accessories

Rackmounts/Conversions

Rackmounting For 602

51/4-inch Rack Adapter — Two 602s may side by side.	be mounted
Order 016-0115-02	\$170
Blank Panel — For covering half of 016-0 Adapter when only one 602 is used.	115-02 Rack
Order 016-0116-00	\$25
Blank Panel — For covering half of 016-0 Adapter when only one 602 is used.	115-02 Rack

Rackmounting For 603A, 604A, 606A, 607A, 608 and 624 Cabinet-to-Rackmount Conversion, equipped with slide-out assembly, to rackmount any TEKTRONIX Display Monitor (except 602) in a standard 19-inch rack. This includes securing hardware and a blank front panel.

Display Monitors (except 602) side-by-side in a standard rack width.

Order 040-0600-00\$90

Rackmount-to-Cabinet Conversion, required to convert a rackmount 603A, 604A, 606A, 607A, 608 and 624 to a cabinet style.

Order 040-0624-01\$70

Light Filters/Graticules

Monitor	Filters/Graticules	Part No.	Price
602	Smoke Gray Filter*	378-0586-00	\$3.50
	Amber Filter	378-0595-00	6.00
	Blue Filter	378-0845-00	1.90
	Graticule*	331-0406-00	6.25
	Clear Shield*	337-1017-00	6.25
603A & 604A	Clear Filter (604*) Green Filter (603*) Amber Filter Blue Filter Gray Filter Graticule (603*)	337-1440-00 337-1440-01 337-1440-02 337-1440-03 337-1440-04 331-0303-00	2.20 2.20 3.30 3.30 2.50 3.50
607A	Blue Filter	337-1674-00	2.15
	Amber Filter	337-1674-05	2.50
	Smoke-Gray Filter*	337-1674-06	2.50
	Graticule	331-0391-00	3.90
606A	Smoke-Gray Filter	337-1674-06	2.50
	Blue Filter	337-1674-11	2.40
	Amber Filter	337-1674-12	3.15
	Graticule*	337-1674-10	2.50
	Clear Shield*	337-1674-13	3.00
608	Amber Filter	378-0704-00	2.20
	Green Filter	378-0705-00	2.20
	Graticule*	337-2126-02	3.50

*Shipped on or with the standard instrument.

Other Accessories

Lab carts. Provide equipment mobility. See pages 256-258.



are guide rails and interface connectors for blank plug-ins.

These modular mechanical packages are available for the 603A, 604A, 608, and 624. Get full details from your Field Engineer or Representative.

1400-line nominal resolution—center screen at 100 cd/m² (30 fL)

Non-linearity \leq .5% within a 9 cm circle—≤1% at corners

<20% phosphor non-uniformity

Modular construction for ease of installation and servicing

Minimal corner defocus (\leq 25% with option 18)

The TEKTRONIX 634 is a very high resolution, low geometric distortion raster scan (video) monitor, designed for applications requiring superior performance. Key specifications include:

Standard resolution of 1400 lines (nominal) - center screen at 100 cd/m2 (30 fL). Delivers detailed imaging and optimum gray scale for photography. Especially important when images have large, varied and detailed data content, like those in multi-imaging, ultrasound and computerized tomography or scanning electron microscopy.

System manufacturers requiring less than 1400-line resolution will want the TEKTRON-IX 634 Option 01. It offers standard resolution of 800 lines nominal — center screen at 10 cd/m² (30 fL) — while meeting other 634 specifications including distortion, phosphor uniformity and corner focus.

Non-linearity: $\leq .5\%$ within a 9 cm circle, <1% at corners — This performance is crucial in applications where highly accurate measurements must be taken from photographs.

≤20% phosphor non-uniformity — means there is more consistent gray scale over the entire display surface area. This is essential when comparing tissue densities from different areas of the display.

The P45 phosphor formulation — standard on the 634 - reduces the graininess of photographs taken with blue-sensitive film (like most x-ray film).

Corner de-focusing is minimized to \leq 25% (with Option 18), providing clear imaging across the entire screen that you can rely on with confidence.

SPECIFICATIONS

Note: To save you valuable calibration time, every 634 is calibrated to meet all specifications before it leaves the factory.

DISPLAY PERFORMANCE

Crt display - monochrome: 9 cm vertically; 12 cm horizontally; 15 cm diagonal (6 in.); flat screen, magnetic deflection; 4 x 3 aspect ratio.

Resolution - Measured by the shrinking raster method with no interlacing, center screen at 100 cd/m² (30 fL).

	634	634 Option 01	
Worst case:	1100 line	650 line	
Nominal:	1400 line	800 line	

Position Accuracy/Non-linearity) — <.5% within 9 cm circle, \leq 1% in corners.



Brightness — 515 cd/m² (150 fL) maximum.

Phosphor Non-uniformity — ≤20% using J16 Photo-

Phosphor Type — P45 Standard.

Black Level Stability - Back porch dc restoration.

VIDEO INPUT

Description — Video with negative sync.

Signal Level — .35 V p-p to 2 V p-p.

Maximum Safe Input — ±5 V p-p.

Bandwidth — 1 Hz to 10 MHz (Standard).

RASTER

Vertical Rate - 60 ramps/sec.

Horizontal Rate — 15,750 ramps/sec. (Adjustable ±10% range).

Note: Our standard instrument will accept the line/ field rate of 625/50.

SAFETY

Department of H.E.W. [BRH Rule 1020.10 (C) (1)] -Standard.

U.L. 544 - Listing and Component Recognition (Options 06 and 09).

POWER

Standard - Ac 50 watts, 50-400 Hz. 100, 110, 120, 200, 220, 240 V, ±10%.

Option 20 - Unregulated dc. +9 V at 300 mA with 1 V ripple; +23 V at 1.6 A with 4 V ripple; -22 V at .70 A with 3 V ripple.

OTHER CHARACTERISTICS

Temperature Range for Electrical Specifications — 0° to +50°C.

Included Accessories - Operator's and Instruction Manual; linearity graticule.

Recommended Cameras — C-5B, C-28 (external 15V dc 750 mA power supply required for C-28).

Dimensions	Cabinet		
	cm	in	
Height (with feet)	14.9	5.85	
Height (without feet and handle)	13.2	5.25	
Width	21.3	8.4	
Depth (Ac power)	41.9	16.5	
Depth (Dc power— Option 20)	36.3	14.3	

ORDERING INFORMATION

634 Raster Scan Display Monitor with standard resolution of 1400 lines nominal, 1100 lines worst case (center screen at 100 cd/ m₂ [30 fL], without handle, feet and covers\$1125

Option 01 Standard resolution of 800 lines nominal, 650 lines worse case (center screen at 100 cd/m2 [30 fL])Sub \$225

PERFORMANCE OPTIONS Option 11 External Sync—SwitchableAdd \$25

Option 13 Video ReverseAdd \$50 Option 16 Remote Brightness, Contrast, Focus, BlankingAdd \$30 Option 17 Contrast, Brightness and Focus Controls are Removed from the Front Panel and Positioned on the Top Side of the Instrument. (Not available with Options

Option 18 ≤25% Corner DefocusAdd \$55 Option 20 DC Supply (±21-25 V +9 V

unregulated)Sub \$50

SAFETY OPTIONS

Option 06 U.L. Listing (Not available with Options 17, 20 or 28) Add \$75

Option 09 U.L. Component Recognition (U.L. 544)No Charge

Mechanical Package Options

Option 23 With Handle, Feet, and Covers (Not available with Options 17 or 20, 28)Add \$50 Option 28 Covers Only. (Not available with

Option 30 Metal ShieldAdd \$35

Phosphors

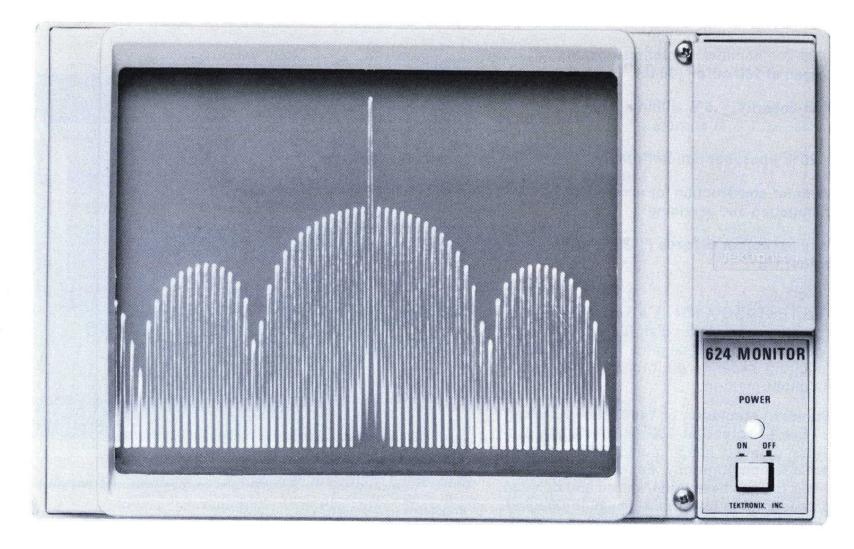
Option 74 P4No Charge

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANU-FACTURERS.

Large 9.8 x 12.2 cm screen

Small spot size — 12 mils

Delivers up to 40 footlamberts usable brightness¹



The TEKTRONIX 624 combines large screen size (9.8 x 12.2 cm), 137 cd/m 2 (40 fL) brightness and small spot size (12 mils). The result: detailed displays that are easy to read in high ambient light and deliver quality photographs.

Major applications include: Ultrasound and other medical non-invasive diagnostic equipment; electronic instrumentation; mechanical measurement systems; and a variety of uses in the military and in aerospace.

A broad selection of options lets you adjust both capability and pricing to meet your system's needs and to make your product more cost-effective.

There's U.L. Listing and component recognition; metal bezel for accommodating heavier cameras including those with motorized film backs; time base, to display voltage vs time; dc power supply that's ±18 V unregulated. This means you can save money by using your system's existing power supply. You' don't have to pay for an additional power supply or power supply design.

SPECIFICATIONS CRT DISPLAY

Cathode Ray Tube — Flat-faced, electrostatic deflection. P31 phosphor standard. P4, P11 phosphors optional.

Display Size — 9.8 cm vertically, 12.2 cm horizontally. Internal graticule is available without charge (Option 01) -8×10 divisions (1.22 cm/div).

Display Linearity — The voltage required to produce a 2.5 cm deflection from any point on the crt will not vary more than 5%.

Spot size — 12 mils.

Acceleration Potential — ≥18 kV overall.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth — Dc to >3 MHz.

Deflection Factor — Adjustable <50 mV to >0.25 V/div. Option 22 extends gain range 5 x to >1.25/V div.

 Measured with quality area flooded by a 60 Hz raster, 320 horizontal lines. Input R and C — 1 M Ω paralleled by less than 47 pF.

X-Y Phase Difference — Not more than 1° to at least 1.5 MHz.

Maximum Input Voltage — ±100 V (dc plus peak ac)

Linear Common-Mode Signal Range (with Option 21) — ± 3 V, non-attenuated. Option 22 extends range 5 x to \pm 15 V.

Common-Mode Rejection Ratio (with Option 21) — At least 100:1 to at least 100 kHz. Option 22 (5X attenuator) reduces cmrr to 40:1 to 100 kHz.

Optional Horizontal Time Base—1 μ s/div to 0.1 s/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated continuously variable between steps and to approximately 1 s/div, TRIG SLOPE/LEVEL control for stable, triggered displays. For nontriggered display, an internal switch selects bright base line or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam.

Bandwith — Dc to 5 MHz over usable range. Sensitivity range is adjustable from zero to ± 1 V to zero to ± 5 V for full intensity control. 0 V input cuts off intensity with front panel control at midrange.

Input R and C — 1 M Ω $\pm 1\%$ paralleled by less than 47 pF.

Linear Common-Mode Signal Range (with Option 21) — ±5 V, non-attenuated.

Common-Mode Rejection Ratio (with Option 21) — \leq 100:1 to 100 kHz.

OTHER CHARACTERISTICS

Power Requirements — Nominal line voltages are 100, 110, 120, 200, or 240 internally selectable, 48 to 440 Hz, 61 W max at nominal line voltage.

Temperature Range for Electrical Specifications— $0^{\circ}\ to\ +50^{\circ}\text{C}.$

Finish — Anodized aluminum front panel, blue vinyl painted cabinet (optionally available), gray vinyl painted frame.

Recommended Cameras — C-5B, C-28 (external 15 V dc 750 mA power supply required for C-28).

Included Accessories — Operator's and Instruction Manuals.

Dimensions	Cabinet		Rackmount	
	cm	in	cm	in
Height	16.9	6.65	13.3	5.25
Width	21.3	8.4	21.3	8.4
Length	51.8	20.4	48.3	19.0
Weight (approx)	kg	lb	kg	lb
Net	8.0	17.6	8.0	17.6
Shipping	10.4	23.0	10.4	23.0

ORDERING INFORMATION

624 Display Monitor \$1075 (without handle, feet and covers)
Option 01 — Internal GraticuleNo Charge
Option 04 — Time Base
Option 06 — U.L. 544 Listed,Add \$75 includes Handle, Feet and Covers
Option 09 — U.L. Component Recognition . No Charge
Option 10 — Remote Program Connector X, Y and Z Single ended inputs only. 25 pin connector
Option 20—Without AC supply (±18V Unregulated dc Supply Required, not available with Option 06)
Option 21 — Full Differential Inputs Add \$25 (X, Y and Z)
Option 22 — Extended Gain Range (X5) Add \$20
Option 23 — Handle, Feet and Covers Add \$50 (not available with Options 06 and 28)
Option 25 — TTL BlankingAdd \$50
Option 26—50 Ω Inputs (X, Y and Z)Add \$20
Option 28 — Covers OnlyAdd \$40 (not available with Options 06 and 23)
Option 29 — Metal BezelAdd \$50
Option 30 — Full Crt Magnetic Shield Add \$75
Option 74 — P4 Phosphor
Option 78 — P11 PhosphorNo Charge

See page 216 for information on cameras, rackmounts, light filters/graticules.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

More usable brightness

Minimal trace halo

10 mil spot

The 608 Display Monitor delivers a lot more than high brightness. It delivers more usable brightness — up to 240 cd/m² (70 fL) — plus improved image contrast and enhanced

detail in shadow areas. A special crt design supresses the diffuse expansion mesh halo usually present in high intensity displays; the result is a more uniformly readable display that provides those subtle nuances of gray scale vital to accurate interpretation.

Ease of interpretation is also aided by large screen size (9.8 x 12.2 cm). Displays are viewed easily, even in high ambient light. Resultant photographs are crisp. And the 608 accurately displays fast signals at varying intensity levels. The specs speak for themselves: Bandwidth of 5 MHz for X and Y axes—10 MHz for Z axis. Settling time: \leq 300 ns. Accelerating potential: 22.5 kV.

A full range of options are provided for broad flexibility in both pricing and capability. And you can select from several phosphors—for high ambient light viewing, longer persistence, photography — depending on your requirements.

The TEKTRONIX 608 can be integrated readily with medical non-invasive diagnostic equipment, electronic instrumentation, analytical instruments and non-destructive test systems.

SPECIFICATIONS

CRT DISPLAY

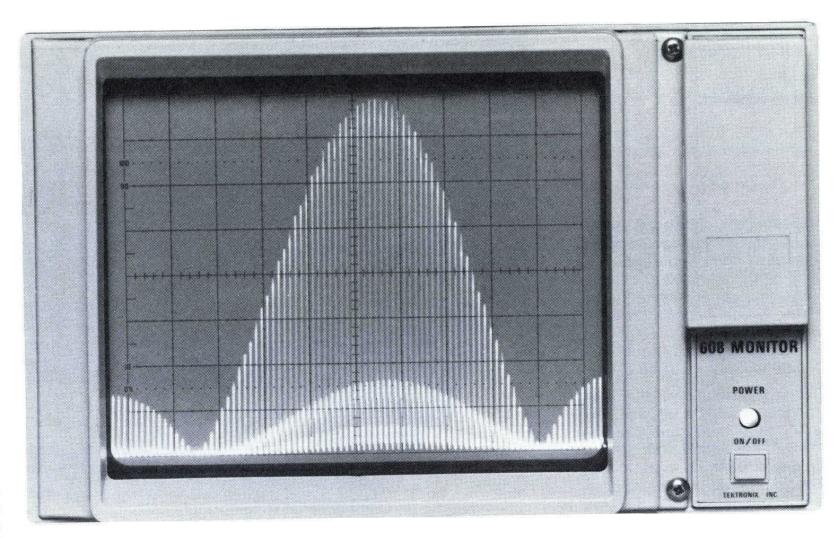
Cathode Ray Tube — Flat-faced, electrostatic deflection. P31 phosphor standard. P4, P7, P11 phosphors optional.

Display Size — \simeq 9.8 cm vertically, 12.2 cm horizontally. Internal graticule is available without charge (Option 01) — 8 x 10 divisions (1.22 cm/div).

Display Linearity — The voltage required to produce a 2.5 cm deflection from any point on the crt will not vary more than 5%.

Spot Size — 10 mils at 50 footlamberts, with usable brightness up to 240 cd/m²—70 footlamberts (0.26 mm, at 0.5 μ A).

Acceleration Potential — 22.5 kV overall.



VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth — Dc to \geq 5 MHz.

Deflection Factor—Adjustable <50 mV/div to >0.25 V/div. Option 22 extends gain range 5X to >1.25 V div.

Input R and C — 1 M Ω paralleled by less than 60 pF. X-Y Phase Difference — Not more than 1° to at least

1.5 MHz.

Maximum Input Voltage — ±100 V (dc plus peak ac).

Linear Common-Mode Signal Range (with Option 21) — $\pm 3V$, nonattenuated. Option 22 extends range 5X to $\pm 15~V$.

Common-Mode Rejection Ratio (with Option 21) — At least 100:1 to at least 100 kHz. Option 22 (5X attenuator) reduces cmrr to 40:1 to 100 kHz.

Recommended Source Impedance — 10 $k\Omega$ or less.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam.

Bandwidth — Dc to 10 MHz over usable range. Sensitivity range is adjustable from 0 to $\pm 1V$ to 0 to $\pm 5V$ for full intensity control, zero V input cuts off intensity with front panel control at midrange.

Input R and C — 1M Ω ±1% paralleled by less than 60 pF

Linear Common-Mode Signal Range (with Option 21) — ±5V, nonattenuated.

Common-Mode Rejection Ratio (with Option 21) — <100:1 to 100 kHz.

OTHER CHARACTERISTICS

Power Requirements — Nominal line voltages are 100, 110, 120, 200, or 240 internally selectable, 48 to 440 Hz, 61 W max at nominal line voltage.

Temperature Range for Electrical Specifications — 0° to $+50^{\circ}$ C.

Finish — Anodized aluminum front panel, blue vinyl painted cabinet (optionally available), gray vinyl painted frame.

Recommended Cameras — C-5B, C-5B Option 01, C59P, C-28 (external 15 V dc 750 mA power supply required with C-28).

Included Accessories — Operator's and Instruction Manuals.

Dimensions	Cabinet		Rackmount	
	cm	in	cm	in
Height	16.9	6.65	13.3	5.25
Width	21.3	8.4	21.3	8.4
Length	51.8	20.4	48.3	19.0
Weight (approx)	kg	lb	kg	lb
Net	8.0	17.6	8.0	17.6
Shipping	10.4	23.0	10.4	23.0

ORDERING INFORMATION

608 Display Monitor
(without handle, feet and covers)
Option
01—Internal graticuleNo Charge
04—Time Base
(See description of time base for 624 on previous
page)
06-U.L. 544 listed, includes Handle, Feet and
CoversAdd \$75
09—UL Component recognitionNo Charge
10—Remote Program-Connector—X, Y and Z,
Single Ended Inputs Only. 25 Pin Connector . Add \$30
20—without ac supply — (±18 V Unregulated dc
Supply Required, not available with Option 06)
Sub \$50
21—Full Differential Inputs (X, Y and Z) Add \$25
22—extended gain range (X5) Add \$20
23—Handle, Feet and CoversAdd \$50
(not available with options 06 and 28)
24—Linearized Z Axis (gamma correction) Add \$50
25—TTL BlankingAdd \$50
26—50Ω Inputs (X, Y and Z)Add \$20
27—Internal Gain Adjustments OnlyAdd \$10
28—Covers OnlyAdd \$40
(not available with Options 06 and 23)
29—Metal BezelAdd \$50
30—Full crt Magnetic ShieldAdd \$75
74—P4 PhosphorNo Charge
76—P7 Phosphor
78—P11 Phosphor
See page 216 for information on cameras, rackmounts, light filters/graticules.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

5-mil or smaller spot size Ideal for photography 10 MHz **Z-axis** bandwith

An excellent choice for sharp photographs and well-defined displays. Spot size is 5 mils (.13 mm), measured by the shrinking raster method. The linear Z-axis amplifier, with 10 MHz bandwidth, delivers the many shades of gray necessary for an accurate, detailed image.

The high resolution of the 606A is most useful in applications such as gamma camera systems, ultrasound systems, electron and scanning Auger microscopes. In medical gamma camera operation, the 606A displays the emission of injected radio-

active fluid as it moves through and collects in areas of a patient's body.

The clear image provided by the 606A is particularily well suited for use with the TEKTRONIX cameras to provide sharp photographs for analysis and diagnosis.

The 606A is also useful where several concurrent waveforms must be displayed while maintaining resolution. For instance, in an ultrasound application the brightness of the 606A results in four high resolution waveforms; the first and third convey tissue density information; the second provides a centimeter scale to measure against; and the bottom waveform imparts time gain curve data from which the operator sets ultrasound system gain characteristics.

SPECIFICATIONS CRT DISPLAY

Cathode-Ray Tube — 5-inch flat-faced rectangular crt with P31 phosphor. P11 phosphor optional.

Display Size — 8 cm vertically, 10 cm horizontally.

Graticule — External 8 x 10 cm graticule included as accessory. Internal 8 x 10 cm graticule supplied as Option 01.

Display Linearity — The voltage required to produce a 2-cm deflection at any point on the crt will not vary more than 5%.

Center Screen Spot Diameter — (Measured with shrinking raster method.) 0.005 inch or less at $0.1 \mu A$ beam current, 0.007 inch or less at 5 µA beam current.

Acceleration Potential - 5.6 kV.

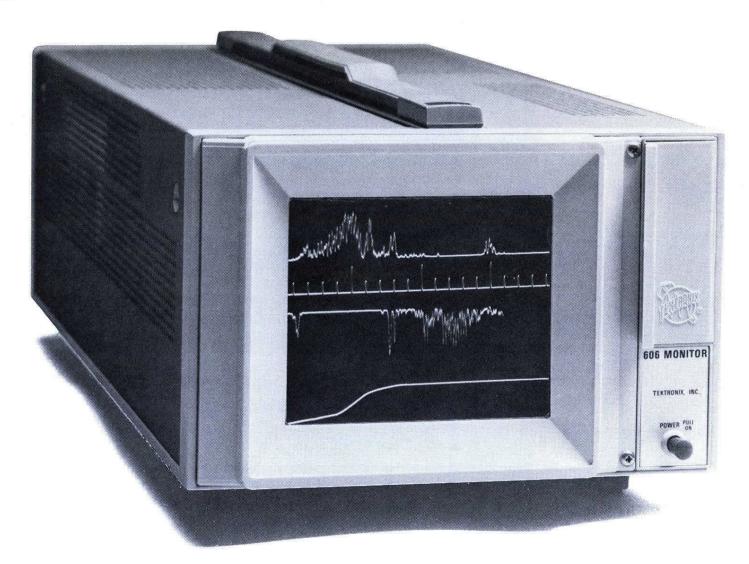
VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth - Dc to 3 MHz at 3 dB down (80% full screen scan).

Polarity — Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor — Vertical and horizontal: Nominally set a 1 V full scale. Internally adjustable from .5 to 2.5 V full scale. 5:1 attenuator (Option 22) extends range to at least 12.5 full scale.

*See page 215 for explanation of "A" designation.



Input R and C — 1 M Ω +1%, paralleled by less than 47 pF.

X-Y Phase Difference — Not more than 1° to at least

Beam Position — Front panel position controls permit setting spot to any point on screen without input signal. Position shift is 0.1 cm or less per hour after 20-min warm-up with cabinet covers in place. Less than 0.2 cm in 24 hours.

Maximum Input Voltage — ± 100 V dc plus peak ac.

Linear Common-Mode Signal Range (with Option 21) +3 V non-attenuated. Option 22 extends range 5X to \pm 15 V.

Common-Mode Rejection Ratio (with Option 21) -At least 100:1 to at least 500 kHz. Option 22 5X attenuator reduces cmrr to 40:1 to 500 kHz.

Recommended Source Impedance — 10 k Ω or less.

Optional Horizontal Time Base—1 μ s/div to 0.1 s/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 s/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base line or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth-Dc to 10 MHz (-3 dB). Sensitivity range adjustable from 0 to 1 V to 0 to 5 V for full intensity control.

Differential Input (Option 21) — Cmrr at least 100:1 to 500 kHz up to 5 V p-p.

OTHER CHARACTERISTICS

Power Requirements — Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V (\pm 10% on each range), 50 to 60 Hz and 400 Hz, 75 watts maximum at nominal line voltage.

Temperature range for electrical specification — 0°C to +50°C.

Finish - Blue vinyl painted cabinet (optionally available), aluminum construction.

Included Standard Accessories — External graticule.

Recommended Cameras — C-59P, C-5B, C-5B Option 01, C-28 (external 15 V dc 750 mA power supply required for C-28).

Dimensions	Cabinet		Rackmount	
	cm	in	cm	in
Height	16.9	6.65	13.3	5.25
Width	21.3	8.4	21.3	8.4
Length, overall	51.8	20.4	48.3	19.0
Weights (Approx)	kg	lb	kg	lb
Net	7.7	17.0	7.9	17.5
Shipping Weight	≥9.9 ≥22.0		≃10.4	≃23.0

ORDERING INFORMATION

606A Dis	play Monitor \$1535 andle, feet and covers)
Option 01	Internal GraticuleNo Charge
Option 04	Time BaseAdd \$165
Option 06 Feet and C	U.L. 544 Listed, includes Handle, coversAdd \$75
Option 09	U.L. Component Recognized . No Charge
	Full Differential Inputs (X, Y
	Extended (X5) Gain RangeAdd \$20
Option 23 (not availa	With Handle, Feet and Covers ble with Option 06 and 28)Add \$50
	50 Ω Inputs (X, Y and Z)Add \$20
Option 28 (not availal	With Covers OnlyAdd \$40 ble with Options 06 and 23)
Option 29	Metal BezelAdd \$50
	P11 PhosphorNo Charge

See page 216 for information on cameras, rackmounts, light filters/graticules.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MAN-UFACTURERS.

X-Y phase difference within 1° to 500 kHz

Time base option

The TEKTRONIX 604A Display Monitor is an excellent choice for cost-sensitive applications. Its 10.2 x 12.7 cm view area, and 5 MHz Z-axis bandwidth result in an easy-to-view display and a versatile instrument with truly competitive pricing.

In logic analyzer applications where up to 16 lines of timing diagrams must be displayed, the 604A lets you see all 16 lines with good definition and clarity — thus making comparisons for digital system analysis and fault-finding significantly easier.

And the larger screen size of the 604A shows more detail in each line for easier detection of even the very small glitches that can affect performance of your digital system.

The larger display area is also important in spectrum analysis, as it permits viewing of the entire spectrum in greater detail.

SPECIFICATIONS CRT DISPLAY

Cathode Ray Tube — $6\frac{1}{2}$ -in flat-faced rectangular crt with P31 phosphor.

Display Size — 10.2 cm vertically; 12.7 horizontally.

Display Linearity — The voltage required to produce a 2.5 cm deflection at any point on the crt will not vary more than 5%.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth — Dc to 2 MHz at 3 dB down from 80% of full scan.

Deflection Factor — Nominally 1 V full scale. Internally adjustable from 0.5 V to 2.5 V full scale. Internal 5X attenuator extends deflection factor range to 12.5 V full scale.

*See page 215 for description of "A" designation.

Input R and C — 1 M Ω ±1% paralleled by <47 pF.

X-Y Phase Difference — Not more than 1° to at least 500 kHz.

Beam Position — Front panel position controls permit setting zero signal position to any point on screen. Position shift is ≤1 mm/hr after 20 min warm up.

Max Input Voltage—±100 V (dc plus peak ac).

Linear Common-Mode Signal Range (with Option 21)— ± 3 V non-attenuated. Option 22 extends range 5X to ± 15 V.

Common-Mode Rejection Ratio (with Option 21) — At least 100:1 to at least 100 kHz. Option 22 (5X attenuator) reduces cmrr to 50:1 to 100 kHz.

Recommended Source Impedance — 10 k Ω or less.

Optional Horizontal Time Base — 1 μ s/div to 0.1 s/div in 6 calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 1 s/div. TRIG SLOPE/LEVEL control for stable triggered displays. For nontriggered operation, an internal switch selects bright baseline or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth — Dc to 5 MHz over usable range. Sensitivity range is adjustable from 0 to \pm 1 V to 0 to \pm 5 V for full intensity control; 0 V input cuts off intensity.

Differential Input (Option 21) — Cmrr at least 100:1 and common-mode range at least \pm 15 V.

Input R and C — 1 M Ω ±1% paralleled by less than 47 pF.

Max Input Voltage — ± 100 V (dc plus peak ac).

OTHER CHARACTERISTICS

Power Requirements — Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V ($\pm 10\%$ on each range), 50 to 60 Hz and 400 Hz, 56 W max at nominal line voltage.

Temperature range for electrical specifications — 0°C to $+50^{\circ}\text{C}$.

Finish — Blue vinyl painted cabinet (optionally available), aluminum construction.

Recommended Cameras — C-5B, C-5B Option 01, C-59P, C-28 (external 15 V 750 mA power supply required for C-28).

Included Accessories — External program connector (131-0570-00); connector cover (200-0821-00).

Dimensions	Cabinet		Rackmount	
	cm	in	cm	in
Height	16.9	6.65	13.5	5.25
Width	21.4	8.4	21.4	8.4
Length	48.9	19.25	48.25	19.0
Weights (Approx)	kg	lb	kg	lb
Net	7.9	17.5	7.9	17.5
Shipping Weight	10.4	23.0	10.4	23.0

ORDERING INFORMATION

604A Display Monitor
Option 01 With Internal Graticule No Charge
Option 04 Time BaseAdd \$165
Option 05 External Vector Display Graticule (P31 Phosphor Only)
Option 06 U.L. 544 Listed, includes Handle, Feet and Covers
Option 08 External SECAM Vector GraticuleAdd \$10
Option 09 U.L. Component Recognized No Charge
Option 10 Remote Program Connector — X, Y and Z 25-pin rectangular connector, Single-ended inputs only
Option 21 Full Differential Inputs (X, Y and Z)Add \$25
Option 22 Extended (X5) Gain Range Add \$20
Option 23 With Handle, Feet and Covers (not available with Option 06 and 28) Add \$50 Option 28 With Covers Only Add \$40
(not available with Option 06 and 23)

See page 216 for information on cameras, rack-mounting, and light filters.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

50-minute storage

Adjustable persistence

Remotely programmable storage functions

The TEKTRONIX 607A stores detailed images up to 50 minutes. Display persistence is adjustable so the image fades at a rate consistent with the event being monitored.

The 607A writes at 0.8 div/ μ s. It features excellent gray scale and 20 mil-(.51 mm) stored, 10 mil-(.25 mm) non-stored spot size, measured by the shrinking raster method.

The detailed gray scale, high resolution and image contrast are ideally suited, for instance, to M-mode ultrasound scans, where gray scale is used to determine tissue density, and the persistence allows accumulation of data to form a clear picture for accurate diagnosis.

In Gamma camera applications, the 607A delivers bright, sharply focused dots over the entire screen. You can adjust the fade time to synchronize with your count rate to insure a complete picture.

The ability to adjust length of storage time adds significantly to the 607A's capability in spectrum analysis, engine analysis and radar/sonar where the highest resolution requires a slow sweep. On the 607A, the persistence can be adjusted to last long enough to see the entire sweep.

SPECIFICATIONS CRT DISPLAY AND STORAGE

Variable Persistence Storage Crt — 5-inch, flat-faced rectangular tube with P31 phosphor. 12 kV accelerating potential (8.5 kV, Option 08).

Display Size — 8 divisions vertically, 10 divisions horizontally at 0.9 cm/div.

Graticule — Standard graticule, external; internal 8 x 10-div graticule available as Option 01.

Maximum Writing Speed — At least .8 div/ μ s for 1 minute viewing time (200 div/ns with Option 08).

Stored Dot Writing Time — A stationary dot written in 500 ns or less can be viewed for at least 15 seconds. With a black background, a stationary dot written in 1 μ s or less can be viewed for at least 3 minutes. (Measured within a 6 x 8 div quality area.)

Storage View Time — Greater than 3 minutes at reduced writing speed.

Save Time — View time is extended to >50 minutes.

Halftone Resolution — At least 18 dots/div.

Halftone Luminance — At least 685.24 cd/m² (200 fL),

Erase Time — Approximately 500 ms.

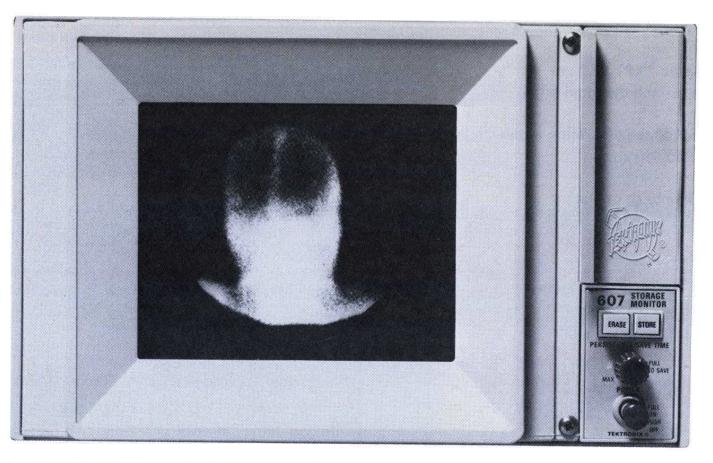
VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth — Dc to 3 MHz at 3 dB down (80% full screen scan).

Polarity — Positive signal to both + inputs moves beam up and to the right.

Deflection Factor — Nominally 1 V full scale. Internally adjustable from 0.5 V to 2.5 V full scale. 5:1 attenuator (Option 22) extends deflection factor range to 12.5 V full scale.

*See page 215 for description of "A" designation.



Input R and C — 1M Ω paralleled by less than 47 pF.

X-Y Phase Difference — Not more than 1° to 500 kHz.

Beam Position — Front-panel position control allows setting zero-signal position to any point on screen. Position shift is \leq 0.09 cm/hr after 20 minute warm-up.

Settling Time — Typically 1.0 μs to settle within 1 spot diameter.

Maximum Input Voltage—± 100 V (dc plus peak ac).

Linear Common-Mode Signal Range (with Option 21) — ± 3 V non-attenuated. Option 22 extends range 5X to ± 15 V.

Common-Mode Rejection Ratio (with Option 21) — At least 100:1 to at least 500 kHz. Option 22 (5X attenuator) reduces cmrr to 40:1 to 500 kHz.

Recommended Source Impedance — 10 k Ω or less.

Optional Horizontal Time Base—1 μ s/div to 0.1 s/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated continuously variable between steps and to approximately 1 s/div, TRIG SLOPE/LEVEL control for stable, triggered displays. For nontriggered display, an internal switch selects bright base line or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam. Display intensity increases with positive inputs.

Bandwidth — Dc to 5 MHz (-3 dB). Sensitivity adjustable from 1 V to 5 V for full intensity control.

Differential Input — Cmrr at least 100:1 to 100 kHz up to 5 V p-p.

Input R and C — 1M Ω paralleled by less than 47 pF.

Maximum Input Voltage — $\pm 100 \text{ V}$ (dc plus peak ac).

OTHER CHARACTERISTICS

Inputs — Provides direct connections at the + X-(horizontal), + Y-(vertical), and + Z-axis amplifiers. The erase, non-storage and save-storage functions can be controlled remotely with TTL compatible signals.

Outputs — Erase interval—TTL Compatible. Logic low is 0.4 V or less. Logic high is 2.5 V or more. Will drive 10 unit loads.

Power Requirements — Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 volts ($\pm 10\%$ on each range), and 50 to 60 Hz. Power consumption is 40 watts max at nominal line voltage.

Ambient Temperature Limits — 0° C to 50° C operating; -40° C to $+70^{\circ}$ C nonoperating.

Finish—Blue vinyl painted cabinet (optionally available), aluminum construction.

Recommended Cameras — C-5B, C-5B Option 01, C-28 (external 15 V dc 750 mA power supply required for C-28).

Included Accessories — External graticule; external program connector; connector cover.

Dimensions	Cabinet		Rackmount	
	cm	in	cm	in
Height	16.9	6.65	13.3	5.25
Width	21.4	8.4	21.3	8.4
Length, overall	51.9	20.4	48.3	19.0
Weights (Approx)	kg	lb	kg	lb
Net	7.7	17.0	7.9	17.5
Shipping Weight	≈9.9	≈22.0	≈10.4	≈23.0

ORDERING INFORMATION

607A Variable Persistence Storage Display Monitor
Option 01 Internal GraticuleNo Charge
Option 04 Time BaseAdd \$165
Option 06 U.L. 544 Listed, Includes Handle, Feet and Covers
Option 08 Fast Writing Speed (200 ns/div), Lower ResolutionSub \$75
Option 09 U.L. Component Recognized . No Charge
Option 10 Remote Program Connector— Contains Remote Save, Erase, Erase Internal, Non-store and Single Ended Inputs only. 25 pin Rectangular Connector
Option 21 Full Differential Inputs (X, Y and Z)Add \$25
Option 22 Extended (X5) Gain Range Add \$20
Option 23 With Handle, Feet and Covers (not available with Option 06 and 28)Add \$50
Option 26—50 Ω Inputs (X, Y and Z)Add \$20
Option 28 With Covers OnlyAdd \$40 (not available with Options 06 and 23)

See page 216 for information on cameras, crt light filters, and rackmounting.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

10-Hour Storage

1 million dot/second stored writing speed

Large 10.2 cm x 12.7 cm viewing area

Stored or nonstored display

The 603A features a bistable storage crt that eliminates refreshing the display and associated costly memory devices. Image brightness adjusts to extend storage time to ten hours. Erase and store commands are remotely programmable (with Option 10) and are accessible together with +X, +Y, and +Z inputs through the Option 10 25-pin connector.

The 603A helps document changing mechanical, electrical or biological phenomena through direct comparison of successive images. In dentistry, for instance, a kinesiograph monitors bite position or jaw movement, producing a series of stored displays on the 603A. These waveforms help the dental specialist in diagnosis.

As a preview monitor, the 603A lets you examine a display in detail before deciding to photograph it. This can eliminate the cost of unnecessary photographs.

SPECIFICATIONS

CRT DISPLAY AND STORAGE

Cathode Ray Tube - 61/2-in flat-faced, bistable storage tube. Phosphor is similar to P1. 3.5 kV accelerating potential. Two storage tubes are available (standard crt for brighter stored display or Option 02 for a faster writing speed at lower stored brightness). When used in the nonstore mode, both tubes exhibit characteristics of a conventional crt.

Writing Speed - Standard crt, at least 20 div/ms; Option 02, at least 200 div/ms.

Dot Writing Time - Time required to write (store) one dot: standard crt, 4 μs or less; Option 02 crt, 0.5 μ s or less.

Information Storage Rate — Standard crt, at least 200,000 dots/s; Option 02 crt, at least 1 million dots/s.

Display Size - 10.2 cm vertically; 12.7 cm horizontally.

Resolution - Stored, equivalent to 80 vertical x 100 horizontal stored line pairs. Nonstored, equivalent to 128 vertical x 160 horizontal line pairs.

Display Linearity — The voltage required to produce a 1-in deflection from any point on the crt will not vary more than 5%.

Viewing Time — At least 1 hr at normal intensity without loss of resolution. Can be extended to 10 hrs with the variable brightness control.

Erase Time - Approx. 250 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth - Dc to 2 MHz at 3 dB down from 80% of

Deflection Factor - Nominally 1 V full scale. Internally adjustable from 0.5 V to 2.5 V full scale. Option 22 (5X attenuator) extends deflection factor range to 12.5 V full scale.

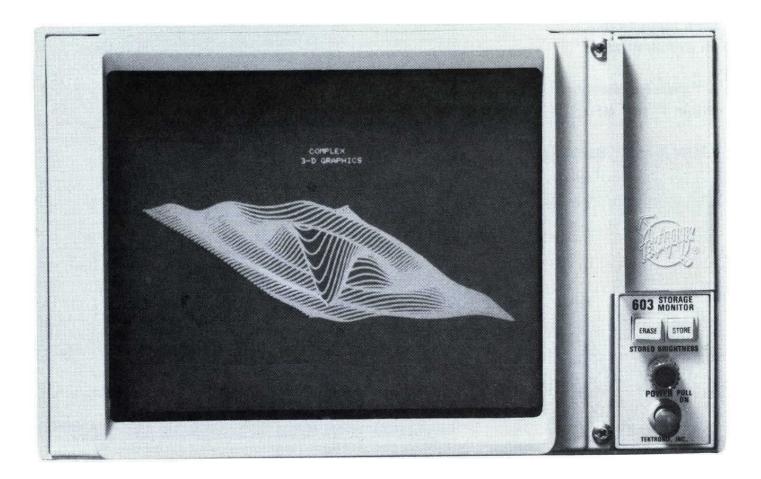
Input R and C — 1 M Ω ±1% paralleled by <47 pF.

X-Y Phase Difference — \leq 1° to at least 500 kHz.

Beam Position - Front-panel position controls permit setting ZAO signal position to any point on screen. Position shift is \leq 1 mm/hr after 20-min warm-up.

Setting Time — 0.2 μs or less for distances of 1 div or less. 1µs or less from any point on the crt to within 1 spot diameter of final position.

Max Input Voltage — \pm 100 V dc plus peak ac.



Linear Common-Mode Signal Range (with Option 21) ±3 V, non-attenuated. Option 22 extends range 5X to \pm 15 V.

Common-Mode Rejection Ratio (with Option 21) -At least 100:1 to at least 100 kHz. Option 22 (5X attenuator) reduces cmrr to 50:1 to 100 kHz.

Recommended Source Impedance — 10 k Ω or less.

Optional Horizontal Time Base - 1 µs/div to 0.1 s/div in 6 calibrated steps (decade sequence), accurate within 3%. Uncalibrated continuously variable between steps and to approx 1s/div. TRIG SLOPE/ LEVEL control for stable, triggered displays. For nontriggered operation, an internal switch selects bright baseline or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam in nonstored mode. Positive input to + input increases the display intensity. To insure storage of each written dot, the Z-axis on-time should be at least 4 μs with the standard crt and at least 0.5 us with the Option 02 crt. The Z-axis pulse should be timed so that the system settling time is completed before unblanking occurs.

Bandwidth - 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; Zero V input cuts off

Differential Input (Option 21) - Cmrr at least 100:1 and common-mode range at least ± 5 V.

Input R and C — 1 M Ω ±1% paralleled by <47 pF.

Max Input Voltage — \pm 100 V (dc plus peak ac).

OTHER CHARACTERISTICS

Power Requirements — Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V ($\pm\,$ 10% on each range), 50 to 60 Hz and 400 Hz. 75 W max at nominal line voltage.

Temperature range for electrical specifications — 0°C to +50°C.

Finish - Blue vinyl painted cabinet (optionally available), aluminum construction.

Recommended Cameras — C-59P, C-5B, C-5B Option 01, C-28 (External 15 V dc 750 mA power supply reauired).

Included Accessories — External program connector; connector cover; external graticule.

Dimensions	Cab	oinet	Rackmount		
	cm	in	cm	in	
Height	16.9	6.65	13.5	5.25	
Width	21.4	8.4	21.4	8.4	
Length	48.9	19.25	48.25	19.0	
Weight (approx)	kg	lb	kg	lb	
Net	7.9	17.5	7.9	17.5	
Shipping	10.4	23.0	10.4	23.0	

ORDERING INFORMATION

603A Storage Display Monitor \$1450 (without handle, feet and covers)
Option 01 Internal GraticuleNo Charge
Option 02 Fast Writing Speed Crt
(200 div/ms)Add \$40
Option 04
Option 06 U.L. 544 Listed, includes
Handle, Feet and CoversAdd \$75
Option 09 U.L. Component Recognized. No Charge
Option 10 Remote Program Connector.
Contains: Erase internal, non-store, enable/disable,
erase and single ended inputs only: 25-pin rectangu-
lar connector
Option 21 Full Differential Inputs (X, Y, Z). Add \$25
Option 22 Extended (X5) Gain Range Add \$20
Option 23 With Handle, Feet and Covers
(not available with Options 06 and 28) Add \$50
Option 28 With Covers Only

See page 216 for information on cameras, rackmounts, light filters/graticules.

*See Page 215 for explanation of "A" designation.

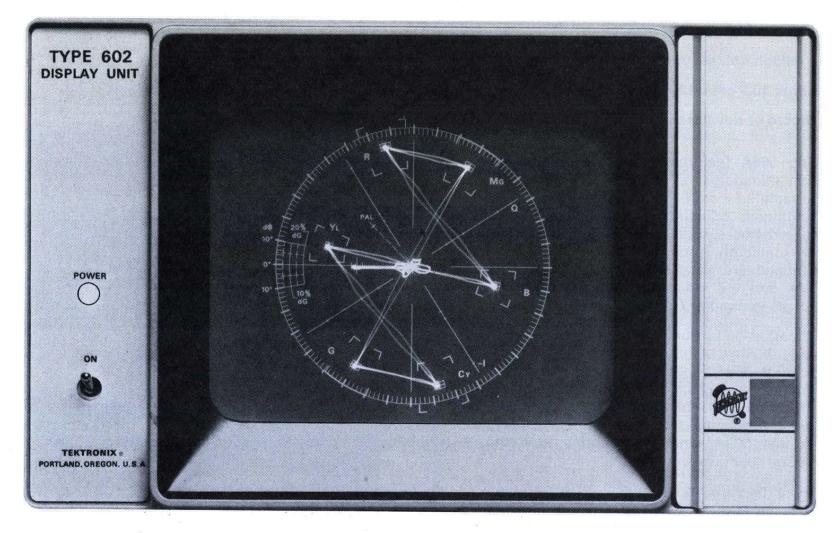
PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANU-FACTURERS.

8-Mil spot size

High resolution an excellent value

X-Y phase difference within 1° to 1 MHz

1 MHz X and Y Bandwidth



The TEKTRONIX 602 is an excellent value — offering high resolution at a competitive price. Its 8-mil (.20 mm) spot size will satisfy many applications requiring high resolution (spot size measured at .5 μ A beam current and by shrinking raster method). A linear Z-axis amplifier permits precise intensity modulation of the writing beam. The 602 display area measures 8 x 10 cm, but the entire monitor is just 16.5 x 21.6 x 44.2 cm.

Its performance features, size, and low cost make the 602 an excellent choice for graphic, alphanumeric, and vector display applications. For instance, when used with a TEKTRONIX 650 Color Monitor in video tape recorder systems, the 602 provides an exceptionally accurate vector display (vector and SECAM vector graticules optionally available).

The 602 Monitor's stability contributes to an accurate color separation display. Phase and amplitude of a tv signal's color-components, as referenced to a standard color burst signal, are aligned when vector peaks line up with designated points on the vector graticule. The result is precise color.

SPECIFICATIONS

CRT DISPLAY

Cathode Ray Tube — 5-in flat-faced rectangular crt with P31 phosphor.

Display Size — 8 cm vertically and 10 cm horizontally.

Graticule — Standard 602 comes without graticule. Internal 8 x 10 cm graticule is available as Option 02. Vector and SECAM Vector graticules are available as Option 05 and 08 respectively.

Trace Width — Max trace width within the 8 x 10 cm display area is 14 mils at $0.5\mu A$ beam current (typically less than 10 mils).

Display Linearity — The voltage required to produce a 2 cm deflection at any point on the crt will not vary more than 2% in the vertical direction and 6% in the horizontal direction.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (horizontal) and Y (vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

Bandwidth — DC to 1 MHz at 3 dB down.

Deflection Factor — Vertical: 90 mV/cm to 135 mV/cm, internally variable. Horizontal: 90 mV/cm to 110mV/cm, internally variable.

Phase Difference — Not more than 1° between X and Y amplifiers up to 1 MHz.

Beam Position — Front panel vertical and horizontal position ranges permit setting zero signal position to any point on screen. Position shift is not more than 1 mm/hr after 20 min warm-up.

Polarity — Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C — 100 k Ω ±10% paralleled by 30 pF or less.

Max Input Voltage — \pm 10 V (dc and peak ac).

Recommended Source Impedance — 1 k Ω or less.

Z-AXIS AMPLIFIER

A linear Z-axis amplifier permits intensity modulation of the writing beam. Analog input: dc to 1 MHz over 0.0 V to \pm 1 V range. Signal input is a BNC connector on the rear panel.

Input R and C — 100 k Ω $\pm\,10\,\%$ paralleled by 70 pF or less.

Max Input Voltage — ± 10 V (dc plus peak ac).

Recommended Source Impedance — 1 k Ω or less.

OTHER CHARACTERISTICS

Power Requirements — 90 to 136 V ac, or 180 to 272 V ac, 48 to 440 Hz. 50 W at 115 V ac, 60 Hz. Rearpanel selector provides rapid accommodation for 6 line-voltage ranges.

Temperature — Electrical specifications are valid over the range of 0° C to $+50^{\circ}$ C ambient.

Finish — Blue vinyl painted cabinet, aluminum construction.

Recommended Cameras — C-5B, C-5B Option 01, C-28 (external 15 V dc 750 mA power supply required for C-28).

Included Accessories — Smoke-gray filter.

Dimensions	Cabinet			
	cm	in		
Height	16.5	6		
Width	21.6	8.5		
Length	44.2	17.4		
Weights (approx)	kg	lb		
Net Weight	7.9	17.5		
Shipping Weight	≈9.9	≈22		

ORDERING INFORMATION

602 Disp	lay Monitor \$1260
	Without cabinetSub \$25
	With graticuleNo Charge
Option 05	Vector Display Graticule sphor Only)Add \$30
Option 08	External SECAM ticule
	P7 PhosphorNo Charge

See page 216 for information on cameras, crt light filters, and rackmounting.

PLEASE NOTE: PRICES QUOTED IN THIS SECTION ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

Cameras, Probes, Oscilloscope Carts, and Other Accessories



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Camera Reference

CHOOSING A TEKTRONIX CAMERA 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 228 indicates the camera adapters required for most TEKTRONIX Instruments and a few by other manufacturers. In some cases, adapters are available from Hewlett-Packard or DuMont to mount TEKTRONIX Cameras to their instruments.

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-5B 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-31 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 adapter, 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-30A 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.

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

0.5 magnification is used for high speed recording, since reducing the size of image increases its brightness.

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

There are two types of shutters: **mechanical** and **electrical**.

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. The SPEEDCOMPUTER control box for the C-30-Series electric shutters requires 115 or 230 V ac. They may be actuated by an insulated switch closure.

The C-50, 51, 52, and 53 electric shutters require + 15 V, 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.

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-5B, are hinge mounted and can be swung aside to allow a wide-angle view of the crt. The lightweight C-5B can easily be slipped off the crt bezel to view the crt. The C-27, 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, 47, 57, and 410.

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.

The more commonly used films for each type of camera back are listed below.

POLAROID FILMS

		Develop.					(CRT Recor	ding Uses		
Film Type	ASA Equivalent Speed	Time (Seconds at 75° F)	Format	Resolution Line Pairs/mm	Characteristics	Repetitive	Stored		Scintilla- tion Type Medical	Graphics, Alpha Numer.	Single Sweep
			P	ACK FILMS 31	¼ x 4¼ in. — Actual image size 7.3 cm x	9.5 cm					
665	75	30	Positive Print Negative Transparency	20-25 160-180	Med. Contrast, wide gray scale	х	х	х			
107	3,000	15-20	Positive Print	20	Medium Contrast	X	X				X
084	3,000	15	Positive Print	20	Medium Contrast			X	X		
667	3,000	30	Positive Print	16	Medium Contrast, no coating required			X	X		
08	75	60	Positive Print	15-17	Color—Balanced for 5500° K	X		X			V
668	75	60	Positive Print	15-17	Color—Balanced for Electronic Flash	X		X			
42	200	15-20	ROLL FILMS Positive Print	25-28	ctual image size 7.3 x 9.5 cm (46L and 14 Med. Contrast, wide gray scale	X	Х	X			
42	3,000	15-20	Positive Print	20-22	Medium Contrast	X	X	^			X
110	10,000	15	Positive Print	20	High Contrast						X
46L	800	120	Positive Trans	35-40	Medium Contrast	X	X	X			
146L	200*	30	Positive Trans	40-50	High Contrast, Blue Sensitive	X				X	
	18 H** 0-1800			SHEET FILMS	4 x 5 in. — Actual image size 8.9 x 11.4	cm					
51	320*	15-20	Positive Print	28-32	High Contrast, Blue Sensitive					Х	
52	400	20	Positive Print	35-40	Medium Contrast, wide gray scale	X	X	X			
55 P/N	50	20	Positive Print Negative Transparency	22-25 160	Medium Contrast, wide gray scale	×	Х	х			
57	3,000	15-20	Positive Print	20	Medium Contrast	X	X			X	X
58	75	60	Positive Print	15-17	Color Balanced for 5500° K	X		X			

^{*}Daylight rating.

Blue type indicates most popular films for oscilloscope trace recording.

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/ μ 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.

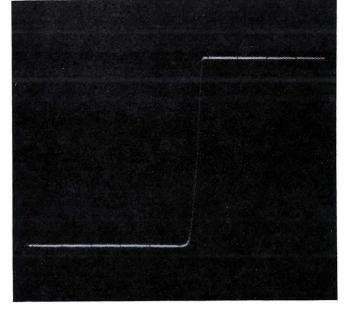
Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The TEKTRONIX Writing Speed Enhancer is designed to fill this need.

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, post-fogging, 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.



This 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			
Туре	ASA Equivalent Speed	Unfo	ogged	Fogged	
		Print viewed with front illumination	Print viewed with back illumination	Print viewed with front illumination	
107	3000	1 (Reference)	Print base is opaque	3	
47	3000	1	1.2	3	
410	10,000	2	2.2-2.4	4	

^{*}Viewing a fogged print with back illumination does not increase the apparent writing speed.

Oscilloscope Camera/Adapter

TYPE OSCILLOSCOPE	RECOMMENDED CAMERAS	USE	C-5B ADAPTER HOOD PART NUMBER	C-50 SERIES, C-28 & C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-12 ADAPTER PART NUMBER
314, 326, 335	C-30A	General Purpose	_	-	016-0327-011	_
422	C-30A	General Purpose	_	_	016-0306-00	_
432 ¹ , 434 ² , 464, 466	C-30A Opt 01 C-5B Opt 02	General Purpose Low Cost	016-0359-00	-	016-0301-00 ³	_
453, 453A, 454, 454A	C-30A C-31	General Purpose High Speed	_	_	016-0306-00	_
455, 465, 475, 475A	C-30A Opt 01 C-31 Opt 01 C-5B Opt 02	General Purpose High Speed Low Cost	016-0359-00	·_	016-0301-00 ³ (C-30A Opt 01) 016-0269-02 ³ (C-31 Opt 01)	_
485	C-30A C-31	General Purpose High Speed	_	_	016-0306-00	_
491	C-30A	General Purpose	_	_	016-0306-00	-
502, 502A	C-59	General Purpose	_	016-0225-03	016-0243-00	016-0226-01
503, 504	C-27	General Purpose	-	016-0225-03	016-0243-00	016-0226-01
520A, 521A, 522A	C-59	General Purpose		016-0295-00		:
528	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-03	016-0248-00	_
529	C-59	General Purpose	_	016-0224-00	016-0244-00	016-0217-00
530, 540, 550 Series	C-27	General Purpose	_	016-0225-03	016-0243-00	016-0226-01
561A, 561B, 564A, 564B	C-27	General Purpose	_	016-0224-00	016-0244-00	016-0217-00
565	C-59	General Purpose	_	016-0225-03	016-0243-00	016-0226-01
568	C-27	General Purpose		016-0224-00	016-0244-00	016-0217-00
575	C-27	General Purpose	_	016-0225-03	016-0243-00	016-0226-01
576	C-27 C-59	General Purpose General Purpose	_	See Adapter Frame/Corrector Lens Systems at right		
5772	C-5B C-59	Low Cost General Purpose	016-0357-00	016-0249-03	016-0248-00	016-0263-00
601, 602	C-30A C-5B Opt 01 C-28	General Purpose Low Cost OEM	016-0357-00	016-0249-03	016-0248-00	016-0263-00
603 ^{6 7} , 603A ^{6 7}	C-5B Opt 01 C-59 C-28	Low Cost General Purpose OEM	016-0357-00	016-0249-03	016-0248-00	016-0263-00
604 ^{6 8} , 604A ^{6 8}	C-5B C-28	Low Cost OEM	016-0357-00	016-0249-03	016-0248-00	016-0263-00
605, 606, 606A, 607, 607A	C-30A C-5B Opt 01 C-28	General Purpose Low Cost OEM	016-0357-00	016-0249-03	016-0248-00	016-0263-00
608, 624, 634	C-59 C-5B Opt 01 C-28	General Purpose Low Cost OEM	016-0357-00	016-0249-03	016-0248-00	016-0263-00
647, 647A	C-27	General Purpose	_	016-0223-00	-	
420 Series	C-5B	Low Cost	016-0357-00	016-0249-03	016-0248-00	016-0263-00
480 Series	C-59	General Purpose	_	016-0342-00	_	_
502 ¹ , 1503 ¹	C-30A	General Purpose	_	_	016-0327-011	_
5030, 5031	C-27 C-59	General Purpose General Purpose	_	See Adapter	Frame/Corrector Lens S	Systems at right
5100 Series	C-5B	Low Cost	016-0357-00	016-0249-031 6	016-0248-001 6	016-0263-001 6
5403/D40, 5440, 5444	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-036	016-0248-006	016-0263-006
5403/D41, 5441	C-58 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-03	016-0248-00	016-0263-00
7313 ² , 7503, 7504, 7514, 7613, 7623A, 7633, 7704A, 7904, R7903, 7834, 7844	C-53, C-27 C-51 C-5B Opt 01 C-58	General Purpose High Speed Low Cost 4 x 5	016-0357-00	016-0249-03	016-0248-00	016-0263-00

TYPE OSCILLOSCOPE	RECOMMENDED CAMERA	USE	C-5B ADAPTER HOOD PART NUMBER	C-50 SERIES, C-28 & C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-12 ADAPTER PART NUMBER
7403N, 7603, 7603-N11S	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-036	016-0248-006	016-0299-006
SC502 ¹ , SC504 ²	C-30A	General Purpose	_	:	016-0327-01	_
T900 Series except T922R	C-5B Opt 03	Low Cost	016-0358-00			_
T922R	C-5B Opt 01	Low Cost	016-0357-00	016-0249-03	016-0248-00	016-0263-00
TELEQUIPMENT Except D83	None	-	_		_	_
TELEQUIPMENT D83	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-036	016-0248-006	016-0263-006
HP 5" Round CRT1	C-27	General Purpose	=	016-0228-00	_	_
HP 8 x 10 cm Rectangular CRT ¹ except 1740A, 1741A	C-27	General Purpose	_	HP 10362-A ⁵	HP 10363-A ⁵ Plus 016-0306-00	HP 10361-A ⁵
HP 1332A	C-59 C-5B	General Purpose Low Cost	016-0357-00	016-0249-03	016-0248-00	016-0263-00
HP 1333A, 1335A	C-27 C-58B	General Purpose Low Cost	016-0357-00	016-0249-03	016-0248-00	016-0263-00
HP 1700 Series except 1740A, 1741A, 1743A	C-30A	General Purpose	_	-	HP 10106-A ⁵	_
HP 1740A, 1741A, 1743A (8 x 10 cm)	C-30A Opt 01	_	_	_	HP 10377-A ⁵	_
HP 182	None	_	_	-	-	_
Philips 8 x 10 cm Portables	C-5B Opt. 019	Low Cost	016-0357-00	_	_	_
600, 5100, 5400, 7000-Series	_	_	014-0045-00 Will mount HP Models 195A, 197A Cameras.			

¹Graticule is nonilluminated and will not photograph.

CAMERA ADAPTER PART NUMBERS & PRICES

014-0045-00	\$70	016-0263-00	\$50
016-0217-00	50	016-0269-02**	60
016-0223-00	45	016-0295-00	45
016-0224-00	45	016-0299-00	50
016-0225-03	45	016-0301-00***	75
016-0226-01	50	016-0306-00†	60
016-0228-00	65	016-0327-01	4
016-0243-00	50	016-0342-00	7
016-0244-00	50	016-0357-00††	15
016-0248-00	65	016-0358-00†††	15
016-0249-03*	50	016-0359-00+++	15

^{*(}Included with C-50 Series Cameras)

tt(Included with C-5B and C-5B \
Opt 01 Cameras)

ttt(Included with C-5B Opt 03 Cameras)

tttt(Included with C-5B Opt 02 Cameras) see page 234 for extra viewing doors and flash units

ADAPTER FRAME/CORRECTOR LENS FOR C-12 or C-27 CAMERA

Expands the field of view of the C-12 and C-27 to fully cover the $6\frac{1}{2}$ in crt and adjacent scale readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of a standard camera's 0.85-mag lens to 0.45 so it can record the entire display on Polaroid $3\frac{1}{4}$ x $4\frac{1}{4}$ in film.

Although each camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. The C-12 provides a view of the crt screen only. The C-27's view is restricted to the lower two thirds of the crt and scale readout. Both cameras can of course be swung aside to allow a full view of the entire display. The adapter frame requires use of a standard camera adapter (016-0226-01 for C-12, or 016-0225-03 for C-27), not included.

Order 016-0264-01\$65

ADAPTER FRAME/CORRECTOR LENS C-50 and C-59 CAMERAS

Expands the field of view of the C-50 and C-59 to fully cover the $6\frac{1}{2}$ -inch crt and adjacent scale-readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of the C-50 to 0.55 and the C-59 to 0.5 so they can record the entire display on Polaroid $3\frac{1}{4}$ x $4\frac{1}{4}$ -inch film.

Although each camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. However, all but the upper one-fourth of the display can be viewed via the viewing tunnel and both cameras can be swung aside to allow a full view of the entire display.

For C-50	Camera,	Order 016-0271-00	\$110
For C-59	Camera.	Order 016-0288-00	\$100

ACCESSORIES FOR GRAFLOK TYPE BACKS (For C-12, C-27, and C-50-Series)

Here are a few of the film holders available for use with the Graflok Backs to allow use of roll film, and Polaroid 4 x 5 inch Film. Order these accessories from the manufacturer or from your local camera store.

RH/10 120 Roll-Film Holder—10 exposures 21/4 x 23/4 inch for 4 x 5 inch Graflok Backs. (122-0736-01)

RH/20 220 Roll-Film Holder—20 exposures, 21/4 x 23/4 inch, for 4 x 5 inch Graflok Backs. (122-0971-00)

RH/50 70 mm Holder—50 exposure, 2 x 2¾ inch, for 4 x 5 inch Graflok Backs only. (122-0967-00)

Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5 inch Single Exposure Film Packets. (016-0201-01)

Roll film holders are also manufactured by several other companies.

²Graticule is nonilluminated and will not photograph except when crt is in the stored mode.

 $^{^3\}mbox{Increases}$ camera's field-of-view so that the full 8 x 10-cm crt display area can be recorded.

⁴C-50, C-51, C-52, and C-53 Cameras require Battery Pack 016-0270-01 for power when not used with 7000-Series Oscilloscopes.

⁵Available from Hewlett-Packard. See HP catalog for additional compatibility information and prices.

 $^{^6\}text{Only}$ the C-5B and C-59 Cameras can entirely record the 6%-inch crt display without cropping.

⁷The C-59 is suitable for the standard-model Type 603 but it cannot photograph the nonilluminated graticule of the Option 01 Model.

⁸The C-59 also mounts directly onto the Type 604 but it cannot photograph the nonilluminated graticule of the standard model.

⁹Does not mount on scope, must be hand held.

^{**(}Adapter with lens included with C-31 Opt 01 Cameras)

^{***(}Adapter with lens included with C-30A Opt 01 Cameras)

t(Included with C-30A, C-31 Cameras)

C-50-SERIES COMMON FEATURES

INTERCHANGEABLE FILM BACKS LIFT-OFF MOUNTING SWING-AWAY HINGING

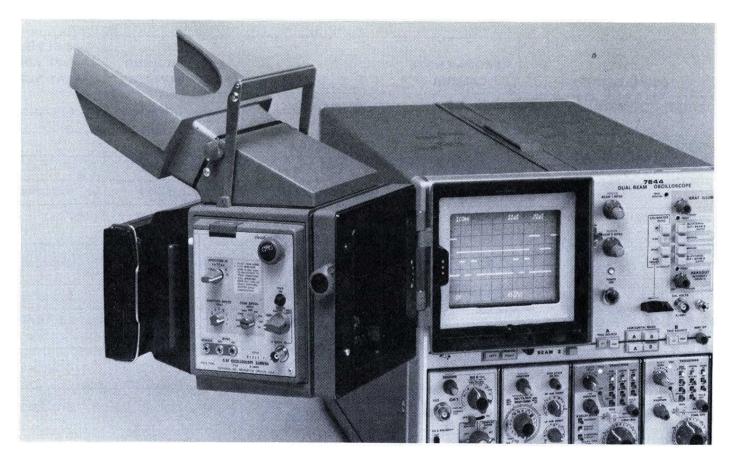
The six C-50-Series Cameras are designed for use with all TEKTRONIX 7000-Series Oscilloscopes. They can also be adapted to most TEKTRONIX 5000-Series Oscilloscopes and 600-Series Display Monitors. Please refer to the oscilloscope/camera/adapter guide, pages 228 and 229.

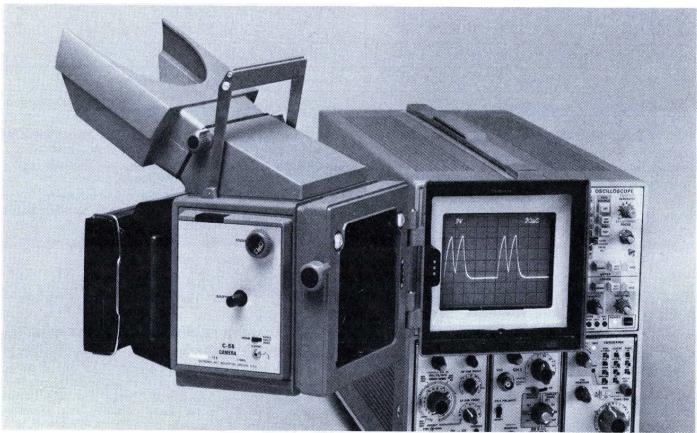
All the C-50-Series Cameras can be ordered for either Polaroid pack or roll film, or a Graflok-type 4 x 5 inch back. All three backs can easily be removed and interchanged without fogging the efilm.

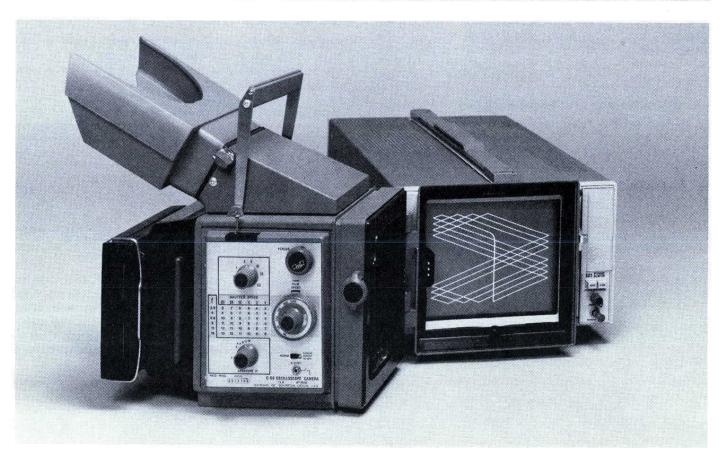
C-50, C-51, C-52 and C-53
Electronic-Controlled Shutter
Photometer Exposure Aid
Range-Finder Focusing
Automatic Single-Sweep Control

C-58
Low-Cost
Unity-Magnification Lens
Wide Field of View with No Vignetting

C-59
Low-Cost
Photometer Exposure Aid
Range-Finder Focusing
Internal Battery Power
For Larger CRT's







SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-50	C-51	C-52	C-53	C-58	C-59
FEATURES	General purpose for crt's up to 6½ inches; Medium writing speed.	Fastest writing speed (at expense of image size)	Full-size image; Medium writing speed	General purpose for 7000-Series with 8 x 10-cm crt's** Medium writing speed	Full-size image of largest field, low price. Slow writing speed	General purpose low price. For crt's up to 6½ inches; Slow writing speed
LENS SPEED	f/1.9	f/1.2	f/1.4	f/1.9	f/2.8	f/2.8
MAGNIFICATION	0.7	0.5	1.0	0.85	1.0	0.67
RELATIVE LIGHT GATHERING ABILITY	1.2	3.0	1.4	1.0	0.4	0.65
FIELD OF VIEW	10.2 x 12.7 cm with Polaroid pack and roll film	8 x 10 cm with Polaroid pack and roll film	8 x 10 cm	8 x 10 cm with Polaroid pack and roll film	8.9 x 11.4 cm with Polaroid 4 x 5-inch film	10.2 x 12.7 cm with Polaroid pack and roll film
SHUTTER	Electrically actuated, Provides x sync.	4 to 1/60 second, plus	Bulb and Time.		Mechanically actu- ated 1 to 1/100 sec, bulb and time. Provides x sync.	Mechanically actu- ated 1 to 1/50 sec, bulb and time. Provides x sync.

Blue type indicates most popular models

DIMENSIONS AND WEIGHTS WITH FILM BACK ORDINARILY USED

	C-5	60P	C-5		C-	52P	C-5	3P	C-5	8G	C-59P	
	In	cm	In	cm								
Height	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2
Width	7.5	19.1	9.8	24.8	7.5	19.1	7.5	19.1	7.7	19.3	7.7	19.3
Length	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3
Weight (Approx)	lb	kg	lb	kg	Ib	kg	lb	kg	lb	kg	lb	kg
Net	7.5	3.4	9.5	4.3	8.0	3.6	7.5	3.4	6.0	2.7	7.0	3.2
Shipping	12.0	5.4	15.0	6.8	12.0	5.4	12.0	5.4	10.0	4.5	11.0	5.0

ORDERING INFORMATION

"P" Models accept Polaroid pack film.

"R" Models accept Polaroid roll film.

"G" Models have Graflok type backs that accept 4 x 5 inch sheet film holders or roll film holders.

	CAMERA CAMERA				•												
			C	-5	1												
C-51P	CAMERA		. •					•		•					. \$1	46	0
C-51R	CAMERA		•		•			000	•			٠	•		. \$1	46	0
	CAMERA																
			C	-5	2												
C-52P	CAMERA	1.000			٠		•		•	•			•	•	. \$1	150	0
C-52R	CAMERA	•		• •		•	٠		•	•		٠		•	. \$1	150	0
			C	:-5	3	Č.											
C-53P	CAMERA										٠		٠		. \$	120	0
C-53R	CAMERA	٠				•	٠	•	•			•		•	. \$*	120	0

				C	<u>;</u> _	5	8														
C-58P	CAMERA			•		٠		•					•					•	٠		\$920
C-58G	CAMERA	•	•	•	•	•	•	•	٠	•	•	•	•	•	•	٠	•	٠	•	•	\$920
				C	-	5	9														
C-59P	CAMERA																				\$730
C-59R	CAMERA				٠																\$730
C-59G	CAMERA																			•	\$730

Included Accessories—Focus Plate for Polaroid pack film (387-0893-02), or focus plate for Polaroid roll back (387-0893-01), or focusing screen integral with Graflok type back; mounting adapter for all 7000, 5000, and small 600-Series (016-0249-03).

OPTIONAL ACCESSORIES

Writing Speed Enhancer—Provides automatic controlled film fogging to increase writing speed by about 3 times for 3000 ASA film and about 2 times for 10,000 ASA film. Installs in minutes.

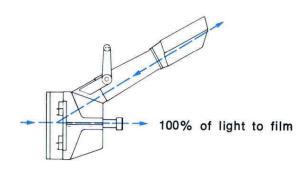
Writing Speed Enhancer for C-51 Camera.

for 10,000 ASA film. Installs in minutes.
Writing Speed Enhancer for C-51 Camera. Order 016-0279-00\$210
Writing Speed Enhancer for C-53 Camera. Order 016-0300-00\$210
Writing Speed Enhancer for C-59 Camera. Order 016-0290-00\$210
Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.
Order 122-0926-01\$130
Polaroid Roll Film Back—Accepts Polaroid roll film. Included with "R" models.
Order 122-0929-00\$170
Graflok Type Film Back, 4 x 9 in—Accepts Polaroid 4 x 5 in film holder, standard cut-film holders, film-pack adapters, roll-film holders (except heavy motorized models). Included with "G" models.
Order 122-0931-01\$170
Carrying Case—Holds a complete C-50-Series Camera with extra film-backs and accessories.
6140

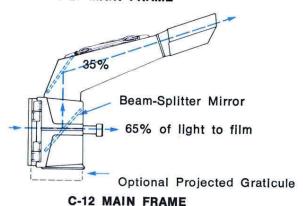
Order 016-0177-00\$140

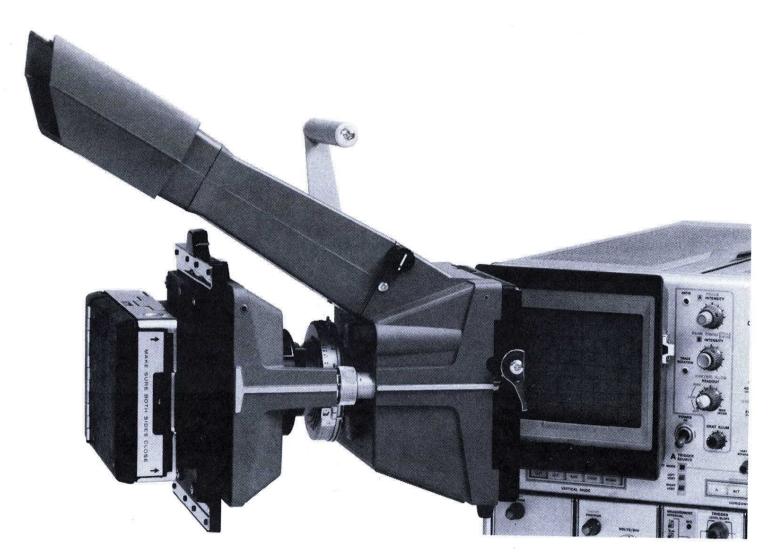
^{**}The C-53 lens records the largest practical image of an 8 x 10-cm crt display on Polaroid pack and roll film.

Interchangeable Lenses Interchangeable Film Backs Mechanical Shutter



C-27 MAIN FRAME





Lens—f/1.9, 0.85 magnification with relative light gathering ability of 1.0. Field of view is 8 x 10 cm with Polaroid pack and roll film (10 x 10 cm with Polaroid 4 x 5 in film). Other lenses available—see options.

Shutter—Mechanical, with speeds of 1 to 1/100S plus bulb and time. Provides X sync.

Included Accessories — Cable release (122-0586-02); split-image focus plate for Polaroid pack film back (387-0893-02) or split-image focus plate for Polaroid roll back (387-0893-01) or focusing screen integral with Graflok type back.

The C-12 is similar to the C-27 except that it employs a beam splitter mirror that eliminates parallax when viewing external graticules used on older oscilloscopes.

ORDERING INFORMATION

Mounting Adapter Required, See Pages 228 and 229

- "P" Models accept Polaroid pack film.
- "R" Models accept Polaroid roll film.
- "G" Models have Graflok type backs that accept 4 x 5 in sheet film holders or roll film holders.

										()-	2	7											
C-27P		•																			•	. 9	885	50
C-27R																								
C-27G			•			٠		•	٠	٠	•	٠	•	•		٠	٠	٠	٠			. \$	85	50
										C	; -	1	2											
C-12P	•		•	٠		:: * ::	•		•							•						\$1	00	00
C-12R																								

Extra interchangeable lenses with mechanical or electrical shutters are available to convert the C-12 or C-27 to the various options. See camera instruction manual or contact your nearest Tektronix Field Office or Representative.

C-27 Options Not Available on C-12 Option 01

FOR RECORDING 8 x 10 CM DISPLAYS ON CONVENTIONAL ROLL FILM

An f/1.9, 0.7 mag lens with relative light-gathering ability of 1.2, records 8×10 cm display on a 6×7 cm format roll flm such as 120, 220, or 70mm.

Option 03 UNITY MAGNIFICATION

An f/1.4 unity mag lens with relative light-gathering ability of 1.4 records full-sized image of 8×10 cm display on a 4×5 -inch film.

Specify Opt 03......Add \$220

Option 04 HIGH WRITING SPEED

An f/1.3, 0.5 mag lens with relative light-gathering ability of 2.6 records 8×10 cm display on Polaroid roll or pack film or on conventional roll or sheet film. Image size is reduced to obtain maximum writing speed.

Specify Opt 04......Add \$220

Dimensions	C-1	2	C-27								
	in	cm	in	cm							
Height	15.4	39.1	17.2	43.6							
Width	7.5	19.1	7.5	19.1							
Length	17.3	43.9	13.4	34.1							
Weight	lb	kg	lb	kg							
Net	12.3	5.5	10.5	4.7							
Shipping	16.0	7.2	14.0	6.3							

OPTIONAL ACCESSORIES

Mounting adapters—see pages 228 and 229.

Writing Speed Enhancer—Provides automatic controlled film fogging to increase writing speed about 3 times for 3000 ASA film and about 2 times for 10,000 ASA film. Installs in minutes.

Order 016-0280-00\$210

X Sync Cable—Mates to mechanical shutters or SPEEDCOMPUTER. Other end of cable has miniature phone plug.

Order 012-0364-01\$16

Carrying Case—Protects your C-12 or C-27 Camera during transport.

Order 016-0208-01\$170

Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.

Order 122-0671-00\$170

Polaroid Roll Film Back—Accepts Polaroid roll film. Included with "R" models.

Order 122-0603-00\$160

4 x 5 inch Graflok Type Back with Focusing Screen—Accepts standard cut-film holders, film-pack adapters, roll-film holders, Polaroid 4 x 5 in film holder. Included with "G" models.

Order 122-0604-00\$160

Projected Graticule (C-12 only)—Projects film work graticule. Includes 8 x 10 cm film work, 6 x 10 cm film work, write-in area film work, mask, graticule film holder, power cord (161-0091-00), for 115 V.

Order 016-0204-00\$300 for 230 V, Order 016-0234-00\$320

Reliable Electric Shutter

Low Trapezoidal Distortion

Easy Operation

U.L. 544 Component Recognition

The C-28 is a high-quality recording camera for systems displaying XY, YT or gray-scale images. It is highly recommended for those using **TEKTRONIX 600-Series Display**

Monitors. It features an f/2.8 lens with userchangeable .67 and .85 magnification ratios to record images from 8 x 10 or 10 x 12 cm crt's. Other magnification ratios are also available as options.

The C-28 shutter is electronically controlled to provide reliable, repeatable operation and to allow remote control by the user's system. Either a TTL low logic level or a switch closure will actuate the shutter. The C-28 has a highly rigid camera body, allowing the use of heavier accessories such as 70 and 90mm motorized rollfilm backs



without "keystone" distortion or defocusing. The Polaroid 31/4" x 41/4" film back is easily removed, leaving a Graflok-type interface for Graflok-compatible accessories. The film back can be rotated to allow prints to be pulled to the left, to the right, or downward. Optional range-finder focus lights allow quick focusing without removing the film. The C-28 uses the same mounting adapters as the C-27 and C-50 Series. The customer must provide a separate 15 Vdc 750 mA power supply. A connector and an 18-inch power-cable assembly is included.

SPECIFICATIONS

Dimensions

Height: Without viewing tunnel hood, 20.5 cm (8.06

Width: 18.5 cm (7.25 in)

Length: 24.6 cm (9.7 in) maximum with Polaroid pack film lower, mounting adapter, and focus set at maximum extension

Environmental

Temperature range for specified performance:

0°-50°C

Altitude: 4500m (15,000 ft) operating 15,000m (50,000 ft) non-operating

Weight: 3.8 kg (8.5 lb) with film pack and adapter

Standard Accessories:

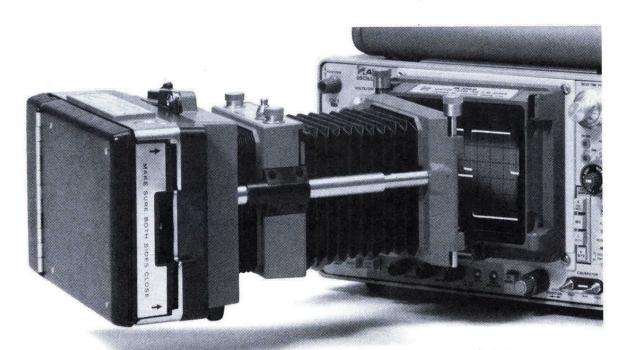
6 pin connector and 18 inch power and control cable assembly 131-1794-00, Polaroid pack film holder 352-0505-01 with focus plate 287-0893-02, viewing tunnel and hood 122-0719-01

ORDERING INFORMATION

C-28 Camera\$1085
Opt. 01 with Focus LightsAdd \$30
Opt. 02 with Graflok Focus Screen and Hood, 122- 0510-00 and 122-0944-00
Opt. 03 without Polaroid Film Back 352-0505-01Subt. \$50
Opt. 04 .8 Magnification OnlyAdd \$25
Opt. 05 .9 Magnification OnlyAdd \$25
Opt. 06 Unity Magnification OnlyAdd \$25
Opt. 08 with 016-0249-03 Adapter for 600, 7000, and 5000 Series
For information about OEM arrangements, contact your Tektronix Representative.

Variable Magnification and High Writing-Speed Camera

C-30A



Adaptable to Many Instrument Types Interchangeable Film Backs

The C-30A and C-31 Cameras are primarily designed for use with the 400-Series portable oscilloscopes, but are also adaptable to 8 x 10 cm crt or smaller 7000, 5000, and 600-Series instruments, and to some others. See chart on pages 228 and 229. The C-30A has variable magnification, permitting it to make use of the entire photo frame even with different crt sizes. The C-31 is designed for maximum writing speed (at the expense of image size).

Option 01 is designed to fit the 455, 464, 465, 466, 475 and 475A. The standard C-30A or C-31 fits the 485.

Relative Light Magnifi- Gathering Field of Lens Camera Speed cation Ability 8 x 10 cm f/1.91.0 C-30A 0.7 to 1.5 C-31 f/1.20.5 2.9 8 x 9 cm

Shutter—Mechanically actuated, with speeds from 1 to 1/60 s plus bulb and time. Provides x sync switch closure for arming oscilloscope single sweep or initiating the event of interest.

Included Accessories: Split-image focusing plate for Polaroid pack back (387-0893-02); or for Polaroid roll back (387-0893-01; mounting adapter for 485 size bezel (016-0306-00).

Dimensions	C-3	0AP	C-3	1 R			
	in	cm	in	cm			
Height	5.1	13.0	5.5	14.0			
Width	7.5	19.1	9.1	23.1			
Length	10.4	25.4	10.6	26.9			
Weight (approx)	lb	kg	lb	kg			
Net	4.8	2.2	6.8	3.1 5.4			
Shipping	9.0	4.1	11.0				

ORDERING INFORMATION

"P" Models accept Polaroid pack films.

"R" Models accept Polaroid roll films.

C.	·J	U	Н

C-30AP CAMERA		٠	•		•	٠	٠	•	•	٠	٠	•	•	•	•	\$75	50
C-30AR CAMERA	•	٠		•	•			•		٠	٠		•	٠		\$75	50
	C	,-	3	1													

C-31P CAMERA\$1000

C-31R CAMERA\$1000

OPTIONS

C-30A Opt 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 016-0301-00 adapter for 465 size crt bezel. Recommended for-455, 464, 465, 466, 475, 475A.

Specify Option 01......Add \$20

C-30-Series Cameras

C-31 Opt 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 016-0269-02 adapter for 465 size crt bezel.

Recommended for-455, 464, 465, 466, 475, 475A.

Specify Opt 01Add \$15

Electric Shutter—Allows remote or automatic actuation of the shutter with an insulated switch closure. Includes SPEEDCOMPUTER control box. Provides speeds of 1 to 1/60 s plus bulb and time. Requires 115 V ac, 50-60 Hz. Also available with Opt. 01.

C-30APE\$1125 C-31RE\$1380

CONVERTING OPT 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30A and C-31 Cameras can be converted to standard models by simply slipping off the Corrector Lens, removing the Adapter Frame, and adding an 016-0306-00 Adapter. Please refer to pages 228 and 229 for prices and compatibility.

CONVERTING STANDARD MODEL TO OPT 01 MODEL

A standard-model C-30A or C-31 can be converted to an Option 01 model by means of the appropriate Adapter Frame/Corrector Lens: 016-0301-00 for C-30A; 016-0269-02 for the C-31. Please refer to pages 228 and 229 for prices and compatibility.

OPTIONAL ACCESSORIES

Writing Speed Enhancer—Increases effective film speed about 3 times for 3000 speed film or about 2 times for 10,000 speed film. Installs in minutes.

Order 016-0284-00\$210

Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.

Order 122-0752-00\$160

Polaroid Roll Film Back—Accepts Polaroid roll film.

Order 122-0754-00\$160

Included with "R" models.

Graflok Type 4 x 5 in Back-Accepts Polaroid Land 4 x 5 in film holders, standard cut film holders, film pack adapters, roll film holders (except heavy motorized roll film holders). Order 016-0487-00\$170 Carrying Case-Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 181/2 x 141/2 x 8 in. Order 016-0587-00\$55 X Sync Cable-Order 012-0364-01\$16 C-30A 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 in. the camera covers 19 x 21 in. Usable with either the C-30A or C-30A

Order 016-0246-02\$25

C-5B

Low Cost Camera

Easy to Use
Low Cost
Graticule Illumination
Modular Versatility
Electric Shutter
Improved Lens

The C-5B is a low-cost general-purpose camera with Polaroid Pack-film back and a graticule illuminator. Its lightweight modular design provides three interchangeable adapter hoods that fit most TEKTRONIX Oscilloscopes and small monitors.

All three adapter hoods have an opening in the top for a lift-up viewing door or a Xenon flash unit for illuminating the crt graticule. The flash unit has a flipdown viewing door.

Lens—New, 3-element lens with improved focus uniformity. 0.67 or 0.85 magnification selectable by user. The fixed f/16 aperture provides a wide depth of field and eliminates need for adjustable focus.

The f/16 lens has a relatively low light-gathering ability of 0.02 and is not recommended for photographing single-sweep waveforms.

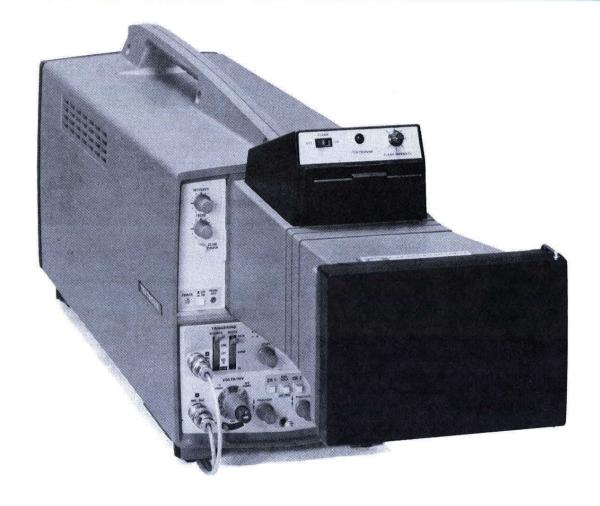
Shutter—Electric with speeds from .1 to 5 seconds.

Graticule Illumination—Variable intensity Xenon flash, triggered by shutter opening, evenly illuminates the crt screen to backlight non-illuminated graticules.

Recommended Film—Type 107, 3,000-speed pack film.

Field of view—0.67 mag— 9.8×12.2 cm, 0.85 mag— 8×10 cm.

Power Source—(4) AA batteries, not included.



Opt 01.

Dimensions in cm Height 5.5 14 Width 6.6 16.8 Length 10.1 25.7 Weights (approx) lb kg Weight 3 1.4 Net Shipping 4.1 1.9

ACCESSORIES

ADAPTER HOODS (also requires door or flash listed below)

Included with the C-5B and C-5B Option 01 C	ameras.
Included with the C-5B Option 02 Camera. 016-0359-00	\$15
Included with the C-5B Option 03 Camera. 016-0358-00	\$15
VIEWING DOOR Fits all three adapter hoods Mounting screws included. Included with Counting of the Oct.	-5B Opt
016-0630-00	\$5
FLASH UNIT Fits all three adapter hoods. Mounting screws included. Included with C-C-5B Opt 03.	-5B and

016-0363-01\$53

Order	For Use With	Adapter Hood (Included) Part Number	Flash Unit Included	Price
C-5B	577, 600-Series with unilluminated graticule, 1420-Series, 5100-Series	016-0357-00	Yes	\$300
C-5B Opt 01	528, 600-Series w/o graticule, or with illuminated graticule, 5400-Series, 7000-Series, T922R, TELEQUIPMENT D83	016-0357-00	No	\$265
C-5B Opt 02	432, 434, 455, 464, 465, 465M, 466, 475, 475A	016-0359-00	No	\$265
C-5B Opt 03	T900 Series except T922R	016-0358-00	Yes	\$300

Probes and Accessories

RECOMMENDED PROBES

INSTRUME		ACTIVE	CURRENT		PASS	IVE	ACTIVE	CURRENT
	PASSIVE	ACTIVE	CORNERI	400 SERIES	. 700		Company Company Company	
7000 SERIES	ASSES 2000X 200 BESSES ASSESSMENT			400 SERIES 485	P6101	P6013A	P6201	P6021
7A11 7A13	Built in FET Probe P6055 P6013	BA	P6021	485	P6106 P6056 P6057	P6015 P6009	P6202 P6046	P6022 P6302/AM503 P6303/AM503
	P6101 P6018 P6060 P6009 P6062B	9	P6022	475A	P6063B P6101	P6013A	P6201	P6021
7A15A	P6101 P6013 P6105 P6019 P6062B P6009	5	P6021 P6022	475	P6106 P6063B	P6015 P6009	P6202 P6046	P6022 P6302/AM503 P6303/AM503
7A16A	P6106 P601 P6101 P601 P6063B P600	5 P6202	P6021 P6022 P6302/AM503	465	P6101 P6105 P6062B	P6013A P6015 P6009	P6201 P6202 P6046	P6021 P6022 P6302/AM503 P6303/AM503
7A18	P6101 P6013 P6105 P601 P6062B P600	5	P6021 P6302/AM503	465M	P6101 P6104	P6013A P6015 P6009	P6201 P6202 P6046	P6021 P6022 P6302/AM503
7A19	P6056 P6057	P6201 P6202	P6022 P6302/AM503 P6303/AM503	455	P6101 P6108	P6013A P6015	P6202	P6303/AM503 P6021 P6022 P6022
7A22	P6101 P6055 P6060		P6021 P6302/AM503	466	P6062B	P6009 P6013A	P6202	P6302/AM503 P6303/AM503 P6021
7A24	P6062B P6056 P6057	P6201 P6202	P6022 P6302/AM503 P6303/AM503	464	P6105 P6062B	P6015 P6009	P6201	P6022 P6302/AM503 P6303/AM503
7A26	P6101 P601 P6106 P601 P6063B P600	5 P6202	P6022 P6302/AM503 P6303/AM503	434	P6101 P6108 P6013A P6009 P6015			P6021 P6022 P6302/AM503 P6303/AM503
5000 SERIES			j j	300 SERIES	1			
5A13N	P6101 P601 P6055 P601 P6060 P600	5	P6302/AM503 P6021	314	P6101 P6149			P6021 P6022 P6302/AM503 P6303/AM503
5A14N	P6101 P601 P6108 P601 P6062B P600	5	P6302/AM503 P6021	335	P6101 P6149			P6021 P6022 P6302/AM503
5A15N	P6101 P601 P6108 P600 P6062B P600	5	P6302/AM503 P6021	326	P6101 P6149			P6303/AM503 P6021 P6022
5A18N	P6101 P600 P6108 P600 P6062B P600	5	P6021 P6302/AM503	323	P6101			P6302/AM503 P6303/AM503 P6021
5A19N	P6101 P6060 P6055 P6108				P6149			P6022 P6302/AM503 P6303/AM503
5A20N	P6101			T900 SERIES				
	P6055 P6060			T935A	P6101 P6108			P6021 P6022 P6302/AM503
5A21N	P6101 P6055 P6060		P6021		P6062B P6009 P6013A P6015			P6303/AM503
5A22N	P6101 P6055 P6060			T932A	P6101 P6108 P6062B			P6021 P6022 P6302/AM503
5A23N	P6101 P6108 P6062B		P6021 P6302/AM503		P6009 P6013A P6015			P6303/AM503
5A24N	P6101 P6108 P6062B		P6021	T922/T922R	P6101 P6108 P6062B P6007			P6021 P6022 P6302/AM503 P6303/AM503
5A26	P6101 P6060 P6055		P6021	T921	P6013A P6015			P6021
5A38	P6101 P60 P6105 P60 P6062B P60		P6021 P6022 P6302/AM503		P6108 P6062B P6006 P6007			P6022 P6302/AM503 P6303/AM503
5A45	P6101 P60 P6105 P60 P6062B P60	13A 15 09	P6021 P6022 P6302/AM503	T912	P6013A P6015			
5A48	P6101 P60 P6105 P60 P6062B P60	13A 15 09	P6021 P6022 P6302/AM503		P6108 P6062B P6007 P6013A			

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 impedance. 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 $M\Omega$ inputs.

VOLTAGE PROBES for 1 M Ω Inputs

Туре	Atten	Length*	Package Number	L	pading	Useful ⁵ BW MHz	Dc Max	Scope C in pF	Readout	Page
P60061	10X	3.5 6 9 12	010-0127-00 Opt 01 010-0160-00 Std 010-0146-00 Opt 02 010-0148-00 Opt 03	10 M Ω	7.5 pF ² 8.5 11 13	35 25 25 12	600 V	15 to 55	NO	244
P6007	100X	3.5 6 9 12	010-0150-00 Opt 01 010-0165-00 Std 010-0152-00 Opt 02 010-0154-00 Opt 03	10 ΜΩ	2 pF ² 2.2 2.4 2.6	25 20 15 13	1.5 kV	15 to 55	NO	244
P6008	10X	3.5	010-0129-00	10 MΩ	7.5 pF	100	600 V	12 to 47	NO	244
P6008 (Environm	10X nentalized)	6	010-0129-01 Std.	10 MΩ Environment	7.5 pF alized —50°C	100 to +150°C	600 V	12 to 47	NO	244
P6009	100X	9	010-0170-00 Opt 04 010-0264-01 Std	10 ΜΩ	2.5 pF ² 2.5	120 100	1.5 kV	12 to 47	NO YES	244
P6010	10X	3.5	Furnished wit	n S-5 (Page 78)	. For other use:	s see P6105 or	P6106			
P6013A	1000X	10 25	010-0177-01 Std 010-0175-01 Opt 03	100 ΜΩ	3 pF 3.5	80 13	12 kV	15 to 55	NO	245
P6015	1000X	10	010-0172-00 Std	100 MΩ	3 pF	75	20 kV	12 to 47	NO	245
P6028	1X	3.5 6 9 12	010-0074-00 Opt 01 010-0075-00 Std 010-0076-00 Opt 02 010-0077-00 Opt 03	1 ΜΩ	50 pF 67 90 112	17 10 7 4	600 V	ANY	YES	245
P6048	10X	6	010-0215-00	1 kΩ	1 pF	100	20 V	15 to 20	NO	
P6053B	10X	6	010-6053-13	10 ΜΩ	12.5 pF	200	500 V	15 to 24	YES	245
P60553	10X	3.5	010-6055-01 Std	1 ΜΩ	10 pF	60	500 V	20 to 47	YES	245
P6060 ³	10X	3.5 6	010-6060-01 Opt 01 010-6060-03 Std	10 ΜΩ	7.5 pF ² 8.5	35 25	600 V	15 to 55	YES4	246
P6062B	10X or 1X 10X or 1X 10X or 1X	3.5 6 9	010-6062-11 Opt 01 010-6062-13 Std 010-6062-15 Opt 02	10 MΩ 1 MΩ 10 MΩ 1 MΩ 10 MΩ 1 MΩ	13.5 pF 100 14 105 17 135	100 8 100 6.7 95 4.5	500 V	15 to 47	YES	246
P6063B	10X or 1X 10X or 1X	3.5 6	010-6063-11 Opt 01 010-6063-13 Std	10 MΩ 1 MΩ 10 MΩ 1 MΩ	11 pF 80 14 105	200 12 200 6	500 V	15 to 24	YES	246
P6101	1X	1 m 2 m 3 m	010-6101-01 Opt 01 010-6101-03 Std 010-6101-05 Opt 02	1 ΜΩ	32 pF 54 78	34 15.5 8	500 V	ANY	_	247
P6105	10X	1 m 2 m 3 m	010-6105-01 Opt 01 010-6105-03 Std 010-6105-05 Opt 02	10 ΜΩ	10.5 pF 13.0 15.5	100 100 95	500 V	15 to 47	YES	247
P6106	10X	1 m 2 m 3 m	010-6106-01 Opt 01 010-6106-03 Std 010-6106-05 Opt 02	10 MΩ	10.5 pF 13.0 15.5	300 ⁶ 250 150	500 V	15 to 24	YES	247
P6108	10X	1 m 2 m 3 m	010-6108-01 Opt 01 010-6108-03 Std 010-6108-05 Opt 02	10 ΜΩ	10.5 pF 13.0 15.5	100 100 95	500 V	15 to 47	NO	247
P6149	10X	2 m	010-6149-03 Std	10 MΩ	15.5 pF	50	500 V	20 to 62	NO	247

^{*}Length in feet except where specified.

^{1.} To convert to uhf connectors, use adaptor 103-0015-00.

^{2.} Rating varies with scopes having other than 20 pF inputs.

Designed for use with scopes having differential inputs.

^{4.} Not compatible with crt readout.

^{5. 25} Ω source.

^{6.} Typically 300 MHz at probe tip with scope bandwidth at least 325 MHz.

Where higher frequencies (above 250 MHz) are encountered, active FET probes which have high input resistance and low input capacitance through their dynamic range should be used. For 50 Ω systems, see adjacent selection chart of 50 Ω divider probes.

FET PROBES

							IN	PUT LIMIT	S		
Туре	Atten	Length ¹	* Package Number	Loading		Rise time in ns	Max dc + pk ac	Linear Dynamic Range	Dc Offset Range	Read- out	Page
P6046	1X	6.0	010-0232-00 Std	1 ΜΩ	10 pF	3.5	±25 V	±5 V		NO	240
Diff/Amp	10X			10 MΩ	3 pF		±250 V	±5 V			240
	1X	6.0	010-6201-01 Std	100 kΩ	3 pF	0.4	±100 V	±0.6 V	±5.6 V	YES	
P6201 FET	10X			1 ΜΩ	1.5 pF		±200 V	±6 V	±56 V		239
	100X	1		1 ΜΩ	1.5 pF		±200 V	±60 V	±200 V		
P6202	10X	2m	010-6202-01 Std	10 MΩ	2 pF	0.7	±200 V	±6 V	±55 V	YES	239
FET	100X	1000000	W/010-0384-00Atn	10 MΩ	2 pF	0.7	±200 V	±60 V	±200 V	NO	200

For rise time measurements, the interaction of the probe capacitance with the source impedance is of importance (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

50- Ω DIVIDER PROBES—For use with 50 $\!\Omega$ input amplifiers

							INPUT	LIMITS		
Туре	Atten	Length*	Package Number	Load	ing	Rise time in ns	Max dc + pk ac	Linear Dynamic Range	Read- out	Page
		6.0	010-6056-03 Std	500 Ω	1 pF	0.1	±16 V	\pm 16 V	YES	
P6056	10X	9.0	010-6056-05 Opt 2							240
DCOEZ	100X	6.0	010-6057-03 Std	5 kΩ	1 pF	0.25	±50 V	\pm 50 V	YES	
P6057	100%	9.0	010-6057-05 Opt 2							240

^{*}Length in feet except where specified.

For measuring currents from dc to 1000 A, see the adjacent selection chart for 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. To obtain the total picture, a measurement of the current waveform is necessary.

CURRENT PROBES

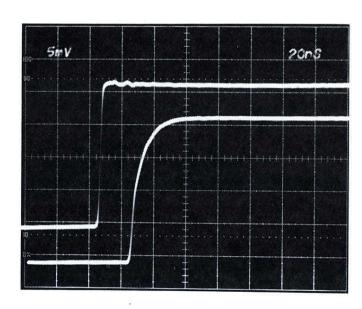
			Current/ Scope		SATU	RATION	ı	UMIXAN	M CURR	ENT		
	Bar			Any Sensi-			dc + pk	ac	Der	ate	Peak Pulse	
Туре	wid Hz to		10 mV/div	tivity mA/mV	Dc Amps	Amp-S Product	ac Amp	p-p Amp	Below	Above	Amp	Page
P6302/	dc	50	1 mA to 5A		20	100x10-6	20	40		1 MHz	50	
AM503 P6302/ AM 503 with CT-5	0.5	20	20 mA to 5 kÅ			0.1		40 k	20 Hz	1.2 kHz	50 k	241
P6303/ AM503	dc	15	10 mA to 50 A		100	10,000x10-	100	200		20 kHz	500	241
P6021 Passive	Valent Service Co.	3507				0.5.40.3		15	300 Hz	5 MHz	250	242
Term	120	60	1 mA to 1A	2 or 10	0.5	0.5x10 ⁻³				THE PARTY OF THE P	15	1
134	12	38			0.5	0.5x10 ⁻³		15	230 Hz	5 MHz	10	-
CT-5/ Passive Term	120	20		40 or 10 k	20	0.5		2000	300 Hz	1.2 kHz	50 k	3
CT-5/134	12	20	20 mA to 1 kA*		20	0.5		2000	230 Hz	1.2 kHz	15 k	1
P6022 Passive Term	8.5 k	200		1 or 10	0.2	9x10 ⁻⁶		6	3 kHz	10 MHz	100	242
134	100		1 mA to 1A*		0.2	9x10-6		6	1.3 kHz	10 MHz	15	1
CT-1	1208030	1000		5mV/mA	0.2	1x10-6		1.4			100	243
CT-2	1.2 k			1m/mA	0.2	50x10-6		7			100	243

^{*}Scope at 50 mV/div

Recommended Probes—For 7000 Series see page 55, for 5000 Series see page 81, for 400 Series see the individual instrument description.

OTHER PROBES

Probe	Package Number	Function	Use	Page
P6058	010-0260-00	Temperature and Voltage Probe	DM 501 7D13	143 73
P6430	010-6430-00	Temperature Probe	DM 44	127
P6104	010-6104-00	Voltage Probe	465M	104
40 kV	010-0277-00	High Voltage Probe	DM 501 DM 502	143 142
P6450	010-6450-01	Data Acquisition Probe	LA 501 W	26
P6451	010-6451-01	Data Acquisition Probe	7D01 LA 501W	23 26
P6401	010-6401-01	Logic Probe	TTL Logic	28
P6420	010-6420-03	RF Probe	DM 501 DM 502 DM 44	143 142 127



Low Capacitance Loading High Frequency Response Full 1X Sensitivity

The lower waveform shows the rise time of a circuit using a passive probe with 10 pF input capacitance. The upper waveform shows the same circuit and an active FET probe with less than 2 pF input capacitance.

Where

- 1. High source impedance points; >50 Ω
- 2. Low power circuits
- 3. Small signal circuits
- 4. >200 MHz frequency responses desired
- 5. Tuned circuits
- 6. No instrument probe power availability
- Generally any circuit where a voltage measurement is needed and minimal circuit disturbance desired
- High cmrr needed—differential measurement

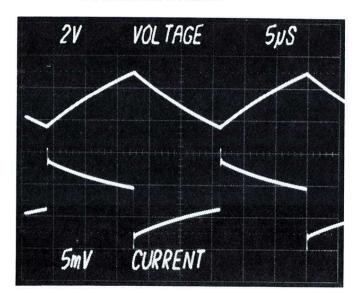
USAGE

What & Why

- P6201 or P6202 depending on frequency and sensitivity desired: the low input C and high input R combination, available only in an active probe, provides fastest rise time (C influenced) and accurate amplitude.
- P6201 or P6202 depending on frequency and sensitivity desired: the high input impedance of an active probe at all frequencies will provide a minimum signal power drain.
- P6201: 1X or full sensitivity without bandwidth loss allows maximum amplitude of small signals.
- 4. P6201, P6202, P6056, P6057: the specific choice will depend upon the frequency and other circuit characteristics.
- 5. P6201, P6202: these probes offer minimum disturbance due to low C.
- P6202: the only active probe available today designed to work from a 110/220 outlet.
- The general benefit of an active probe is its combination of low C and high R.
- P6046: to obtain maximum cmrr, the active circuitry needs to be at the measurement point.

Descriptions of active and 50-Ω probes begin on page 239. A performance summary is on page 237.

USING A CURRENT PROBE



Lowest Loading
Clip-on; No Need to Break Circuit
under Test
Observe Current Waveform
Differential Measurements
Measure Bare Conductors

This picture shows the difference between a voltage and a current waveform. This application is looking at the charging voltage and current of a capacitor.

When

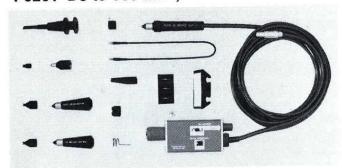
- 1. Looking at reactive sources (capacitive, inductive).
- 2. Evaluating current dependent devices (transistors, SCR's, commutators, etc)
- Probing high source impedance points (drains, collectors, plates, and other passive or active high impedance points).
- 4. Evaluating source points sensitive to loading.
- Any time information on current characteristics is needed.

Why

- 1. Voltage measurements tell only a portion of the system's characteristics.
- 2. A voltage measurement alone can't characterize the operation of the device.
- Lower loading providing more accurate rise time and amplitude measurements.
- Voltage techniques may alter the operating characteristics of circuits sensitive to loading. Current probes exhibit significantly less source loading, providing more accurate signal representations (minimize alteration of actual circuit operation).
- A current measurement directly defines current characteristics without calculations and assumptions about the circuit.

For current probes, see pages 241, 242 and 243, or the performance summary on page 237.

P6201 Dc to 900 MHz, 1X



Dc to 900-MHz Bandwidth
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. The very low input capacitance of the probe permits acquisition of high frequency signals with minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The P6201 will maintain excellent rise time and pulse fidelity in higher source impedance circuits, due to low input capacitance when compared to other general-purpose probes.

The P6201 provides a dc offset feature to bias out a voltage level and allow observation of signals riding atop a carrier. This allows the signal to be brought within the linear input window of the probe. Ac or dc coupling selection is also available. When ac coupled, the dc voltage component, which could otherwise saturate an active probe, is blocked, allowing viewing of the superimposed signal. The P6201 is designed primarily for use with TEKTRONIX 7900, 7800, and 7700 Series, 475, 475A and 485 Oscilloscopes, due to its direct compatibility with the probe power available on these instruments. The P6201 is valuable for use in the 50 Ω and 1 $M\Omega$ input real time oscilloscope systems and also with sampling systems, spectrum analyzers, and counters where high performance and minimum signal source loading is desired.

The probe includes a locking-type BNC connector which provides scale-factor readout information to instruments having readout capability, while maintaining compatibility with those instruments without readout. The 10X and 100X attenuator heads couple readout information to the instrument via the output connector.

The 1101 Accessory Power Supply is available to power the P6201 for use with instrumentation not supplying probe power.

Bandwidth (-3 dB) dc to 900 MHz. Rise Time is 0.4 ns or less. Probe Gain is 1X within 3%. Attenuator Accuracy \leq 4% with probe (10X or 100X). Input Impedance (probe only) is 100 k Ω (within 1%) shunted by approx 3.0 pF. Attenuator heads are 1 $\mbox{M}\Omega$ (within 1%) shunted 1.5 pF or less. Dynamic (Signal) Range is at least \pm 600 mV; extends to \pm 6 V with 10X attenuator, ± 60 V with 100X attenuator. Dc Offset Range is at least -5.6 to +5.6 V (with respect to tip of probe without attenuator head). Effective offset is extended by 10X and 100X attenuation heads to \pm 56 V and \pm 200 V respectively. **Noise** (Tangential) is 300 μV or less at output. Max Input Voltage is \pm 100 V, probe only and \pm 200 V with attenuation heads, derating with frequency. Lf Response (-3)dB) (ac coupled) is 10 Hz or lower; 10X attenuator extends If response to \leq 1 Hz; with 100X attenuator, If response is \leq 10 Hz.

Included Accesories:

ORDERING INFORMATION

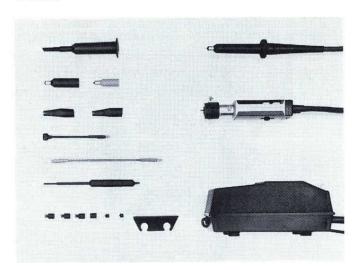
P6201 FET Probe, Order 010-6201-01..\$700 1101 Power Supply

Accessory Power Supply, for powering up to four P6201 Probes.

1101 Probe Power Supply, Order 1101 \$400

P6202

Low Cost



Dc to 500-MHz Bandwidth
Self-Contained Power Supply
Dc Offset
High Input Impedance through Freq Range
Small Probe Size
Rugged

The P6202 is an active (FET) probe providing dc to 500-MHz bandwidth. Because of its self-contained power supply, it can be used on any instrument without concern for 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 probe was designed to be used with any oscilloscope (real time, sampling, spectrum analyzer, etc) where high frequency signals are acquired and/or low circuit loading is necessary. A switch in the output of the probe amplifier allows the probe to be used on 50 Ω or 1 M Ω inputs.

The probe body is small for getting into tight areas, and is very rugged to withstand the rigors of production testing and yet sophisticated enough for R & D work.

Optional accessories are a plug-on 10X attenuator head for 100X attenuation and a plug-on ac coupling head to block out unwanted dc components.

The probe includes a BNC connector which provides scale readout on the 10X mode to instruments having readout capability, while maintaining compatibility with the instruments without readout.

Included Accessories:

013-0097-01 1 TIP, retractable hook

352-0351-00 1 PROBE HOLDER

344-0046-00 2 CLIPS, alligator

175-0849-00 1 LEAD, 8 cm ground

016-0378-00 1 CARRYING CASE (not shown)

003-0675-01 1 TOOL, adjustment

175-1017-00 1 LEAD, 13 cm ground

2 TIPS, probe*

166-0404-01 1 SLEEVE, insulating

*Available in package of 10 only, order 206-0230-01

ORDERING INFORMATION

P	6202	FET	Probe,	2	N	16	et	eı	-	C	al	b	le	,							
Oi	rder	010-	6202-01				٠				٠	•	•	•	٠	•	•	٠	•	\$39	0
100	- 0	101111211	100																		

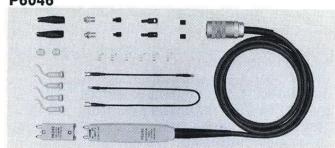
Optional Accessories:

P6202 10X	Attenuator,	Order	010-0384-00	\$45
				-00\$22

SPECIFICATIONS

Characteristic	Probe	Opt 10X Attenuator Head	Opt Ac Coupling Cap
Bandwidth (-3 dB)	dc to > 500 MHz	dc to ≥ 500 MHz	16 Hz to \geq 500 MHz
Rise Time	<0.7 ns	≤0.7 ns	\leq 0.7 ns
Attenuation	10X within 4%	100X within 2%	-
Input Impedance	10 MΩ within 2% shunted by approx 2 pF	10 MΩ within 2% shunted by approx 2 pF	approx 4 pF
Dynamic Range	0 to ±6 V	0 to ±60 V	-
Dc Offset Range	−55 V to +55 V	_200 V to +200 V	-
Noise (Tangential)	150 μV or less	150 μV or less	
Max Safe Input Voltage	200 V dc + peak ac	200 V dc + peak ac	200 V dc + peak ac

Active and 50- Ω Probes P6046



Dc to 100 MHz with 1000:1 Cmrr at 50 MHz

The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities when used with all TEKTRONIX Oscilloscopes. With this probe system, 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. In addition, the wide-band capability of the P6046 Probe and Amplifier provides dc to 100 MHz single-ended and differential measurements. The cmrr of the P6046 and amplifier is 1000:1 at 50 MHz.

A switch on the probe selects ac or dc input coupling. Accessories include a plug-on 10X attenuator for extending the differential input voltage range, and a ground tip for applications requiring single-ended input. Unique swivel tips provide variable spacing to accommodate varying distance between test points.

The P6046 Amplifier mounts conveniently on the side of the oscilloscope and features a calibrated 1 mV/div to 200 mV/div (2 V/div with 10X attenuator) deflection factor (oscilloscope deflection factor set at 10 mV/div). The output impedance of the amplifier is 50 Ω . A 50- Ω termination is supplied with the amplifier for use with 1-M Ω systems.

The P6046 Differential Probe may be used with the 1A5 Differential Amplifier with TEKTRONIX 540 and 550 Series Oscilloscopes. The P6046 Probe extends the differential measurement capabilities of the 1A5 to 45 MHz. The 1A5 supplies both probe power and amplification.

CHARACTERISTICS Probe and Amplifier

Deflection Factor is 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). Bandwidth is dc to 100 MHz at 3 dB down. Rise Time is 3.5 ns or less. Common-Mode Rejection Ratios with deflection factors of 1 mV/div to 20 mV/div to at least 10,000:1 at 50 kHz, 5000:1 at 1 MHz, 1000:1 from 10 MHz to 20 MHz, and 1000:1 at 50 MHz. Common-Mode Linear Dynamic Range is ± 5 V, ± 50 V with 10X attenuator. Input RC is 1 $M\Omega$ paralleled by 10 pF or less. Input Coupling is ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is 3 dB down at 20 Hz, 2 Hz with 10X attenuator. Displayed Noise is 280 μV or less (tangentially measured). Max Input Voltage is ± 25 V (dc + peak ac), ± 250 V with 10X attenuator. Output Impedance is 50 Ω through a BNC-type connector. A 50- Ω termination is supplied with the amplifier for use with 1-M Ω systems. Probe Cable is 6 ft long terminated with a special nine-pin connector. Amplifier Power Requirements are 10 W max, 48 to 400 Hz. Factory wired for 105 V to 125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal).

Included Accessories:

014-0029-00 1 HANGER, power supply assembly

012-0076-00 1 CABLE, 50Ω

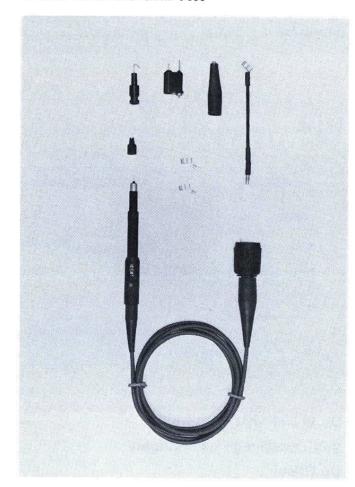
011-0049-01 1 TERMINATION, 50Ω

016-0111-01 1 CARRYING CASE, (not shown)

ORDERING INFORMATION

P6046 FET Differential Probe, Amplifier, and Power Supply,

P6056 Dc to 3.5 GHz 10X



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 adapter. 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.

Attenuation is 10X. Input Resistance is 500 Ω at dc and approx 300 Ω at 1 GHz. Input Capacitance is 1.0 pF. Rise Time is less than 100 ps, probe only. Typical Rise Time with 7904 Oscilloscope and 7A19 Amplifier is 0.8 ns. Bandwidth is 3.5 GHz probe only, dc to 500 MHz with 7A19 and 7904. Max Input Voltage RF (CW) 22 V, dc 16 V. Max Power Dissipation is 0.5 W. Transit Time Variation from probe to probe is less than 70 ps.

Included Accessories:

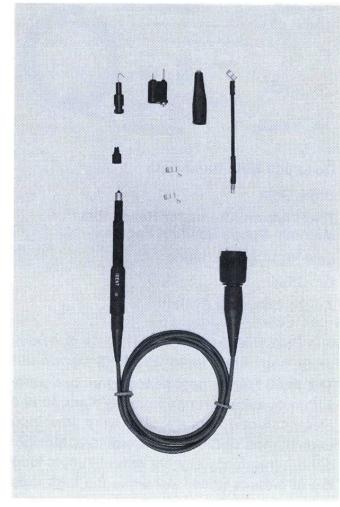
344-0046-00 1 CLIP, alligator 206-0114-00 1 TIP, hook 013-0085-00 1 TIP, bayonet ground

214-0283-00 1 **CONTACT**, electrical 175-0249-00 1 **CABLE**, ground

ORDERING INFORMATION

Opt 02, 9 ft, Order 010-6056-05\$110

P6057 Dc to 1.4 GHz 100X



The P6057 is a miniature low-capacitance probe for use with 50 Ω , wide-band oscilloscopes. Bandwidth is dc to 1.7 GHz. This probe can also be used with 50- Ω sampling systems, with an appropriate BNC female adapter (017-0063-00).

The P6057 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.

Attenuation is 100X. Input Resistance is 5000 Ω at dc and approx 1500 Ω at 1 GHz. Input Capacitance is 1.0 pF. Rise Time is less than 250 ps, probe only. Typical Rise Time with 7904 Oscilloscope and 7A19 Amplifier is 0.8 ns. Bandwidth is 1.4 GHz probe only, dc to 480 MHz with 7A19 and 7904. Max Input Voltage 50 V dc or rms to 500 MHz decreasing to 21 V at 1 GHz. Transit Time Variation from probe to probe is less than 70 ps.

Included Accessories:

344-0046-00 1 **CLIP**, alligator

206-0114-00 1 TIP, hook

013-0085-00 1 **TIP**, bayonet ground 214-0283-00 1 **CONTACT**, electrical

175-0249-00 1 CABLE, ground

ORDERING INFORMATION

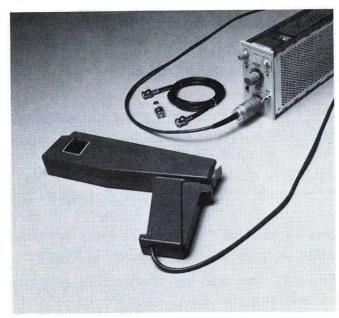
P6057 100X 50 Ω Probe, 6 ft, Order 010-6057-03\$110

Opt 02, 9 ft, Order 010-6057-05\$110

SUGGESTED MEASUREMENTS

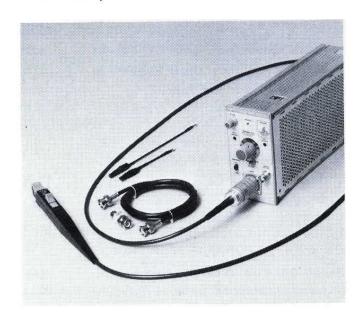
X-Ray Tube Currents **SCR Currents Power Supply Currents Motor Start-Up Currents Industrial Control Currents Relay Currents**

Common-Mode Rejection of Dc and **Ac Currents**



P6303 CURRENT PROBE 100 A Ac and Dc Current Measurements Dc to 15-MHz Bandwidth Peak Pulse Measurements to 500 A Ac or Dc Coupling 1 inch x 0.830 inch (2.5 x 2.1 cm) **Jaw Opening** Minimal Loading — 0.02 Ω Insertion

Z at 1 MHz, 0.15 Ω at 15 MHz.



P6302 CURRENT PROBE 20A Ac and Dc Current Measurements DC to 50 MHz Bandwidth

Peak Pulse Measurements to 50A, 50,000 A with the CT-5 Current Probe

Current Probe

Ac or Dc Coupling

Small Loading — 0.1 Ω Insertion Z at 5 MHz, $0.5~\Omega$ at 50 MHz.

The TEKTRONIX P6303 and P6302 are two current probes designed to be used with the AM 503 Current Probe Amplifier, any TM 500 Power Module and an oscilloscope.

Both probes make ac or dc coupled current measurements simply by opening their sliding jaws and placing them around the conductor being tested. With their combination ac and dc measurement capabilities, both can measure fast transients, low frequency response, and dc levels all at the same time. For differential or sum measurements, just place the conductors in the probe jaw in the proper phase.

The P6303, new this year, measures currents to 100A within the frequency range of dc to 15 MHz. It features a large 1 x 0.83 inch (2.5 x 2.1 cm) jaw opening to accommodate large cables. Peak pulse measurements may be made to 500 A.

The P6302 measures currents to 20 A, 50 A peak, within the frequency range of dc to 50 MHz. By adding the CT-5 current probe, you can extend the capabilities of the P6302 to a 5000 A/div range (50,000 A peak).

Both the P6303 and the P6302 are used for making SCR power supply, industrial control, and motor start-up current measurements. The P6303 is especially recommended for measuring the current in X-ray tubes to insure compliance with the performance standards of PL 90-602, The Radiation Control for Health and Safety Act of 1968. Both are valuable measurement tools when low loading is important, as when testing high impedance points, or with current dependent devices.

The P6303 or P6302 is connected to the AM 503 through a multi-pin connector. The AM 503 operates in any of the TM 500 Power Modules. 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 P6303 or 20 A dc with the P6302. A push button allows degaussing of probe when it is removed from the circuit and locked in operating position.

The output of the P6303/AM 503 can be displayed on any oscilloscope with at least a 50-MHz bandwidth and 10 mV sensitivity, the P6302/AM 503 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 Ω recording instrument, or a 50 Ω termination which is supplied.

P6303 SPECIFICATIONS

Bandwidth — Dc to \geq 15 MHz (-3 dB), \leq 7 Hz to \geq 15 MHz (-3 dB) ac coupled. Bandwidth can be limited to \simeq 5 MHz with AM 503 front-panel switch.

Rise Time — 23 ns or less.

Maximum Current — 100 A (dc + peak ac).

Maximum Peak Pulse Current — 500 A.

Amp Second Product — 10,000 Aμs

Sensitivity - 10 mA/div to 50 A/div within 3% (in calibrated steps) into 50 Ω load; indicating device (oscilloscope) sensitivity 10 mV/div.

Insertion Impedance — 0.02 Ω at 1 MHz, 0.15 Ω at 15

Maximum Voltage (bare conductor) - 700 V. Maximum Conductor Size — 0.830 inch (2.11 cm).

INCLUDED STANDARD ACCESSORIES

016-0622-00 1 CARRYING CASE

P6302 SPECIFICATIONS

Bandwidth — Dc to \geq 50 MHz (-3 dB), \leq 7 Hz to >50 MHz (-3 dB) ac coupled; the system's bandwidth may be limited to ~5 MHz with the AM 503 front panel switch.

Rise Time - 7 ns or less.

Maximum Current — 20A (dc + peak ac).

Maximum Peak Pulse Current — 50 A.

Amp Second Product — $100 \text{ A}\mu\text{s}$.

Sensitivity - 1 mA/div to 5 A/div within 3% (in calibrated steps) into a 50 Ω load; indicating device sensitivity 10 mV/div.

Insertion Impedance — 0.1 Ω at 5 MHz, 0.5 Ω at 50

Maximum Voltage (bare conductor) — 500 V. Maximum Conductor Size — 0.15 inch.

INCLUDED STANDARD ACCESSORIES

175-0124-01 1 LEAD, elec, probe ground, 5 inch (13 cm) 175-0263-01 1 LEAD, elec, probe ground, 3 inch (7.5 cm)

344-0046-00 2 CLIPS, miniature alligator

ORDERING INFORMATION

P6303 Current Probe, Order 010-6303-01
P6302 Current Probe, Order 010-6302-01\$315
AM 503 Current Probe Amplifier \$650
F-5010P3 System (includes assembled and tested P6303, AM 503
and TM 501)\$1525
F-5010P2 System (includes assembled and tested P6302, AM 503
and TM 501)\$1175

AM 503 INCLUDED STANDARD ACCESSORIES

012-0057-01 1 BNC CABLE, 50 Ω

011-0049-01 $\,$ 1 BNC TERMINATION, 50 Ω

The AM 503 Current Probe Amplifier requires one of the TM 500-Series Power Modules listed below. The number of plugins 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.

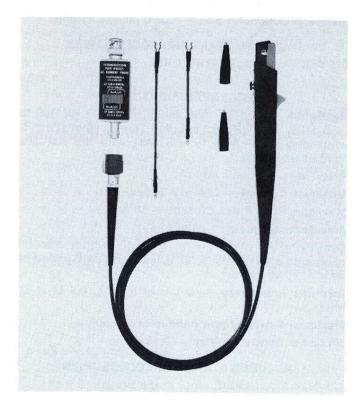
TM 501 Power Module
With Opt 02 Interface+55
TM 503 Power Module
With Opt 02 Interface+75
TM 504 Power Module 190
With Opt 02 Interface+100
TM 506 Power Module 250
With Opt 02 Interface
RTM 506 Power Module
(rackmount version) 340
With Opt 02 Interface+150
TM 515 Traveler Mainframe 325
With Opt 05 Interface
With Opt 06 48-440 Hz Fan+150
OPTIONAL ACCESSORIES
CT-5 Current Probe
Order 015-0189-01\$750

Order 015-0189-00\$590

CT-5 Opt 05 (w/o dc buckling coil)

Current Probes

Ac Current Probes—12 Hz to 200 MHz



P6021 w/Term For General-Purpose Applications 120 Hz to 60 MHz Clip-on Probe

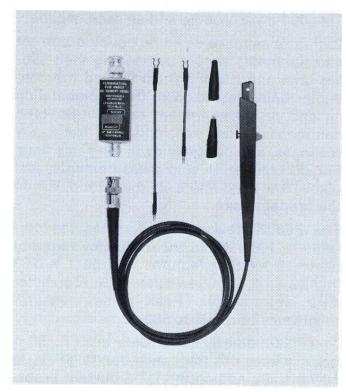
The individual units, P6021, 134, and P6022 provide versatility in a user-assembled ac current measurement system. These various components can be assembled into a variety of performance packages.

- 1. P6021 w/134 3. P6022 w/134
- 2. P6021 w/term 4. P6022 w/term
- The P6201 and P6022 are ac current probes designed for use with real-time oscilloscopes. Either probe, with passive termination or with the amplifier, can be used with oscilloscopes having input resistance of 1 $M\Omega$ or greater. (Neither the termination nor the amplifier is required to use the P6021 probe with the TEKTRONIX 5A21N Ampli-

fier.) Both probes provide the facility for

accurate current measurements over a wide

range of frequencies without breaking the



P6022 w/Term Small Size Suitable for Compact Circuitry 935 Hz to 200 MHz Clip-on Probe

circuit under test. Just open the spring-loaded slide, place the conductor (up to 0.15 inch with P6021 and 0.1 inch with P6022) in the probe slot, and release the slide. No electrical connection is required.

The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under the test.

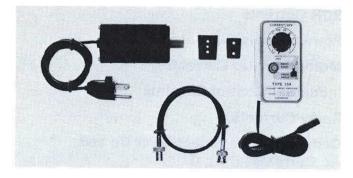
For general-purpose applications, the P6021 offers wide-band performance with excellent low-frequency characteristics. The extrasmall size of the P6022 makes it ideally suited for measuring current in compact semiconductor circuits.

Both probes' low-frequency capabilities and sensitivity can be expanded using the 134 Current Probe Amplifier.

PERF	ORM	ANCE	CHARA	CTER	ISTICS
Ducks		D		1981 1989	

		Probe with Passive Termination	Probe with 134 Amplifier					
Sensitivity	P6021	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy \pm 3%.	134 Amplifier switchable in steps from 1 mA/div to					
e e	P6022	1 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.	1 A/div (with 50 mV/div oscilloscope setting). Accuracy ± 3%.					
Bandwidth†	P6021	2 mA/mV \leq 450 Hz to 60 MHz 10 mA/mV \leq 120 Hz to 60 MHz	12 Hz to 38 MHz					
Probe Only*	P6022	1 mA/mV— \leq 8.5 kHz to 130 MHz 10 mA/mV— \leq 935 Hz to 200 MHz	100 Hz to 65 MHz					
Max Current (CW)	P6021	15 A p-p sine wave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV.	15 A p-p sine wave between 230 Hz and 5 MHz					
	P6022	6 A p-p sine wave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV.	6 A p-p sine wave between 1.3 kHz and 10 MHz					
Max Current (Pulse)	P6021	250 A peak, not to exceed 500 A-μs or 5 A rms	15 A peak, not to exceed 500 A-μs or 5 A rms					
•	P6022	100 A peak, not to exceed 9 A-μs or 2 A rms	15 A peak, not to exceed 9 A-μs or 2 A rms					
Noise		Sec.	≤ 150 μA					
Max Voltage (bare conductor)		600 V (dc + peak ac)	600 V (dc + peak ac)					
Net Weight		≥ 1 lb	≈ 5 lb					

†All bandwidths stated are -3dB



134 Current Probe Amplifier

Use to Expand the Low Frequency Capability and Sensitivity of **Either Probe**

The 134 is used to extend the measurement capabilities 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 and 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.

ORDERING INFORMATION P6021

P6021 Current Probe and Term, 5 ft,
Order 015-0140-02\$200
Opt 02, 9 ft and Term, Order 015-0140-03\$200
Opt 06, 5 ft w/o Term, Order 010-0237-02\$150
Opt 02 and 06, 9 ft w/o Term,
Order 010-0244-02\$150
P6022
P6022 Current Probe and Term, 5 ft.
Order 015-0135-00\$225
Opt 02, 9 ft and Term, Order 015-0135-01\$225
Opt 06, 5 ft w/o Term, Order 010-0238-00\$175
Opt 02 and 06, 9 ft w/o Term,
Order 010-0238-02\$175
134

134 Currer	nt Probe Amplifier,
Order 015	-0057-02\$400
Included Acc	cessories:
014-0029-00	1 HANGER assembly

012-0104-00 1 CABLE assembly

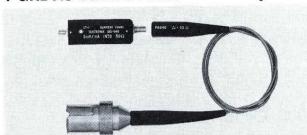
015-0058-01 1 POWER SUPPLY, 110 V Opt 04, 230 V ac, Order 015-0057-03\$400 Included Accessories: Same as above, but with 230 V power supply (015-0059-01).

OPTIONAL ACCESSORIES for P6021, P6022, and 134

\$25 PM 55 1901 30 PM 55
Calibrator Adapter, BNC, Order 013-0092-00\$33
Carrying Case for P6021 and P6022, and a 134 Ampli-
fier, Order 016-0087-01\$18
Passive Termination
For P6021, Order 011-0105-00\$85
For P6022, Order 011-0106-00 \$95

^{*}To estimate the scope/probe system bandwidth from the probe only bandwidth, use the relationship $(t_system)^2 = (t_sprobe)^2 + (t_scope)^2$ $t_r = 0.35 BW$

CT-1 1 GHz Ac Current Probe for 50 Ω Systems



Used with 50 Ω Systems, or Wide Band Nonsampling Oscilloscopes Using a 50 Ω Term CT-1 Permanently Inserted in 50 Ω Circuit Has Minimum Effect in the 50 Ω Environment

Probe Cable

The 010-0133-00 probe cable is an interconnecting cable for the CT-1, used between the transformer and oscilloscope input. If several CT-1 Transformers are in a circuit, the probe cable can be used to monitor any one of them.

The probe cable can be used with other test-point connectors, such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF.

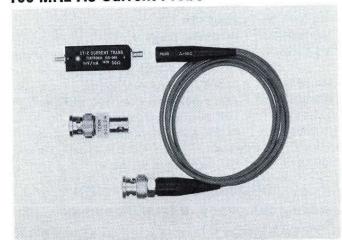
Impedance is 50 Ω . Attenuation is 1X. Output Connector is a GR type. Cable Length is 18 in. Additional 50 Ω cable can be used in series with the probe. RG213/U or RG58A/U is recommended for best preservation of the CT-1 Transformer high-frequency response.

CT-1 Current Transformer

Sensitivity is 5 mV/mA into a 50 Ω load. Accuracy is \pm 3%. Decay Time Constant is 5 μ s, approximated by 1% per 50 ns; limit, 1 μ s. Rise Time is less than 350 ps. Frequency Response is 35 kHz to 1 GHz (3 dB down). Insertion Impedance with a 50 Ω termination is 1 Ω shunted by approx 5 μH ; 2 Ω shunted by approx 5 μH without a 50 Ω termination. Capacitance Loading to a bare wire passing through the CT-1 Transformer is typically 1.5 pF for #14 gauge, 0.6 pF for #20 gauge. Max Voltage of Circuit under Test is 1000 V dc. Direct Current reduces the L/R time constant by a factor of 2 at 0.6 A. Pulse Current Rating is 100 A peak, with a max amp-second product of 1 A μ s. Rms Current Rating is 500 mA max. Temperature Rating is -25°C to +65°C. Physical Dimensions are 3/8 x 9/16 x 1-13/16 in plus #6-32 x 1/4 in mounting stud.

ORDERING INFORMATION CT-1 Current Transformer and Probe, Order 015-0041-00\$95 Opt 05 CT-1 Current Transformer (without Probe), Order 015-0040-00\$51 Probe Cable, Order 010-0133-00\$46

CT-2 100 MHz Ac Current Probe



Use with Oscilloscopes up to 100-MHz BW Insulated Case for Limited Space Applications

Several CT-2 Transformers Can Be Used in the Circuit and Monitored by One Cable

Probe Cable

The 010-0164-00 probe cable connects the CT-2 Transformer and the oscilloscope input. A 50 Ω termination is used with the probe cable for terminating the probe cable at the high impedance input of the oscilloscope.

Impedance is 50 Ω . Attenuation is 1X. Output Connector is BNC type. Cable Length is 42 in. Additional 50 Ω cable can be used in series with the probe. RG213/U or RG58A/U cable is recommended to preserve the high-frequency response.

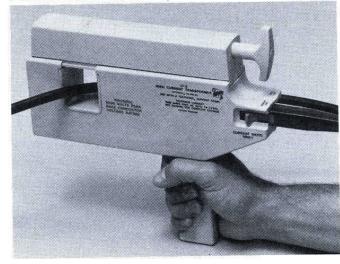
CT-2 AC CURRENT PROBE

Sensitivity is 1 mV/mA into a 50 Ω load. Accuracy is $\pm 3\%$. Decay Time Constant is 125 μ s, approx by 1% per 1.25 μ s; limit 25 μ s. Rise Time is approx 0.5 ns. Frequency Response is 30% down at 1.2 kHz, 7% down at 200 MHz. Insertion Impedance with a 50 Ω termination is 0.04 Ω shunted approx 5 μ H; 0.08 Ω shunted by approx 5 μ H without a 50 Ω termination. Capacitive Loading to a bare wire passing through the CT-2 Transformer is typically 2.1 pF for #16 gauge, 0.7 pF for #22 gauge. Max Voltage of Circuit under Test is 1000 V dc. Direct Current reduces the L/R time constant by a factor of 2 at 0.5 A. Pulse Current Rating is 100 A peak, with a max amp-second product of 50 μ s. Rms Current Rating is 2.5 A max. Temperature Rating is -25° C to $+65^{\circ}$ C.

ORDERING INFORMATION

Included Accessories:	
010-0164-00 1 CABLE, probe	
011-0049-01 1 TERMINATION, 50 Ω	
CT-2 Plus Cable and Term,	
Order 015-0047-00\$9	9
Opt 05 w/o Cable or Term, Order 015-0046-00\$5	51
Probe Cable, Order (010-0164-00)\$3	34

CT-5 Pulsed Currents to 50,000 A



20 mA per Division Sensitivity 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 which extends the measurement capability of TEKTRONIX Clip-on Current Probes. Maximum low-frequency performance is obtained using the P6302/AM 503 Dc Current Probe. Pulse current to 50,000 A 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 power 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 is insulated from the windings and the handle. This allows measurements on bare conductors to 3000 V, and to 10 kV rms when using high voltage bushing. Use of dc bucking coil assembly allows up to 300 A of dc to be tolerated without appreciably degrading the measurements. This is very useful for measuring ac signals riding on top of dc.

CT-5 CHARACTERISTICS

The following are characteristics of the CT-5 using either the P6302/AM503 or P6021/134 combinations.

Rise Time is 17.5 ns or less. Insertion Impedance is $20~\mu\Omega$ or less at 60 Hz, increasing to $20~m\Omega$ at 1 MHz. Current Range is 20~mA/div to 100~A/div with P6302/AM503, and 20~mA/div to 20~A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with P6302/AM 503, 1 A/div to 1 kA/div with P6021/134, (1000:1 step down ratio). Accuracy is $\pm 4\%$. Max Current is 1000 A peak cw.* Amp-Sec product is 8 A-s. Max Voltage of circuit test is 3000 V (bare conductor). Max Dc Bucking Current is 300 mA to buck out 300 A dc (using dc bucking coil). Dimensions and weight—the length is 10.5 in, width is 2.25 in, height is 9.5 in, net weight is approx 4 lb.

*Max current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.

Included Accessories:

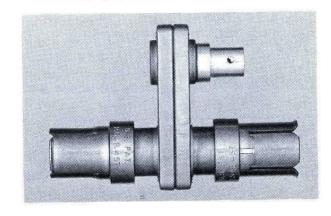
016-0191-03 1 CARRYING CASE 015-0194-00 1 BUSHING, high voltage, 12 in

ORDERING INFORMATION

CT-5 Current Probe (Includes Dc Bucking
Coil) Order 015-0189-01\$750
Opt 05 w/o Dc Bucking Coil, Order 015-0189-00\$590
OPTIONAL ACCESSORIES

Dc Bucking Coil, Order 015-0190-00\$190 High-Voltage Bushing, 4 ft long, inside diameter 1 in, Order 015-0194-01\$32

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.

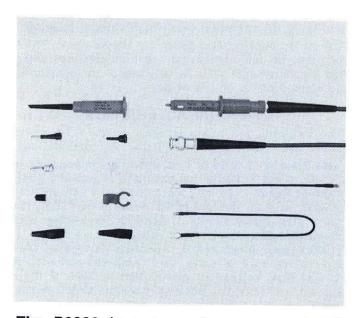
Sensitivity is 10% of the voltage under test, into a 50 Ω load. Decay Time Constant is 4.5 μ s at 0 dc current. Rise Time is less than 0.4 ns. Frequency Response is 50 kHz to 875 MHz at 0 dc current. Insertion Impedance with a 50 Ω termination is 1 Ω shunted by 4.5 μ H, 2 Ω shunted by 4.5 μ H without a 50 Ω termination. Vswr is less than 1.2 at 1.5 GHz. Voltage Rating at 0 V dc is 25 V rms, 1-kv pulse peak. The Vs product is 100 V μ s. If exceeded, the L/R decay will decay rapidly toward zero.

CT-3 Signal Pickoff, Order 017-0061-00\$99

CT-5 Current Measurement Combinations

Ĩ	Curren		1	A-s				
Product	Scope 10 mV/div	50 mV/div	Bandwidth	Product	Rms	Peak Pulse		
CT-5/P6302/AM 503	20 mA to 5 kA	20 mA to 1 kA	0.5 Hz to 20 MHz 12 Hz to 20 MHz	0.1 0.5	700 A 700 A	50 kA 15 kA		
CT-5/P6021/134 CT-5/P6021/Term	400 mA to 100 A	2A to 500 A	120 Hz to 20 MHz	0.5	700 A	50 kA		

P6006 Dc to 35 MHz 10X



The P6006 is a general-purpose probe. It can be compensated to match all TEK-TRONIX Plug-ins and Oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 M Ω . This probe is more rugged and has a higher voltage rating than the miniature probes.

Attenuation is 10X; Input Resistance is 10 M Ω ; Input Capacitance for 3.5 ft. probe is approx 7.5 pF when used with an instrument having a 20 pF input capacitance; 8.5 pF for the 6 ft version, 11 pF for the 9 ft version, 13 pF for the 12 ft version; Probe Rise Time is approx 5 ns; Voltage Rating is 600 V dc, ac peak, or dc and ac peak combined.*

ORDERING INFORMATION P6006 10X Probe, 6 ft,

Order 010-0160-00\$50)
Opt 01, 3.5 ft. BNC, Order 010-0127-00\$50	
Opt 02, 9 ft. BNC, Order 010-0146-00\$50)
Opt 03, 12 ft. BNC, Order 010-0148-00\$50	j

*P-p voltage derating is necessary for cw frequencies higher than 5.7 MHz when working into a 20 pF input, or higher than 3.6 MHz when working into a 47 pF input.

P6007 Dc to 25 MHz 100X

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 M Ω . The P6007 is similar to the photo of the P6006.

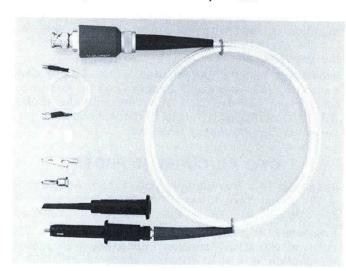
Attenuation is 100X; Input Resistance is 10 M Ω ; Input Capacitance for 3.5 ft probe is approx 2.0 pF when used with an instrument having a 20 pF input capacitance; 2.2 pF for the 6 ft version, 2.4 pF for the 9 ft version, 2.6 pF for the 12 ft version; Probe Rise Time is approx 14 ns for the 3.5 ft version; Voltage Rating is 1.5 kV dc or ac rms, 4.2 kV ac p-p.*

ORDERING INFORMATION

P6007 100X Probe, 6 ft,	
Order 010-0165-00\$	72
Opt 01, 3.5 ft, Order 010-0150-00\$	72
Opt 02, 9 ft, Order 010-0152-00\$	72
Opt 03, 12 ft, Order 010-0154-00	

*P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 10 MHz, the max allowable p-p voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.

P6008 (Environmental) 10X



The P6008 Environmental Probe is designed to operate over -50°C to $+150^{\circ}\text{C}$ for the probe body and cable; the compensation box operates from -15° to $+55^{\circ}\text{C}$. It is designed for use with TEKTRONIX dc to 100 MHz Oscilloscopes. The probe can be compensated to match TEKTRONIX Plugins and Oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance to 1 M Ω .

Attenuation is 10X; Input Resistance is 10 M Ω ; Input Capacitance is approx 7.5 pF when used with an instrument having a 20 pF input capacitance; Probe Rise Time is less than 3.5 ns; Bandpass is 100 MHz; Voltage Rating is 600 V dc, ac peak, or dc and ac peak combined.*

Included Accessories:

134-0013-00	1 PLUG, banana
344-0045-00	1 CLIP, miniature alligator
175-0925-00	1 LEAD, ground, 12.5 in
352-0090-00	1 PROBE HOLDER
013-0071-01	1 TIP, retractable book

ORDERING INFORMATION

P6008	10X Probe,	6	f	t,	E	ī	11	/i	r,						
Order	010-0129-01								•	•	×,	٠		٠	. \$135

*P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the max allowable p-p voltage is 300 V.

P6008 (Non-Environmental) 10X

The P6008 Non-Environmental Probe is designed for use with TEKTRONIX dc to 100 MHz Oscilloscopes. This 10X attenuation probe can be compensated to match plugins and oscilloscopes with input capacitances of 8 pF to 50 pF and input resistance of 1 $\ensuremath{\mathrm{M}\Omega}$.

The P6008 (Non-Environmental) is similar to the photo of the P6008 (Environmental).

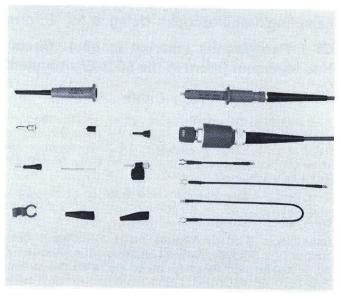
Attenuation is 10X; Input Resistance is 10 M Ω ; Input Capacitance is approximately 7.5 pF. Probe Rise Time is less than 3.5 ns. Bandpass is 100 MHz; Voltage Rating is 600 V dc, ac peak or dc and ac peak combined*.

Included Acc	cessories:
134-0013-00	1 PLUG, banana
344-0046-00	2 CLIPS, miniature alligator
175-0125-01	1 LEAD, ground, 12 in
175-0124-00	1 LEAD, ground, 5 in
175-0263-01	1 LEAD, ground, 3 in
352-0068-00	1 PROBE HOLDER
013-0071-00	1 TIP, retractable hook
206-0060-00	1 TIP, probe, male, w/6-32 threads
206-0105-00	1 TIP, probe, w/6-32 threads

206-0015-00 1 TIP, w/straight shank
013-0052-00 1 ASSEMBLY, bayonet ground assembly includes: 214-0325-00 1 PIN, center

*P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the max allowable p-p voltage is 300 V.

P6009 Dc to 120 MHz 100X



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 $M\Omega$.

A version of the P6009 is equipped with a special BNC connector that provides CRT READOUT† information when used with plugin units and mainframes that have these features. The readout connector is not compatible with most standard non-readout BNC connectors.

Attenuation is 100X. Input Resistance is 10 M Ω . Input Capacitance is approx 2.5 pF when used with an instrument having a 20 pF input capacitance; Probe Rise Time is approx 2 ns; Voltage Rating is 1.5 kV dc or ac rms, 4 kV ac p-p.* Cable is 9 ft. long, terminated with a BNC connector; Net Weight is approx 16 oz.

Included Accessories

meladed Ac	cessories:
175-0125-01	1 CABLE, ground lead, 12 in
175-0124-01	1 CABLE, ground lead, 5 in
175-0263-01	1 CABLE, ground lead, 3 in
013-0071-00	1 PINCHER TIP
352-0090-00	1 HOLDER, probe
013-0052-00	1 ASSEMBLY, bayonet ground assembly
	includes: 214-0325-00 1 PIN, center
344-0046-00	2 CLIPS, miniature alligator
206-0060-00	1 TIP, probe, male, w/6-32 threads
206-0105-00	1 TIP, probe, w/6-32 threads
134-0013-00	1 PLUG, banana, female, w/6-32
	threads
206-0015-00	1 TIP, w/straight shank

ORDERING INFORMATION

P6009 100X Probe,	9	f	t,	W	/F	₹6	a	d	C	U	it	,			
Order 010-0264-01													. \$	115	
Opt 04 w/o Readout, Or															

*P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 40 MHz, the max allowable p-p voltage is 425 V.

†Readout coding inoperative with 7A15A and 7A22.

P6013A 12 kV 1000X

The P6013A provides 1000X attenuation for oscilloscope measurements of high amplitude waveforms or dc potentials up to 12 kV. The probe can be compensated for oscilloscope input capacitance up to 60 pF and input resistance of 1 M Ω . The P6013A is similar to the P6015 shown in photo.

Attenuation is 1000X. Input Resistance is 100 M Ω . Input Capacitance of probe with 10 ft cable is 3 pF; 3.5 pF with 25 ft cable. Probe Rise Time is 7 ns or less with 10 ft cable, 13.5 ns or less with 25 ft cable. Voltage Rating is 12 kV, peak pulse, or peak ac.* Net Weight is approx $5\frac{1}{2}$ lb.

Included Accessories:

015-0083-00 1 COMPENSATING BOX, BNC

344-0005-00 1 CLIP, alligator 352-0056-00 1 PROBE HOLDER 016-0129-01 1 CARRYING CASE

ORDERING INFORMATION

*P-p voltage derating is necessary for cw frequencies higher than 100 kHz. At 1 MHz, the max allowable p-p voltage is 5.5 kV.

P6015 40 kV 1000X



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.

Attenuation is 1000X. Input Resistance is 100 M Ω . Input Capacitance is approx 3 pF. Probe Rise Time is approx 4 ns. Temperature Range is 10°C to 55°C. Voitage Rating is 40 kV peak ac or pulse, 20 kV dc or rms continuous at 25°C.*

Included Accessories:

015-0049-00 1 COMPENSATING BOX, BNC

344-0005-00 1 CLIP, alligator

352-0056-00 1 PROBE HOLDER

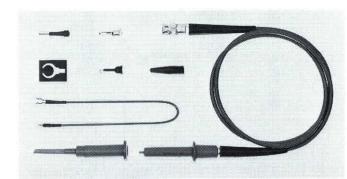
252-0120-00 1 CAN of high-voltage dielectric fluid

016-0128-02 1 CARRYING CASE

ORDERING INFORMATION P6015 1000X Probe, 10 ft, Order 010-0172-00\$395

*P-p voltage derating is necessary for cw frequencies higher than 100 kHz. At 10 MHz, the max allowable p-p voltage is 13 kV.

P6028 Dc to 17 MHz 1X



The P6028 is a general-purpose 1X voltage probe designed for use with TEKTRONIX Oscilloscopes that have BNC input connectors.

Attenuation is 1X. Input Resistance is 1 $M\Omega$, instrument input R included. Input Capacitance for 3.5 ft version is approx 30 pF, 47 pF for the 6 ft version, 70 pF for the 9 ft version, and 92 pF for the 12 ft version, instrument excluded. For total input capacitance of the system, add input C of instrument. Probe Rise Time is approx 10 ns. Voltage Rating is 600 V dc or ac p-p.*

Included Accessories:

175-0125-01 1 CABLE ground lead, 12 in 352-0068-00 1 HOLDER, probe, molded 344-0046-00 1 CLIP, miniature alligator 013-0071-00 1 PINCHER TIP 134-0013-00 1 TIP, probe, hook 206-0060-00 1 TIP, probe, spring

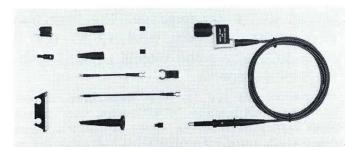
ORDERING INFORMATION

P6028 1X Probe, 6 ft,

Order 010-0075-00		\$33
Opt 01, 3.5 ft, Order 010-0074-00		
Opt 02, 9 ft, Order 010-0076-00		
Opt 03, 12 ft, Order 010-0077-00	•	\$3

*P-p voltage derating is necessary for cw frequencies higher than 1 MHz. At 10 MHz, the max allowable p-p voltage is 60 V.

P6053B Dc to 250 MHz 10X



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 is 10X. Input Resistance is 10 M Ω . Input Capacitance for the 3.5 probe is 9.5 pF; 12.5 pF for the 6 ft version. Bandwidth, when used with an oscilloscope with a bandwidth of at least 225 MHz: 3.5 and 6 ft probes is approx 200 MHz and the 9 ft probe is approx 115 MHz. Voltage Rating is 500 V (dc + peak ac).*

Included Accessories:

013-0107-03 1 TIP, probe, retractable, hook assy

w/flange

352-0351-00 1 HOLDER, probe, plastic adhesive

back

206-0114-00 1 TIP, probe, hook

013-0085-00 1 TIP, probe, ground

175-0124-01 1 **LEAD**, electrical, ground 5 in

175-0263-01 1 **LEAD**, electrical ground, 3 in 344-0046-00 2 **CLIPS**, miniature alligator

166-0404-01 2 **SLEEVES**, ins, plastic

ORDERING INFORMATION

P6053B 10 X Probe, 6 ft,

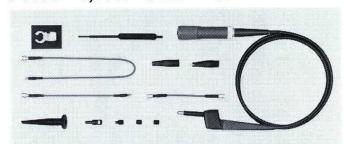
Order 010-6053-13\$105

Opt 1, 3.5 ft, Order 010-6053-11\$105

Opt 2, 9 ft, Order 010-6053-15\$105

*Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the max allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.

P6055 20,000:1 Cmrr 10X



The P6055 is a miniature, low-capacitance, 10X probe designed for use with TEK-TRONIX Differential Amplifiers having 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 M Ω \pm 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.

Cmrr is 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz, measured at probe tip using probe pair with 7A13. Attenuation is adjustable to 10X. Input Resistance is 1 M Ω \pm 0.5%. Input Capacitance is approx 10 pF when used with an instrument having 20 pF input capacitance; 12.5 pF when used with an instrument having 47 pF input capacitance. Typical Rise Time of the probe with 7A13 and 7704 Oscilloscope is 5.4 ns. Voltage Rating is 500 V (dc + peak ac).*

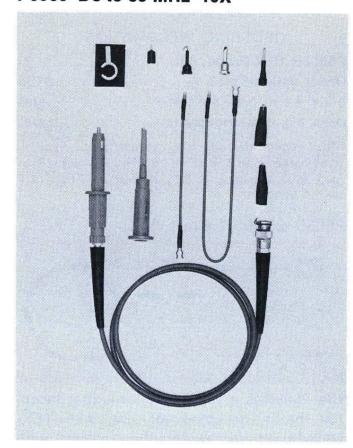
Included Accessories:

013-0107-03 1 TIP, probe, retractable, hook 003-0675-00 1 SCREWDRIVER, probe adjust 175-0124-01 1 LEAD, electrical, 5 in 175-0125-01 1 LEAD, electrical, 6 in 175-0125-01 1 LEAD, electrical, 12 in 206-0114-00 1 TIP, probe 344-0046-00 2 CLIPS, miniature alligator 166-0404-01 2 TUBES, insulating 352-0090-00 1 HOLDER, probe

ORDERING INFORMATION P6055 10X Differential Probe, 3.5 ft, Order 010-6055-01\$165

*P-p voltage derating is necessary for cw frequencies higher than 12 MHz. At 70 MHz, the max allowable p-p voltage is 100 V.

P6060 Dc to 35 MHz 10X



The P6060 is a precision passive probe with 10X attenuation, for use with TEKTRONIX low and mid-frequency oscilloscopes used in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications, such as amplitude measurements with a differential comparator. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 $M\Omega$.

The BNC-type connector utilizes a special grounding clip to shift the deflection factor indicator to 10X normal reading in 5000-Series Oscilloscopes.

Attenuation is 10X. Accuracy when used with a 1 M Ω \pm 0.15% instrument input will be within \pm 0.4% When used with a 1 M Ω \pm 2% instrument input the accuracy will be within \pm 2%. Input Resistance is 10 M Ω within \pm 0.25% with a 1 M Ω \pm 0.15% instrument input; 10 M Ω within \pm 0.4% when used with a 1 M Ω \pm 2% instrument input. Input Capacitance for 15 pF instruments is \simeq 6.0 pF with 3.5 ft probe, and \simeq 7.7 pF with 6 ft; with 55 pF instruments it is \simeq 9.5 pF with the 3.5 ft, \simeq 11.5 pF for the 6 ft. Cmrr (Probe Pair)—At least 400:1 (with 5A20N or 5A21N) dc to 30 kHz. Bandwidth—3.5 ft probe at least 40 MHz (with scope bandwidth of at least 60 MHz); 6 ft probe at least 30 MHz (with scope bandwidth of at least 60 MHz). Max Input Voltage—600 V (dc + peak ac).*

Included Accessories:

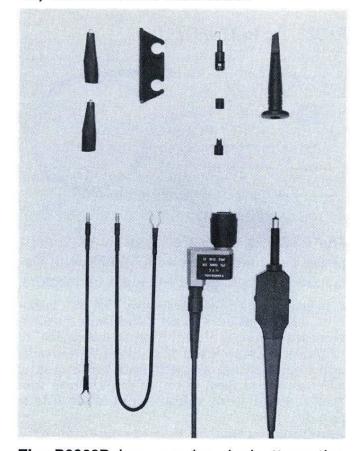
1 TIP, probe, spring
2 CLIPS, miniature alligator
1 PLUG, banana, threaded
1 CABLE, ground lead, 12 in
1 CABLE, ground lead, 5 in
1 TIP, probe, hook
1 TIP, probe, BNC
1 HOLDER, probe, plastic
1 TIP, probe, retractable hook,
screw-on

ORDERING INFORMATION

0.15E111110	6			•	4	 11/		я.	•	ш	•					
P6060 10X Probe, 6	3	ft,	î.													
Order 010-6060-03				٠	٠				•					2.00	. \$	57
Opt 01, 3.5 ft, Order 010)-6	30	60	-0	1		2012	01020		9 2	ST 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0200	8 6	3 94	\$	57

*P-p voltage derating is necessary for cw frequencies higher than 3 MHz. Max input voltage at 50 MHz is 50 V.

P6062B Dc to 100 MHz 1X, 10X Selectable Attenuation



The P6062B is a passive dual attenuation probe designed for TEKTRONIX Oscilloscopes with bandwidths to 100 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 P6062B can be compensated with instruments having a nominal input capacitance of 15 to 47 pF. 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.

Attenuation, 10X and 1X. Input Resistance 1X position, 1 M Ω ; 10X position, 10 M Ω ±0.5%, oscilloscope input resistance must be 1 M Ω within 2%. Input Capacitance for the 3.5 ft probe is 100 pF in the 1X position, and 13.5 pF in the 10X position; for the 6 ft version, 105 pF in the 1X position, and 14 pF in the 10X position. For the 9 ft probe, 135 pF in the 1X position and 17 pF in the 10X position. Bandwidth of the 10X probe is at least 100 MHz for the 3.5 ft and 6 ft, and 95 MHz for the 9 ft when used with a 465 or 464 Oscilloscope. Bandwidth of the 1X probe 3.5 ft is at least 8 MHz, 6 ft is at least 6.7 MHz and 9 ft is at least 4.5 MHz. Voltage Rating is 500 V (dc + peak ac).

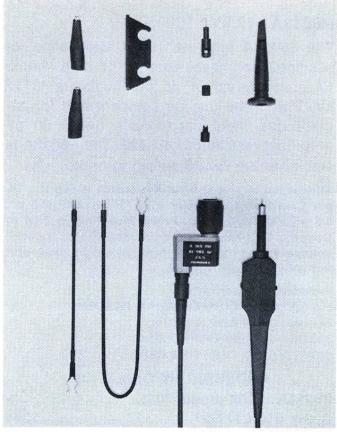
Included Accessories:

included Ac	cessories:
352-0351-00	1 HOLDER, probe
206-0114-00	1 TIP, probe
013-0107-03	1 TIP, probe; ret hook assy
175-0124-01	1 LEAD, elec, probe ground, 5 in
175-0125-01	1 LEAD, elec, probe ground, 12 in
344-0046-00	2 CLIPS, miniature alligator with cove
166-0404-01	1 SLEEVE, insul for 0.188 dia
	probe bushing
016-0521-00	1 POUCH, accessory (not shown)

ORDERING INFORMATION

P6062B Switchable	Attenuation	Probe, 6 ft,
Order 010-6062-13		\$100
Opt 01, 3.5 ft, Order 010	0-6062-11	\$100
Opt 02. 9 ft. Order 010-6	3062-15	\$100

P6063B Dc to 200 MHz 1X, 10X Selectable Attenuation



The P6063B is a fast-rise dual attenuation, passive probe designed for TEKTRONIX Oscilloscopes with bandwidths greater than 100 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 P6063B can be compensated with instruments having a nominal input capacitance of 15 to 24 pF.

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.

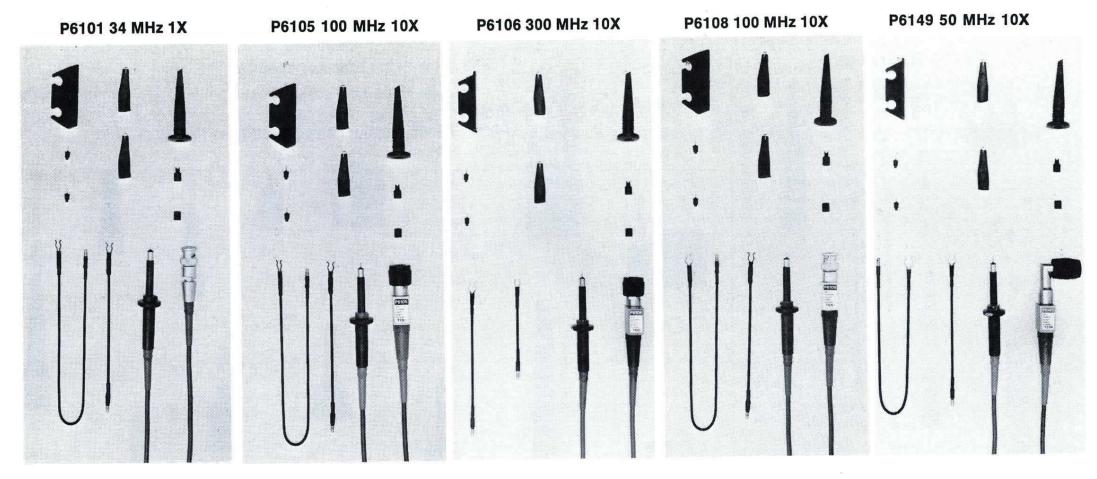
Attenuation is 10X and 1X. Input Resistance 1X position, 1 M Ω ; 10X position, 10 M Ω within 0.5%, oscilloscope input resistance must be 1 M Ω within 2%. Input Capacitance for the 3.5 ft probe is 80 pF in the 1X position and 11 pF in the 10X position; for the 6 ft version 105 pF in the 1X position and 14 pF in the 10X position. Bandwidth of the 10X position (3.5 ft and 6 ft versions) is at least 200 MHz when used with an oscilloscope with a bandwidth greater than 225 MHz. Bandwidth of the 1X position for the 3.5 ft probe is at least 12 MHz and for the 6 ft probe at least 6 MHz. Voltage Rating is 500 V (dc + peak ac).

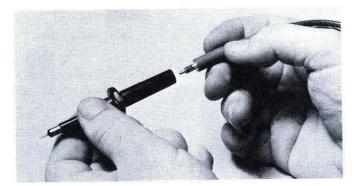
included Accessories:

included Acc	essories:
352-0351-00	1 HOLDER, probe
206-0114-00	1 TIP, probe
013-0107-03	1 TIP, probe, ret hook assy
175-0124-01	1 LEAD, elec, probe ground, 5 in
175-0263-01	1 LEAD, elec, probe ground, 3 in
344-0046-00	2 CLIPS, miniature alligator
166-0404-01	1 SLEEVE, insul for 0.188 dia
	probe bushing
016-0521-00	1 POUCH, accessory (not shown)

ORDERING INFORMATION

P6063B Switchable	Attenuation	Probe, 6 ft,
Order 010-6063-13		\$125
Opt 01 3.5 ft. Order 01	0-6063-11	\$125





Modular parts snap together

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, 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 is two meters long.) These probes may be used to acquire high fidelity signals from low source-impedance circuits.

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 above chart. The P6106 is standard with the 475A and 475 oscilloscopes.

The P6105 is standard with the TEKTRONIX 434, 455, 465, and rackmount oscilloscopes. And the P6108 is standard with the T932 and T935 oscilloscopes.

The P6101 is a 1X, 1 M Ω probe. The P6105, P6106, and P6108 are 10X, 10 M Ω probes.

Туре	Attenuation	Length	Package Number	Loa	ading	Useful BW MHz	Dc Max	Scope C in pF	Readout
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	1 ΜΩ	32 pF 54 pF 78 pF	34 15.5 8	500 V¹	ANY	
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	10 ΜΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V ³	15 to 47	YES
P6106	10X	1 m 2 m 3 m	010-6106-01 010-6106-03 010-6106-05	10 ΜΩ	10.5 pF 13.0 pF 15.5 pF	300 ⁵ 250 150	500 V ⁴	15 to 24	YES
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	10 ΜΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V ³	15 to 47	NO
P6149	10X	2 m	016-6149-03	10 MΩ	15.5 pF	50	500 V ³	20 to 62	NO

¹Max Input Voltage is 500 V dc + peak ac to 300 kHz derated to 20 V at 30 MHz

²Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 27 V at 100 MHz

³Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 30 V at 50 MHz

4Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 70 V at 100 MHz

⁵Scope bandwidth must be 325 MHz

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 features a right angle BNC connector. This can be useful when bench space is limited.

Included Accessories:

All probes, except as noted

175-0263-01 1 **LEAD**, ground, 7.5 cm P6106 only _____** 2 **TIPS**, probe

* 3 PR. MARKER BANDS, (black, white, and silver gray) All except P6149 (not shown) * 2 PR. MARKER BANDS, (gray, and

silver gray) P6149 (not shown)
344-0046-00
2 CLIPS, miniature, alligator
352-0351-00
1 PROBE HOLDER

016-0521-00 1 **POUCH**, accessory (not shown) **Available in packages of 10 only, 206-0191-01.

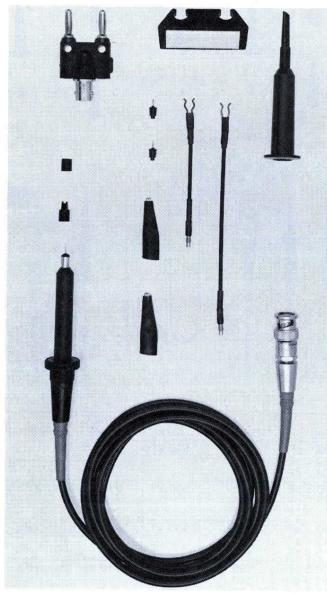
*Available in packages of 9 sets of different colors— 016-0633-00.

ORDERING INFORMATION

ORDERING INFORMATION
P6101, 1X Probe, 2 m, Order 010-6101-03\$38
Opt 01, 1 m, Order 010-6101-01\$38
Opt 02, 3 m, Order 010-6101-05\$38
P6105, 10X Probe, 2 m, Order 010-6105-03\$70
Opt 01, 1 m, Order 010-6105-01\$70
Opt 02, 3 m, Order 010-6105-05\$70
P6106, 10X Probe, 2 m, Order 010-6106-03\$90
Opt 01, 1 m, Order 010-6106-01\$90
Opt 02, 3 m, Order 010-6106-05\$90
P6108, 10X Probe, 2 m, Order 010-6108-03\$55
Opt 01, 1 m, Order 010-6108-01\$55
Opt 02, 3 m, Order 010-6108-05\$55
P6149, 10X Probe, 2 m, Order 010-6149-03\$65

Probe Accessories

P6420 Rf Probes



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 sine-wave input.

Designed to be used with a digital multimeter with a 10 $M\Omega$ input resistance, the P6420 is compatible with the DM44, DM501 and DM502. For relative flatness readings, it can also be used with oscilloscopes which have a 1 M Ω input.

This new probe is easy to repair. It uses the same modular cable and the same cable BNC connector as the other TEKTRONIX Modular Probes. The standard length is 2 meters. However, 1 and 3 meter lengths, which do not change specifications, can be ordered separately.

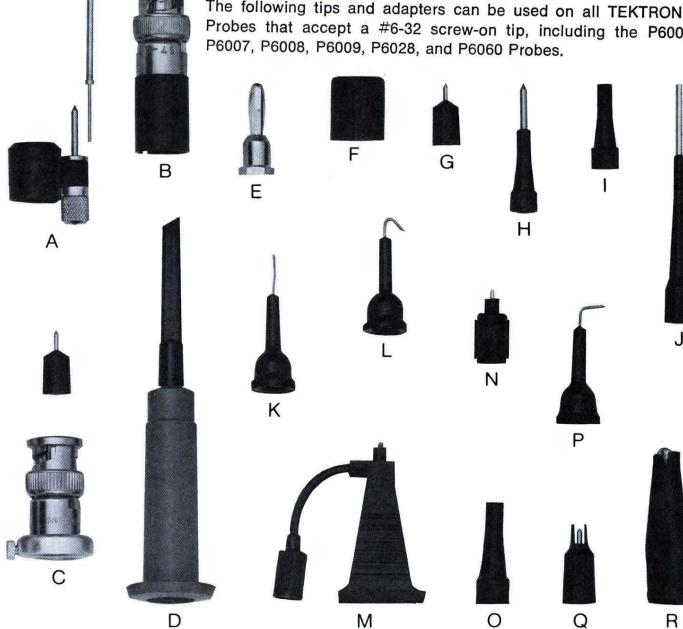
Included Accessories:

013-0097-01	1 TIP, retractable hook
344-0046-00	2 CLIPS, miniature alligator
175-0849-00	1 LEAD, ground, 8 cm
175-1017-00	1 LEAD, ground, 13 cm
166-0404-01	1 SLEEVE, insulating
352-0351-00	1 PROBE HOLDER
103-0090-00	ADAPTER, BNC to banana
206-0230-01	PROBE TIPS

ORDERING INFORMATION
P6420, 1X Probe, 2 m Order 010-6420-03
For 1 meter length cable,
Order 175-1661-00\$2
For 3 meter length cable,
Order 175-1661-02\$21

#6-32 Probe Tips and Accessories

The following tips and adapters can be used on all TEKTRONIX Probes that accept a #6-32 screw-on tip, including the P6006,



#6-32 PROBE TIPS AND ACCESSORIES

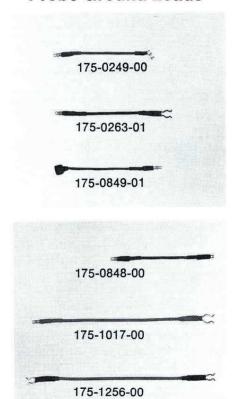
CODE	DESCRIPTION	PART NUMBER	PRICE
A	Bayonet ground assembly	013-0052-00	\$ 5.00
В	Probe tip to BNC adapter	013-0054-00	12.50
С	Probe tip to BNC adapter (for P6028)	013-0056-00	14.00
D	Probe retractable hook tip	013-0071-00	2.50
E	Probe banana tip	134-0013-00	0.50
F	Probe ground cover (for P6009)	166-0428-00	1.00
G	Probe straight tip (0.055 in dia)	206-0015-00	0.45
Н	Probe spring tip (0.080 in dia)	206-0060-00	0.85
Į.	Probe spring tip (accepts 0.065 in dia pin)	206-0061-00	0.65
J	Probe calibration tip (0.063 in dia)	206-0100-00	8.00
K	Probe long straight tip (0.032 in dia)	206-0104-00	0.80
L	Probe hook up	206-0105-00	0.80
М	Probe pin tip (accepts 0.025 in IBM SLT in)	206-0134-03	3.15
N	Probe ground lead adapter (#6-32 to 0.025 in x 0.025 in square pin)	206-0137-01	1.40
0	Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	1.75
P	Probe right angle hook tip	206-0185-00	1.05
Q	IC test tip	206-0203-00	1.00
R	Miniature alligator clip	344-0046-00	1.00

Slip-on Probe Tips and Adapters

The following tips and adapters are designed for use with TEK-TRONIX Miniature Probes that accept a slip-on tip.



Probe Ground Leads



DESCRIPTION	ENGTH (in)	PART NUMBER	PRICE
Ground lead†	3.5 in	175-0263-01	\$1.50
Ground lead†	5.5 in	175-0124-01	1.50
Ground lead†	12.5 in	175-0125-01	1.50
Ground leads for S-3A, P6056, P6057	3. in	175-0249-00	3.75
Ground leads for P6053 P6054, P6075, 7A11, P6201	3 in 5 in 12 in	175-0848-00 175-0848-01 175-0848-02	1.20 1.20 1.20
Ground leads for P6202, P6420	3 in 6 in	175-0849-00 175-0849-01	4.50 4.50
Ground lead for P6055	6 in	175-1256-00	3.50
Ground lead for S-3A	6 in 12 in	175-1017-00 175-1018-00	2.35 2.35

†For the P6053B, P6054A, P6075A, P6101, P6105, P6106, P6108, P6149 and other probes requiring clip-on ground leads.

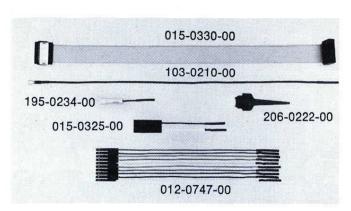
CABLE MARKER SETS			
DESCRIPTION	PART NUMBER	PRICE	
For 1/8 in dia cable	016-0130-00	\$4.50	
For 3/16 in dia cable	016-0127-00	2.95	
For modular cable	016-0633-00	3.75	

SLIP-ON PROBE TIPS AND ADAPTERS

	SLIP-ON PROBE 11F3 AND ADAPTERS						
CODE	DESCRIPTION	PART NUMBER	PRICE	CODE	DESCRIPTION	PART NUMBER	PRICE
AA	Probe tip to BNC adapter for P6202	013-0084-01	\$ 8.00	PP	Miniature probe to #6-32 adapter (for P6045, P6046, P6202, 7A11, S-3A)	103-0051-00	2.80
ВВ	Probe tip to BNC adapter for all, except P6202	013-0084-02	9.00	QQ	Miniature probe to #6-32 adapter (for all miniature probes except	103-0051-01	2.80
CC	Bayonet ground assembly	013-0085-00	5.00		P6045, P6202, includes all modular probes	s)	
DD	Retractable hook tip (for P6010, P6048)	013-0090-00	2.75	RR	Miniature probe to #6-32 adapter with ground connection	103-0131-00	4.00
EE	Retractable hook tip (for S-3A, P6202)	013-0097-01	5.25	SS	Miniature probe tip ground cover, insulating sleeve (for all miniature	166-0404-01	0.20
FF	Retractable hook tip (for all modular probes)	013-0105-00	4.50	TT	probes, including modular) Chassis mount test jack— (for miniature probes, including modular)	131-0258-00	3.25
GG	Retractable hook tip (for 7A11, P6401)	013-0106-00	6.50	UU	Ground lead, insulating sleeve, P6201	166-0433-00	0.65
нн	Retractable hook tip (for 211, 212, 213, 214, 221)	013-0107-02	2.50	VV	Probe tip hook (for all miniature probes, including modular)	206-0114-00	2.10
П	Retractable hook tip (for P6053B, P6054A, P6055, P6101, P6105, P6106,	013-0107-03	2.50	ww	Probe tip straight (for all miniature probes, including modular)	206-0114-01	2.10
	P6108, P6149, P6075A, P6049B)			XX	Replaceable probe tip, pkg of 10.	206-0191-01	12.50
JJ	Miniature retractable hook tip for P6451	206-0222-00	5.00		All miniature probes including modular except P6202, P6420		
KK	P6201 probe tip to BNC adapter	013-0145-00	10.00	YY	Replaceable probe tip for P6202	206-0230-01	12.00
LL	Miniature probe tip cover, IC tester, Package of 10	015-0201-01	2.20		and P6435, pkg of 10		4.00
	Package of 100	015-0201-01	10.00	ZZ	Probe tip extractor	003-0825-00	1.00
MM	Miniature probe tip to GR adapter	017-0076-00	30.00	AAA	Probe tip flexible for 0.025 sq pin	206-0193-00	6.00
NN	Miniature probe tip to GR 50-Ω termination adapter	017-0088-00	40.00	BBB	Probe tip flexible, adapts miniature probe to retractable hook tip (JJ)	103-0177-01	5.00
00	P6201 probe tip to GR 50-Ω termination adapter	017-0094-00	32.00	ccc	Probe pin tip (accepts 0.025 in, IBM SLT pin)	206-0209-00	2.65
	termination adapter						0.40

Accessories

14 OR 16 PIN IC KLIP KIT



The Klip Kit is used with the P6451 Data Acquisition Probe in adapting the probe to the circuit. Its various pieces cut hook-up time when making measurements. The Klip Kit is also usable with modular probes and P6006 style probes.

Includes:

015-0330-00 1 DIP CLIP, low profile w/025 sq. pin adapter
012-0747-00 1 10-WIDE COMB. SET, for P6451
206-0222-00 10 MINIATURE RETRACTABLE HOOK TIP
015-0325-00 2 DUAL LEAD ADAPTER, for miniature

probes

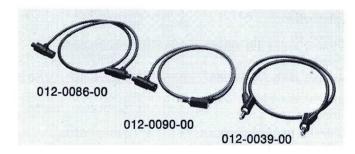
103-0210-00 2 FLEXIBLE PROBE TIP, P6006 type 195-0234-00 2 GROUND LEAD, P6006 type

Order 020-0357-00

\$150.00

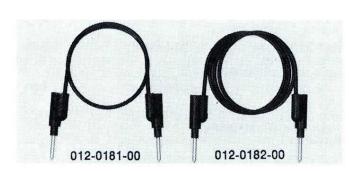
\$2.85

PATCH CORDS



BNC to BNC, 18 in

Red Black	012-0087-00 012-0086-00	\$3.00 3.00
BNC to banana plug-jack, 18 Red Black	012-0091-00 012-0090-00	\$3.00 3.00
Banana plug-jack to banana Red Black	plug-jack, 18 in 012-0031-00 012-0039-00	\$3.00 2.50



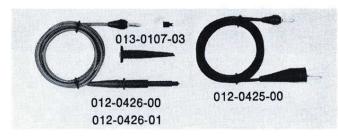
Pin-Jack to pin-Jack, 0.08 in dia pin
Red, 8 in 012-0179-00
Red, 18 in 012-0180-00

 Red, 18 in
 012-0180-00
 3.00

 Black, 8 in
 012-0181-00
 3.00

 Black, 18 in
 012-0182-00
 3.00

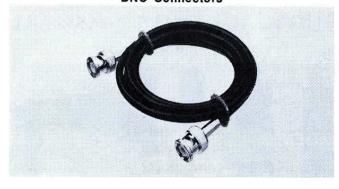
TEST LEADS



Test Lead, Black, 4 ft	012-0425-00	\$ 5.50
Test Lead, Red, 4 ft	012-0426-00	10.00
Test Lead, Black, 4 ft	012-0426-01	10.00
Test Lead set of 012-0425-00,		
012-0426-00, and 013-0107-03	012-0427-00	17.00

COAXIAL CABLES

BNC Connectors



Coaxial, 50 Ω , 42 in	012-0057-01	\$15.00
Coaxial, 75 Ω , 42 in	012-0074-00	15.00
Coaxial, 93 Ω , 42 in	012-0075-00	15.00
Coaxial, 50 Ω , 18 in	012-0076-00	15.00
Coaxial, 50 Ω Precision, 36 in	012-0482-00	22.00

N Connectors 50 Ω



Coaxial N connectors, 6 ft 012-0114-00 \$25.00

GR Connectors 50 Ω

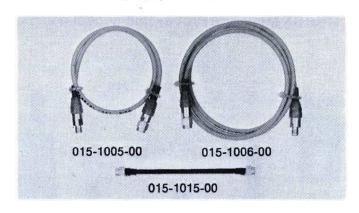


Coaxial 10 ns RG58A/U	017-0501-00	\$42.00
Coaxial 5 ns RG213/U	017-0502-00	42.00
Coaxial 1 ns RG58A/U*	017-0503-00	22.00
Coaxial 20 ns RG213/U	017-0504-00	45.00
Coaxial 2 ns RG58A/U	017-0505-00	42.00
Coaxial 5 ns RG58A/U	017-0512-00	42.00
Coaxial 10 in RG213/U	017-0513-00	42.00
Coaxial 20 in RG213/U	017-0515-00	42.00

^{*}Connector on one end only.

50 Ω CABLES

SMA (3 mm) Connectors 50 Ω



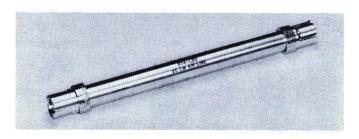
Coaxial 2 ns	015-1005-00	\$ 60.00
Coaxial 5 ns	015-1006-00	110.00
Coaxial semirigid 500 ps	015-1015-00	40.00
Coaxial semirigid 750 ps	015-1017-00	35.00
Coaxial 1 ns	015-1019-00	60.00

BNC to BSM Connectors 50 Ω



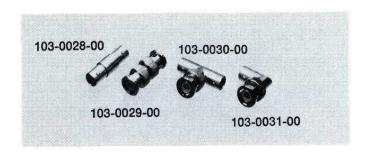
Coaxial, 10 in, RG58		
BSM Female to BNC Male	012-0128-00	\$15.00
Coaxial, 18 in, RG58		
BSM Female to BNC Male	012-0127-00	15.00

50 Ω AIR LINE



The 20 cm 50 Ω 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 Ω \pm 0.4%. Time delay is 0.6698 ns \pm 0.4%. 50 Ω Air Line 017-0084-00 \$60.00

ADAPTERS



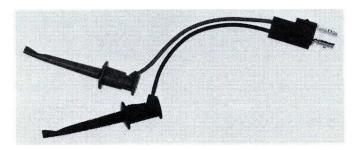
BNC Female to BNC Female	103-0028-00	\$4.65
BNC Male to BNC Male	103-0029-00	5.50
BNC T	103-0030-00	6.50
BNC Elbow Male to Female	103-0031-00	5.50



BNC Male to GR	017-0064-00	\$30.00
BNC Male to uhf Female	103-0032-00	4.75
BNC Male to Binding Post	103-0033-00	4.25
BNC Male to Dual Binding		
Post	103-0035-00	12.00
BNC Male to N Female	103-0058-00	6.75



BNC Female to clip leads	013-0076-00	\$16.00
BNC Female to GR	017-0063-00	23.00
BNC Female to uhf Male	103-0015-00	4.00
BNC Female to BSM Male	103-0036-00	13.00
BNC Female to N Male	103-0045-00	11.00
BNC Female to Dual Banana	103-0090-00	7.50



BNC Female to EZ Ball 013-0076-01 \$16.00



GR to N Male	017-0021-00	\$25.00
GR to C Male	017-0027-00	40.00
GR to N Female	017-0062-00	32.00
GR to C Female	017-0065-00	32.00



GR to BNC Female	017-0063-00	\$23.00
GR to BNC Male	017-0064-00	30.00
50 Ω termination, thru-line	017-0083-00	60.00

*(GR to BNC Male)

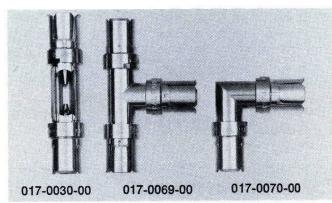
*Upper frequency limit vswr not specified



N Male to GR	017-0021-00	\$25.00
N Female to GR	017-0062-00	32.00
N Male to BNC Female	103-0045-00	11.00
N Female to BNC Male	103-0058-00	6.75



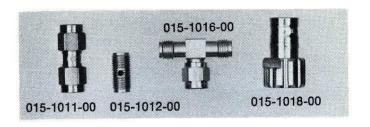
"F" Female to BNC Male	013-0126-00	\$10.00
"F" Female to GR874	017-0089-00	35.00
"F" Male to "F" Male	103-0157-00	7.50
"F" Male to BNC Female	103-0158-00	8.50
"F" Female to "F" Female	103-0159-00	7.50



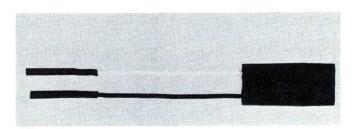
GR Insertion Unit	017-0030-00	\$70.00
GR T	017-0069-00	75.00
GR Elbow	017-0070-00	70.00



015-1007-00	\$ 40.00
015-1008-00	50.00
015-1009-00	47.00
015-1010-00	170.00
	015-1008-00 015-1009-00



SMA Male to Male	015-1011-00	\$16.00
SMA Female to Female	015-1012-00	16.00
SMA T	015-1016-00	27.00
SMA Male to BNC Female	015-1018-00	6.00



Miniature Probe Dual Lead
Adapter 015-0325-00 \$8.00

ATTENUATORS—TERMINATIONS



50 Ω ±0.1% precision feedthrough termination (dc - 100 kHz, 11 V rms max) 011-0129-00 \$36.00 50 Ω feedthrough termination 1011-0049-01 25.00 50 Ω 10X (20 dB) attenuator² 011-0059-02 30.00 50 Ω 5X (14 dB) attenuator² 30.00 011-0060-02 50 Ω 2X (6 dB) attenuator² 011-0069-02 30.00 50 Ω 2.5X (8 dB) attenuator² 011-0076-02 30.00 50 Ω feedthrough termination $(5 \text{ W})^3$ 011-0099-00 35.00

Characteristics—Dc resistance is 50 Ω \pm 1 Ω . Attenuation accuracy is $\pm 2\%$ dc, $\pm 5\%$ at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

¹Less than 1.1 dc-250 MHz and less than 1.2 dc-500 MHz.

²Less than 1.1 dc—1.0 GHz and less than 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 min loss		
attenuator	011-0057-00	22.00
50 Ω to 93 Ω min loss		
attenuator	011-0058-00	22.00
75 Ω 10X attenuator	011-0061-00	26.00
93 Ω 10X attenuator	011-0062-00	24.00
600 Ω feedthrough termination	1	
(1 W, dc to 1 MHz)	011-0092-00	27.00
75 Ω to 50 Ω min loss atten-		
uator (ac coupled)	011-0112-00	45.00

CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2%

Power Rating of attenuators is 1/2 W and termina-Voltage Standing Wave Ratio (vswr) not specified.

ATTENUATORS and TERMINATORS N 50 Ω



Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω .

011-0085-00	\$70.00
011-0086-00	70.00
011-0087-00	90.00
	011-0086-00

GR

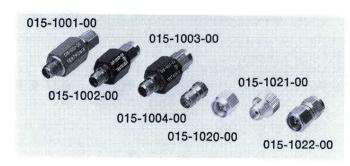


125 Ω min loss	017-0052-00	\$ 85.00
50 Ω 10X attenuator	017-0078-00	100.00
50 Ω 5X attenuator	017-0079-00	100.00
50 Ω 2X attenuator	017-0080-00	100.00
50 Ω termination, end-line	017-0081-00	80.00
50 Ω 2X attenuator	017-0080-00	100.00

CHARACTERISTICS

Accuracy of indicated attenuation ratio is $\pm 2\%$ at dc, $\pm 3\%$ at 1 GHz. Voltage standing wave ratio (vswr) is less than 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	e 015-1020-00	16.00
Short-Circuit termination		
Female	015-1021-00	15.00
50 Ω termination Male	015-1022-00	32.00

CHARACTERISTICS

	Dc — 12.40 G	- Hz	12.41 - 18.00 G	Power	
	Atten Accuracy	Vswr	Atten Accuracy	Vswr	Contin- uous
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 having a disc capacitor (4700 pF, $\pm 20\%$) in series with the inner conductor. Reflection ratio (in 150 ps tdr system), max is 0.03. Voltage rating is 200 V.

Coupling Capacitor SMA

(3 mm)

015-1013-00 \$130.00

The coupling capacitor is a short length of coaxial line having a disc 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

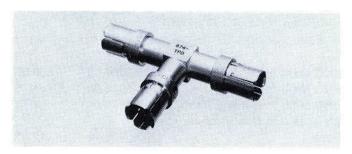
\$55.00

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). Max 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



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 broadband 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Power Divider GR

017-0082-00 \$210.00

ACCESSORY HOUSING



Accessory housing without electrical components is useful for applications requiring special circuitry. Accessory Housing 011-0081-00 \$30.00

Mechanical Measurement Transducers

for TM 500, 5000-Series and 7000-Series Products

TRANSDUCER PACE	KAGE	DESCRIPTION	PERFORMANCE	RECOMMENDED ACCESSORIES
	PRESSURE 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 _n ≃65 kHz	012-0209-00 20 ft multi- conductor cable
	PRESSURE 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 _n ≃24 kHz	012-0209-00 20 ft multi- conductor cable
	PRESSURE (EAS) 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
	ACCELERATION 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 _n ≃30 kHz	012-0211-00 microdot to BNC 20 ft cable
	VIBRATION (EAS) 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 \simeq 3500 pF Temp: -40° C to $+150^{\circ}$ C fn \simeq 11 kHz	012-0137-00 BNC-BNC cable 50 ft
	VERTICAL VIBRATION 015-0166-00 HORIZONTAL VIBRATION 015-0167-00	TYPE: Seismic (geophone) Self generating SIGNALS: Velocity Displacement (integrated velocity) RANGE: 0.050 inch peak to peak	Accuracy: <5% Scale Factor: Velocity \simeq 600 mV/in/s Displacement \simeq 10 mV/0.002 in Freq Range: 10 Hz to 2 kHz $f_n \simeq 8$ Hz Temp: -40° C to $+71^{\circ}$ C	012-0136-00 BNC-BNC cable 20 ft long
	FORCE (Displacement) 015-0164-00*	RANGE: 50 grams 50 lbs (with load cell) 0.120 mm TYPE: 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
	DISPLACEMENT 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
	STRAIN 015-0171-00	RANGE: $30,000~\mu$ 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 Adapter, 015-0169-00 Cement Kit 015-0172-00
	STRAIN GAGE ADAPTER 015-0169-00*	Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type PS501-1 modified Transducer Power Supply. Has variable shunt resistor for gage factor calibration. The adapter 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
A PROPERTY OF THE PARTY OF THE	CEMENT KIT 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 (012-01	136-00)\$3	0
20 ft low-noise	coaxial cable with BN	C
connectors on	both ends.	

CABLE (012-0209-00)\$115 20 ft low-noise six-conductor cable with 6-pin connector on each end.

CABLE (012-0210-00)\$66 20 ft six-conductor cable with 6-pin male connector on one end. CABLE (012-0211-00)\$27
20 ft low-noise coaxial cable with miniature coaxial connector on one end and BNC connector on the other.

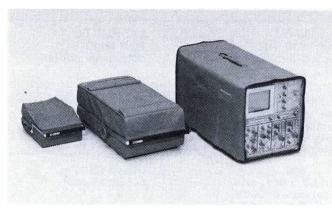
CONNECTOR (131-0618-00)\$22 Mates Type PS501-1 Transducer Power Supply INPUT 6-pin connector.

TRANSDUCER PACKAGE PRICE LIST

\$200	015-0167-00	\$500	015-0161-00
\$525	015-0164-00	\$550	015-0162-00
\$360	015-0168-00	\$600	015-0117-00
\$30	015-0171-00		015-0165-00
\$200	015-0169-00	\$320	015-0116-00
\$38	015-0172-00		015-0166-00

^{*}Requires PS501-1 custom modified Transducer Power Supply mounted in a TM 500-Series Mainframe. Consult a Tektronix Field Engineer for price and installation information on power supply and adapter.

OSCILLOSCOPE PROTECTIVE COVERS



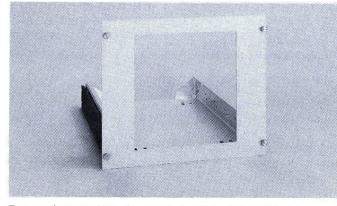
The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000-Series Laboratory Oscilloscopes have clear vinyl frontal areas.

PROTECTIVE COVERS

INSTRUMENT	PART NUMBER	PRICE
200 Series	016-0512-00	\$12.00
323, 324, 1401A, 1401A-1, 1501	016-0112-00	15.00
314, 335	016-0612-00	55.00
326	016-0532-00	40.00
453A, 454A, 491	016-0074-01	16.00
455	016-0344-00	16.00
434, 464, 466	016-0365-00	17.00
465, 475, 485	016-0554-00	12.00
560 Series (except 565, 567, 568)	016-0067-00	14.50
565, 567, 568	016-0069-00	14.50
540 Series	016-0068-00	14.50
1480C, 1481C, 1482C, 1485C	016-0085-00	14.50
5000 Series	016-0544-00	15.00
7300, 7400, 7600 Series	016-0192-01	12.00
7704A, 7900	016-0531-00	12.00

PLUG-IN UNIT CARRYING CASES

RACK ADAPTERS



For rackmounting the 7000-Series Oscilloscopes and 611 in a standard 19 in wide rack. Rack adapter includes slide-out assemblies. 7000-Series mask finish is light gray, 611 mask finish is black.

For 7704 and 7904, rack height is 15.75 in, rack depth is 21.75 in, shipping weight is approx 41 lb.

For 611, rack height is 14 in, rack depth is 21.75 in, shipping weight is approx 41 lb.

Order 040-0551-01\$250.00 For 455 and 465M, includes cradle mount, rack height 7 in, rack depth 18.75 in.

Order 040-0825-00\$200.00

RACK ADAPTERS



For rackmounting most TEKTRONIX Generators in a standard 19 in wide rack. The rack height is 5.25 in, rack depth is 19.75 in. Rack adapter includes slideout assemblies. Shipping weight is approx 24 lb.

The adapter provides forced air ventilation and black panels are provided to cover the unused openings. Mounting kits must be ordered separately for each instrument to be mounted.

Rack Adapter includes half-rack width blank panel (333-1384-00).

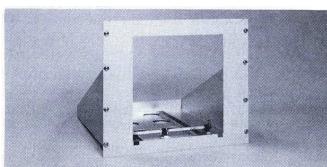
	er 016-026		*** * *****		\$	575.0
284	Mounting	Kit	includes	quarter-rack	width	blanl
pan	el (016-010	09-00)).			
0-4	016 010	7 00	out to the contract of the con			A40 0

Order 016-0187-00	.\$48.00
106, 114, 115, and 191 Mounting Kits.	
Order 016-0186-00	. \$35.00
2101 and 2901 Mounting Kits.	

Order 016-0188-00	
286 Mounting Kit.	
Order 016-0190-00	

For rackmounting	two	TM	503's.		
Order 040-0616-02				 	\$69.00
For rackmounting	one	TM	503.		

CRADLE MOUNTS



For rackmounting 500 and 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. 500-Series mask finish is blue vinyl, and 7000-Series mask finish is light gray.

For 7704A, rack height is 15.75 in, rack depth is 22 in, shipping weight is approx 16 lb.

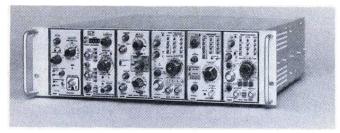
Orue	# U4	0-0500	-00 .			*** * *******			. \$1	40.00
For	540	Series	and	575,	rack	height	is	17.5	in,	rack
dept	h is	21-9/1	16 in,	ship	ping	weight	is	appro	x ·	16 lb.
Orde	er 04	0-0281	-00						•	an nn

For 561B and 564B, rack height is 15.75 in, rack depth is 21-9/16 in, shipping weight is approx 17 lbs.

Order 040-032-01\$80.00

REAR-SUPPORT CRADLES

STORAGE CABINETS



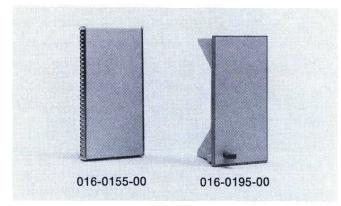
For 7000-Series Plug-in Units—Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high.

Order 437-0126-01\$190.00

For 1-Series and Letter-Series Plug-in Units—Holds 3 plug-in units. Measures 19 in wide, 8¾ in high, 9¾ in deep. Net weight is approx 9 lb.

Order 437-0031-00\$90.00

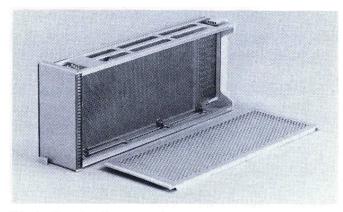
BLANK PANEL



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 EMI shielding.

7000 Series, 2600 Series, Order 016-0155-00 ...\$19.00 5000 Series, Order 016-0195-00\$ 7.50 TM 500 Series, Order 016-0195-01\$ 11.00

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\$65.0	
5000 Series, Order 040-0818-02\$30.0	0
TM 500 Series, Order 040-0652-03\$30.0	0
560 Series, Order 040-0245-00\$42.0	0
1 and Letter Series, Order 040-0065-00\$42.0	0

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 Field Engineer for bezel-viewer compatibility before ordering.



View Hood (folding)—for 200 Series, 314, 323, 324, 326, 335, 400 Series, 576, 577, 5000, and 7000-Series Oscilloscopes.

osciniosopes.
For 576, order 016-0259-00\$10.00
For 577, 5000, and 7000 Series
order 016-0260-00\$10.00
For 200 Series (not pictured),
order 016-0199-01\$ 6.15
For 323 and 324 (not pictured),
order 016-0247-01\$ 7.25
For 326, 314, 335, SC502, SC504 (not pictured),
order 016-0297-00\$ 6.50
For 464, 466, 455 (not pictured),
order 016-0592-00\$11.50



Polarized Viewers—For TEKTRONIX 5 in oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

Rectangular Viewer, order 016-0039-00\$26.00

Plastic Round Viewer, order 016-0053-00\$26.00

Viewing Hood—For TEKTRONIX 5 in oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.

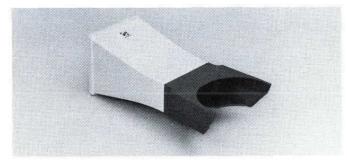
Order 016-0001-01\$26.00



Collapsible Viewing Hood—For oscilloscopes with rectangular crt's. Blue vinyl material, folds flat for convenient storage.

convenient storage.	
For 422, 453A, 454A,	485, 491,
order 016-0082-00	
For 422, 453A, 454A,	485, 491,
order 016-0274-00	\$12.00

Polarized Collapsible Viewing Hood—To reduce reflections and glare under high ambient light conditions for 432, 434, 455, 465, 475, 464, 466, order 016-0180-00\$23.00

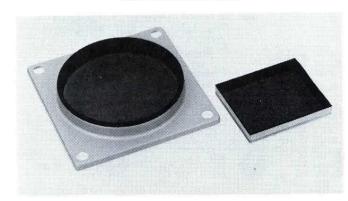


Viewing Hood—For 576, 5000 and 7000-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

576, c	016	-0153-00	 	 	\$1	7.00
		Series,				
		54-00				

Viewing Hood (folding binoculars)—For some 400 Series.
For 434, 455, 464, 466,
Order 016-0566-00\$13.00

CRT MESH FILTERS



The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions. The filter is a direct replacement for the existing graticule cover on most TEKTRONIX instruments, or, in the case of the new portable oscilloscopes, snaps in the crt opening on the front panel.

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 emi filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the emi spectrum.

INSTRUMENT*	PART NUMBER	PRICE
314, 326, 335	378-0063-00	\$18.00
323, 324	378-0596-00	23.00
432, 434	378-0682-00	22.00
422, 491, 453A, 454A, 485	378-0648-00	20.00
465, 475, 464, 466, 434	378-0726-01	30.00
540 Series, 565	378-0572-00	25.50
529, 561B, 564B, 568	378-0575-00	25.00
7400	378-0696-00	25.00
7500, 7700 Series	378-0603-00	25.00

*For both cabinet and rackmount instruments.

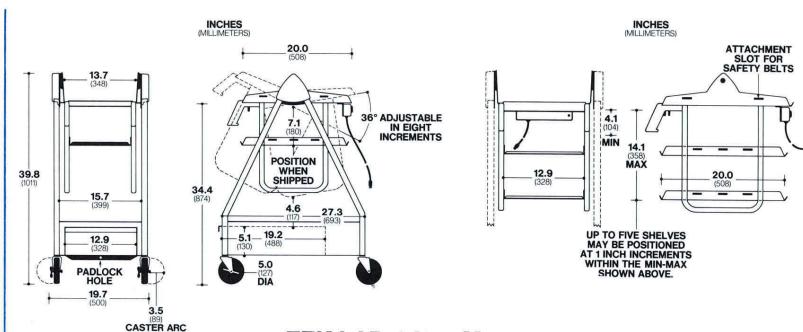
CATHODE-RAY TUBE LIGHT FILTERS

	E-RAY TUBE LI	PART	
INSTRUMENT*	COLOR	NUMBER P	RICE
314, 335	Blue Amber	378-2016-00 3 378-0843-00	\$1.80
200 Series	Blue	378-0691-00	0.95
455	Clear	337-2122-01	2.50
accessor:	Blue	337-2122-00	2.50
323, 324	Smoke-gray Blue†	426-0403-00 426-0811-00	2.70 2.70
020, 024	Amber	426-0513-00	2.70
326	Blue†	426-0871-00	2.70
422, 491, 453A,	Smoke-gray Green	378-0549-00 378-0557-00	1.50 1.50
454A, 485	Blue†	378-0664-00	1.50
105 175 101	Amber	378-0559-00	1.50
465, 475, 464, 466	Blue Clear	337-1674-00 337-1674-01	2.15 2.50
	Smoke-gray	337-1674-07	2.50
540, 550 Series,	Smoke-gray† Green	378-0567-00 378-0568-00	3.00
565, 575	Blue	378-0569-00 378-0570-00	2.30
	Amber Smoke-gray†	378-0560-00	3.00
529, 561B, 567,	Green	378-0561-00	2.30
568	Blue Amber	378-0562-00 378-0563-00	2.30
520A, 521A,	Smoke-gray†	378-0581-00	2.90
522A		070 0010 00	2.20
576	Blue† Amber	378-0616-00 378-0616-01	2.20 2.20
602	Blue	378-0845-00	1.90
	Smoke-gray† Amber	378-0586-00 378-0595-00	3.50 6.00
	Graticule	331-0406-00	6.25
603, 604	Clear Clear (603)†	337-1440-00 337-1440-01	2.20
	Green	337-1440-01	2.20
	Amber Blue	337-1440-02 337-1440-03	3.30
	Gray	337-1440-04 331-0303-00	2.50
	Graticule (8 x10 div)	331-0303-00	0.00
605, 606, 607	Blue	337-1674-00 337-1674-05	2.15
	Amber Graticule	337-1674-10	2.50
	Clear Shield Gray†	337-1674-13 337-1674-06	3.00 2.50
	Graticule	331-0391-00	3.90
608	(8 x10 div)	378-0704-00	2.20
608	Green	378-0705-00	2.20
7004 7044	Graticule†	337-2126-02 378-0625-00	3.50 2.20
7904, 7844, 7313, 7700	Amber	378-0625-01	2.20
Series, 7613 7623	Gray Green	378-0625-02 378-0625-03	2.20
7020	Gray Tv Gratic	ule 378-0625-05	4.00
	CCIR Gray Tv Gratic	ule	
	NTSC Clear Shield	378-0625-06	4.00
	With Spectrum	Analyzer	3.50
7613, 7623,	Graticule Spectrum	337-1159-02	3.50
7623A, 7633	Analyzer	378-0625-07	4.00
	Green (UV) Tv Graticule	378-0625-08	
	CCIR Tv Graticule	378-0625-09	4.00
	NTSC	378-0625-10	4.00
7403N, 7603	Blue	378-0684-00 378-0684-01	3.20
	Amber Gray	378-0684-02	3.20
	Green Gray Tv Gratic	378-0684-03	3.20
	CCIR	378-0684-04	4.50
	Gray Tv Gratic	378-0684-05	4.50
	With Spectrum Graticule	1 Analyzer 337-1439-01	3.00
	Blue Implo-	337-1700-01	2.20
	sion Shield† Clear Implo-		
	sion Shield	337-1700-04	3.00
5100 and 5400 Series	Clear Green	337-1440-00 337-1440-01	2.20
(except 5441)	Amber	337-1440-02 337-1440-03	3.30
	Gray	337-1440-04	2.50
5441	Cleart	337-1674-01	2.50
	Gray Graticule	337-1674-06 331-0391-00	2.50 3.90
1	(8 x10 div)	070 0077 00	0.50
434	Clear	378-0677-00 378-0678-01	2.50
	15.30		

*For both cabinet and rackmount instruments unless rackmount version is listed.

†Standard filter supplied with instrument.

QUICK REFERENCE
Product Cart Model
TM 5033
TM 5043
TM 506205
21206
31206
432200C
434200C
455, 465M200C
464200C
465200C
466200C
475, 475A200C
485200C
491200C
520-522205
528*
530, 540, 550-Series3
560-Series3
5763
5773
602-607*
611205
613205
632205
650-Series205
670-Series205
1105*
1140A205
1340205
1420-Series*
4601206
4610206 4623206
4632206
4661
4921206
4922206
5100-Series
5400-Series
73133
76033
76133
7623A3
76333
7704A3
78343
78443
79043
All rackmounts (R Series)7
0 8



TEK LAB CART MODEL 3

Recommended For:

5100, 5400, and 7000-Series three and four plug-in oscilloscopes, all 400-Series, 576, 577, 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 57 lb, 25.8 kg. Shipping weight 75 lb, 34 kg. Blue vinyl finish.

INTERNATIONAL VERSION deletes power module for shipment outside U.S.A.

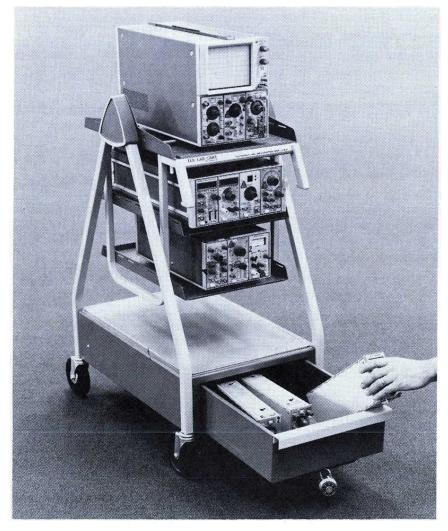
Optional Accessories

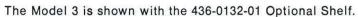
Extra shelf with four mounting screws. Net weight 0.9 lb, 0.4 kg. Shipping weight 3 lb, 1.4 kg.

Order 436-0132-01\$25

SAFETY BELT to secure instruments on top tray, shelves, or base. (Not needed for 5000or 7000-Series Scopes on top tray.) Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

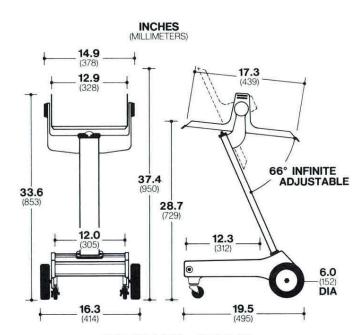
Order 346-0136-01\$15







^{*}These products are applicable to several carts-see dimensions and features for your specific needs.



MODEL 200C

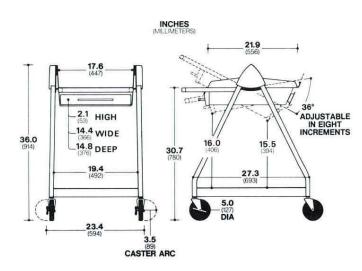
Recommended For:

All 400-Series Portable Scopes.

MODEL 200C includes brakes on front casters, safety belt to secure instrument on top tray. Blue vinyl finish. Net weight 16 lb, 7.3 kg. Shipping weight 27 lb, 12.2 kg.

Order Model 200C \$170





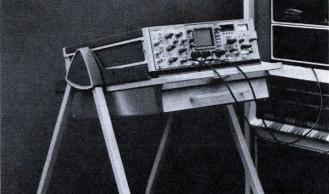
SCOPE-MOBILE® CARTS MODEL 205

Recommended For:

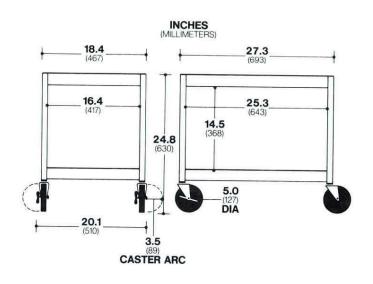
All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray.

MODEL 205 includes brakes on front casters, storage drawer, power distribution module (three outlets, 15 ft cord). Blue vinyl finish. Net weight 43 lb, 19.5 kg. Shipping weight 57 lb, 25.8 kg.

OPTIONAL SAFETY BELT recommended to secure instruments on top tray. Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg. Order 346-0070-01\$35







MODEL 206

Recommended For:

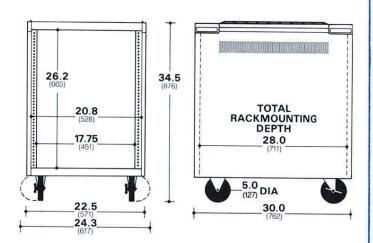
Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment.

MODEL 206 includes brakes on caster at one end of cart. Plastic laminate on top tray and base. Light gray vinyl finish. Net weight 30 lb, 13.6 kg. Shipping weight 38 lb, 17.2 kg.



SCOPE-MOBILE® Carts

INCHES (MILLIMETERS



TEK RACK CART MODEL 7

Recommended For:

Rackmounted systems and instruments.

MODEL 7 allows mounting of equipment to front or rear of cart. Adjustable rails for slide mounted equipment are provided. The Model 7 is designed and UL listed for up to 300 lbs mounted in place. It has removable side panels and a light gray vinyl finish. Several rackmount accessories are available such as blank panels, etc. A brochure describing the Model 7 and accessories is available from your local Tektronix Field Office Representative, or Distributor.

Net Weight 60 lbs, shipping weight 77 lbs.

Order Model 7\$470

Included Accessories

Extra Hardware Mounting Kit 016-0624-00

Optional Accessories

Stabilizer

Required to meet UL specifications for slide mounted equipment.

Order 015-0318-00\$85

Safety Belt

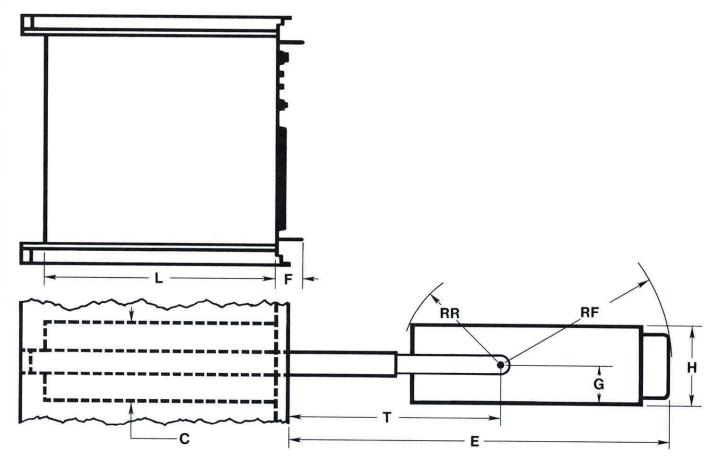
Mounting Brackets

To mount RTM 506 at angle for easy operation.

Order 016-0390-00\$35



Rackmount Instrument Dimensions



DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

Symbol	Description	Definition
Н	Height	Height of front panel.
L	Length	Rack front to rearmost permanent fixture excluding cables.
F	Forward Clearance	Back of front panel to foremost protrusion
G	Vertical Axis	Bottom of front panel to horizontal plane of rotation.
E	Extended Inst	Maximum forward clearance with instrumen out and horizontal.
RF	Radius — Front	Front radius of rotation.
RR	Radius — rear	Rear radius of rotation.
Т	Track	Rack front to pivot point.
С	Cabinet	Cabinet height.

MOUNTING DIMENSIONS

		Н		L	F		G			E	R	F	R	R		r	f	С
PRODUCT	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	_	_	7 <u>—</u> 7	9.00	_	_	_				5.3	13.5
R465*, R475*, R475A*	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		-	0.0	21.0	- 3.5	25.0	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	-	_	-		10.5	47.0	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	_				pa		5.3	17.8
R7912*	5.3	13.5	26.9	68.3	1.8	4.6		_	26.9	68.3		<u> </u>					5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	_		30.7	78.0	N-10	_					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				(2			5.2	13.2
016-0115-02	5.3	13.5	16.3	41.4	0.3	0.8	22	924-22	2000	_	_	10.00				-	5.3	13.5
016-0268-00	5.3	13.5	19.8	50.3	1.8	4.6		-	=	_					27—		5.2	13.2
040-0551-00	14.0	35.6	22.4	56.9	0.6	1.5		_	30.9	78.5		_					5.2	13.2
040-0554-00	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	_	_	_		_		-	_	_	7-2	5.3	13.5
040-0616-00	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5			20000	_		1200	5.25	13.3
040-0617-00	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	_	_		_			5.3	13.5
040-0624-00	5.25	13.3	18.3	46.5	0.7	1.8	_		_	_		7.00	2-	V.—.		-=	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	_	_		_		_	Name of the last	200	=		5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6		_	(_							7.1	18.0
437-0126-01	5.3	13.5	22.3	56.6	2.0	5.1	_	_	25.2	64.0		-				=	6.6	16.8

^{*}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.

Customer Information

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 service advice and after-the-sale support.

A network of service centers throughout the U.S. and most other parts of the world provides speedy and competent calibration, maintenance, and repair service.

The long term support program insures 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.



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.

COMMUNICATIONS

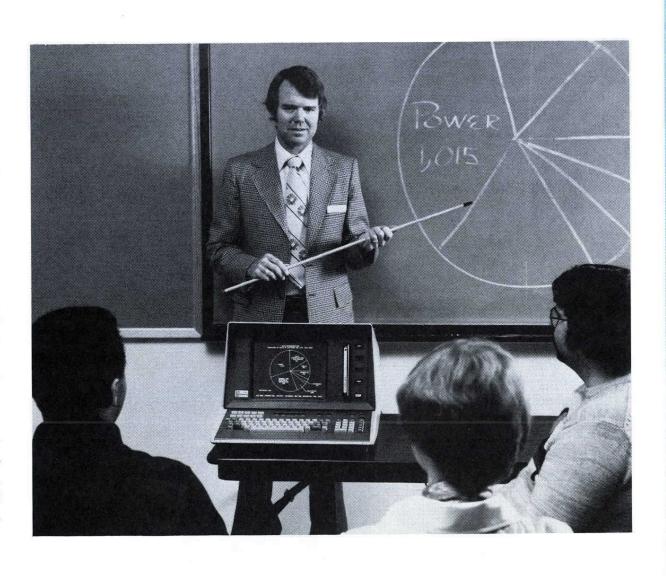
Your Sales Engineers are a valuable communication link between you and the factory. They know the exact person to contact in each circumstance, and can reach that person fast and easily. Let them help your communications on any problem related to your TEKTRONIX products.

ORDERING

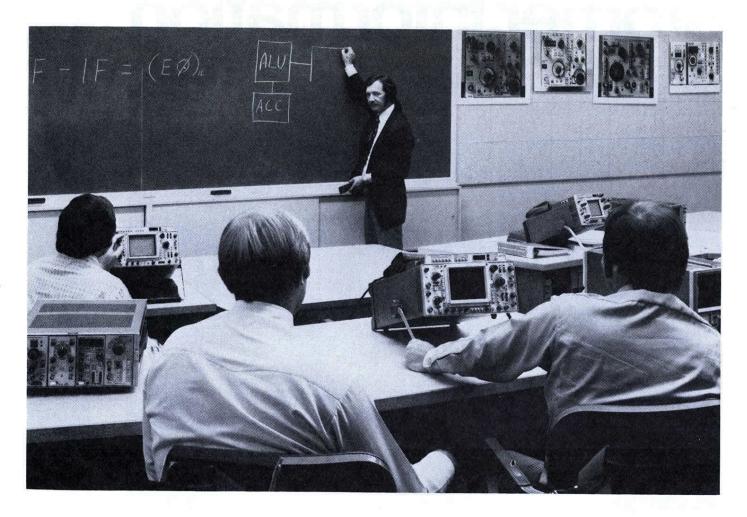
There are many types of products, each designed for a specific application area. Your Sales Engineer can help you select the one best suited to your present and future needs, and will be happy to arrange a demonstration of the product . . . in your application if you so desire.

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.





Tektronix Service and Support



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.

FACTORY TRAINING

Often there is a need for in-depth training that cannot be fully accomplished locally. To meet these needs, Tektronix has established a program of factory training which is an extension of Tektronix sales engineering. Customers who participate in this program attend classes at the Tektronix customer training centers located in the Tektronix Industrial Park in Beaverton, Oregon, or on the Isle of Guernsey. Your Sales Engineer has full details, and will make all the arrangements.

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 Microprocessor Development Systems. At your request, they will arrange to demonstrate TEKTRONIX instruments for you — in your application, if you wish.

CALIBRATION & CERTIFICATION

Services furnished are provided in accordance with all applicable Tektronix specifications. Actual test data can be made available when required.

Tektronix' calibration measurements are traceable to the National Bureau of Standards to the extent allowed by the Bureau's calibration facilities.

TEKTRONIX Service Quality Program satisfies the requirements of MIL-I-45208A, and MIL-C-45662A.

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.

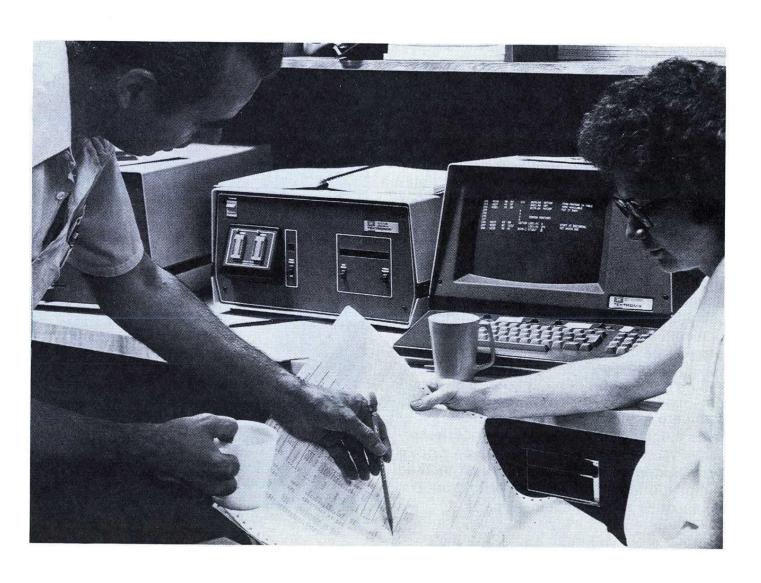
The manufacture and final calibration of TEKTRONIX products are controlled by the use of Tektronix reference and working standards and testing apparatus in accordance with established procedures and with documented results. (Reference MIL-C-45662A)

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.

CUSTOMER ASSISTANCE

Tektronix willingly assumes much of the responsibility for continued efficient operation of the products it manufactures. If you should experience a stubborn maintenance problem, we will gladly help you isolate the cause. Often a telephone call will help you get your product back in operation with minimum delay. If yours is a large laboratory, we can help your maintenance engineers by conducting informal classes on test and calibration procedures, troubleshooting techniques, and general maintenance.



PRODUCT SERVICE

To help assure adequate product service and maintenance facilities for our customers, Tektronix has established Field Offices and Service Centers at strategic points throughout the United States. Contact your Sales Engineer or Service Center for details concerning • Warranty • Calibration • Emergency Repairs • Repair Parts • Scheduled Maintenance • Reconditioning and Overhaul • Pickup and Delivery • Maintenance Agreements • On-Site Service for Fixed Installations — Other Services available through these local offices and centers. Outside the United States, service is offered in all countries where the products are locally sold.

EMERGENCY REPAIR

Should an emergency arise — "at home" or on the road — just bring your instrument to the Service Center closest to you. We'll start working on it on a priority basis. In most cases, we'll get you on your way in a matter of minutes. (There is an additional charge for this service.)

MAINTENANCE AGREEMENTS

Your TEKTRONIX products are initially covered by warranty. Several types of contracts are usually available to help you extend that initial coverage. The Blanket Repair Agreement, for example, allows you to establish a "not-to-exceed" amount, it also saves on paperwork by centralizing the billing procedure. Many other aspects of service are negotiable.



If you'd like us to maintain your products on a regular basis, ask a service center about our fixed fee maintenance program. For a fixed cost that you can budget for, we'll remind you when a product is due for calibration, and perform the service within a specified turnaround time.

Contact your service center for a schedule of service fees, more information about maintenance agreements, local services offered, or possible provisions for your special requirements.

REPAIR PARTS

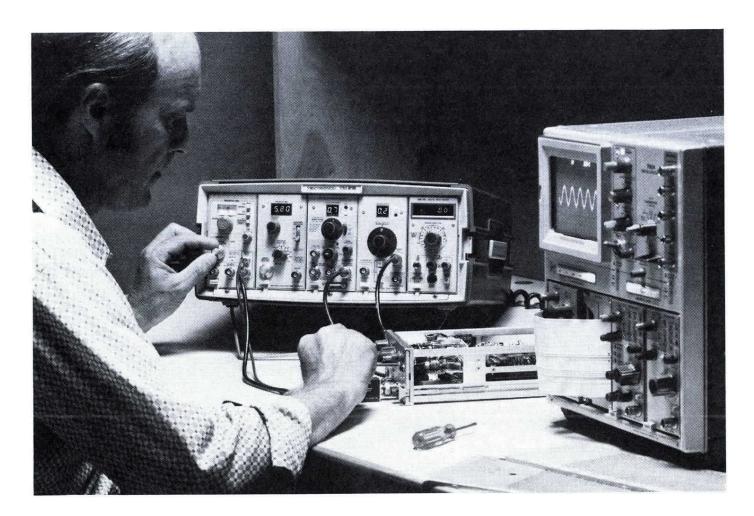
Repair and replacement parts service is geared directly to the field, therefore, all requests for repairs and replacement should be directed to the Tektronix Field Office in your area. This procedure will assure you the fastest possible service. Please include product type number and serial number with all requests for parts or service. PLEASE DONOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

TEKSCOPE

A bimonthly publication whose objective is to provide informative, timely articles presented in a readable manner across the whole of Tektronix technology. Each issue of TEKSCOPE contains articles describing instruments, measurements, and techniques. The New Products section provides information on products recently introduced, including photos, brief descriptions of unique features, and major specifications for each product.

APPLICATION NOTES

Some unique measurement capabilities of TEKTRONIX products in the field of television broadcasting, radar, communications, etc., are described in a series of application notes available at no charge.



General Terms Of Sale And Warranty

Orders should be placed with your Tektronix Field Engineering Office listed on page 272.

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 Field Engineer.

NET 30 DAYS

Tektronix, Inc., standard terms of sale are NET 30 days following the date of shipment. As with 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.

LEASE AGREEMENT

All new and used instruments are available under this program. Accessories and parts are not available unless they are associated with the products being leased. Minimum lease is \$1000.

A standard lease term of 6, 12, 18, 24, 30, and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement, the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at the expense of Tektronix, Inc. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the installments will be credited toward the purchase price.

The standard Tektronix, Inc., warranty and quantity discount apply to products leased under this installment term.

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.

INFORMATION DISPLAY PRODUCTS

Most Information Display 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 with a declining rate 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 Information Display 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 Field Engineer.

WARRANTY

Tektronix intends to provide to our customers excellent value in our products, services and business practices. TEKTRONIX products are warranted against defective materials and workmanship. Tektronix will repair or replace, at its option, those products determined to be defective under warranty. The period of coverage is specified in a warranty statement accompanying each product.

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.

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TEKTRONIX products are designed as long-term investments. Tektronix training is designed to enhance the value of those products. To meet these needs, Tektronix has established several types of programs: (1) formal classroom maintenance training; (2) audiotapes on operation, circuit description, and calibration; (3) videotapes on basic concepts as well as operation and some applications; and (4) a new venture into standalone training packages, incorporating the multi-media use of printed materials and videotapes and/or audiotapes.

1978 Beaverton Maintenance Training Classes

All classes will be conducted in Beaverton, Oregon. The tuition for each class is noted in the class description.

Maintenance classes teach operation, signal flow, calibration, troubleshooting and repair of the instrument. A combination of lecture and lab sessions is the usual format for maintenance training. Any preparation material in addition to maintenance manuals will be mailed directly to you.

7704A/7904/7633 Class \$675/Student

The 7000 Series classes are a combined study of the 7704A/7904/7633 Oscilloscopes. The prerequisite for the 7904/7633 class is training on the 7704A. Class duration is two weeks: first week devoted to 7704A, second week devoted to 7904/7633. Plug-ins taught are representative of the units most frequently purchased with these mainframes.

Class Dates: March 20-31, 1978 June 5-16, 1978

> August 7-18, 1978 October 23-November 3, 1978

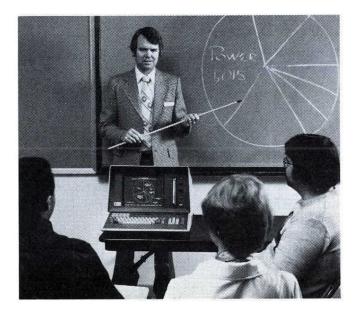
December 4-15, 1978

465/475 Class \$300/Student

The 465/475 Oscilloscopes maintenance class is taught to the component level of troubleshooting and repair. The student is encouraged to study the circuit description portion of the manual. Class duration is one week.

Class Dates: May 1-5, 1978

June 19-21, 1978 August 21-25, 1978 November 6-10, 1978



Sampling-7S11-7T11 \$400/Student

Besides the prerequisites and preparation described previously, the student must be familiar with the operating characteristics of the 7704A Oscilloscope Mainframe.

Class Date: April 10-14, 1978

5100/5400 Class

The 5100/5400 Oscilloscope class covers representative plug-ins for the products. Class duration is one week.

\$300/Student

Class Date: July 31-August 4, 1978

Logic Analyzers Class \$300/Student

The 7D01/DF1 Logic Analyzer is a new product on the 1978 customer training schedule. The prospective student is encouraged to study the circuit description in the 7D01/DF1 manual. Class duration is one week.

Class Date: September 25-29, 1978

TM 503/DC503/DM502/TG501/PG501/ FG501 Class \$275/Student

The TM 500 products selected for this class represent each of the major categories in the Test and Measurement area. Class duration is one week.

Class Dates: May 8-12, 1978

August 28-September 1, 1978 November 13-17, 1978

WDI-7912/1350 Class \$800/Student

The student must have operational knowledge of the 7704A-Series Oscilloscope; he must also have satisfactorily completed study of the audio circuit description training program on the R7912. This package (062-2708-00) is available through the local Tektronix Field Office. It should be ordered at least 60 days before class participation, because the subject material is quite lengthy. Class duration is one week.

Class Date: August 21-25, 1978

DPO-P7001/1350 Class \$800/Student

The student must have operational knowledge of the 7704A Oscilloscope; he must also have satisfactorily completed study of the audio circuit description training program on the P-7001. This package (062-2707-00) is available through your local Tektronix Field Office. It should be ordered at least 60 days before class participation, because the subject material is quite lengthy. Class duration is one week.

Class Date: March 27-31, 1978

4051/4631 Class

The 4051/4631 intelligent terminal class requires an understanding of microprocessors for full appreciation of class content. Class duration is two weeks.

Class Dates: July 24-August 4, 1978 December 4-15, 1978

4010/4014/4631 Class

The 4010/4014/4631 Graphic Display Terminal class is taught to board level maintenance; greater depth is taught when signal

flow concepts are necessary. Class duration is one week.

Class Dates: April 17-21, 1978

June 26-30, 1978

August 27-September 1, 1978 November 6-10, 1978

4081/4905/4641 Class

The 4081 intelligent terminal system is a new product on the 1978 customer training schedule. Understanding of microcomputer and microprocessor theory is necessary for full appreciation of class content. Class duration is two weeks.

Class Dates: May 15, 1978

August 14-25, 1978

8002 Emulator Modules

The 8002 Microprocessor Lab is a new product on the 1978 customer training schedule. Understanding of microcomputer and microprocessor theory is necessary. Class duration is two weeks.

Class Dates: April 17-28, 1978

July 10-21, 1978

October 23-November 3, 1978

1978 Field Maintenance Training Classes

Tektronix will provide maintenance classes for selected products at local Field Offices.

7704A/7A26/7B80-85 Class \$500/Student

The 7704A Oscilloscope combination is taught to the component level of trouble-shooting and repair. The student is encouraged to study the circuit description portion of the manuals. Class duration is one week.

Class Dates: July 10-14, 1978

Dallas, TX
September 18-22, 1978
Boston, MA
November 13-17, 1978

Rockville, MD

465/475 Class \$500/Student

The 465/475 Oscilloscope maintenance class is taught to the component level of troubleshooting and repair. The student is encouraged to study the circuit description portion of the manual. Class duration is one week.

Class Dates: July 30-August 4, 1978

Boston, MA
September 18-22, 1978
Dallas, TX
October 9-13, 1978
Irvine, CA

TM 504/DC503/DM502/TG501/PG501/ FG501 Class \$425/Student

The TM 500 products selected for instruction represent each of the major categories in the Test and Measurement area. Class duration is one week.

Class Dates: August 7-11, 1978

Irvine, CA October 9-13, 1978 Rockville, MD Nov. 27-Dec. 1, 1978 Chicago, IL

Customer Training

8002 Emulator Modules

The student is taught to the board level of troubleshooting and repair. Understanding of microcomputer and microprocessor theory is necessary for full appreciation of class content. Class duration is two weeks.

Class Date: September 18-29, 1978 Rockville, MD

4051/4631 Class

\$900/Student

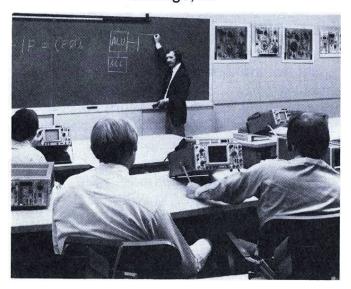
The student is taught to the board level of troubleshooting and repair. Understanding of microprocessor theory is necessary for full appreciation of class content. Class duration is two weeks.

Class Dates: June 12-23, 1978 Rockville, MD October 16-27, 1978 Santa Clara, CA

4010/4014-4610/4631 Class \$585/Student

The 4010/14-4610/31 Graphic Display Terminal and Hard Copy Unit class is taught to board level maintenance; greater depth is taught when signal flow concepts are necessary. Class duration is one week.

Class Dates: June 5-9, 1978
Santa Clara, CA
July 10-14, 1978
Boston, MA
September 25-29, 1978
Chicago, IL

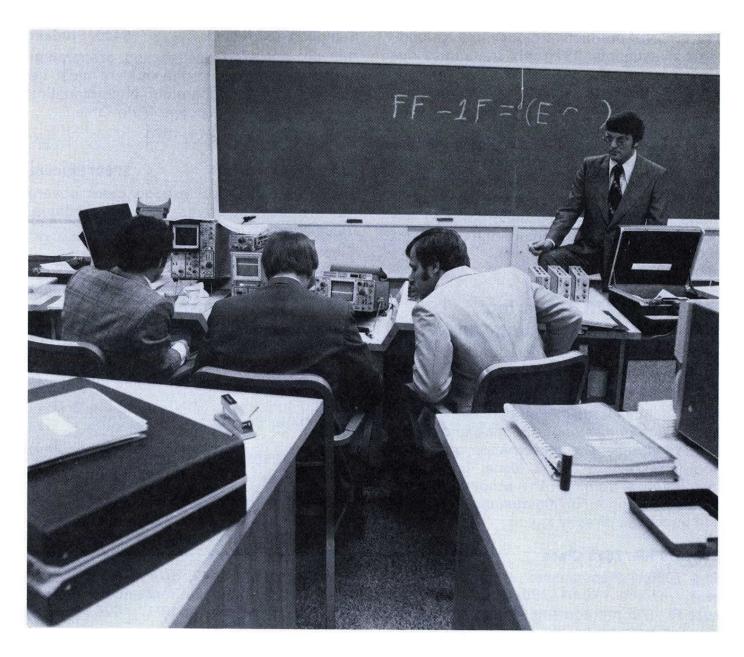


INFORMATION AND REGISTRATION

For information regarding customer training or to register for a class, please contact the nearest Tektronix Field Office. Customers outside the U.S. may obtain a schedule of classes offered on the Isle of Guernsey through their Tektronix Representative.

Multi-Media Training Materials

Tektronix produces an extensive list of audio and video training tapes as well as multimedia training packages which are available for customer purchase. Among the topics covered are circuit and block descriptions, calibration, basic analog and digital concepts, as well as instrument operation and applications. These training aids help customers make their training programs more effective. A complete list of available audio and video tapes is contained in the current Customer Training catalog, which may be obtained from the nearest Field Office.



S-3000 Series Training Classes

Tektronix provides System Application and Maintenance training for both the S-3260 and S-3000 Series of Automated Test Systems in order to enable you to make most effective use of your systems. Tektronix offers application and maintenance training classes for two persons for each system purchased.

Application Training

In System Application Training students become familiar with the Software Operating System and system hardware elements, with emphasis on the customer's specific testing requirements and system configuration. A combination of lectures and lab work helps students master essential skills for writing and debugging basic functional and parametric device test programs. Two-week application training classes are held in Beaverton and are limited to eight students per class.

Each student must have experience in programming with high-level computer languages such as FORTRAN or BASIC, and be knowledgeable about devices and testing techniques applicable to company needs.

First-Level Maintenance Training

In System Maintenance Training classes, students learn to isolate and replace faulty system modules with the use of software diagnostic programs and become familiar with system calibration procedure. These three-week classes are held at Tektronix in Beaverton.

Each student must have experience in programming with high-level computer languages such as FORTRAN or BASIC, as well as knowledge of logic networks and the ability to troubleshoot them.

Maintenance Workshop (S-3260 only)

A three-week advanced maintenance workshop is available for those of you who wish to assume system maintenance responsibility without a Tektronix maintenance contract.

Satisfactory completion of the First-Level Maintenance Training class, and 60 days of on-line maintenance experinece with an S-3260, are prerequisites for this class.

The training cost is \$2,000 per student.

Class Schedules

Class schedules may be obtained directly from the Semiconductor Tests System Training Co-ordinator at (503) 645-6464, extension 1187.

	225 224
A to D Converters	Cameras, Oscilloscope
Accessory Power Supply	Cardiac Monitoring Instrument
Accessories, Spectrum Analyzer 192	Carts, Lab and Rack
Accessories, TM 500	CATV Preamp
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Analyzers	Cords, Patch
Logic	Correctors, TV Signal
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APL Terminals	Counters, Time Interval
Attenuators	
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Our 1500-Series Cable Testers are valued by users including airlines and telephone companies. The 1500s provide maintenance people with a fast, accurate, portable tool for checking the internal condition of cables and pinpointing problems. Maintenance people can identify and locate opens and metallic shorts, as well as crimps, frays, and poor connections in coax. In telephone cables, they can also see splices, sheath damage, water, splits and resplits, load coils, bridged taps and other kinds of trouble. The 1500-Series Cable Testers are simple to operate and can be used on everything from coax to lamp cord. See pages 170 and 171.



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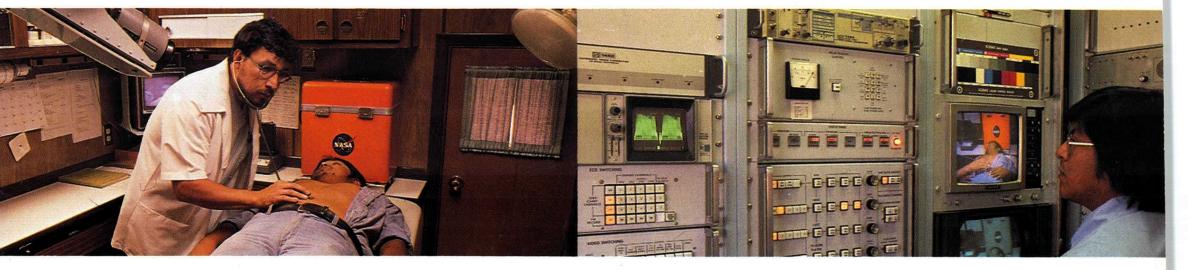




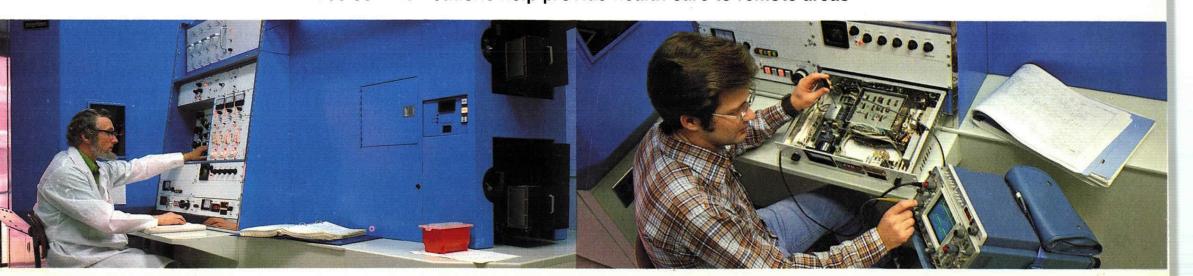
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Cable testing means finding cable disturbances quickly



Video communications help provide health care to remote areas



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