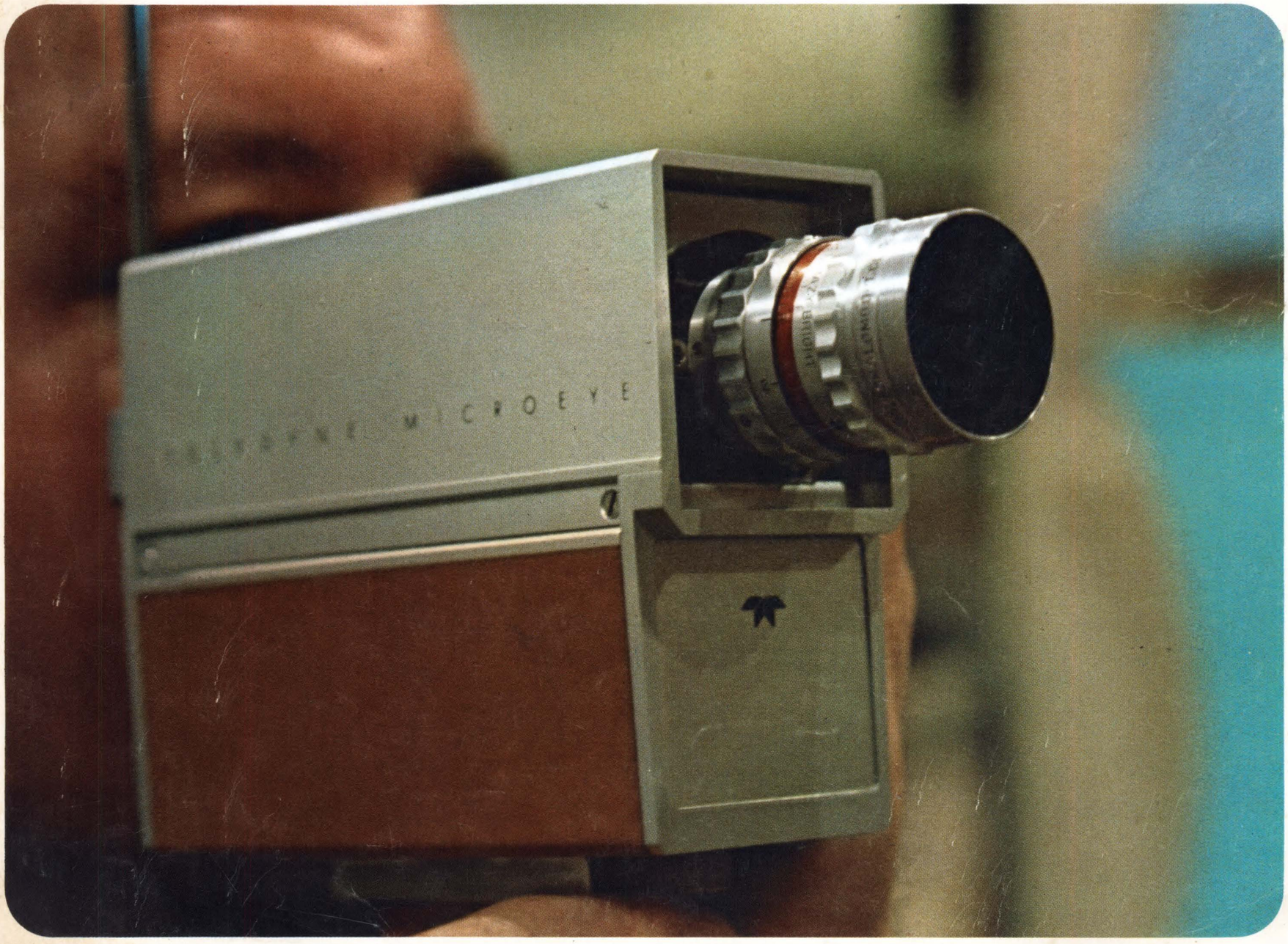
EDN

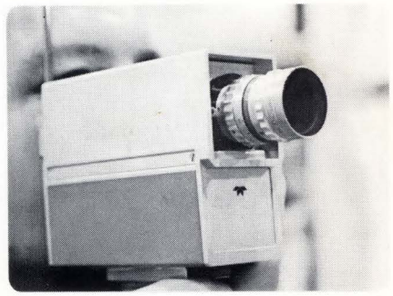
A CAHNERS PUBLICATION

MAY 1967



EDN MAGAZINE

The Electronic Engineer's Design Magazine



COVER shows "Microeye", Teledyne's complete television station—camera, power supply and transmitter—completely self-contained in a package only slightly larger than a pack of cigarettes. The small size of the system, which conforms to established conventional television practices, is made possible through the use of integrated circuits and ultraminiature discrete-component assemblies.

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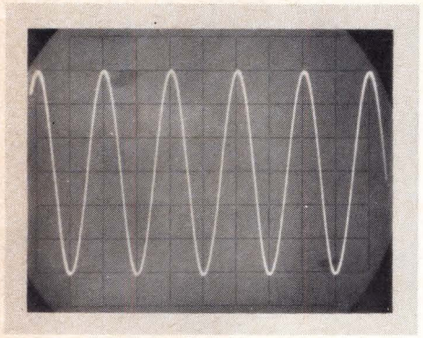
INTERNATIONAL PUBLISHING NETWORK — DESIGN ELECTRONICS · ELECTRONICS WEEKLY · EDN · ELEKTRONIK-ZEITUNG · INTER ELECTRONIQUE — ELECTRONIC

NEW *197A Camera Gives More On-Target Shots,*



Fewer Near-Misses

hp's new 197A saves time and film because it eliminates many of the cut-and-try procedures required by conventional oscilloscope cameras. Color-coded controls, for example, are all on a single, conveniently located panel—no fumbling, no reaching inside the camera.

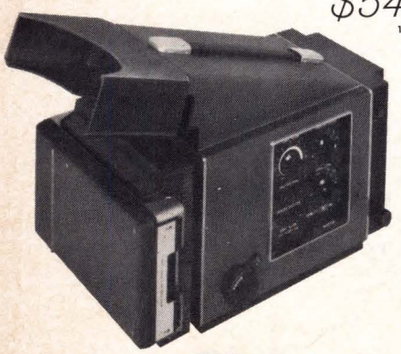
Exposure times from 1/30 to 4 sec are more accurate, more consistent and more reliable because the shutter is electronic. Electronic control also lets you trigger the camera from an external source more reliably.

You get better pictures. An adjustable ultra-violet light source illuminates the internal graticule—provides unmistakable contrast between graticule lines and the trace itself. This gives you high measurement accuracy, even when trace and graticule lines are coincident.

The 197A back can be rotated to a vertical position to facilitate two small traces on the same print. It can also be moved through 11 detented positions for multiple exposures. The reduction ratio is variable from 1:1 to 1:0.7 for optimum display of CRT on any size film. The standard Polaroid® Land Pack Film back may be replaced with a 4 x 5 Graflok® if desired. The camera mounts directly on all hp scopes, swings away for normal CRT viewing. Bezel adaptors available ($15) for mounting to other scopes. Weight, 10 lbs.

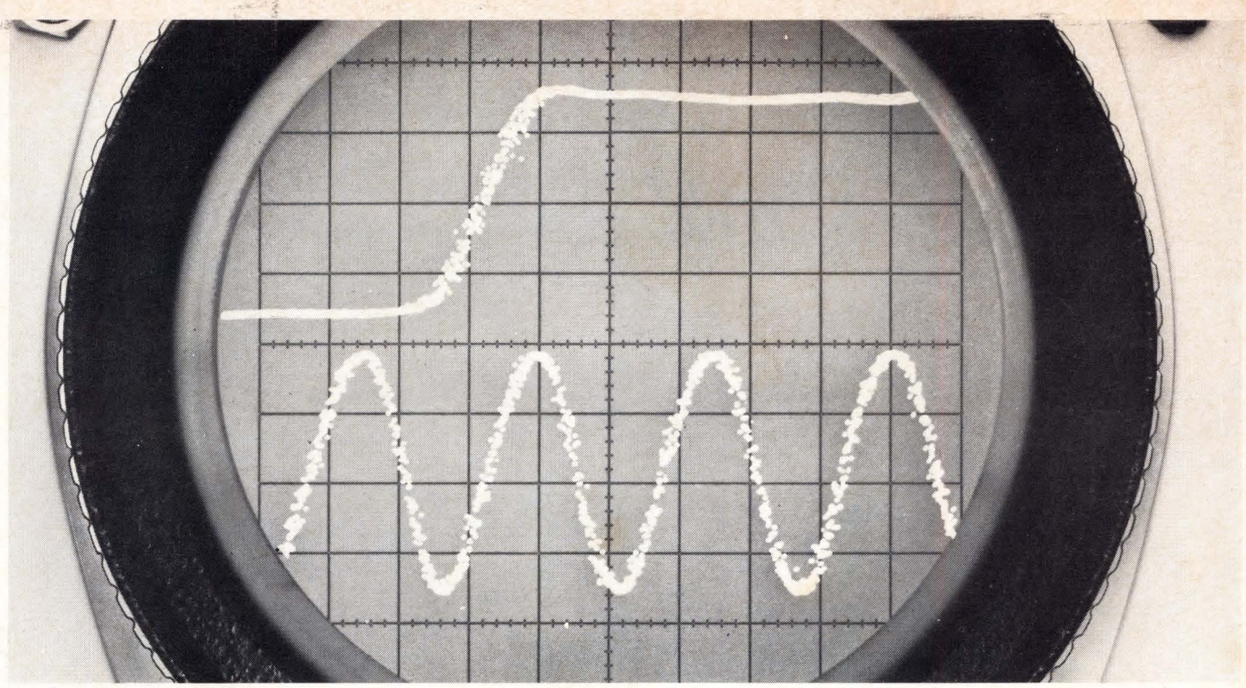
$540.

116A R



HEWLETT hp PACKARD

An extra measure of quality



Put this new design window in your lab

SEE WAVEFORMS TO 12.4 GHz & BEYOND

For the first time, you can directly see 12.4 GHz phenomena, 28 psec rise time pulses, delayed sweep displays, and 40 psec TDR. And, for an encore, this new sampling scope system gives you less than 20 psec jitter for sharp displays, automatic triggering for fast easy trace set-up, and remote samplers which monitor feedthrough signals with minimum loading. Time difference between channels is less than 5 psec for accurate phase measurements. You can build your system around the field-proven 140A mainframe (or the stop-action 141A with variable persistence and storage) using these all solid-state plug-ins:

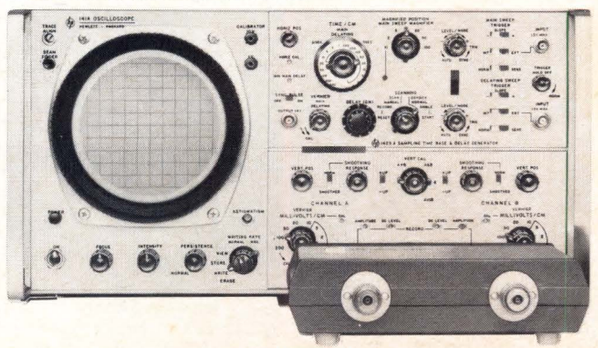
NEW DUAL-CHANNEL 1411A VERTICAL AMPLIFIER functions with any of three dual-channel remote samplers, with sensitivities to 1 mv/cm: (1) Model 1430A with 28 psec rise time for optimum pulse response; (2) Model 1431A, DC to 12.4 GHz with an extremely flat bandwidth and low VSWR (1.4:1 to 8 GHz, 2:1 at 12.4 GHz); and (3) Model 1432A with 4 GHz bandwidth, 90 psec rise time. Additional versatility is provided by front panel recorder outputs, and A vs. B mode for accurate phase measurements. Price of the 1411A Vertical Amplifier: $700. Samplers: $3000 for 1430A and 1431A; $1000 for 1432A.

NEW 1425A TIME BASE & DELAY GENERATOR, first with delayed sweep sampling, gives sharp, jitter-free magnification of complex signals or long pulse trains. It provides maximum sweep speeds of 10 psec/cm, triggering to 1 GHz and delay times as long as 5 ms. Straightforward control nomenclature and layout make it easy to use. So does automatic triggering, push-button return to X1 magnification and an intensified dot which locates the expansion point for you when setting up a magnified trace. $1600.

Also available: Model 1410A Vertical Amplifier with 1 mv/cm at 1 GHz ($1600), 1104A/1106A Countdown for triggering to 18 GHz ($750), and 1105A/1106A 20 psec Pulse Generator ($750). Mainframe prices: 140A, $595; 141A, $1395. With the versatile hp 140 Scope System, you get *better performance in any direction:* 20 MHz wideband • TDR • high-sensitivity with no drift • variable persistence and storage – *and sampling.*

Get complete specs on the new hp sampling oscilloscopes. Write or call Hewlett-Packard, Palo Alto, California, 94304. Phone (415) 326-7000. In Europe: 54 Route des Acacias, Geneva.

087/11 R



HEWLETT hp PACKARD

An extra measure of performance

Circle No. 2 on Reader Service Card for more information.

For immediate sales contact, circle No. 78

Cinch
Creative
Problem
Solving

to produce a precision contact connector

design an 18 station progressive die

This unusual, highly complex contact design provides the necessary balance between contact pressure and insertion force required by a unique PC edge connector application. Its complexity made economical production doubtful . . . then Cinch tool design engineers tackled the problem.

RESULT: An 18 station, high speed progressive die that holds contact tolerance to ± 0.003" through eleven bends in four directions. Individual sections of the die can be adjusted or replaced without removing the die from the press—thus assuring maintenance of tolerances as the die wears.

The die produces over 4,500 contacts per hour from special controlled grain structure metal stock.

Here is another demonstration of the extra dimension in Cinch's engineering and developmental skills. Beyond the ability to design fine products, we offer in-depth production engineering capabilities, including tool, die, mold and equipment design and fabrication.

Our skills and services are available to you. For Cinch creative problem solving assistance contact Cinch Manufacturing Company, 1026 South Homan Avenue, Chicago, Illinois 60624.

CINCH

DIVISION OF UNITED-CARR

MEMBER
THE CINCH ELECTRONICS GROUP

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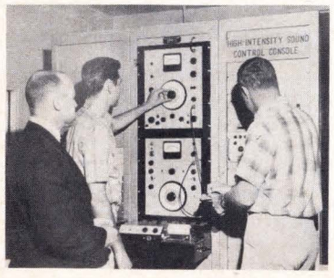
CONSISTING OF CINCH MANUFACTURING COMPANY, CINCH-GRAPHIK, CINCH-MONADNOCK, CINCH-NULINE, UCINITE (ELECTRONICS) AND PLAXIAL CABLE DEPT.

C-6709

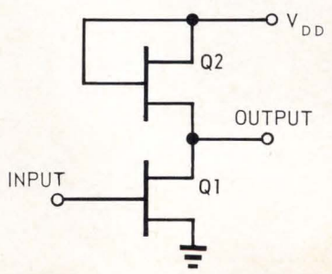
EDN
MAGAZINE
The Electronic Engineer's Design Magazine
Vol. 12, No. 6—May 1967

DEPARTMENTS



The Engineering Grad

More schools in the future will be on the quarter system and the co-op program. From what once was the nearly universal standard curriculum, two stalwart offsprings have developed. We choose to christen them the Industry-Oriented Program and the Flexible Program. See p. 90.

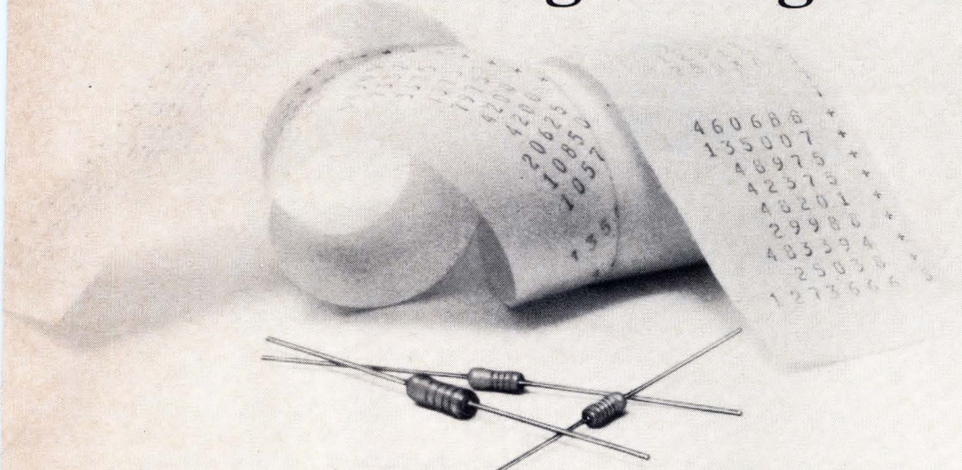


Multiphase Clocking

This article by ARINC Research relates the advantages obtained when multiphase clocking is used in conjunction with MOS (metal-oxide-semiconductor) devices. These advantages result in reduced chip size, lower power dissipation and increased operating speed. See p. 36.

It used to be a nagging pain figuring out how much resistor precision to buy.

Then Corning changed the rules.



The new CORNING® C-style Resistors handle precision, semi-precision and general purpose applications. What could be easier? They offer precision stability and reliability at far less than precision prices.

---

100 ppm TC. 1, 2 and 5% tolerances. Performance requirements of both MIL-R-22684B and MIL-R-10509F, Char. D.

New C-Style Resistors come with 1/10, 1/8, 1/4, 1/2 watt ratings, in the 10 ohm to 499K range. Samples and complete data for the asking. Meanwhile, we're looking for more changes that will improve resistors. That's how we've earned our qualifications for exceptional stability and for reliability. That's how our line of glass tin oxide film resistors has grown to be one of the most extensive. Including precision, high reliability, low power, high power and water cooled types. Corning Glass Works, 3901 Electronics Drive, Raleigh, North Carolina.

CORNING
ELECTRONICS

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Noted in Passing?

"It should be noted in passing that there was a professional degree awarded to practicing engineers having 5 or so years of experience and submitting a thesis based on their work." Thus, the Goals Committee of the American Society for Engineering Education dismisses an important opportunity to encourage continuing education, to relieve the congestion in our graduate schools and to improve the largely nonexistent dialogue between professor and practitioner.

Formerly, the degree of Professional Engineer, ranking between the M.S. and the Ph.D., was awarded. Past professional educators conceded that education could continue past the confines of the ivory tower and that significant contributors to the well-being of mankind might come from the industrial laboratory as well as from the university.

This is no longer true. Formal recognition of professional competence in engineering now can be obtained only in the classroom and all too often is reserved for those with no industrial experience whatsoever.

We do not agree with the Goals Committee that this concept should be noted "in passing". We feel that it merits careful and serious study and consideration. We would like to see our professional societies join together in an effort, not to see why it won't work, but to make it work. There is no reason whatsoever to believe that baptism by the professorial palm is requisite to recognition of significant professional accomplishment.

Just for openers, we throw in these recommendations for your consideration.

- That colleges establish machinery whereby home-study courses in specific technical areas could be followed by degreed working engineers. These courses would be tailored to fit the individual's occupational bent.
- That the engineer be required to meet regularly with a qualified faculty advisor for consultation.
- That, after completion of the home-study course to the satisfaction of the advisor, the candidate for degree of Professional Engineer (or whatever name you wish) be required to submit a significant thesis in his specific technological field.
- And finally, that this thesis and the candidate be examined for professional competence by a review board comprised of professors and qualified members of the professional society most concerned.

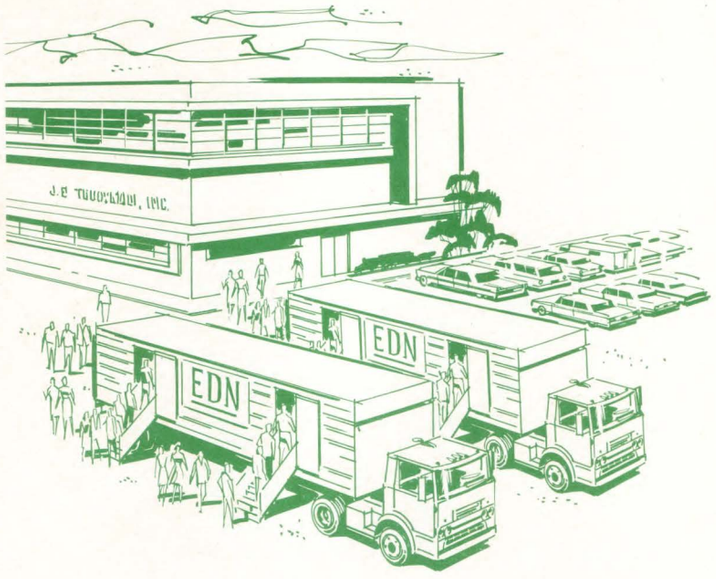
By these means, much of merit can be accomplished. Such a "retreat" into past practice will not be welcomed by the educators, but we feel that, unless they follow some such course, the gap that now exists between industry and the colleges will continue to widen. This is a way of reversing the trend. Let us, and your professional society, know your thoughts on the subject.

Thomas B Stephenson

Western Editor

News from the Field

EDN REPORTS
THE LATEST FROM THE
ELECTRONICS WORLD



EDN's first mobile exhibit tour adds another dimension to the trade show concept—take the show to the engineer!

Couldn"t Attend the Trade Show?

ENGLEWOOD, COLO.—Well, the show is coming to you—a part of it is, at least.

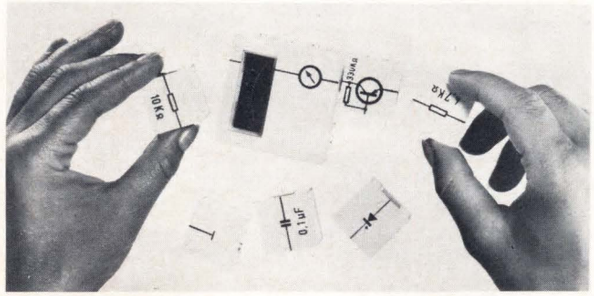
Beginning July 10, modern 40-ft mobile exhibit vehicles will travel across the country. In each van several different companies will exhibit their product lines and have representatives on hand to discuss engineering applications. The vans will visit more than 54 major cities with preplanned "shows" scheduled in company parking lots and similar locations during the 17-week tour. Engineers in each city are invited to visit the exhibit when it is in their local area.

The caravan concept was developed by EDN to provide a service to the busy engineer. Rather than spending hours interviewing a number of vendors throughout the week, the engineer can contact several in a few minutes. He will have the opportunity to get up-to-date information on the latest products, secure application information and detailed specifications.

In addition, he can visit the exhibits accompanied by members of his staff or others who might not accompany him to a trade show. An additional advantage is that the equipment display in the van is already set up and operating. The engineer may operate the equipment at his own location rather than attempt to simulate a particular problem miles from the source.

The product lines of the exhibitors represent a broad cross-section of frequently used components. Included are Babcock Relays, Beckman Helipot, Erie Technological, Hughes Vacuum-Tube Products and Master Specialties. Also, there will be an Information Handling Services' VSMF (Visual Search Microfilm File) catalog system that will reproduce data sheets for exhibitors' products.

If you would like to be notified when the exhibit is in your area, Circle No. L65.

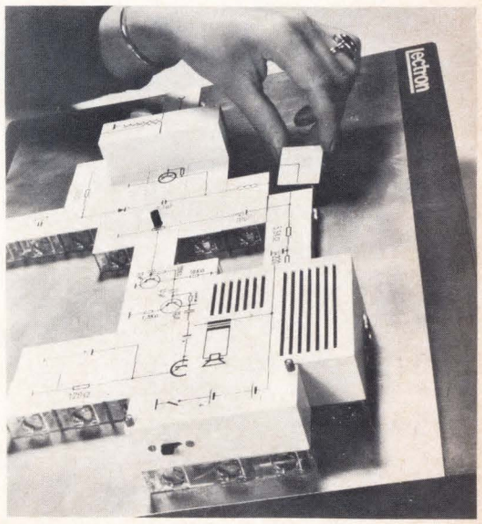


Working elements of new electronic dominoes (above) help form instant circuits and thus teach electronic theory as fast as a teacher can block out diagrams on the board (below).

Dominoes Teach Electronic Theory

LEXINGTON, MASS.—A new aid to the teaching of electronic theory, an electronic domino, has been developed by Macalaster Scientific Corp., a subsidiary of Raytheon Co. The dominoes are encased in see-through plastic, fitted together with internal magnets, and represent various working parts of individual circuits. On top of each domino is printed its identifying symbol. Dominoes are fitted together by students according to the teachers' diagrams, forming the circuitry for such things as AM radio receivers, directional signals, a voltage divider, a rectifier, an amplifier and others. More than 90 different experiments in electronics are possible with one set of dominoes.

Dominoes form an AM radio in about 10 minutes. Built-in circuit diagram aids students' comprehension and makes checking circuit simple.



Holograms Via the Computer

Researchers at IBM's Scientific Center, James A. Jordan, Jr., Peter Hirsch and Louis B. Lesem, left to right, are shown with the equipment they used to produce a 2-D hologram of the Greek letter lambda.

HOUSTON, TEX.—Researchers at the IBM Scientific Center here announced last month at the International Symposium on Modern Optics that they have programmed a computer to calculate the interference patterns that would be created if light waves actually had been reflected from an object. With this method, however, neither the real object nor actual light waves are required to produce the holograms.

To date the researchers have only obtained two-dimensional holograms. They expect that with further work they will be able to work out a program for a 3-D reconstruction. They feel that when they have the programming completed they could reconstruct not only optical holograms but microwave, acoustic, radio-frequency and infrared holograms.

In the experiment illustrated at the symposium, the IBM researchers described the physical form of the Greek letter lambda in terms of numbers representing the intensity of points on the symbol. This series is fed into the computer, which then calculates a digital hologram.

A graphic plotter converts the digital hologram into a visible one on a sheet of translucent material. The plotter records the data in 32 different shades of gray under computer control. The plotted hologram then is photographed in ordinary light with a conventional camera and standard film. To be viewed as a reconstruction, the hologram then must be illuminated by laser light.

USC Hosts Flat Cable Seminar

LOS ANGELES, CALIF.—The University of Southern California's School of Engineering, in cooperation with the Institute of Printed Circuits, will host a full-day seminar on flat-cable technology. Entitled "Flat Cable—Present and Future", the meeting is sponsored by EDN and is open without charge to all engineers.

Why Flat Cables? Like most technologies in the electronic industry, flat cable has a short history—10 to 12 years. During this period the use of flat cable as an interconnection medium has progressed from a highly sophisticated, expensive technique to an immediate commercial necessity. Flat cable has many advantages, each accompanied by some limitations. This regional seminar will examine flat-cable interconnection—its advantages, limitations and design considerations.

So Who's Interested? Most engineers realize that electrons are fine, but sooner or later you have to do something with them. (And to do something, electrons first have to be transferred by wires or cables—hence flat cable.) This symposium has been developed to serve the needs of both design and production engineers. Design engineers must consider interconnection techniques in early design stages. The use of flat cable may reduce design and development time. Production engineers may benefit by examining the economic and manufacturing compromises that accompany the use of flat cable, both in new designs and in redesign of existing equipment.

Historically This will be the 38th regional engineering seminar, sponsored by EDN and its sister publication, DESIGN NEWS. The program has evolved into an efficient method of continuing engineering education and will feature papers, given by recognized experts, of vital interest to the electronic design engineer. (EDN sponsors these seminars as a noncommercial service.)

The Speakers Are R. A. Klotz, Douglas Aircraft, "Flat Cable for Saturn S-IVB Vehicles".

P. L. Hill, Douglas Aircraft, "Flat-Cable Manufacture and Installation".

J. W. Peterson, Electro-Mechanisms, "A Flat-Cable Termination Technique".

A. B. Chase, W. L. Gore Assoc., "Applications of Flat-Cable Conductor Cables".

Roy Witte, Cinch Mfg. Co., "Simplified Flexible-Cable Terminations".

W. S. Rigling and H. T. Davis, Martin Co., "Kapton Polyimide Flexible Printed Circuits".

Joseph Marshall, Advanced Circuits International, "Flat Cable as Multi-Signal Transmission Lines".

Dave Crimmins, ACI Div. of Kent Mfg., and Ken Collin, Flexiprint Div. of Sanders Assoc., "State-of-the-Art and Future Projections for Flexible Flat Cable and for Flexible Printed Circuits".

Walter Gammel, G. T. Schjeldahl Co., "Flexible Flat Cables and Their Insulation".

When? The 1967 seminar will begin at 9 a.m., June 20, in Hancock Auditorium on the USC campus.

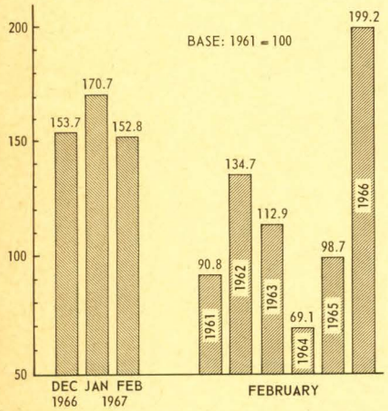
Any Questions? Contact, for all the answers, EDN Magazine, 5670 Wilshire Blvd., Los Angeles, Calif. 90036, (213) 933-9525.

Demand Down For Engineers

NEW YORK, N.Y.—During February the demand for technical people dropped to 152.8—a 10.5-percent decrease from the January level. The Deutsch & Shea Engineer/Scientist Demand Index for January showed a rise of 17 points to the level of 170.7. However, this increase has been erased by the 17.9-point drop that brought the February index down below the December level of 153.7.

This drop is much more severe than dips in February of previous years. For example, the demand in February 1964 dropped only 0.1 point. In February 1965 it dropped 2.5 points. And in February 1966 it rose 8.1 points.

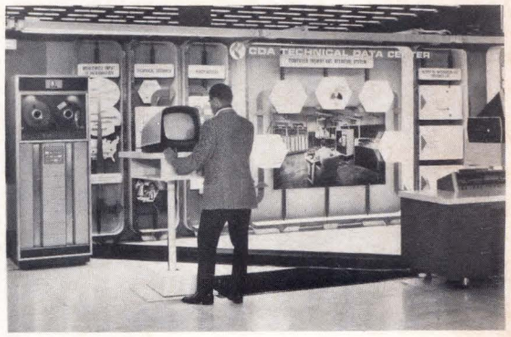
Although a seasonal upturn is expected in March, Deutsch & Shea interprets the February 1967 decline as an additional indication of the slowly declining market for engineers. This decline is expected to characterize 1967. In January the Deutsch & Shea report included the prediction that in 1967 the demand for technical people will remain at a fairly high level. However, this year the demand may not reach the high levels recorded in 1966.



Deutsch & Shea Engineer/Scientist Index shows the demand during December 1966, January and February 1967 and the demand during previous Februarys.

Circle No. 8 on Reader Service Card for more information.

Copper Information



NEW YORK, N.Y.—An industry association and research institute have teamed up with a computer to provide copper information retrieval service for engineers. A demonstration by the Copper Development Assn. (CDA) at the IEEE Show exhibit in New York used a desk-sized computer and display screen to show, on a small scale, the system in operation.

The special demonstration enabled an engineer to type in his information request phrased in the CDA's terminology. His request appeared on the display screen above the keyboard and, while the search was being carried on by small computer in the exhibit, the request statements were rearranged alphabetically and displayed along with their interrelated terms. The screen then displayed the answer to the inquiry in the form of document number. By simply referring to the extract volume on a shelf under the display unit, the engineer could review the information he had requested.

The maximum response time for the complete search by this small, low-speed demonstration computer (Control Data 160-A) was 50 sec or less. The demonstration was programmed with only 10 percent of the information in the entire system to illustrate its operation. The total retrieval program employs a larger Control Data 3400 computer.

The Technical Data Center established in 1965 by the Copper Development Assn. provides engineers, who select and apply materials, with complete and up-to-date technical data on the properties, processing and applications of copper, brass and bronze. This computer-based information service is the first of its kind offered in the metal industry.

Anyone?

A special-interest checklist card submitted by the inquirer will obtain periodic reports and data sheets about copper from the CDA Technical Center. There is no charge for either service.

Information and data from both published and unpublished sources are collected and reviewed by specialists at the Center located in the Columbus, Ohio, laboratories of Battelle Memorial Institute. Each selected document is sent for evaluation to one of the 70 engineers in the copper and brass industry who are staff experts guiding the program technically.

After evaluation, the information and data are edited into an extract containing all of the text, tables and figures with long-term usefulness. This document then receives a serial number that is stored in the computer memory behind each appropriate term of the more than 5000 terms in CDA's resource of terms on copper.

The Technical Data Center stands ready to search for and provide available data on copper and copper alloys that are needed in connection with specific materials, selection and metal-processing problems and operations. The Center covers copper technology from refining of metals through the end-use performance of parts, components and systems made from its new products.

Materials included are copper, copper alloys, iron and steel with copper as an alloying element, copper chemicals and materials competing with copper applications. Worldwide in scope, the system handles data originated outside the U.S. with guidance provided by European engineers and copper development groups who are participating in the program.

Lasing a Rainbow

Multiple exposure shows the new laser. Beams were separated by rotating a prism in front of the laser.

YORKTOWN HEIGHTS, N.Y.—A simple liquid laser that can produce a rainbow of different colors has been developed by researchers at IBM. Using a new flash-lamp-pumped laser that emits in a broadband about 100Å wide at varying frequencies, colors of green, yellow, orange and red laser light have been produced. In principle, all wavelengths in the visible and infrared should be possible. The color of the beam is changed simply by refilling the liquid laser with different solutions of organic dyes.

Scientists at IBM first observed lasing action in an organic dye last year. But organic dyes had to be pumped by a giant-pulse ruby laser (an expensive and cumbersome technique) or complex frequency-doubling methods are needed. Fast pumping is essential for lasing fluorescent dyes so a flash-lamp and laser assembly that generates pumping pulses with a risetime of 300 nsec was developed.

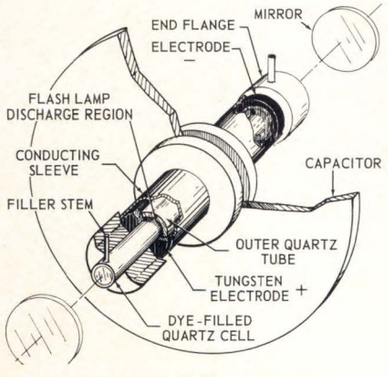
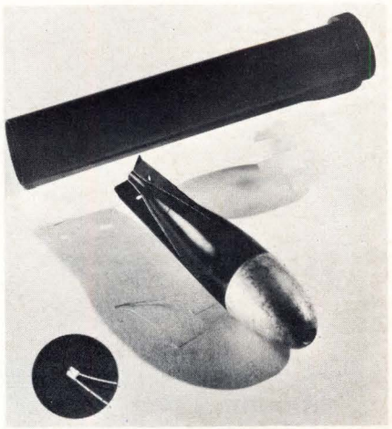


Diagram of the new laser. The capacitor is used to fire the flash lamp, enabling different colored dyes to be pumped with incoherent light.

Probe Takes Ocean's Temperature

MARION, MASS.—Depths to 1500 ft are being measured rapidly and accurately according to the developers of a new expendable bathythermograph system. The new probe provides a graphic record of temperature versus depth over this distance within 90 sec after the drop is initiated. The probe carries, as its temperature-sensing element, a thermistor measuring 0.030 inch per side encased in a thin protective coating of parylene plastic that has been vacuum-deposited onto the thermistor.

In use, the probe in its canister is loaded into a launching device. The thermistor forms an element of an electrical path composed of a voltage source, wire lead and a recorder. The seawater provides the return electrical path. A depth accuracy of ±2 percent is obtained with an accuracy of ±0.4°F. According to the Sippican Corp., developer, this is much more accurate than conventional, mechanical probes, which also require that the ship's maneuvering be minimized, its speed be reduced to 15 knots and an attendant be present on deck for 10 minutes for each cast. The Sippican system, however, can be used at speeds up to 30 knots, does not limit maneuvering and only needs watching for 30 sec for each drop.



Probe, canister and thermistor (also enlarged in inset) of new bathythermograph system.

Superconductive Memories After 11 Years

PRINCETON, N. J.—After 11 years of intensive research, RCA has announced what it calls the first practical process for building superconductive computer memories that may store up to a billion bits of data and operate several times faster than present information-storage units.

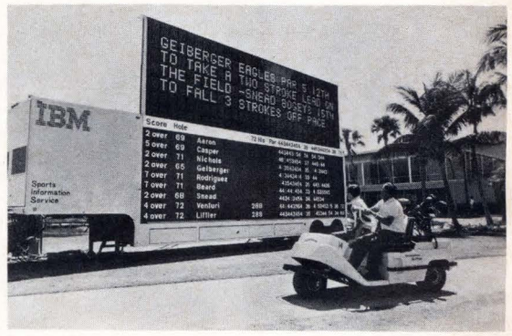
RCA scientists have constructed a cryoelectric unit that stores 14,120 bits of information in arrays of microscopic loop cells made of superconductive materials deposited in thin films on glass slides. The experimental unit can recall the stored information at a rate of nearly 1/2 million bits per sec. The company expects this method could make possible memories that store up to a billion bits of computer data. Because of their large capacity coupled with their high-speed operation, such superconductive memories are expected to compete favorably with the slower punched card, magnetic drum or magnetic tape systems.

The key to the experimental system was the development of a loop-cell structure that could be fabricated uniformly by the thousands and still carry a current that could be sensed or removed. A cell was developed that consists of thin layers of lead, tin and an insulating material deposited in large arrays on a glass slide.

A photolithographic fabrication technique was used to help eliminate the penumbra along the film edge, resulting in a better inductance factor. (Film thickness cannot be indiscriminately large or the inductive time constant will be excessive because of a smaller restored resistance time.)

The experimental memory contains four such slices tacked one on top of the other and interconnected along the edges. The stack must be kept in liquid helium at a temperature of 7k above absolute zero. This cryoelectric memory then is hybridized to room-temperature decoders compatible with the loop-cell arrays.

Computerized 'Tote Board' Hits the Road



NEW YORK, N.Y.—A van-mounted, computer-controlled mobile information unit was designed and built by IBM and the Datex Div. of Giannini Controls Corp. to supply officials, local audiences, broadcast television and the press with detailed real-time information and statistical background on such sporting events as major golf tournaments.

The new information unit has a 28- by 9-ft display with foot-high characters, a character-write speed of 4000 per sec and an on-line computer internal to the van.

'67 Wrong Year To Goof on Taxes

MARTINSBURGH, W.VA.—The computer will get you if you didn't watch out last month. 1967 is the first year that all federal income-tax returns will be scrutinized by the Internal Revenue Service's National Computer Center here. IRS Commissioner Sheldon S. Cohen described the system:

"At the National Center the returns are matched against the master files which include a record for every single tax-paying entity in the country.

The files bring together in one place for thorough scrutiny all tax transactions of all taxpayers. Every taxpayer has only one account and all information affecting his tax status is matched against that account and no other."

Did George Orwell, in his book "1984", say how the whole thing started? Big Brother at least has his foot in the door.

QUIKTRAN 2 Centers Spreading

WHITE PLAINS, N.Y.—IBM announced last month that by the end of 1967 it will have 10 time-sharing centers in cities across the country able to use its improved QUIKTRAN 2 system. The more powerful new system, according to IBM:

- Is up to 10-times faster in internal-processing speed than QUIKTRAN.
- Supports up to 175 users and is available for 12 hours daily (as opposed to 50 users at a time for 4 hours a day of the old system).
- Is sold in time segments as small as 5 hours a month—former minimum was 25 hours a month.

A customer may have up to five terminals simultaneously connected to the system at no increase in charge other than the cost of the additional terminals. Minimum monthly cost of QUIKTRAN 2 is $185 for 5 hours of systems use and one 38,400-word storage block within the computer. In operation are the centers in Cleveland, Chicago, Los Angeles, New York and Philadelphia.

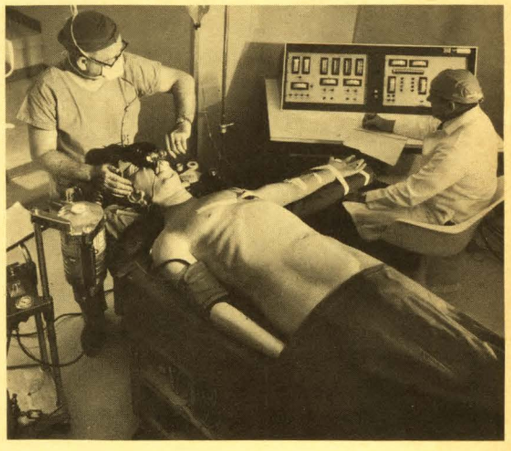
Simulated Man

LOS ANGELES, CALIF.—Anesthesiologists-to-be now have a manikin, complete with all of the necessary human structures, on which to practice their art. The manikin is controlled by computer to simulate nearly every condition that could occur on the operating table and will provide the future doctors with one of the most complex medical teaching tools ever devised.

Sim One, as the patient-simulator is known, was developed by medical researchers at the University of Southern California working with engineers of Aeroject-General Corp.'s Von Karman Center, Computing Sciences Div. "He" is covered by a plastic that has the texture and color of skin. The jaw is hinged, permitting the mouth to open and close normally. Inside the mouth are all structures found in the human patient, ranging from tongue and teeth to bronchial tubes.

Sim One has a heartbeat, carotid and temporal pulse beats and blood pressure. The diaphragm and chest move to simulate breathing. The eyes open and close and the pupils of the eyes dilate and constrict.

All of these mechanical actions are driven by computer-programmed, electronic systems that simulate

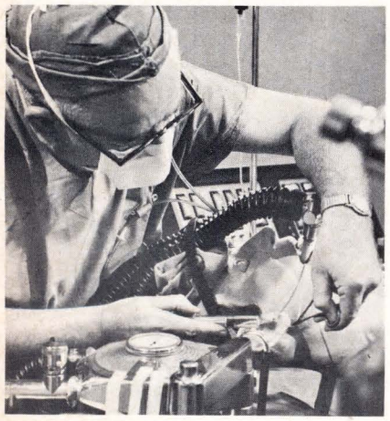


Sim One, the lifelike simulated patient, is controlled by computer to duplicate the symptoms and physiological responses that occur during major surgery.

Teaches Doctors

the symptoms and physiological responses an anesthesiologist may encounter during an actual operation. The programming provides appropriate responses to the injection of four different drugs, administered in varying dosages, as well as to the administration of both nitrous-oxide and oxygen.

One of the most helpful things that Sim One will do is to teach what doctors call endotracheal intubation. This is the procedure that involves passing a semirigid tube into the trachea, or windpipe. Through this tube anesthesia gases are administered directly to the lungs while controlled artificial breathing is maintained. The technique demands a high degree of skill and Sim One will provide the necessary tool to help doctors develop such skills.



Hailed as a revolutionary medical-educational tool, Sim One reflects realistically the external cause-and-effect relationships and externally monitored actions and responses of a patient. The computer will make the manikin react automatically to certain conditions on the operating table. Or the instructor can override the automatic responses and manually introduce problem situations. This helps to prepare the student for the unexpected in actual surgical practice.

An oscilloscope picture in 10 seconds: any longer is a waste of time.

Polaroid Land films don't make you wait to see if your trace zigged when it should have zagged.

They let you know in ten seconds.

They give you an oscilloscope picture you can study, attach to a report, send as a test record with a product shipment, or file for future reference.

You have a choice of 5 films for oscilloscope recording.

The standard film has an A.S.A. equivalent rating of 3000. It comes in both roll film [Type 47] and pack film [Type 107]. They both give you 8 pictures 3¼ x 4¼ inches. This emulsion is also available in 4 x 5 sheets [Type 57].

For extremely high-speed recording, there's Polaroid PolaScope Land film [a roll film Type 410]. It has an A.S.A. equivalent rating of 10,000.

It can take pictures of traces too fleeting for the human eye: such as a scintillation pulse with a rise time of less than 3 nanoseconds.

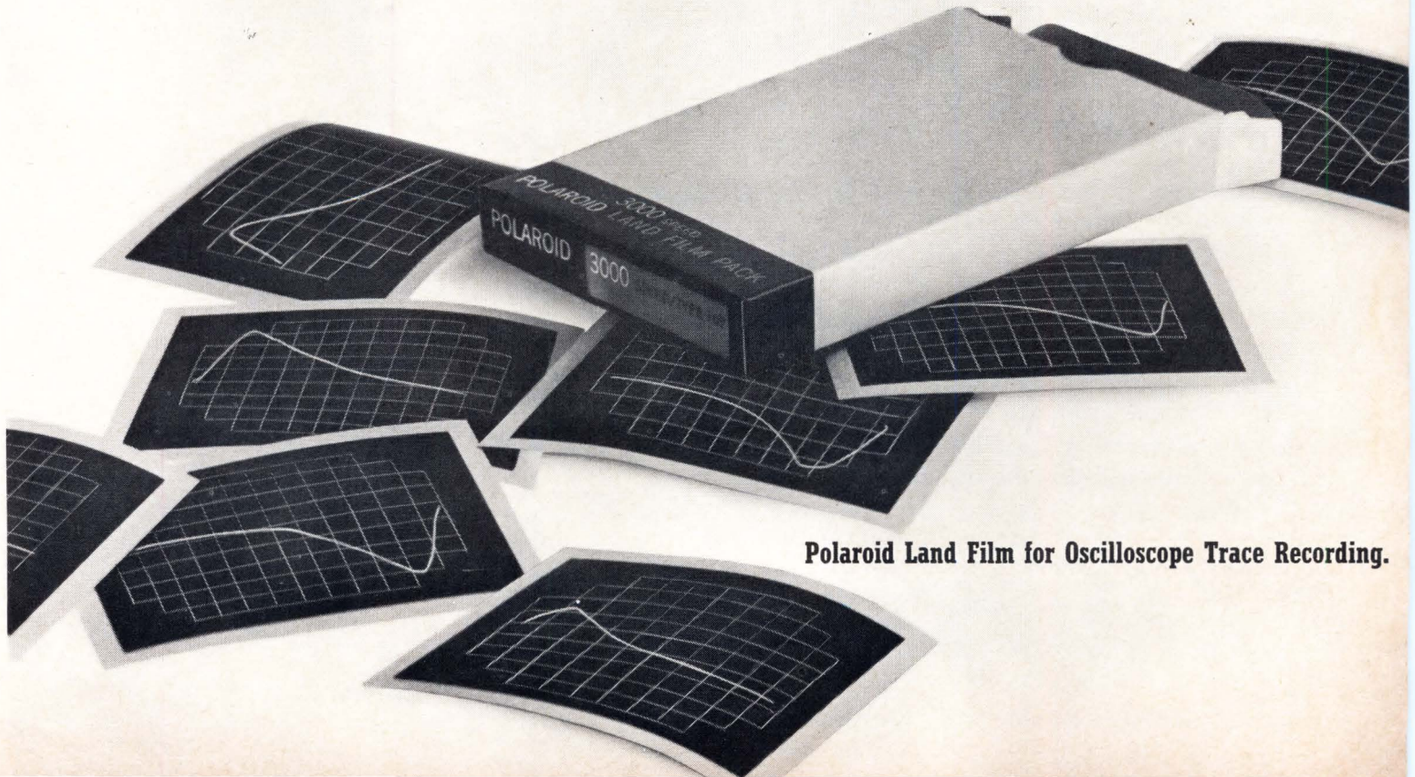
One thing all these films have in common is a sharp, high-contrast image that's easy to read. Because the films are so sensitive, you can use small camera apertures and low-intensity settings.

To put these films to work on your scope, you need a camera that will take a Polaroid Land Camera Back. Most oscilloscope camera manufacturers have one. For instance: Analab, BNK Associates, Coleman Engineering, EG&G, Fairchild, General Atronics, Hewlett-Packard, and Tektronix.

You can get complete information by writing to Polaroid Corporation, Technical Sales Department, Cambridge, Massachusetts 02139, or by writing to one of the manufacturers mentioned above.

It will probably take a little longer than 10 seconds, but we promise the information won't be a waste of time.

"Polaroid" and "PolaScope"®



Polaroid Land Film for Oscilloscope Trace Recording.

EDN | NEWS FROM ABROAD

Britain's Top Bank Computerized

Largest computer order ever by private enterprise placed by Barclays Bank, London, Britain's top bank and largest in world outside U.S. Worth $32 million, system will process all aspects of bank's operations, using Burroughs B8500 computer at London headquarters and custom-designed terminal computers at most of the 2500 branch offices throughout UK. At peak periods, 1 million transactions per hour can be handled. Should be operational in 1970 in time for sterling decimalization. Barclays claims it will be largest on-line, real-time computer banking system in world.

Color Still Confusing Europe

Two more countries, Poland and Austria, have joined opposite sides in European color-TV battle. Poland is to try out the French SECAM system regularly from 1970 and Austria has adopted the German PAL system. Despite inability of 23 countries to reach common agreement on systems, over half already showing or planning regular programs within 5 years. Both PAL (Phase-Alternation-Line) and SECAM (Sequential and Memory) claimed to be better technically than American NTSC system that has been cold-shouldered—although UK had planned to use it until French and German industries began lobbying for their systems. France convinced Russia to use SECAM, influencing Eastern Bloc countries, and appears to be winning Spain over. Portugal awaits result, probably will follow winner.

Diagnosis a la Double

Purpan Hospital, Toulouse, France, encouraged by good results of experimental transmitter-receiver system used to send in details of accident victims within 12-mile radius. Coding apparatus transmits data on pulse, blood pressure, heart, etc., of people injured or taken ill at work or home. Doctors at hospital can give immediate diagnosis or advice to ambulance attendants based on patient's records.

Loran D—Wanted for Vietnam

Recent $23-million contract awarded by USAF to ITT Federal Labs. for Loran C/D hyperbolic navigational system. Reports that earlier Loran program has run into major delays reveal critical problem in Vietnam. Loran D started in February 1965 to produce lightweight, tactical airborne navigation system using microcircuits that give greater positional accuracy to both troops and aircraft. Currently in use in Vietnam is Decca Navigator system—very effective for directing U.S. Army helicopters. New Loran D less "jammable" than Decca's, but with compatible receiver could be used by Vietcong for own navigation. Army and Air Force need accurate positioning system to prevent recurring tragedies of bombing own troops. However, apparent lobby among U.S. firms to prevent Air Force from using Decca Navigator and pressure is on to introduce Loran D.

Fuel Injected By Computer

CONVENTRY, ENGLAND—Whether you drive a car with the largest V-8 engine, a two-stroke motorcycle or your own plane, a new electronically controlled fuel-injection system developed here can help squeeze a 20-percent fuel saving and an 8-percent power increase from your engine.

A 5-year R&D program at Brico Engineering has produced a miniature solid-state computer that continuously monitors engine conditions such as speed, air and coolant temperature, and change of inlet manifold pressure, and synchronizes fuel injection for maximum efficiency. The monitor unit and its computing section are coupled to a pulse generator that controls the solenoid-operated injectors. A subsidiary unit automatically enriches the fuel-air mixture for cold starts.

Computer and monitoring unit being mounted. Solenoid-operated injectors are fed from ring main fuel system seen at bottom. Each injector is as close as possible to inlet valve for optimum speed and distribution of fuel. Rate, timing and duration of injector operation are governed by pulse generator through a trigger-distributor unit.

Circle No. 15 on Reader Service Card for more information.

Electric Compact Hits the

REDLANDS, CALIF.—A lot of firms have talked about it, but Westinghouse Electric Corp.'s Marketeer plant here has done it. Last month the company announced that it is manufacturing a small electric two-passenger vehicle designed to be driven on the public streets.

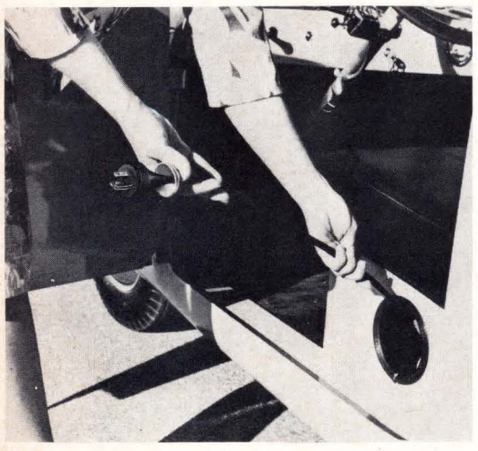
Dubbed the Markette, the new car runs quietly on lead-acid batteries at a rated top speed of 25 miles an hour and a range of 50 miles between chargings. While Westinghouse does not see the Markette as the answer to freeway driving, it does believe sales of the car initially will be to community developers, electric utilities, urbanites and governmental agencies that want to explore the possibilities of electric in-town vehicles under their own controlled conditions.

The developers are talking about a price of $2000 for early models. With an electric-power cost of less than $0.01 per mile, low maintenance and depreciation, the Markette promises to be relatively inexpensive to own and to operate. According to Westinghouse, the vehicles should last at least 10 years with no major repairs.

In standing by the lead-acid battery, Westinghouse points out that this battery is not the ultimate power source for electric vehicles. It stores only 10 to 12 w-hr of electricity per pound of battery, which is only about 1/6 the amount acceptable for good performance and distance driving. NiCd batteries give twice this energy density while silver-zinc batteries, prohibitive in cost, would raise the figure to 30 w-hr per pound. The company feels the fuel cell is the longest-range automotive energy source of all. However, it claims to be working on a small, experimental battery that will have an energy density even larger than that of the silver-zinc one. Considerable work still is needed to translate this laboratory experiment into a practical battery.

Streets

Urban dwellers could be a prime market for the new Markette. The compact measures 116 inches long, 54-1/2 inches wide and has a turning circle of only 11 ft. A storage area for shopping packages behind the front seat covers the twelve 6v lead-acid batteries. Access to them is made by folding down the seat's backrest and flipping up the storage-area floor.



"Refueling" is accomplished by slipping out the retractable cord from under the front seat and plugging it into any 120v, a-c receptacle. A full charge would take about 8 hours.

Liquid Laser Unwrapped

A 6-inch tube containing selenium oxychloride produces a pulsed beam that is more economical than solid-state lasers, while comparable in performance, but without the heat-dissipation problems.

NEW YORK, N.Y.—General Telephone and Electronics Labs., Inc., took the wraps off the liquid laser that researchers there have been working on since 1960. In a public demonstration this spring at the IEEE show, the laser was featured at the Sylvania booth.

The laser on display was the one the company announced last August (see Sept. 14, 1966, EDN, "Lasing by Liquid", p. 6). It used a solvent that does not contain atoms with a low mass, selenium oxychloride. The absence of these atoms increases the efficiency of the laser's operation because the active neodymium ions are more likely to emit photons of light than to dissipate their energy in heating the solvent. The developers feel this approach could generate a whole family of liquid lasers using rare-earth ions and heavy-atom solvents.

One of the major advantages of a liquid laser is that it restores itself after the agitation caused by each spike, even without circulation.

The company hopes that with continued development work it can design a continuously operating version of a liquid laser. While this pulsed version produces very high-powered bursts, a CW liquid laser would find more applications, particularly in communications.

Instant Replay In Three Speeds And Color

REDWOOD CITY, CALIF.—A new high-quality color-recording system that provides instant color replays in slow motion and stop action was announced last month by ABC Television and Ampex Corp.

The unique part of this system is that the recording is made on metal discs instead of conventional magnetic tape. The two companies claim that this is the first system capable of color recording and instantaneous replay of televised action at normal, fast and slow speeds down to frame-by-frame stop action. They also claim the color is of extremely high quality and the slow motion and instant replay features are better than any previous methods, even black and white.

Ampex was asked by ABC to build the system for use in televising sports action. But the new system also could be used effectively for rapid low-cost production of color commercials and special-effects material, according to company spokesmen.

Metal disc records and plays back 30 sec of action in color. For replay any part of the recording can be cued for on-the-air use in 4 sec. The control panel and timer permit precise pushbutton operation of the system.

Ge IC's Coming Up

YORKTOWN HEIGHTS, N.Y.—The first reported germanium integrated circuits were described at ISSCC '67 by IBM scientists, F. H. Dill, A. S. Farber and H. N. Yu. They announced that these circuits, although still experimental, are already faster than the fastest known silicon circuits.

Even though the Ge devices are about three times as large as the smallest Si IC's, switching speeds are about three times as fast as those of comparable-sized silicon devices. These speeds are possible because the circuits take advantage of the inherently greater speed of electrons and holes in germanium. Switching delays of 350 psec have been measured—including an estimated 100-psec delay resulting from the test package and an isolation capacitance delay of about the same amount.

Hop and Stop Recruiting

NEW YORK, N.Y.—Careers, Inc., a leading management organization in the recruiting field, has initiated a new jet-age approach to technical recruiting. On April 11 top recruiters took off in a "Brain Plane" on the first of a series of visits to several medium-sized U.S. cities that usually are neglected by recruiters in search of technical manpower.

Nicknamed "Mr. Brain Drain" by the British, William A. Douglass, president of Careers, feels that this flying operation will allow client companies to tap the manpower potential in smaller communities. During future months the plane will fly to several cities including Albany, Hartford, Syracuse, Buffalo, Dallas, Tulsa, Denver, Salt Lake City, St. Louis, Wichita and Kansas City.

Contracts In the News

Burroughs Corp., Detroit, Mich.—$22.4 million from the Federal Aviation Agency to supply 177 radar digitizers—key elements in the nation's emerging semiautomatic air-traffic-control system. Also $6.6 million from the USAF for a semiautomatic airspace surveillance and control system to be installed in the Ryukyu Islands.

North American Aviation, Inc., Los Angeles, Calif.—$8.9 million from NASA for maintenance and support of the XB-70 aircraft.

Sylvania Electric Products, Inc.—$7.5 million from the U.S. Navy for the production of electronic equipment.

Bendix Corp., Teterboro, N. J.—$7.4 million from NASA for development and production of a pointing control system (PCS) for the Apollo telescope mount.

MEMCOR, Inc., Hungtington, Ind.—$6.4 million from the U.S. Army for the receiver-transmitter portion of a family of FM vehicular radio communications kits. Potential value of the contract is $77.5 million.

General Dynamics Electronics Corp., San Diego, Calif.—$4.5-million contract negotiation with NASA to provide modification of the Goddard Range and Range Rate spacecraft tracking system.

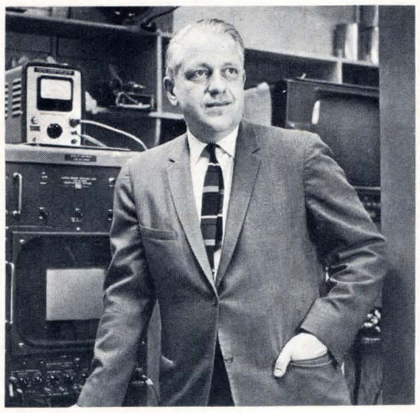
ITT Federal Labs., Nutley, N. J.—$3.7 million from the USAF for Loran-C long-range navigation sets for C-141A Starlifter jet transport aircraft.

Collins Radio Co., Dallas, Tex.—$1.7 million from the Mexican government for a 295-mile-long microwave communication system to run between Nogales and the U.S. space tracking and communication station near Epalme-Guaymas, Sonora.

Philco-Ford Corp., Philadelphia, Pa.—$1.3 million from the USAF to provide a microwave radio communications system for Air Force use in Germany.

Truxal: The Engineer's Educator

INTERVIEW



Dr. John G. Truxal is one of those men who makes the word "teacher" an honored profession. The phrase "ivory-towered" is a far cry from his approach to education—the field he has been in since graduation from Dartmouth in 1943.

Now Provost at Polytechnic Institute of Brooklyn, he has been active in every phase of engineering education. Any E.E. who has attended school in the last 12 years will recognize his name as the author of the classic text, "Automatic Feedback Control Synthesis". Work on his doctorate at MIT led to this book.

He began teaching in 1950 at Purdue University's School of Electrical Engineering, moving in 1954 to Polytechnic. In 1957 he was appointed head of its E.E. department and in 1961 was made vice-president for Educational Development. In 1964 he became Dean of Engineering and last year was made Provost of the Institute, a newly created post.

Dr. Truxal also has been active in professional, industrial and governmental affairs. Most notably he just finished his term as President of the Instrument Society of America. He is a Fellow of IEEE, works with many educational groups, chaired NASA's Research Advisory Committee on Navigation, Guidance and Control, and has been a consultant to the Ford Foundation, the National Science Foundation and National Institute of Health.

EDN interviewed Dr. Truxal April 7.

EDN: *What are your thoughts on the recent trends in curriculum in engineering schools?*

TRUXAL: The curriculum is very much the sort of thing that goes up and down in cycles. During the late 50's we had heavy emphasis on engineering science. Now, the really exciting thing that is happening is the emphasis on involving the student at a very early stage of his education in a set of graded design problems. We start him off in the freshman year, very trivially, and advance to rather sophisticated problems by the time he gets to the doctorate. Of course, this is enormously expensive to do and the resources in money and faculty are what limits us.

EDN: *What is the answer to the problem of the ever-expanding curriculum that attempts to keep up with the technology?*

TRUXAL: It is becoming more and more necessary in engineering for the student to do at least some graduate work. But we are trying very hard to focus on fundamental viewpoints and not so much on mechanistic routine. We also have the real advantage that the high schools are giving us kids who are better able to do more.

EDN: *Are the high schools doing a better job in teaching the basic sciences?*

TRUXAL: Right. They are doing a better job in English as well. But it is noticeable particularly in the basic sciences. The very significant change in the last decade is toward emphasizing the idea of students discovering for themselves, rather than being spoon fed.

EDN: *The computer has added impact to engineering education. Is it going to affect radically the quality and quantity of this education?*

TRUXAL: Oh, there is no question about this. We are just beginning to have some idea of the magnitude of the effect now. The computer, so far, has been used for data processing—calculations. Now we are beginning to find that it has an enormous impact on education. It is difficult to picture a decade ahead but if one tries, one can visualize the computer having the central role in education—not only in engineering education, but across the board. It will not replace the teacher but will give a much fuller and more meaningful educational experience to the student.

EDN: *At the recent IEEE convention in New York it was pointed out that the computer can expose the engineering student to much more complex work and make it possible to cover more material each day.*

TRUXAL: It does this. It also removes the dependence upon mathematical dexterity, which always plagues science and engineering education. The third thing the computer does is to get the student talking to the computer. This is a tremendous way to force the student to talk in specific unequivocal terms. If the student is going to talk to the computer, he has to phrase that problem very exactly and precisely. He must do it with complete logic and in education we never before had any way to force the student to think and to talk in these terms.

EDN: *Will the computer change the engineer's role in industry?*

TRUXAL: Well, it certainly is going to make unnecessary the significant number of engineers who do nothing but routine standard design. An engineer is going to have to work with the computer and use it to provide data for evaluation of alternate designs and so forth.

EDN: *Do you think that engineering schools today are turning out the kind of engineer that industry actually needs? Is the graduate as well trained as he was 10 years ago?*

TRUXAL: On this subject I feel very strongly, but I am sure I am prejudiced. Engineering education has a tendency, much more than any other field, for self-evaluation and self-criticism and one gains the wrong impression from this. I really think that engineering education is doing a fantastically marvelous job in preparing students, not only for engineering careers but for a lot of other careers such as medicine or law.

We have a product and input in the high-school students that come to us who have certain pictures of engineering, certain aspirations. And we have a market in industry for our graduates. But very often that market doesn't match the ambitions and aspirations of some of our input-product. So we have to be the impedance-matching device between the entering student and the industrial employer. And sometimes this is a very difficult task.

Our students all want to work on bioengineering or social problems to try to make a real contribution to the world they live in. Yet in both of these areas there is relatively little profit for the industrial concerns. Industry, on the other hand, is looking for engineers who are willing to work in public utilities, the defense business or space.

However, if you approach industry and ask them objectively, "Are we doing a good job or not?" the answer is "Of course not." But if you really try to find out what they think you will find that, by and large, industry is pleased.

EDN: *Occasionally industry seems to prefer the recent graduate to the man who has been out for 15 years.*

TRUXAL: There we are really in trouble. The schools are not doing much of anything for the man who has been out for a decade. Unless universities, professional societies and upper management in industry really get together and tackle this problem, we are going to be in real trouble.

EDN: *There always seems to be the problem that the engineer has a tremendous grind-type course and this precludes his being exposed to the humanities.*

TRUXAL: As I mentioned earlier, we are pulling away sharply from the routine problem-solving, drafting-type of engineering education into one that is much more meaningful. And every engineering school I know of is trying hard to strengthen its program in the humanities and social sciences. But we should turn around and state that we are doing a vastly better job than the liberal arts schools in giving their students some understanding of modern technology.

If you read the report by the committee headed by John Pierce (at BTL) that just came out on computers and education, you will find that almost no liberal arts college in the country is really giving its students any understanding of the computer and its impact on society.

EDN: *Do you think it is important for professors to keep abreast of the technology by participating in industry? How can a relationship with industry be worked out for schools?*

TRUXAL: This is very important. This is one of our advantages here. We are right in the middle of a research- and developmental-oriented community. But this is an exceedingly difficult problem for the engineering school that is located in Monticello, Ind., or away from an industrial contact. University administrators must encourage their faculty in every way possible to do consulting, to do summer work with industry, to take leaves of absence, sabbaticals (where they do not go to Europe and sit on the Riviera, but work at one of the major companies in their field, instead). I think the Ford Foundation program that has about 50 teachers a year going out for a year's work in industry is one small approach to this problem. It is significant, but it is still much too small.

EDN: *Do you find it is difficult to compete with the higher salaries of industry for teachers?*

TRUXAL: I really don't think this is a problem. Nationally, salaries in engineering universities are beginning to be fairly competitive with industry. I think (my colleagues might kill me) that you want in teaching those people who really are enthusiastic about it. It is important that teaching salaries be slightly lower than comparable industrial salaries.

EDN: *So you try to get the man who wants to teach more than he wants an attractive salary?*

TRUXAL: Right. Professors' salaries certainly have to be of the same order of magnitude as industrial salaries. You can say the same thing about elementary and high-school teaching, incidentally. They should be high enough to attract, to permit the really interested and well-qualified young man or woman to go into the field but not so high that they attract people from other jobs simply for the money.

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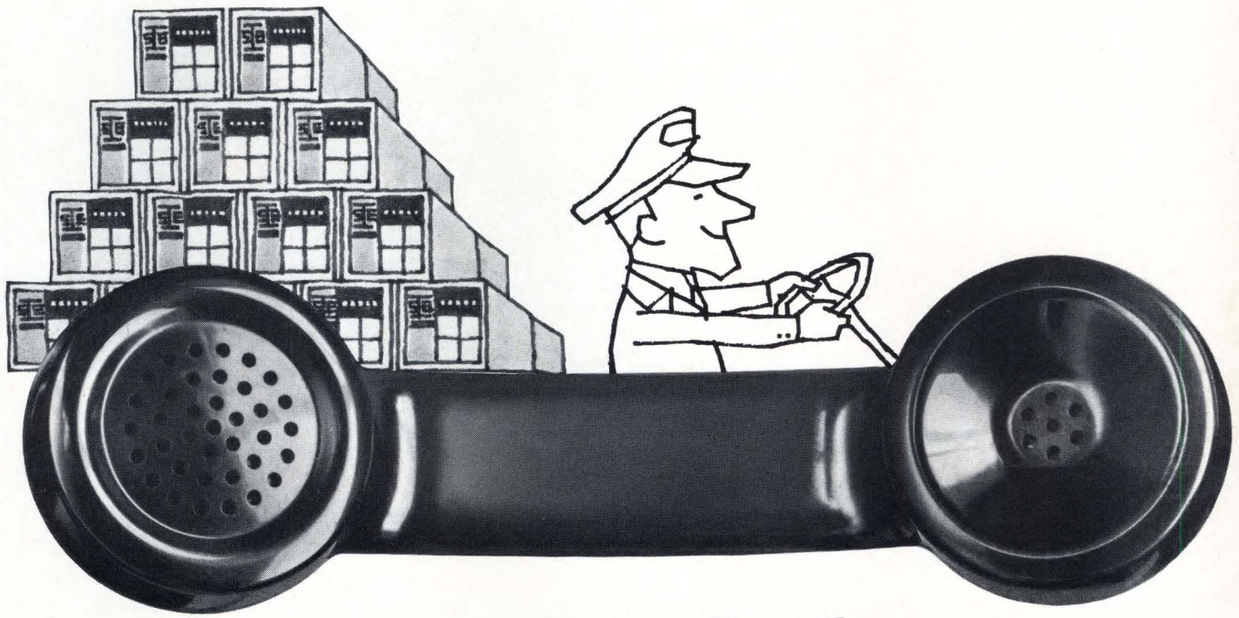

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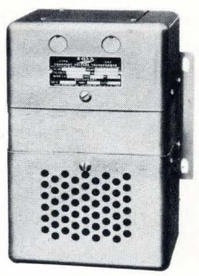

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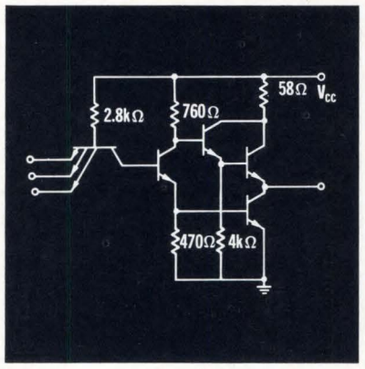
23 new TTL circuits from TI

Series 54/74 features three levels of speed and power dissipation



Typical Characteristics	Gate	Flip Flop
Propagation delay	6 nsec	17 nsec
Power dissipation	22 mW	80 mW
Noise immunity	1 V	1 V
Fan-out		
Standard loads	12	12
High-speed loads	10	10

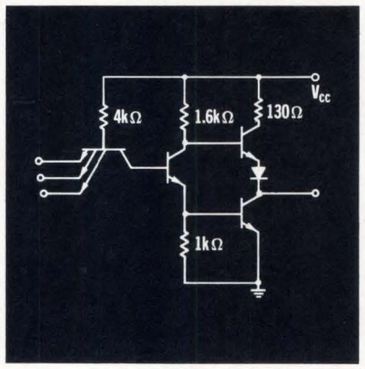
16 Series 54H/74H high speed circuits feature 6 nsec propagation delay

This line offers the highest speed available in saturated logic . . . six nanoseconds per gate. Applications include critical portions of digital systems such as high speed computation and data processing sections.

Series 54H/74H circuits may also be combined with standard and low-power TTL circuits in a single system . . . giving you the advantage of speed where it is required while keeping system power consumption low.

Sixteen circuit functions include AND gates as well as NAND so you can design simpler less costly systems.

Circle 210 for data sheets.



Typical Characteristics	Gate	Flip Flop
Propagation delay	13 nsec	40 nsec
Power dissipation	10 mW	60 mW
Noise immunity	1 V	1 V
Fan-out	10	10

27 standard Series 54/74 circuits include cost-saving complex function devices

Standard Series 54/74 integrated circuits offer a combination of speed and power dissipation best suited for most applications. When used with the new high-speed and low-power circuits, they provide today's system designer with unprecedented flexibility . . . in selecting speed and power requirements.

Twenty-seven circuits are offered in the standard line, including many complex-function devices that perform up to forty gate functions. These complex-function circuits enable you to cut costs while simplifying system design and improving reliability.

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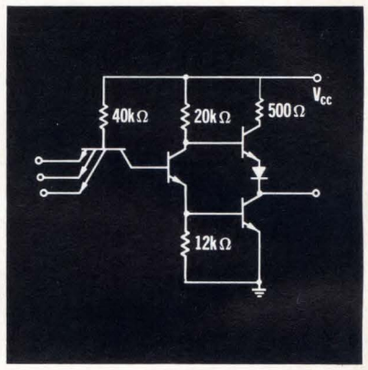


Typical Characteristics	Gate	Flip Flop
Propagation delay	33 nsec	47 nsec
Power dissipation	1 mW	3.8 mW
Noise immunity	1 V	1 V
Fan-out		
Standard loads	1	1
Lower-power loads	10	10

New series 54L low-power circuits feature 1 mW per gate power drain

This line of four circuits features power requirements less than one-tenth that of standard circuits . . . yet speeds are approximately twice as fast as other circuits with similar power dissipation.

TI's Series 54L/74L circuits are specifically designed for space systems, avionic systems and other applications where power consumption and heat dissipation are critical. They may be combined with standard and high-speed Series 54/74 circuits to provide almost any desired speed/power dissipation combination the system designer requires.

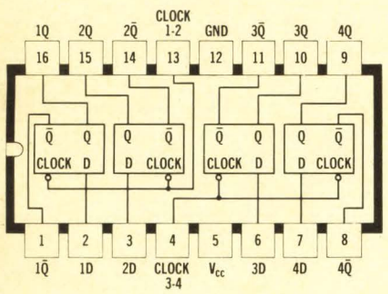
Circle 212 for data sheets.

New additions reduce cost and improve performance of systems using Series 54/74 TTL

With three speed ranges, three power dissipation levels, two lead arrangements, two packages, and two temperature ranges, TI's Series 54/74 family of 47 TTL integrated circuits is industry's most versatile and complete logic line. All circuits use the same 5 Volt supply voltage and all use the same familiar TTL design rules.

Here are three new additions to the standard line that open the way to further cost reductions and improvements in performance.

SN7475 quadruple bistable latch replaces four flip flops



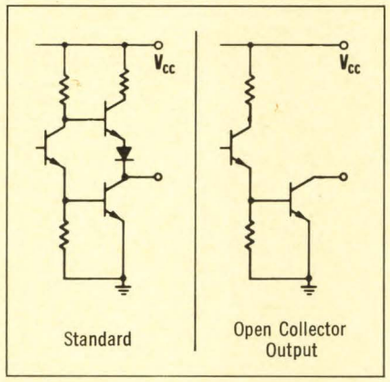
This specialized circuit was designed for readout tube applications. When used with the SN7490 decade counter and the SN7441 decoder/driver, the SN7475 will enable you to realize substantial savings in overall system costs.

This latest addition to TI's growing group of complex-function circuits features a propagation delay of 30 nanoseconds. Power dissipation is 40 milliwatts per latch.

Circle 213 for data sheet.

SN5401 NAND gate features open collector output for "Wire-OR" logic

This circuit enables designers to employ the economical "Wire-OR" logic function to simplify system designs. With the open collector output, the "collector-OR" function is built-in, permitting outputs to be connected directly.

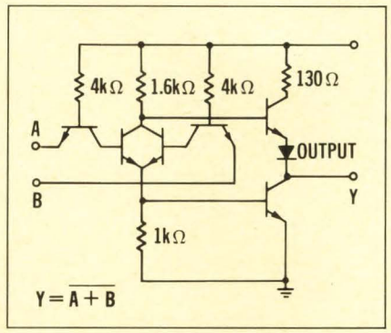


Before this circuit was developed, "Wire-OR" logic could only be used with DTL and RTL circuits. Now system designers can take advantage of this simplification and still benefit from the speed, economy and noise immunity of TTL.

Circle 214 for data sheet.

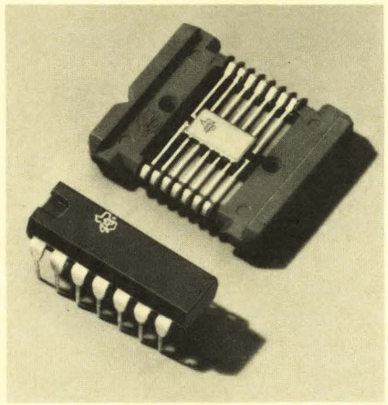
SN5402 NOR gate reduces package count and propagation delays

Here is a quadruple 2 input NOR gate that performs the "Not-OR" logic function directly. It eliminates the need for three or four NAND gates, making possible a 100 percent speed improvement as well as a 67 percent reduction in gate count.



Designers may use the SN5402 with other Series 54/74 circuits... including complex-function types ...to reduce overall system costs significantly below that possible with any other logic types.

Circle 215 for data sheet.



No other high-performance IC family is as complete, versatile and economical as Series 54/74 TTL from Texas Instruments. For more information, contact your nearest TI field sales engineer or authorized distributor, or write P. O. Box 5012, Dallas, Texas 75222.

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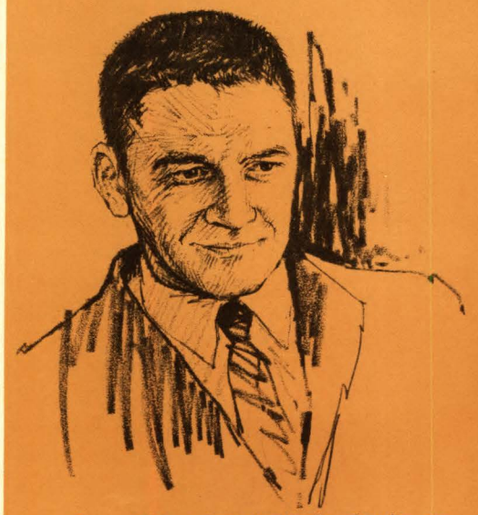


Compatible microelectronic circuits are looked at this month with an eye toward what makes them compatible. Author Marder discusses the internal similarity of these circuits and provides guidelines from which compatibility can be recognized. The end result is more versatility for optimizing that system.

A second article entitled "Multiphase Clocking—A Natural for MOS" demonstrates the advantage of new circuit design. Author Collymore develops the argument for multiphase clocking with MOS devices and shows how this technique reduces the size of the circuit chip, reduces power dissipation and, at the same time, increases operating speed.

R. E. Koeper

Bob Koeper,
Microelectronics Editor

THE ELECTRONIC ENGINEER'S DESIGN MAGAZINE

Compatible Circuits Boost Design Flexibility

If certain circuit characteristics are similar among different logic forms, the circuits can be intermixed for optimization. Here's how one major IC manufacturer is able to provide circuit compatibility.

The present trend in digital design is to obtain maximum operating frequency with maximum efficiency utilizing integrated circuits. The nature of a complex system, be it a computer, control apparatus or a simple function box, dictates that to optimize overall system design, slower devices must be used to translate high-rate electronic functions to usable machine or human language. It is obvious that for a 50-MHz counter, only the first stage must operate at maximum speed. In a computer central processing unit, an arithmetic adder must operate at top speed, but peripheral components accepting end results could operate more slowly without decreasing overall system speed.

Current Sinking

The trend of most system designers is to utilize one type of element throughout a system where only a small section demands this kind of element. This, of course, necessitates stringent design rules throughout the system and additional costs in power and packaging associated with high-frequency elements.

To incorporate different logic elements into a single system that requires a combination of high- and low-speed logic with tailored power consumption requires that common characteristics of the logic elements be established.

However, in order to determine these common characteristics, the design engineer must delve into a mass of specifications that accompany each circuit. This requirement presents quite a time-consuming problem to the engineer. This article will describe the compatibility of current-sinking logic elements that will enable the design engineer to take advantage of compatible circuit characteristics without complicating his design rules.

Compatible Circuits

Three major integrated-circuit families will be used to illustrate the simplicity of this current-sinking concept. These families represent high-speed, medium-power TTL logic, medium-speed, low-power DTL logic and medium-speed, very low-power DTL logic.

A basic common feature that often is ignored is the fact that logic-signal levels are contained within the external electrical references; that is, the logic-signal swing never exceeds the power-supply voltage or goes below ground level.

These two reference levels, which are common to the entire system and the external world, obviously are susceptible to environmental noise and may interfere with logic propagation. A noise-free channel exists between the V_{cc} and ground for current-sinking elements. Current-sinking logic elements set their own signal levels by input and output interconnection and by the level-setting elements within the circuit.

Design Similarity

The common characteristics of the three families mentioned are the result of compatible circuit de-

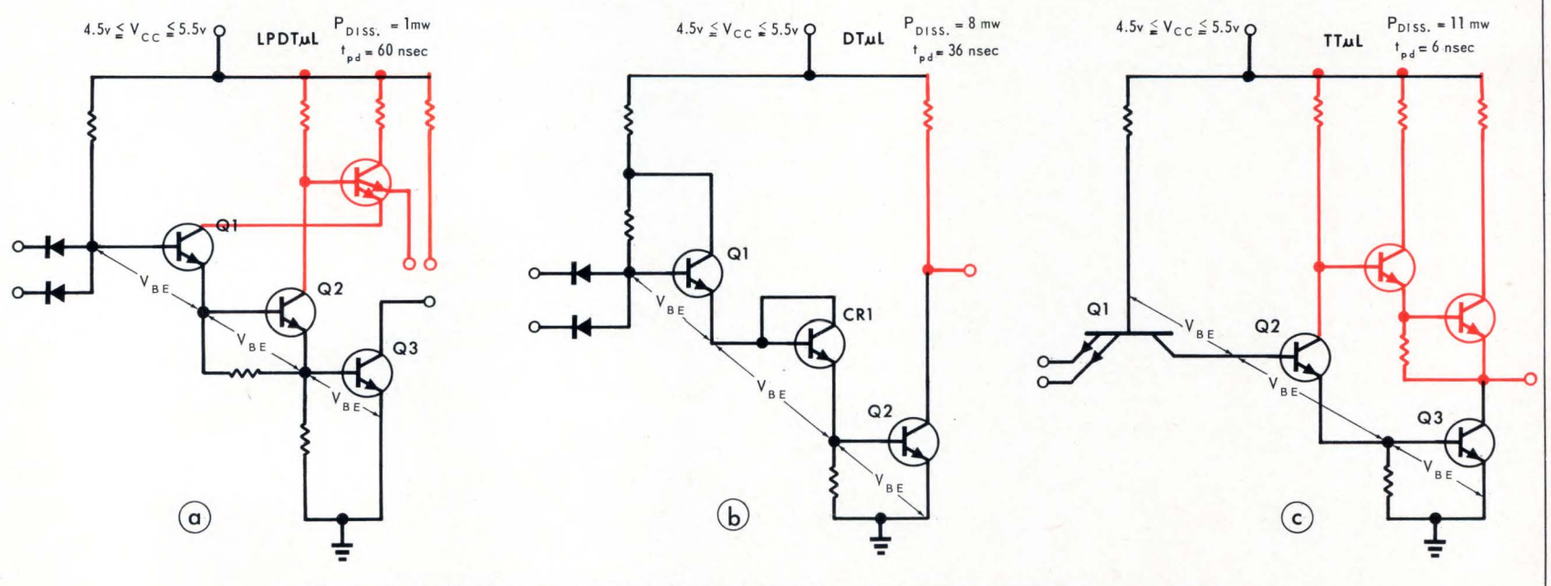


Fig. 1 — **Schematic of the three compatible circuits** illustrates why operating characteristics are similar.

Abraham Marder has been with Fairchild Semiconductor for 1 year. His duties include promotion of new products, establishing design needs for digital IC's and product engineering. He holds a B.S.E.E. from City College of New York.

sign exhibiting similar internal-circuit configurations. Examination of circuit behavior (**Fig. 1**) shows this compatibility. When the output of all circuits is at the ZERO level, there are three forward-biased diodes and one reverse-biased diode isolating the input from the output.

In the LPDTL series (**Fig. 1a**), the three diodes are base-emitter diodes of transistor Q1, Q2 and Q3. In the DTL series (**Fig. 1b**), the three diodes are the output transistor Q2, the input transistor Q1 and the diode CR1. In the TTL series (**Fig. 1c**), the output transistor Q3 and the split-phase transistor Q2 base-emitter diode constitute two diodes, while the third is the base-collector diode of the input transistor Q1 operated in the inverse mode. The reverse-biased isolation diode is a normal base-emitter diode.

Design Advantages

The main advantage of using three diodes as level-setting devices is that all three circuit types, although having different power consumption and sustaining different currents, have the same logic levels. The importance of equivalent logic levels is illustrated when compatible circuits are used in the same system. The same d-c noise immunity is expected as well as the same shift in direction and magnitude of signal levels under temperature and supply variations.

A detailed examination of these circuits shows the similarity of output driving capability and the internal constraints of each element.

When the output is at the ZERO level (**Fig. 1**), the element is sinking current from the load through the saturated transistor only. When the output is

(Continued)

Design Flexibility (Cont'd)

at the ONE level, the output is driving current into the load, and while this is accomplished, the bottom circuit (in black) and the input circuit are in the OFF condition. For each output level a separate circuit (shown in black and red) within the device is either ON or OFF.

Assuming a 50-percent duty cycle, it can be seen that the current within the device is alternating. This means that heat generated as a result of current flow is minimized. This allows the elements inside the device to be made smaller in size, which will reduce both internal stray capacitance and propagation delays. Circuit speed also is increased by removing stored charge from the circuit while it is in the inactive condition.

Compatibility Analysis

The first step toward compatibility is analysis of input-output voltage levels. **Fig. 2** shows that all three series have similar input and output logic swings oriented to guarantee minimum noise immunity. The following equations show that by intermixing worst-case elements a minimum of 0.5v/d-c noise immunity is achieved.

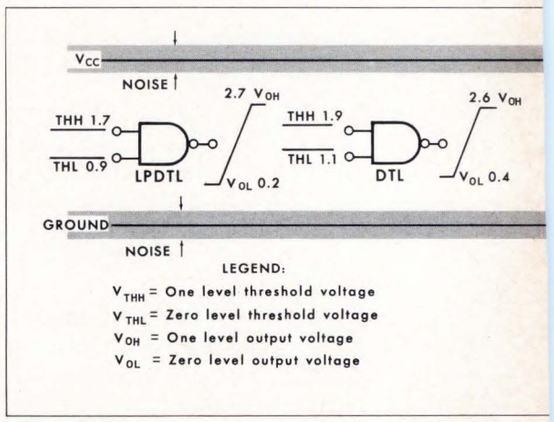
$$\text{noise immunity HIGH} = V_{OH} - V_{THH} \quad (1)$$

$$\text{noise immunity LOW} = V_{THL} - V_{OL} \quad (2)$$

For maximum noise rejection input and output, impedance matching should be considered. LPDTL, DTL and TTL were designed to accomplish a maximum possible match restricted only by the power handling of each circuit.

Note that in each circuit (**Fig. 1**) the output, in the ZERO level, is associated with a low-impedance saturated transistor. At the ONE level, the output is driving current from a moderately high impedance. The corresponding inputs of the driven device are low impedance at the ZERO level and high impedance at the ONE level, respectively.

Once the interfacing capability is understood and system noise margins are established, certain rules



for fan-out and fan-in must be resolved. The following table lists the input and output currents of each series and should assist the designer in understanding the proper rules of compatibility.

			LPDT	DTL	TTL
I_{OL}	Output current low (min)	ma	1.60	12.0	17.6
I_F	Input current low (max)	ma	0.16	1.6	1.76
I_{OH}	Output current high (min)	ma	0.060	0.650/ 0.160*	1.0
I_R	Input current high (max)	ma	0.001	0.005	0.100

Example: Interfacing DTL into TTL

$$\text{Fan-out} \leq \frac{I_{OL}}{I_F} = \frac{12.0}{1.76} = 6.8$$

$$\text{Fan-out} \leq \frac{I_{OH}}{I_R} = \frac{0.650}{0.100} = 6.5$$

Using the smaller integer, fan-out = 6

**DTL with 2-kilohm pull-up*

Power-Supply Variation

One should bear in mind that the preceding table lists worst-case numbers using conservative limits at extreme conditions and these numbers could be relaxed when controlled environment is considered.

The positive power supply required for all compatible elements is 5v. Variation in power-supply voltage under practical conditions will affect all three series in the same manner. Therefore, power-supply variation consideration should be applied to the system as though only one series of elements was being used.

The common shift of parameters resulting from power-supply shift allows for a 20-percent variation in voltage. Identical circuit design and processing of the three series contribute to common dynamic behavior of the elements under temperature changes. This will free the designer from the tedious calculation of changes in parameters as a result of temperature variations. ■

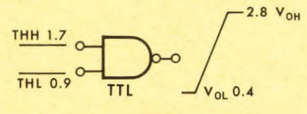


Fig. 2—**Operating voltage levels** for ZERO and ONE logic levels can be used to find both noise immunity and fan-out.

100-bit MOS

Multiphase Clocking

A NATURAL FOR MOS

Couple MOS fabrication simplicity with multiphase clocking and the result is less chip area, lower power dissipation and higher speed.

The potential advantages of MOS devices in integrated digital arrays can be realized only if proper consideration is given to circuit choice. Although many circuit configurations are possible, only one or two take advantage of the unique properties of MOS devices to achieve a high figure of merit of functional complexity per unit at high yield.

An inverter that uses an enhancement-type MOS transistor as a load for the inverting MOS transistor is shown in **Fig. 1**. Although this circuit is a poor choice from a discrete-component point of view, it possesses a very high figure of merit considered in

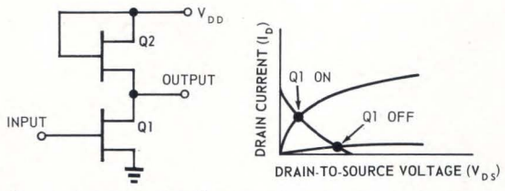


Fig. 1—**Inverter circuit** shows how enhancement-type MOS transistor is used as load and the resulting load line.

Walter A. Collymore is a senior engineer at ARINC Research's Western Div. where he is a specialist in IC design and analysis of digital systems. He has extensive background in microminiature system design fabrication and checkout and is responsible for preparing and presenting portions of the company's Integral Electronics Training Course. This course deals with IC design and analysis and system engineering considerations. Mr. Collymore received a B.S.E.E. from Univ. of Illinois in 1961.

(Continued)

Multiphase Clocking (Cont'd)

the light of digital integrated arrays. First, it uses the absolute minimum area because, to operate at all, the load MOS device must be smaller than the inverting MOS device. Second, the processing required to fabricate the circuit is minimized because the load device is made by the same process used for the inverter device.

Operation of the circuit depends on controlling the transconductance ratio of the two devices. Although the absolute value of transconductance depends on a number of factors, including the oxide thickness under the gate, the ratio is determined by the geometries of the two devices. When accurate masks are used, therefore, the ratio can be held constant even with variations in processing.

Single-Channel Arrays

The basic circuit shown in **Fig. 1** can be developed into a wide variety of digital circuit arrays. Parallel connection of the inverter transistor forms a NOR gate (**Fig. 2a**) while series connection (**Fig. 2b**) forms a NAND gate. When the NAND gate is

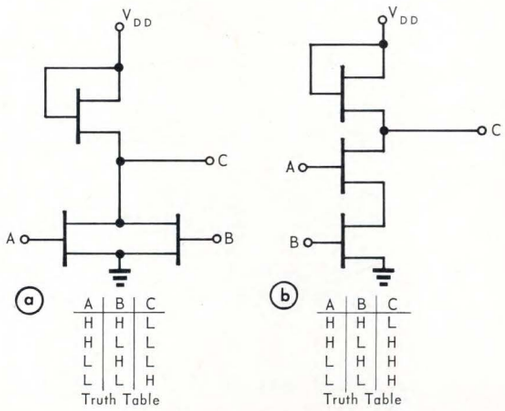


Fig. 2—**MOS logic gates** (a) parallel connection for NOR and (b) series-connected NAND gate.

used in conjunction with the NOR gate, the resulting configuration offers a high degree of logic flexibility. However, the series connection suffers from the disadvantage that the inverter transistors must be twice as large as their parallel counterparts to maintain the same control of logic levels.

Clocking Schemes

MOS logic circuits are unique in that temporary storage is practical by relying on capacitor storage. However, to use temporary storage, clocked-gating

(Continued)

Multiphase Clocking (Cont'd)

schemes are necessary. These schemes are limited to applications where computation speeds are in excess of a few kiloHertz (kHz).

Two-Phase Gate

A two-phase gate is shown in **Fig. 3**. In this configuration, two clocks, $\phi 1$ and $\phi 2$, are applied to the gate; $\phi 1$ leads $\phi 2$ and does not overlap $\phi 2$.

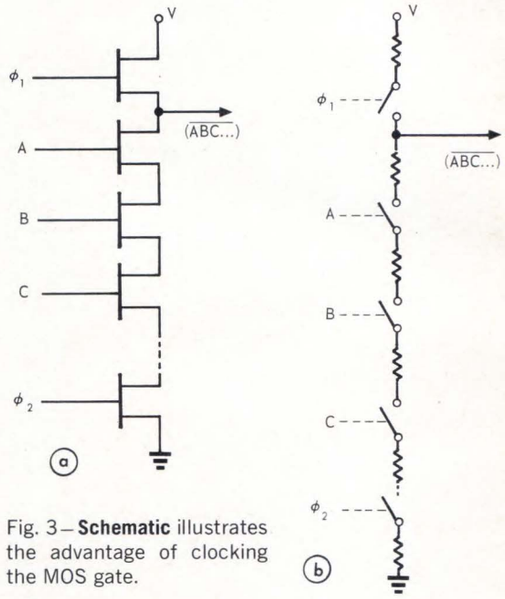


Fig. 3—**Schematic** illustrates the advantage of clocking the MOS gate.

When $\phi 1$ comes true, the gate is unconditionally set true by charging the output capacitance to a positive voltage. When $\phi 2$ comes true, the gate is conditionally set false as a function of the A, B and C terms in the ground path.

Resistances of the ground path and the V path are independent; thus, the logic configuration is arbitrary and the response time, when the output is going positive, can be improved. If improved response time is not required, then the system will permit the use of slower and smaller devices in the

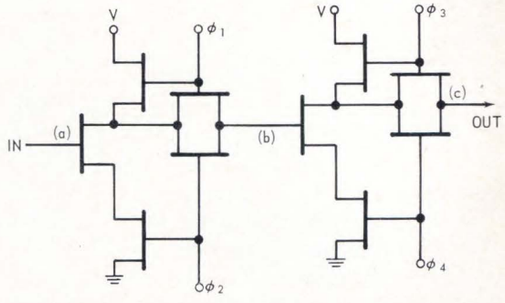


Fig. 4—**Four phases** applied to MOS shift register.

ground path that in turn allows more complex functions to be mechanized in the same area. Further, since $\phi 1$ and $\phi 2$ are not on simultaneously, the d-c current is reduced because V is only required to supply transient current (that is, capacitor current) as opposed to d-c current in a single-phase gate.

Four-Phase Clock System

The two-phase gate can be applied to a full-scale system if a four-phase clock system is used. One stage of a simpler shift register can be mechanized as shown in **Fig. 4**.

The shift-register stage shown may be classified as two parallel devices with isolated output. The shift-register stages are a very simple example of the more general case illustrated in **Fig. 5** where the crosshatched boxes can contain complex logic functions mechanized by series/parallel paths.

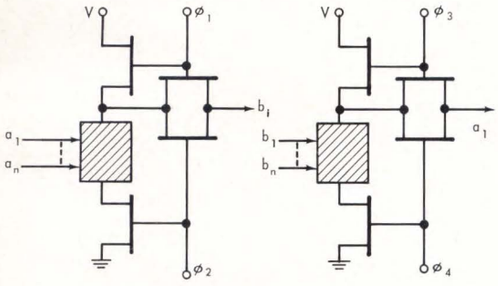


Fig. 5—**Four-phase** logic mechanization.

In general, the desired logic functions will involve AND-OR combinations of the generated functions and inverses of AND-OR combinations of generated functions. To provide this capability, the system illustrated in **Fig. 6** can be used.

The inputs to a logic block must be stable slightly before the V path is disabled and remain stable until the ground path is enabled and disabled. The timing diagram of **Fig. 7** shows that the required conditions are satisfied.

Conclusions

The MOS transistor is well suited for complex logic functions on a single die because of the small device size, low power, temporary storage capability and perhaps most important, the simple process that can lead to high yields. The use of a multiphase clocking system maximizes the advantages of the MOS device and makes possible the interconnection of up to 1000 devices on a single die by using single-layer metallization.

The main drawback to wide-scale use of MOS integrated-circuit arrays is the apparent 2-MHz

(Continued)

Multiphase Clocking (Cont'd)

upper frequency limit. There are, however, many systems (both commercial and military) that do not require a high frequency of operation. These systems can take advantage of the reduction in size, weight and power offered by MOS integrated-circuit arrays. ■

Reference

ARINC Research Corp. "Integral Electronics Training Course Notebook".

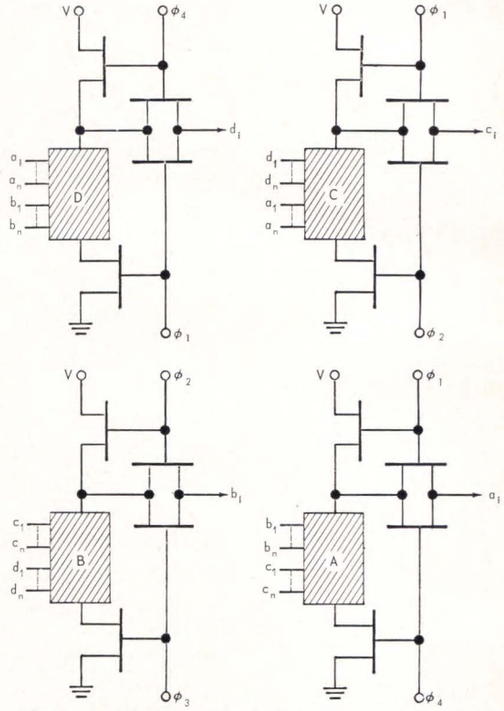


Fig. 6—**General** mechanization of four-phase logic.

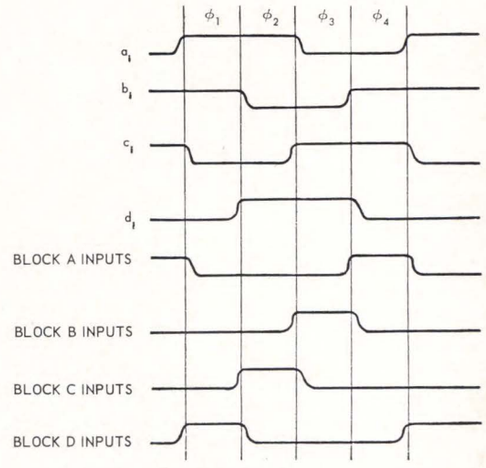


Fig. 7—**Four-phase timing diagram** illustrates how input stability requirements are satisfied.

EDN MAGAZINE

CIRCUITS AND SYSTEMS

The designer looking for an RF amplifier to be used in the UHF bands, with improved noise figures, will find the story on p. 42 of interest. A breadboarded parametric amplifier could fill the bill.

The widespread Northeast blackout in 1965 was an expensive lesson to many engineers caught without backup power supplies. Other than groping around in the dark looking for candles, how can you prevent those blackout blues? We have an article on the subject, p. 48.

Electrons do a very good job of initiating explosives—even when you don't want them to. This month on p. 52 we take a look at a laser-detonated explosive system that effectively eliminates premature explosions caused by stray electromagnetic or RF energy.

Microwave heating and drying of thin or filamentary materials are relatively unsatisfactory. Production, located in Los Angeles, provided us with a story of its microwave dryer that minimizes these limitations.

Al Horne

Al Horne,
Circuits and Systems Editor

Breadboard Your Paramp

Looking for an RF amplifier to be used in the UHF band with improved noise figures? A breadboarded parametric amplifier could fill the bill.

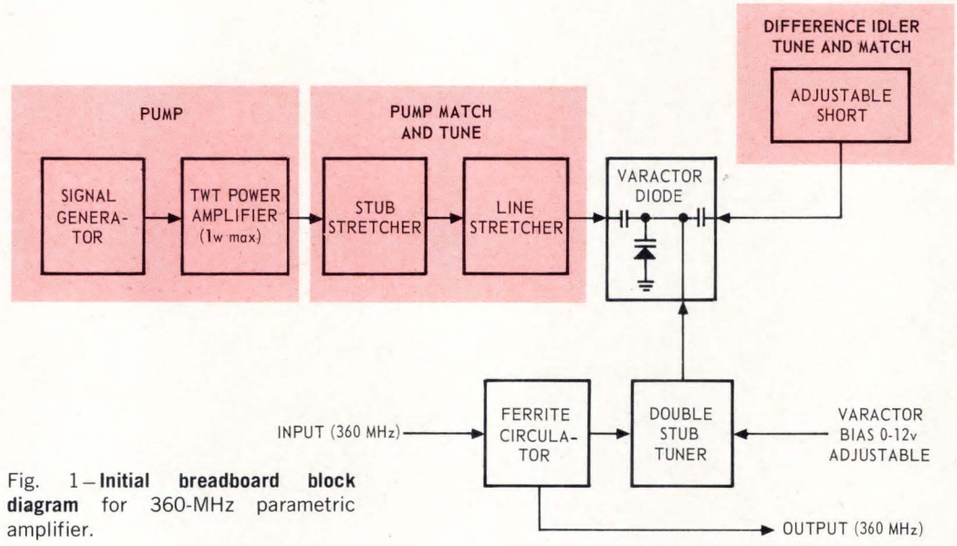


Fig. 1—**Initial breadboard block diagram** for 360-MHz parametric amplifier.

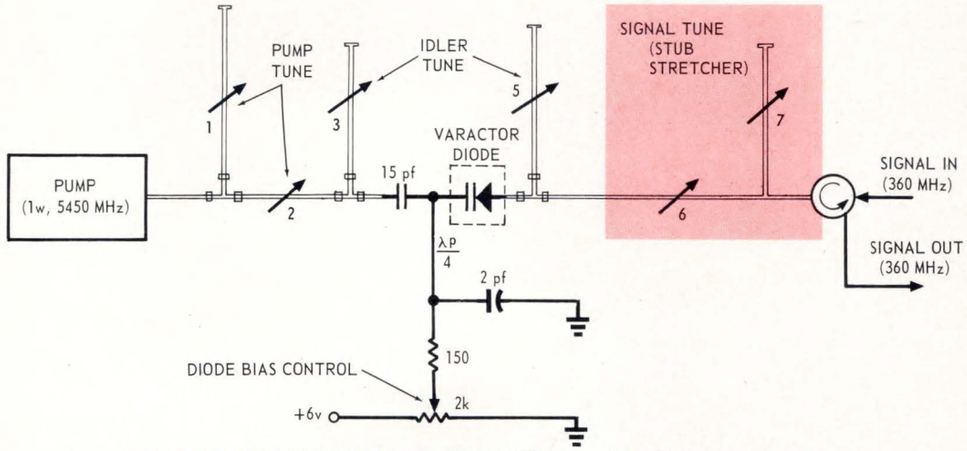


Fig. 2—**Schematic of the 360-MHz parametric amplifier** showing all tuning adjustment stubs.

A paramp to be used as an RF amplifier in the UHF band can be designed by analysis and breadboard circuits. Pump power, noise figure and pump frequency usually can be determined analytically. However, intermodulation, bandwidth and dynamic range can best be determined by constructing a coaxial breadboard of the device.

Basic Decisions

An immediate consideration in the design of the paramp is the choice of varactor. This choice rests upon intermodulation and noise figure. The first requirement is met more aptly by an alloy junction than a diffused junction because the alloy junction exhibits an excellent square-law characteristic. The second requirement of low noise figure can be met more easily by a high cutoff frequency varactor. Analysis has shown that the higher the cutoff frequency of the varactor, the lower is the obtainable noise factor.

A specific gain calculation for the paramp does not lend itself to direct analysis because it depends upon the match of the positive source resistance to the negative transducer impedance, which characterizes a pumped capacity in the lower sideband mode. The bandwidth of the paramp is similarly not analyzed because of its direct dependence on the gain. Both of these characteristics should be experimentally obtained for this reason.

Breadboard Design

The complete circuit for the paramp design is in **Fig. 1**. The pump circuit consists of a 618B Hewlett Packard signal generator followed by TWT power amplifier that was capable of producing a maximum of 1w of pump power with a gain of 30 db. The frequency was in the 5-GHz region since the available TWT would be most effective at this frequency and the overall deterioration on the noise factor of the paramp from optimum would be negligible.

A variable short and line stretcher match and tune

the pump into an equivalent 1.2 ohms (R_s) of the varactor. A pair of adjustable shorts is tuned as resonant circuit for the idler frequency. The signal circuit tune and match adjustments are made with a stub stretcher. The input circuit also requires the use of a ferrite circulator, which should have an isolation characteristic of about 10 db beyond the gain of the amplifier to insure stability. (The stability of the paramp would be compromised severely by change of input impedance since the input impedance determines critically the amount of gain that the paramp produces.) For the breadboard paramp, a Melabs circulator with 25-db isolation was used.

In the circuit shown in **Fig. 2**, the varactor is pumped in series with the signal loop. Since the signal matching circuit has a very coarse adjustment for the signal frequency, it also can be used as an adjustment for the pump frequency. Thus, the signal tuner (6 and 7) is used as a signal- and pump-matching circuit simultaneously.

The pump-tuning adjustment requires a preliminary adjustment of all seven tuning elements. The following adjustments should be made with a scope and a C-band detector to monitor the circulator output and a directional coupler with power meter to measure the reflected pump power. Stub 7 is adjusted so that a minimum voltage is detected by the scope. Stubs 3 and 5 should be adjusted for maximum voltage at this point. The other three adjustments (1, 2 and 6) are made so that a minimum of reflected power is measured at the pump source. This procedure matches the pump to the varactor

The author, **Joseph Klarl,** is an electronic design engineer in the Communications Section, Martin Marietta Corp., Orlando, Fla. He received a B.A. from Marquette University in 1953, a B.S.E.E. in 1957 and has done postgraduate work in math at Illinois Institute of Technology. The article is the result of some of the research in high dynamic range, solid-state RF amplifiers at Martin Marietta.

(Continued)

Paramp (Cont'd)

diode. The signal matching circuit is now adjusted to the varactor by maximizing the 360-MHz signal whose modulation can be monitored on the scope. Similarly the idler stubs (3 and 5) are adjusted until the 360-MHz signal is maximized. Trimming of the pump circuit now can be made and the amplifier is operational.

The interaction between the signal source and the pump source is at a minimum since quarter- and half-wave stubs are used for isolation. The signal is isolated from the pump by a stub that is shorted by a 2-pf capacitor. The pump is isolated from the signal by stub tuner (7) and by the circulator.

The photograph of the varactor housing (**Fig. 3**) shows the bias stub through which varactor bias is applied and the method of mounting the varactor diode in the assembly.

Test

Gain up to 30 db was attainable by adjusting the pump power. Above 30 db the adjustments were so critical that oscillations would occur with the slightest change of almost any tuning parameter, and the amplifier was uncontrollable. The bandwidth was 3 MHz at 30 db of gain. It was 12 MHz at the half-power points with 10 db of gain.

An attempt to measure noise factor yielded inconclusive results. The noise-figure meter would read anywhere between 8 and 0 db with idler tuning. However, these readings were sus-

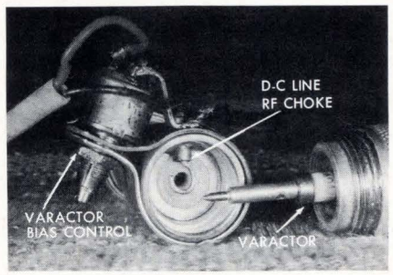


Fig. 3—**Heart of the parametric amplifier.**

pected and it appeared that the signal circuit was so critical to source impedance at 30-db gain that the paramp would be unstable when the automatic noise-figure instrument fired the argon noise tube. The noise-factor instrumentation problem was not resolved satisfactorily.

The upper limit of dynamic range as indicated by the 1-db compression point of a −50-dbm signal (which is the minimum visual signal of the spectrum analyzer) was about −5 dbm for an interfering signal in the bandpass of the device. Thus, the amplifier shows a high dynamic range capability.

The intermodulation products were 45 db down from two signals that were at a −24-dbm level in the bandpass of the paramp. They were only 25 db down from −10-dbm signals.

The stability of the amplifier was reasonable under 16 db of gain, and even though it is sensitive to pump power variation, it does not indicate any very critical parameters. However, it is advisable to have good pump power regulation (1 db) when the gain is in the 16-30-db range and to provide all tuning adjustments with screw rather than slide mechanisms.

The use of paramps in the UHF region can be justified solely for their improved noise figures. In all other characteristics they are successfully matched by tubes and transistors, which are quite a bit simpler and less expensive to build and maintain. ■

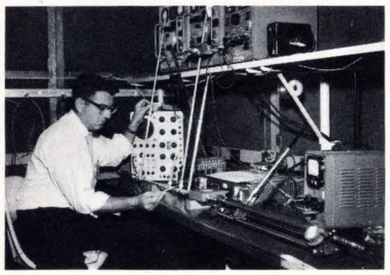


Fig. 4—**Parametric amplifier** set up for intermodulation test (author in photo).

Circle No. 42 on Reader Service Card for more information.

A New Twist To Microwave Drying

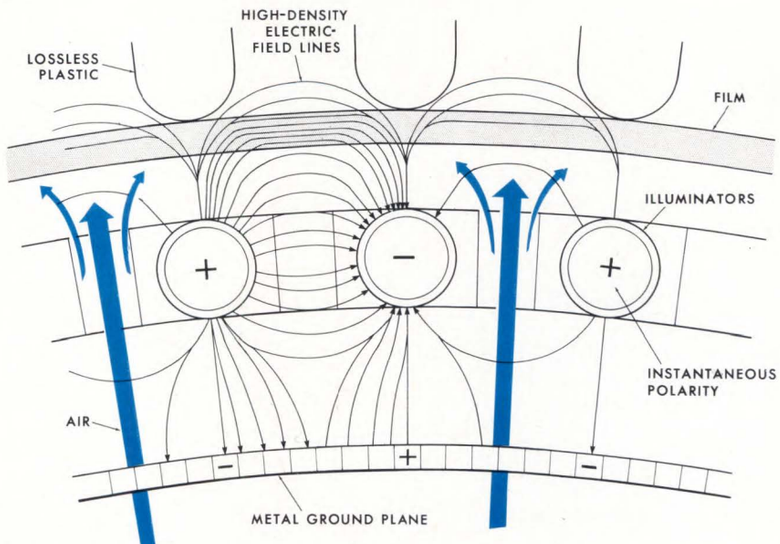
How do you concentrate microwave energy within a filamentary material?

External electromagnetic fields generated by microwave energy are used to dry photographic film. Launched on an open wire serpentine adjacent to the surface of the film, microwave energy is coupled to the moisture in the film to produce rapid drying.

A microwave transmission-line circuit couples fringing fields to water in the film. The line operates neither as a pure traveling-wave system nor a pure standing-wave system. In the pure standing-wave system, the total attenuation of the line loaded by the film must be greater than 6 db to avoid dumping excessive power in the external dummy load. With a pure standing-wave system, the RF fields travel many times through the material before attenuating to some negligible value.

Both approaches have inherent drawbacks. In the former, to obtain a 6-db loss, the line would have to inordinately long; in the latter, the system requires very sharp tuning. The new system is based on a combination of both principles, namely a hybrid circuit providing the advantages of both systems while minimizing the limitations.

Microwave heating and drying of bulk material are a widely accepted practice. When applied to the thin or filamentary materials, however, microwave-heating techniques are relatively unsatisfactory. Heating or drying of any material requires concentration of the electromagnetic field within the physical boundaries of the material. As the dimension of the material becomes small (with respect to the wavelength), the concentration of the absorbed energy is reduced. The new high-impedance coupling circuit concentrates the energy within the load material itself by developing the maximum field component parallel to the web of the film.



Drying of film is accomplished with serpentine elements (called illuminators) incorporated into surface of drum. Film moves adjacent to elements along surface of drum. By interspersing air jets between folded path of coupler, film will flow at correct height above coil for maximum coupling efficiency.

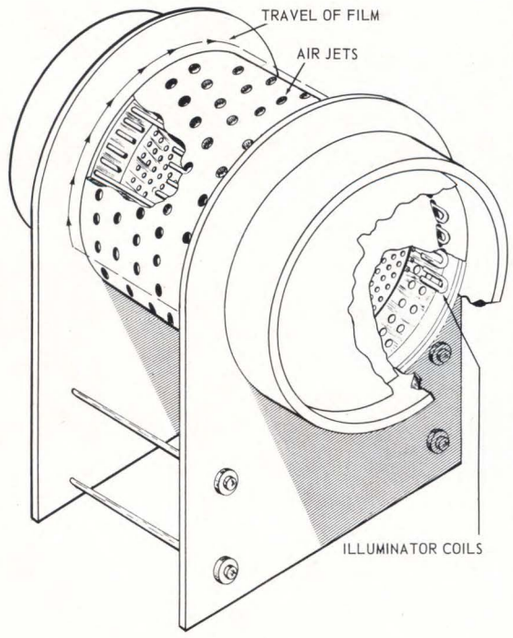
The conventional method of applying microwave energy to filamentary material uses slotted waveguides of rectangular cross-section. The film passes through the slots and absorbs the microwave energy in the waveguide. Many problems result from dragging the film through multiple slots, with the attendant problem of dispensing with the moisture after it is removed from the film.

The new microwave-drying technique eliminates these problems by using the air-bearing principle. Air jets adjacent to the coupler create a Bernoulli effect, which suspends film over the coupler. The film is not in physical contact with the equipment and the airstream carries off the evolving vapor from the film.

Although specifically designed for drying photographic film, the technique has potential use in drying paper, fabric and man-made and organic fibers. The more efficient coupling between energy source and material causes reduced input-power requirements and allows increased material drying rates. Use of a fringing-field circuit concept permits the drum to be designed for specific purposes, to take almost any width of material. A complete dryer can consist of one or more such drums, arranged to provide either vertical or horizontal loops of material. An added advantage is that any attempt of the material to take a set curl is completely eliminated.

The microwave dryer was designed by Productron, a Div. of Houston-Fearless Corp., Los Angeles, Calif., under F. Mehner, president. The concept was developed by Gunter Schmidt, president of productron, and Ivan Ryman, vice president. ■

JIM ROSE, Western Editor



Cross-section of drum illustrates drying principle. Microwaves are launched on surface of illuminator elements. Moisture in film causes resulting electric-field flux lines to be bent and pass through material. Heating results from action of microwave field on water molecules. When nonpolarized water molecule is in an electrical field, it tends to physically align itself with the direction and polarity of the field. Rapidly reversing the field makes molecules attempt to rotate, resulting in molecular agitation, which heats the material. To prevent inward radiant energy, a reflective metal screen is placed approximately 3/4 inch behind coil structure.

PREVENT THOSE BLACKOUT BLUES

What will happen to your equipment when the lights go out? Will it just stop quickly and peacefully or go on a rampage and cause considerable damage? These questions, and many others, should be answered by every engineer to prevent losses caused by power failure.

BOB COMPTON, Midwest Editor

Since the Northeast blackout in 1965, the demand for high-capability emergency power sources has increased drastically. For example, the sales volume for one of the fastest emergency-power sources, the d-c to a-c inverter,

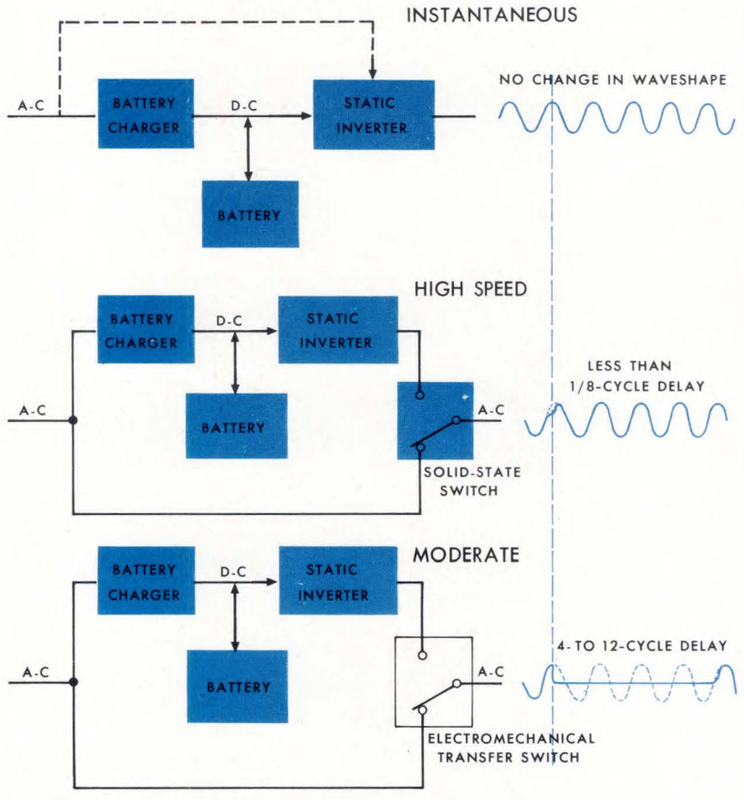


Fig. 1—**Various degrees of protection can be obtained** by interconnecting battery, battery charger and inverter in different ways.

has more than doubled in the last year. This skyrocketing demand has proved that the blackout was an expensive lesson to many engineers caught without backup power supplies. And to those not affected by the blackout, it was a strong note of warning that it could happen to them.

A Power-Loss Analysis

Economics, safety and loss of irreplaceable equipment all play a key role in deciding whether or not a system should be protected by an emergency power supply. In the area of loss of man-hours alone, blackout costs can be staggering. Also, shutdown of expensive equipment, such as computers, can send the blackout costs sky high. A less obvious but quite serious problem is the shutdown of process-control equipment. Losing control of a process may cause extensive damage to the equipment itself or possible injury to the operators. Thus, the losses that occur because of a power failure take many forms. Every possible danger or loss must be weighed with respect to the cost of the emergency power supply. Some of the more pertinent questions that should be asked when making a power-loss analysis are listed in **Table I**. Of particular importance is the aspect of timing; in some cases, an interruption of even a fraction of a second can cause the loss of irreplaceable information and set schedules back many hours.

High-Speed Emergency Power

Most high-speed systems are based on the use of emergency battery banks driving a d-c to a-c converter. There are several techniques for using the

(Continued)

Blackout Blues (Cont'd)

inverter-battery combination, each with its own cost-performance advantages.

Three techniques illustrated in **Fig. 1** have responses that range from instantaneous to an 8-cycle delay. To achieve an instantaneous response, line power is rectified to keep a battery charged and to supply input power to the inverter. The battery automatically delivers power to the inverter any time the rectified voltage decreases below the battery potential. This technique is very inefficient and is used where no power loss can be tolerated.

A common technique uses the a-c directly. The battery is maintained charged by the line, but normally is not active in supplying a-c to the load. When a power failure occurs, an electromechanical transfer switch senses the voltage loss and automatically switches over to the battery-powered inverter. This switch-over is accomplished in 4 to 8 cycles—sufficient for most applications and relatively inexpensive.

Some systems are adversely affected by any delay over 1/2 cycle. To meet such stringent conditions, the electromechanical transfer switch is replaced with a solid-state switch. Such devices not only switch to the inverter in 1/8 cycle or less but, in conjunction with the inverter, can do it synchronously. Fast switching provides continuous power for even the most discriminating equipment.

Another method, called the reverse-transfer

Table 1—**Typical power-loss analysis questions**

- When power fails, will the equipment stop without damage to itself or its load?
- If an emergency causes shutdown damage, how easily can the equipment be repaired?
- If parts are damaged, are they readily available and how expensive are they?
- What about operator safety? Will a dangerous condition be created by a power loss?
- Will irreplaceable computer memory or data be lost?
- If an emergency power source is needed, what must its steady-state output be? And for how long must this output be supplied? 15 minutes? 1 hour? 5 hours?
- Can momentary power failures be tolerated?
- What interruption time can be tolerated?

technique (**Fig. 2**), is designed for very high reliability. It is a combination of the instantaneous technique and the synchronous-switching technique. The combination provides guaranteed power in the event of failure in either the line or the inverter. It is designed for critical loads where the regulation built into the inverter provides the added advantage of isolating the load from power-line surges.

Conclusion

The engineer has several ways to prevent equipment damage caused by loss of power. His most important task is to analyze his system and determine what damage will occur from a power failure, then select the most inexpensive system that will provide power within the minimum allowable time. ■

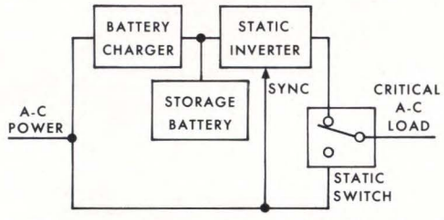
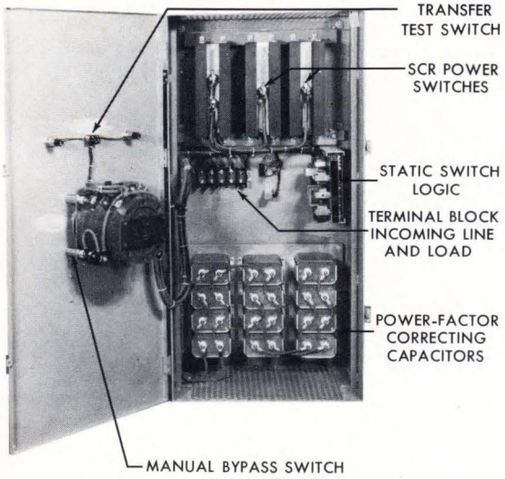


Fig. 2—**Reverse transfer for critical loads.**



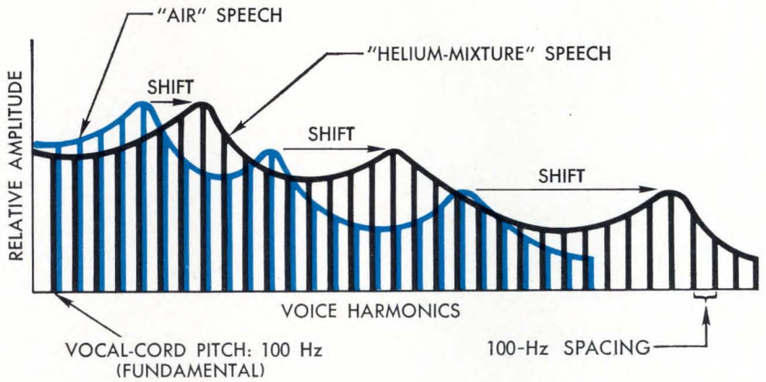
Internal view of typical TRW automatic static transfer switch showing location of major components.

Report from

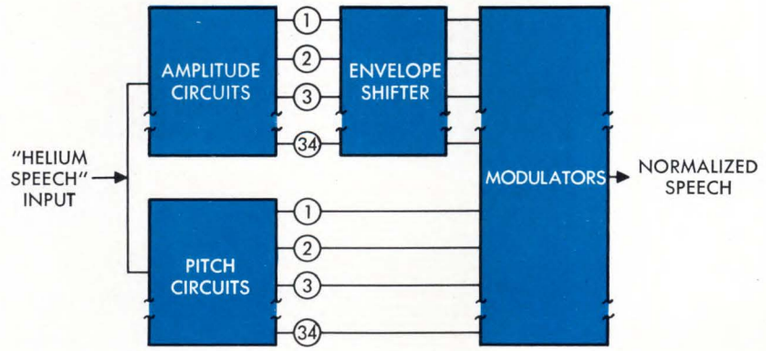
BELL LABORATORIES

Making voices from the depths sound deeper

Bell Telephone Laboratories has had a long-term interest in speech research—tracing back, indeed, to the work of Alexander Graham Bell. It was for this reason that the U. S. Navy asked us to investigate a problem encountered in Sealab II. To prevent "bends" and nitrogen narcosis, the divers breathe a pressurized mixture of oxygen, nitrogen and helium, but the helium gives their voices an unnatural, squeaky, Donald-Duck-like quality. As a result, voice communications between divers and people on the surface are seriously impaired.



Fundamental pitch and harmonics (vertical bars) for normal "air" voice sound (color) and "helium speech" sound (black). Note that the frequencies of the fundamental and harmonics do not change very much, whereas the envelope of the amplitudes shifts toward the right. Note also that the magnitude of the shift increases with increasing frequency.



Block diagram of system for restoring helium speech to normal voice quality. Helium speech is fed to amplitude and pitch circuits. In the pitch circuits, the frequencies of the 34 lowest harmonics are determined. In the amplitude circuits, the power levels within each of 34 150-Hz intervals of the speech spectrum are determined. The amplitudes are shifted and applied to harmonics of lower frequency. In the modulators (right), these power levels control the loudness of the 34 harmonic frequencies . . . thus producing a pattern or envelope closely corresponding to the envelope of normal speech.

THE MAJOR PROBLEM is that the velocity of sound in the helium mixture is much higher than in air. This does not appreciably affect vocal-cord frequency, but does strongly affect the acoustic resonances of the vocal tract—which give the voice its characteristic sound quality. So, though fundamental voice pitch remains approximately the same (about 100 Hz in men), the amplitudes or loudness values of the various harmonics change markedly. Specifically, the pattern of these resonances (the envelope) shifts toward the higher frequencies (see graph), and voice timbre is grossly distorted.

THE SOLUTION to this problem was found at Bell Laboratories by research scientists M. R. Schroeder, J. L. Flanagan, and R. M. Golden. The distorted "helium speech" is separated into harmonic frequencies and their amplitudes are measured (see diagram). Then the envelope of the harmonic amplitudes is shifted back toward the more normal or low-frequency condition. In other words, the amplitudes of the harmonics are adjusted to match a more normal envelope.

As a test, the technique has been used on recordings of helium speech made in the U. S. Navy's Sealab II. The processed voices are readily understandable and sound enough like the speaker's "air" voice to be identifiable.

Bell Telephone Laboratories
Research and Development Unit of the Bell System

A LASER-DETONATED EXPLOSIVE SYSTEM

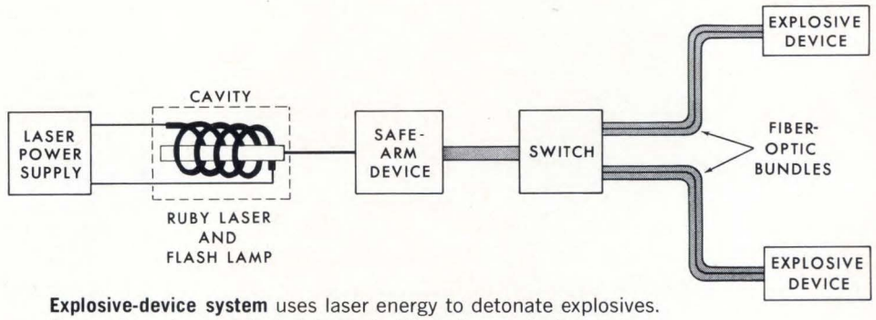
When you think about it, electrons do a very good job of initiating explosives—even when you don't want them to.

JIM ROSE, Western Editor

A ruby laser serves as a source of intense coherent light. Routed to remotely located explosive devices via fiber-optic bundles, laser light initiates the explosive material. The laser-detonated explosive system effectively eliminates premature explosions caused by stray electromagnetic or RF energy.

Because there are no electrical leads into the explosive device, the pyrotechnic compounds are effectively enveloped in a Faraday shield. This eliminates the need for protecting firing lines and electrical connectors to guard the explosive systems from actuation by stray currents.

The system, designated LEED (laser-energized explosive device), would consist of one or more lasers and their associated power supplies contained in a single package. Also in the package would be safe-arm devices and optical switches for sequencing the explosive devices. As projected, the power supply would be self-contained and the total system controlled by light-activated controls. Light-activated controls eliminate electrical connections to the system and thus increase immunity from electromagnetic or radio-



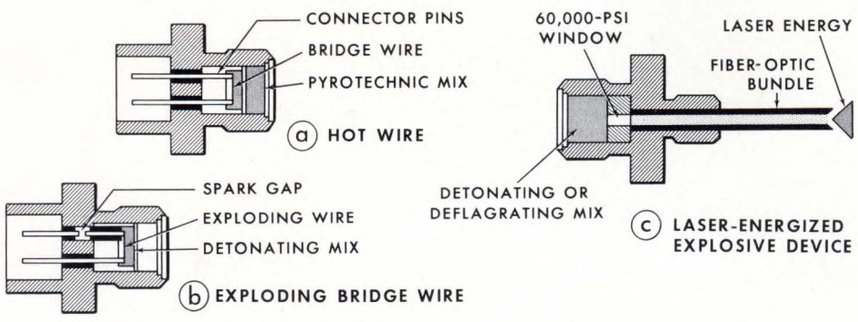
Explosive-device system uses laser energy to detonate explosives. Energy from laser units is interrupted by safe-arm device such as simple shutter. From arming device, light is transmitted through fiber-optic bundles to solid-state optical switch, which selects the explosive devices to be initiated. Dual bundles can be used for redundancy. End-to-end check passes light through one bundle and is monitored through other or passed through both bundles and monitored with a third.

frequency interference.

The use of an optical path into the initiators offers a unique advantage—a complete end-to-end inspection of the system, including the explosive. Materials that would change colors to reflect the conditions of the explosive could be mixed with the explosive. For example, materials that change to red in the presence of moisture, and another material that changes to green when oxidation occurs, might be used. To enable inspection of device readiness at any time, white light could be transmitted through the fiber-optic bundles to the surface of the explosive. Color of the reflected light would indicate condition of system.

There are several other advantages of the laser system over the conventional hot-wire or exploding-bridge-wire detonating systems. When compared to the hot-wire system, the laser system is extremely safe from human errors because it requires the unique intense laser energy to detonate the explosive. The exploding-bridge-wire system is less sensitive than hot-wire systems, but extra precaustions must be made because of the type of signal used. The massive shaped pulse used to break down a spark gap causes the conductors to radiate. Although the laser energy source is much like that used for the exploding-bridge-wire initiator, the energy is not transmitted through long conductors. The laser also eliminates the difficulty in simultaneous initiations because there are no secondary timing components between the laser and the explosive.

The LEED system is under development by Donald J. Lewis, research director for Space Ordnance Systems, Inc., El Segundo, Calif. ■



Comparison of laser-energized explosive device with conventional hot-wire and exploding-bridge-wire devices. Hot-wire system (a) uses low voltage to heat bridge wire, which breaks down primary explosive adjacent to it.

Exploding-bridge-wire technique (b) uses high current with predetermined wave shape to break down spark gap and vaporize bridge wire. Exploding bridge wire detonates either a primary or secondary explosive. Laser system (c) uses direct energy from ruby laser through window to detonate secondary explosive.

PHOTOCONDUCTORS IN CONTINUOUS BALANCE SYSTEMS

Cadmium-selenide photoconductors with copper leads offer a practical alternative to mechanical choppers in applications requiring chopping of d-c voltages as low as 0.1 μv.

Mechanical choppers have long been the only resource for detecting microvolt d-c levels. However, these mechanical devices suffer from such limitations as short life, noise and large physical size. Also, they require extensive electromagnetic and electrostatic shielding.

In contrast, the photoconductor offers virtually infinite life, little or no electromagnetic shielding is required and its driving circuitry is no more complex or expensive than that required for mechanical choppers. The exceptions where the mechanical chopper is still the best choice are in applications involving temperature extremes and measurements below 10 nv.

Electrical Considerations

State-of-the-art cadmium-selenide photoconductors are designed for fast switching speeds and negligible photovoltaic and thermal offsets. In addition, junction field-effect transistors in the carrier input stage have a source resistance for optimum noise figure that coincides with the typical ON resistance of the photoconductor.

These characteristics make possible chopping rates with extremely high efficiency at frequencies to 400 Hz, if care is taken as to how they are driven by the light source. A square-wave light source will not give a square-wave photoconductor resistance response (**Fig. 1**). A photoconductor turns on to its light resistance very fast, typically 0.2 msec, but turns off to its dark resistance in a rather complicated fashion. An approximation of its turn-off characteristic would be to assume a fixed delay in which the photoconductor remains at its light resistance, followed by a turn-off in typical exponential fashion. This is directly analogous to the storage phenomenon in switching transistors. The loss in efficiency for square-wave light drive may be calculated for the series-shunt modulator (**Figs. 3** and **4**) by using the linear approximation for turn-off time (**Fig. 1**):

$$\text{Efficiency (Percent)} = \frac{\frac{T}{T_f} - 1}{\frac{T}{T_f} + \frac{R_S}{R_L} + 1} \times 100$$

A method that may be used to obtain square-wave photoconductor resistance response is illustrated in **Fig. 2**. Simply pulse the light source at a duty cycle of less than 50 percent, usually around 25 percent, depending upon frequency. In the series-shunt photomodulator shown in **Fig. 3**, a system noise improvement can be realized by a duty-cycle drive of less than 50 percent. Also break-before-make action is attained, minimizing source loading.

To realize 1 μv or less resolution with photoconductors, photovoltaic and thermal offset characteristics must be negligible. Thus, for these levels, the device should have tinned copper leads. The thermocouple offsets of "Kovar" leads, compared to most other conductors, make voltage resolution of less than 10 μv a frustrating task.

Mating Photoconductor To System

Figs. 3 and **4** illustrate block diagrams of two

Author **S. Cameron Reid** has been with Fairchild Instrumentation for 9 months and, as senior engineer, is presently involved with research, design and development of nanovolt instrumentation. Mr. Reid earned his B.S.E.E. from Virginia Polytechnic Institute; he has two patents pending. This is Mr. Reid's first appearance in **EDN**.

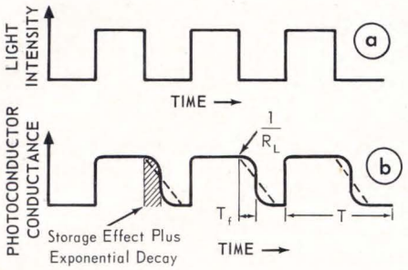


Fig. 1—**(a) Square wave light source.** (b) Typical CdSe photoconductor response at 250 Hz, illustrating poor efficiency.

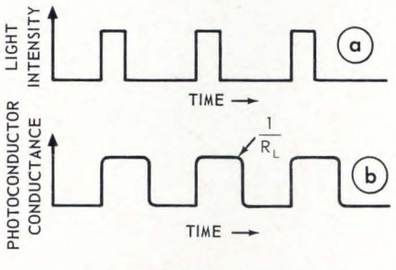


Fig. 2—**(a) Duty-cycle light source** drive. (b) Approximate square-wave resistance response of photoconductor.

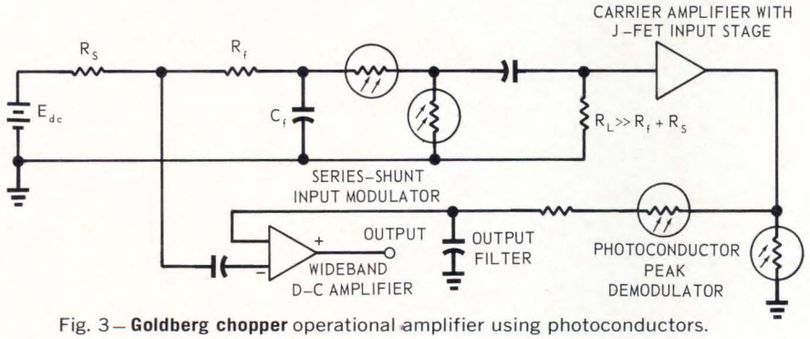


Fig. 3—**Goldberg chopper** operational amplifier using photoconductors.

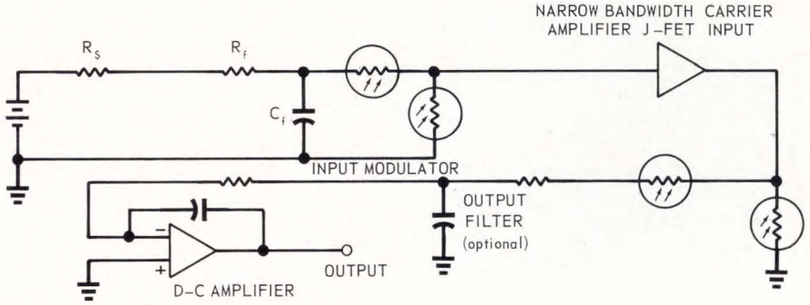


Fig. 4—**Chopper amplifier** for less than 1 μv resolution.

(Continued)

chopper-stabilized amplifier configurations that maximize the photoconductor's advantages as a chopper. The input d-c modulator is in the series-shunt configuration. This provides minimum loading while presenting a time average source impedance near the optimum for best noise performance of a junction FET. The J-FET is used for the input stage of the carrier amplifier because it combines high input impedance with the lowest noise figure of any presently available solid-state device.

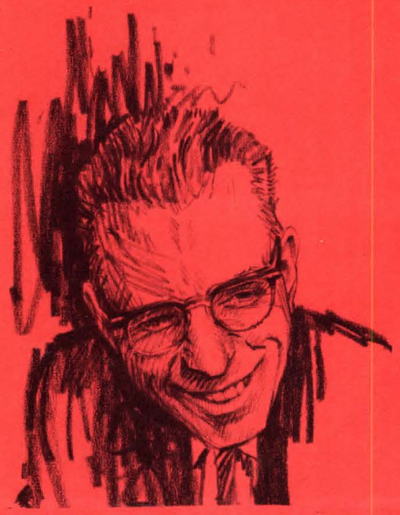
The series-shunt input modulator should be driven by light pipes or fiber optics to isolate the photoconductors from spikes and the heat generated by the light source. The entire input circuit should be surrounded by an electrostatic shield and all interconnections soldered with a low thermal solder.

The output of the carrier amplifier is a photoconductor peak detector that operates over the carrier's full output swing without pulling, false nulls, d-c offset or leakage current. The photoconductors comprising the peak detector can be mounted next to the light source, the small amount of drift introduced being divided by the carrier gain.

An instrumentation amplifier constructed in the configuration of **Fig. 3** has an initial d-c offset of less than 1μv, offset current less than 2×10^{-12} amps, and a 0- to 1-Hz noise of < 2 μv peak-to-peak with a source resistance of 1 megohm. The modulator and demodulator photoconductors are driven by the same light source with a 30-percent duty cycle. ■

EDN MAGAZINE

INSTRUMENTATION AND MEASUREMENT



Resistive dividers are old friends—but there are good reasons for getting better acquainted with the properties of inductive dividers. "Would You Believe 1 Million Taps?" on p. 58 pins down some of these.

We expect problems to pop up when a high-impedance circuit is connected through a long line—and they seldom fail to show! A practical way around one such problem is covered in "FET Tames Long Cables" (p. 60).

Transistor testing has problems, too. Among them are bias nonuniformity and damage caused by unsoldering for test. Both are attacked head-on: Bias in "Transistor Bias—Set It, Forget It" on p. 63, and the unsoldering problem in "In-Circuit Tester Speeds Testing of Semiconductors" on p. 64.

Earle Dilatush

Earle Dilatush,
Instrumentation Editor

THE ELECTRONIC ENGINEER'S DESIGN MAGAZINE

WOULD YOU BELIEVE 1 MILLION TAPS?

We're talking about the decade transformer divider, a versatile drift-free component capable of dividing voltage into 10^6 parts, with applications galore in precision measurement and control.

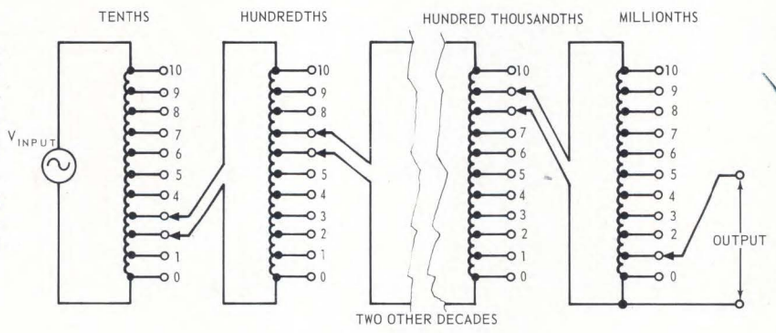
SAM SHATAVSKY, Eastern Editor

The transformer divider is comprised of cascaded autotransformers packaged as one component to achieve 0.0001-percent (1 ppm) ratio accuracy. Its immunity to temperature drift, and hence stable input-output ratio, is attributed to integral copper turns on its magnetic toroidal core. It is impossible to wind fractions of a turn so that encapsulated windings produce a divider whose turns ratio cannot vary with age, temperature or other environmental extremes.

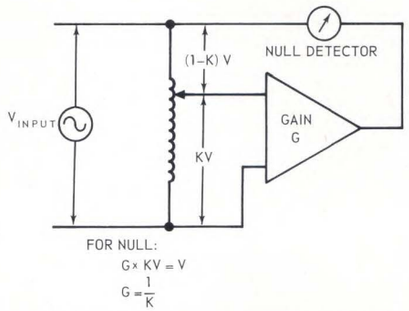
The component can be applied in a-c measurement and control circuits with significant advantages over its counterpart, the resistive divider. Superior temperature stability, high voltage and high current capability, immunity to loading errors and output phase shifts are strong features of the inductive divider. Its high input-to-output impedance ability—as much as 200,000-ohm input to 5-ohm output—is not uncommon.

Applications cover gain, phase shift and linearity measurement of precision repeaters and amplifiers as well as attenuation and response of filters. The ability to develop an accurate a-c reference voltage makes the transformer divider valuable for resolver-synchro testing and turns ratio-impedance measurement of precision transformers. Development, special applications and manufacture of inductive dividers are being carried out at North Atlantic Industries, Inc., Plainview, N.Y.

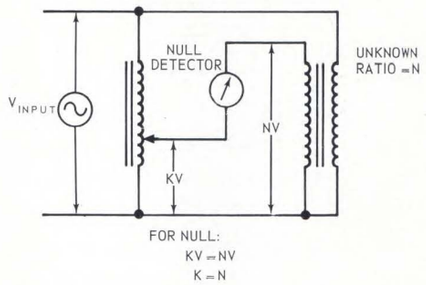
Decade divider employs many separate autotransformers packaged together and connected to achieve the equivalent of 1 million output taps. Stability is outstanding because turns are not altered by environmental changes.



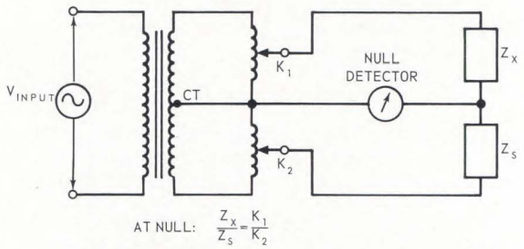
Transformer divider decade section.



Amplifier gain is measured precisely by setting decade-divider taps until null is obtained.



Transformer ratio, N, accurately determined by decade divider at null setting.



Impedance bridge, based on a pair of inductive dividers, provides enormous ratio range, enabling only one impedance standard for many different kinds of measurements.

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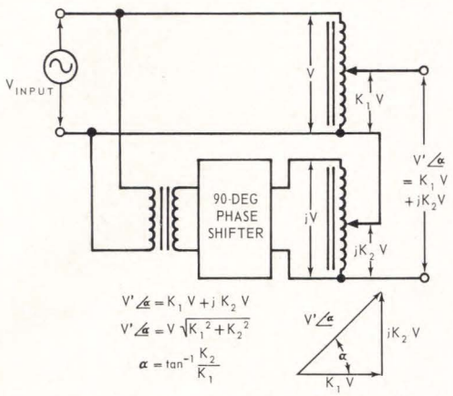
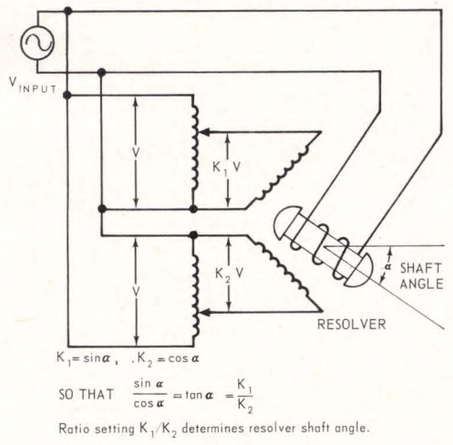
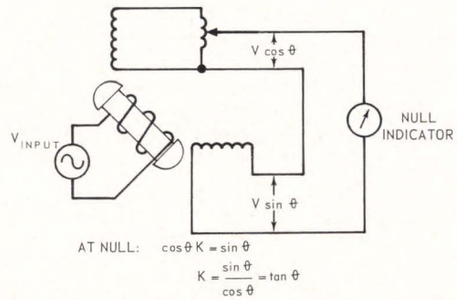
1 Million Taps (Cont'd)



Voltage-output vector angle and magnitude are accurately determined with two inductive dividers.



Precise resolver positioning signals developed from two transformer dividers simulating a resolver transmitter. Manual switching can be replaced with electronic switching to permit digital programming of position commands.



Shaft-angle readout in terms of tan θ is determined by transformer-divider tap position at null condition. ■

FET TAMES LONG CABLES

High-impedance transducer output fed down long cables has always been troublesome. Enter the FET —with solutions to accelerometer noise and response problems.

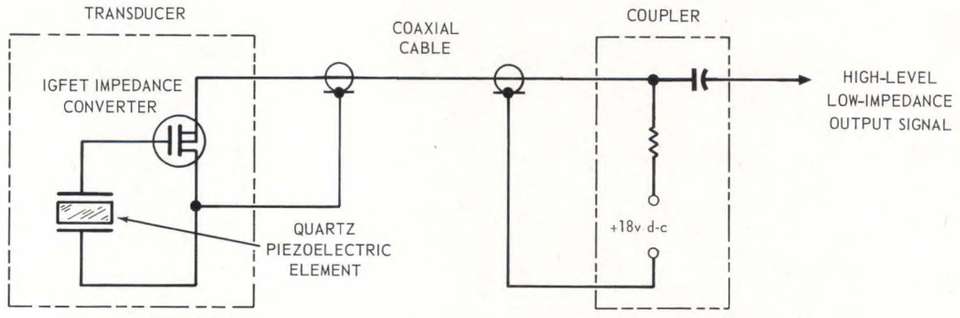
SAM M. SHATAVSKY, Eastern Editor

Installation of an IGFET in the same housing with a quartz-crystal accelerometer solves insulation resistance and noise pickup problems encountered in long cable use of high-impedance transducers. The IGFET located within the transducer lowers the impedance level of the crystal output from 10^{14} to 100 ohms. The system needs only one single-wire shielded cable to conduct the transducer signal and carry d-c power for the FET.

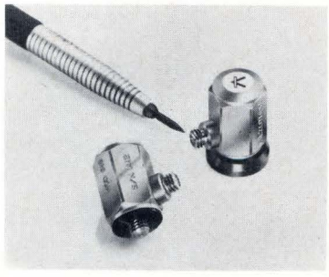
This new concept eliminates the need for expensive charge amplifiers previously necessary in using high-impedance quartz crystals for acceleration measurements.

The low-impedance output permits using thousands of feet of cable without response and signal-to-noise ratio deterioration caused by cable capacitance and cable motion. The arrangement allows full use of the high open-circuit transducer-voltage sensitivity of piezoelectric quartz crystals in shock and vibration measurements.

This transducer system was developed and is manufactured by the Kistler Instrument Corp., Clarence, N.Y. ■



Quartz-crystal high output impedance stepped down to 100 ohms with IGFET built into accelerometer case. Low output impedance permits long signal cable, which also carries d-c power for FET. Noise level is 0.01g rms acceleration—independent of cable length with sensitivity of 10 mv/g. Low-frequency response of 2 Hz is possible by utilizing the temperature stability of quartz. Monitoring d-c detects faults in cable or transducer during accelerometer operation.



Accelerometer with built-in IGFET is 0.78 inch high, 1/2-inch hex shape with a coaxial connector output.

Circle No. 63 on Reader Service Card for more information.

TRANSISTOR BIAS— SET IT, FORGET IT

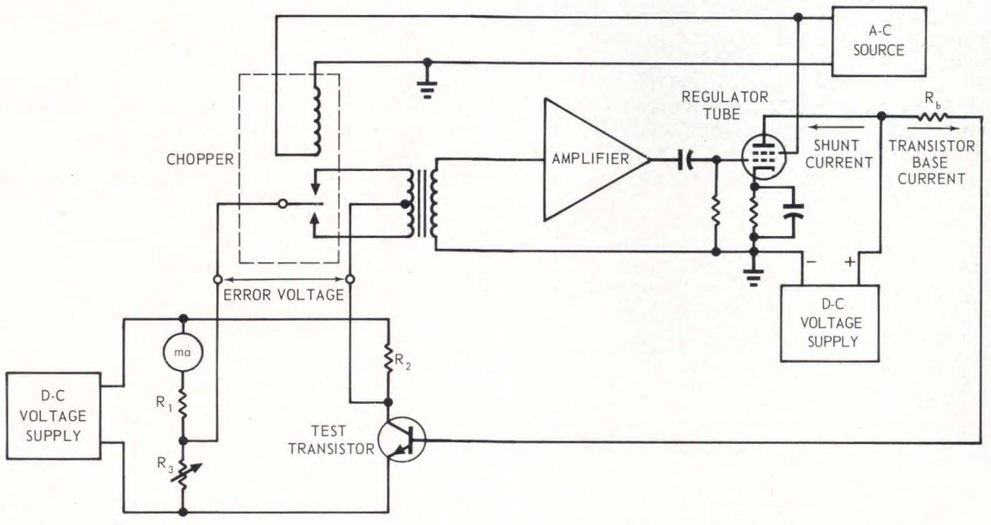
Electronic control automatically establishes uniform bias conditions in production transistor testing.

SAM SHATAVSKY, Eastern Editor

Performance testing many transistors makes it desirable to automatically adjust the collector current and voltage to predetermined levels. This can be accomplished by operating the transistor in an error-generating comparator network. The error voltage in conjunction with a chopper amplifier and phase discriminator-regulator determines the error-corrected current fed back to the base. This in turn automatically establishes the proper collector operating current and voltage.

This transistor-test system evaluates transistors of the same type under identical operating conditions. By providing uniform d-c bias conditions the dynamic a-c testing of the transistors can proceed under uniform operating-point conditions.

This transistor-testing apparatus was developed and patented under U.S. Patent 3,221,245 by G. L. Allerton of the Western Electric Co., Inc., New York, N.Y.



Transistor under test is one leg of bridge formed with equal resistors R_1, R_2 and variable R_3. Manual setting of R_3 predetermines collector-current value, indicated by milliameter, to be established by automatic error-correcting circuit. Incorrect transistor operating conditions generate d-c bridge error voltage converted to a-c by chopper. Conduction of current-regulator tube in parallel with R_b and base circuit shunts base current as a function of error voltage, causing degenerating collector-current decrease to desired value to stop control action of current-regulator tube.

Initial conditions of regulating circuit are determined by R_b to yield collector and base currents higher than desired. Control action reduces current levels by a-c phase-discriminating action of regulator tube. Phase discrimination occurs by applying same a-c source to control-tube screen grid and chopper so that conduction is possible only when a-c potential of screen grid passes through positive half of cycle and transistor collector current is greater than desired level. ■

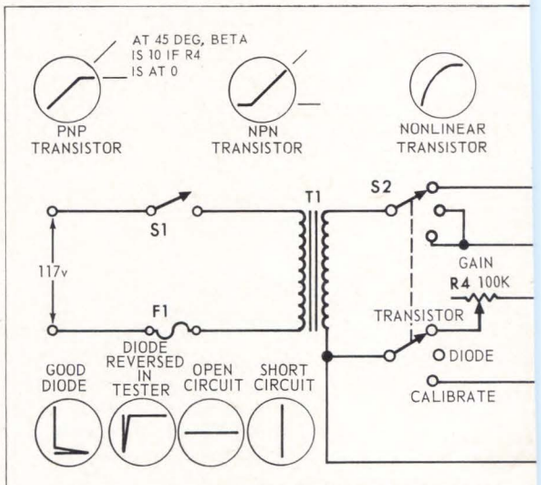
In-Circuit Tester Speeds Testing of Semiconductors

Detecting defective components without removing them from the circuit can greatly reduce trouble-shooting time and cost. In-circuit testing of semiconductors is doubly attractive because it also eliminates heat damage during unsoldering.

With this tester, plus an oscilloscope, transistors and diodes can be evaluated without removing them from the circuit. It can be used to determine the approximate gain and linearity of transistors, to tell whether they are pnp or npn, and to determine their condition. Also, diodes can be tested for opens or shorts, for polarity and for their rectifying action.

Transistor Testing

When a pnp transistor is under test, the emitter has a positive voltage applied through R1 and the collector is at a negative potential. Unless there is



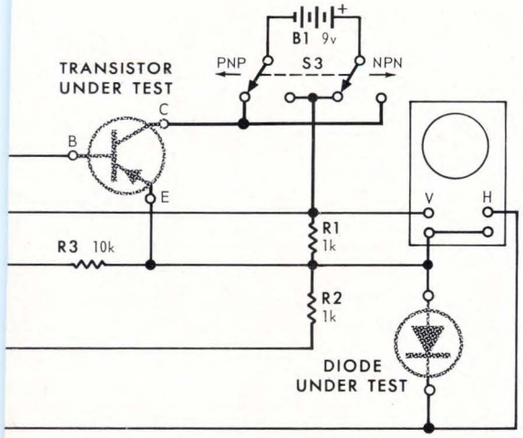
Schematic and test waveforms for

current flow in the base-emitter circuit, only a very small leakage current flows in the collector-emitter circuit.

During the half-cycle that makes the emitter positive, emitter-base current flows through R3 and R4 (R3 is used for current limiting when R4 is set at zero). The voltage produced by this current flow is applied to the horizontal terminals of the oscilloscope and is a measure of the transistor input current.

Since the collector-emitter circuit is forward-biased by B1, it follows that when base current flows, collector current flows through R1. This is the transistor output current, which is applied to the vertical terminals of the oscilloscope.

During test, the vertical and horizontal voltages are dependent on the current flow through resistors R1, R3 and R4. If R4 must be set at zero to get a 45-deg trace, then there is 10 times more current flowing through the 1-kilohm output resistor R1 than is flowing through the 10-kilohm input resistor R3 to make their voltage drops equal. When its out-



in-circuit semiconductor tester.

(Continued)

In-Circuit Tester (Cont'd)

put current is 10 times its input current, a transistor has a beta (current gain) of 10.

As the value of R4 needed to maintain the scope trace at 45-deg rises, so does the ratio of the output current to input current. Thus, when a calibrated dial plate is used for R4, the approximate transistor gain can be read from its setting.

Before making tests, the oscilloscope gain should be calibrated. To do this, turn switch S2 to the "calibrate" position. This produces equal voltages across R1 and R2 and hence at the horizontal and vertical inputs. By adjusting the vertical and horizontal gain controls, a 45-deg line trace then can be obtained on the screen.

Diode Testing

When testing a diode, 6.3v a-c is applied to it. This forward-biases it during the positive half-cycle and reverse biases it during the other half-cycle.

During conduction, the diode effectively short-circuits the oscilloscope's horizontal input. The full voltage then appears across R1 and the oscilloscope shows only a vertical trace.

Throughout the half-cycle when the diode is not conducting, no current flows through R1 and there is only horizontal deflection. When the recurrent half-cycle traces are combined, the pattern is half vertical and half horizontal for a "perfect" diode. Actual diodes produce an imperfect pattern.

If a low-voltage zener diode is being tested, the horizontal leg will break down at some distance out from the junction if the zener is rated at less than 10v. Higher back resistance shows up on the trace as a downward slanting of the horizontal leg. With high forward resistance, the vertical leg slants to the right.

In-circuit testing will reveal the mentioned traces if the circuit resistance is more than that of the component under test; if not, the trace will vary by the degree of external circuit properties. When the printed-circuit board has more than one identical circuit, it is a simple matter to compare these to find a bad component.

Inquiries concerning this invention may be directed to: Technology Utilization Officer, Marshall Space Flight Center, Huntsville, Ala. 35812. Reference: B66-10447. ■

EDN MAGAZINE

PACKAGING AND MATERIALS

Adaptability is the word for the packaging system described on p. 68. Engineers at Hewlett-Packard have chosen a design course that falls between many individually tailored units and an all-purpose universal unit. The end result is a line of transducer conditioning equipment that uses a few easily modified subassemblies that can be assembled to suit a variety of end-use requirements.

It will probably be a while before portable TV transceivers become as common as today's walkie-talkies, but three engineers at Teledyne Systems have taken a large step in this direction. They have developed a complete TV station—camera, transmitter and power supply—that is smaller than many home movie cameras. Called the "Microeye", this example of microminiaturized packaging techniques is described on p. 73.

James Hulet

James Hulet,
Packaging and Materials Editor

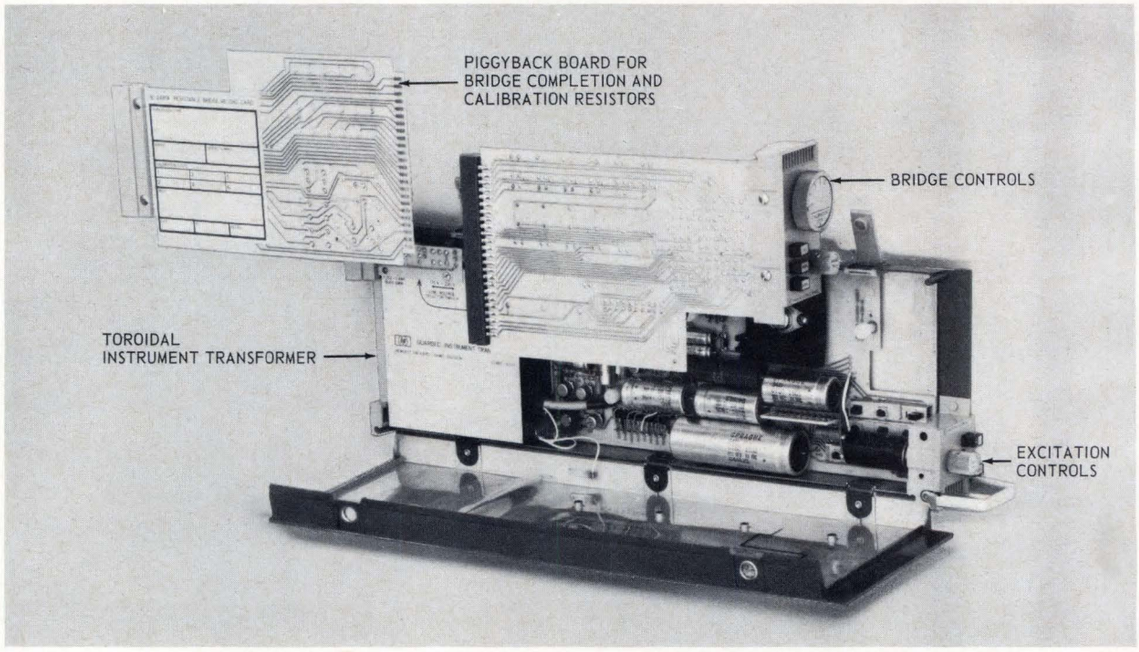
FLEXIBLE PACKAGING FOR END USE

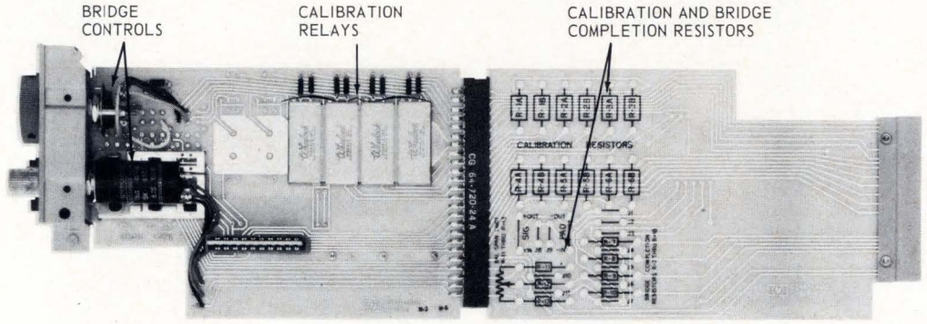
What do you need for a unit that does everything? A box to put it in!

Four printed-circuit boards determine the final configuration of a unit that is designed to meet a wide variety of system requirements. Housed in a plastic case, choice of three of the four boards is set by initial system requirements. Minor system requirements are met by modifying the components mounted on one of the boards. Field selection of component values modifies the third board for specific requirements. The package is arranged so that the same configuration is used while individual submodules are varied to match the end use. The modular construction simplifies manufacturing as well as facilitating the various end-product configurations.

The problem of maintaining consistent production facilities and at the same time matching a variety of user requirements often arises. Two extreme alternatives could be considered: A number of individually tailored units, each designed specifically to match a customer requirement; on the other hand, a universal unit could be designed to fit all of the desired requirements. Both techniques usually result in higher unit cost, the first because of numerous manufacturing changes in the production of different models. The second technique is expensive because the user must buy capabilities that he may never use.

JIM ROSE, Western Editor





Basic excitation supply with secondary boards removed. In this configuration each transducer channel has its own independent power supply. Special toroidal instrument transformer gives low profile and reduces stray flux lines. Molded case is of ABS plastic, while hinges and snaps are of polypropylene.

Secondary boards provide bridge control, bridge completion and calibration functions. All bridge controls are contained on first board and number of calibration steps is determined by the number of calibration-resistor relays installed. Second board contains bridge-completion resistors and calibration resistors. Resistor positions are labeled to indicate location of resistor.

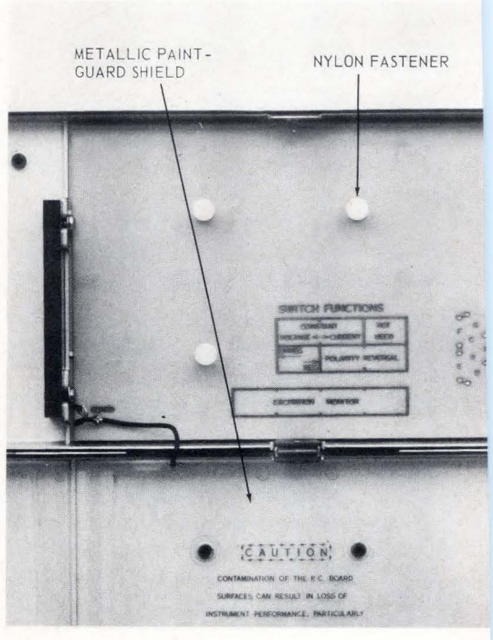
(Continued)

Flexible Packaging (Cont'd)

Obviously, a compromise between these two extremes is in order. That is, combine the benefits of a consistent production line with a modular construction that allows the user to select only the functions he needs. This technique is demonstrated in the Hewlett-Packard 2480 Series of transducer conditioning equipment.

A single molded-plastic case is used for all variations of the unit. Selection of one of two circuit boards determines whether each channel will operate from its own power source or will use a common power source. These two boards contain all primary excitation controls and switches.

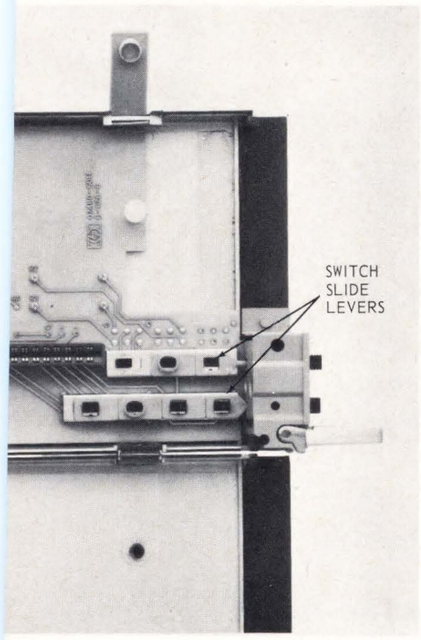
A second set of universal printed-



Common-channel power-supply circuit board illustrates unique fasteners and switch configuration. Nylon insert fasteners snap into receptacles in case. Special slide-action switches are operated by molded-plastic levers. By varying

circuit boards is used to match the particular type of transducer being used. Arranged in piggyback configuration, the first board provides bridge-control functions. The required calibration steps are determined by the number of relays mounted on the front printed-circuit boards. The piggyback board accommodates the necessary bridge completion and calibration resistors. With no controls, this makes it economical to keep additional PC boards already loaded to match the different transducers that are used.

The 2480 series of signal-conditioning modules was developed by Tom Poulter and Mel Cotterill, Dymec Div., Hewlett-Packard, Palo Alto, Calif.



physical location of switches and the configuration of switch-lever slots, ganged switches can operate in various modes. Complete guarding of power supply is accomplished by spraying inside of case with conductive metallic paint. ■

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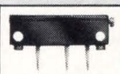
	 Helitrim Model 77	 Competitive Model 3067 Wirewound	 Competitive Model 3068 Carbon
Resistance Range, ohms	10—2 meg	50—20 K	20 K—1 meg
Resistance Tolerance	10%	10%	20%
Resolution	Essentially infinite	1.7 (100Ω) to 0.3 (20 K)	Essentially infinite
Sealing	Yes	No	No
Power Rating, watts	0.75	0.5	0.2
Maximum Operating Temp. °C	105	85	85

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JIM ROSE, Western Editor

A TV STATION IN A CIGARETTE PACK?

Well, not exactly, but here is a complete television station, camera, power supply and transmitter in 20.25 cu in! No apologies to Chester Gould.

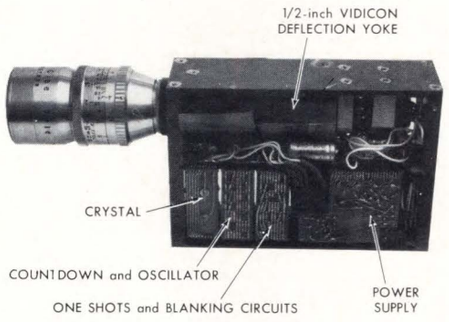
Both integrated circuits and ultraminiature discrete-component assemblies contribute to the extremely small package size of a miniature television system (**Fig. 1**). Advanced circuit-packaging design in conjunction with ingenious solutions to circuit problems allowed the construction of the system, which conforms to established conventional television practice.

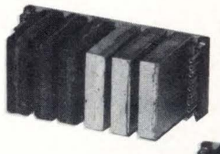
The ultraminiature television camera transmitter, called "Microeye", is completely self-contained. Operating from a nominal 28v supply, the system is complete with vidicon, camera control circuits, automatic illumination circuits, power supply and transmitters. The unit transmits on UHF and accommodates standard 8-mm optics. Completely compatible with standard commercially available television monitors, the system provides a study in advanced packaging techniques.

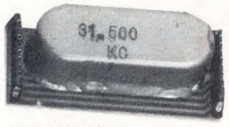
Overall Package Design

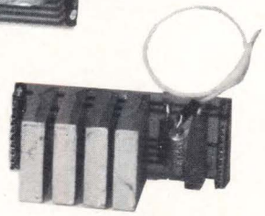
The extremely small package size (**Fig. 2**) of the "Microeye" is accomplished by utilization of MEMA's (microelectronic modular assemblies). See EDN, Sept. 14, 1966, p. 102. These assemblies are hybrid in approach and use either integrated-circuit chips or discrete components bonded on an alumina substrate (**Fig. 3**). Conformal in size, the substrate serves as a vehicle for deposited resistors and capacitors as well as interconnections between the

Fig. 1—**Ultraminiature TV system** is 3 by 4-1/2 by 1-1/2 inches and weighs about 1-1/2 lb without optics.









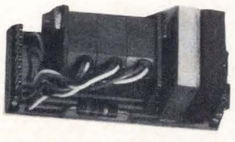


Fig. 2—**Packaging techniques** used in "Microeye". Half-inch vidicon and deflection yokes utilize 1/3 of total volume package. Unit is assembled of discrete components and integrated circuits.

(Continued)

TV Station (Cont'd)

elements. Wire leads are used to interconnect component and substrate pads.

The MEMA packages (0.5 by 0.5 by 0.162 inch) have leads on one side that are attached to interconnection boards. Interconnection boards have printed-circuit conductors on both sides and are used to make all interconnections within a subassembly. Each subassembly forms a solid block. Subassemblies are arranged in opposition and overall interconnections are accommodated by two mother boards at opposite ends of the interconnection boards.

The Camera Tubes

The largest element (and the only nonsolid-state component) is the vidicon tube. Initially, two vidicon approaches were analyzed. (1) A magnetically deflected and magnetically focused vidicon appeared impractical because the deflection and focus coils associated with the tubes were too large. (2) To achieve minimum size, an electrostatic deflection and focus unit would be the most desirable. However, none is available.

As in most cases, a compromise resulted in the use of a 1/2-inch vidicon with magnetic deflection and electrostatic focus.

The Video Amplifier

The small package size precluded the use of large capacitors and inductive elements. Further, the inherently low input impedances and associated shunt capacitance of the vidicon made the use of integrated-circuit elements impossible. Conventional video amplifiers (**Fig. 3**) use large capacitors and peaking coils to achieve broadband-pass characteristics. A stable video amplifier was designed for the "Microeye", which gave broadband capabilities without the use of peaking coils. Initially, the physical size of coupling capacitors limited the low-frequency response to 300 Hz. Advances in capacitor technology now allow responses down to 60 Hz with no size compromises. The video amplifier is assembled of discrete components packaged in six MEMA assemblies. Each stage has its own decoupling and feedback to increase isolation and reduce noise. The video amplifier is located in proximity to the target electrode of the vidicon to minimize noise and as-

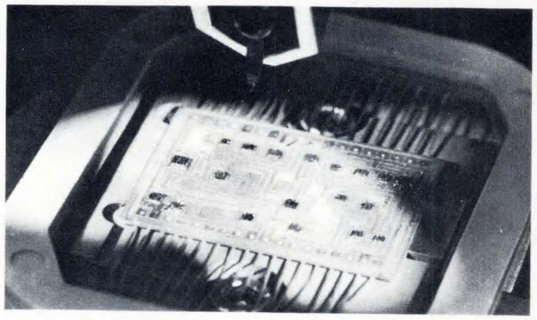
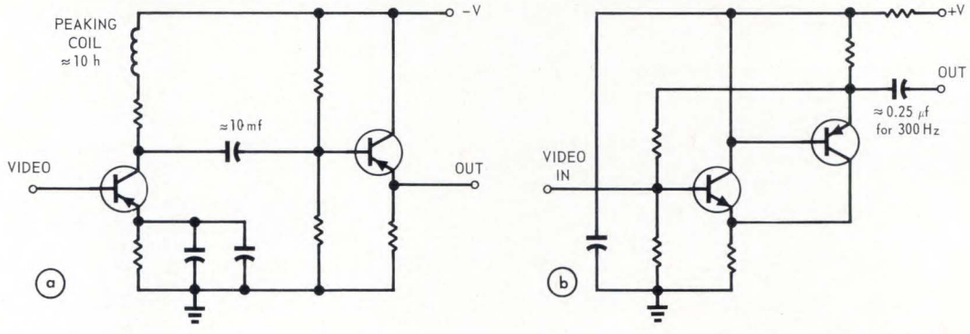


Fig. 3—**MEMA package** uses either discrete components or integrated circuits. Video-amplifier stage is fabricated from discrete components, while countdown circuit uses multiple integrated chips.

Fig. 4—**Video-amplifier circuit** had to be developed without the use of peaking coils and large capacitors. Typical video-amplifier stage (a) is compared with new circuits (b). Each new circuit is contained in a MEMA package.



sociated shunt capacitance.

Vidicon Control Circuits

In keeping with good television-design practice, a 15.75-kHz horizontal sweep is used. To obtain full interlace, a 31.5-kHz crystal-controlled temperature-stabilized oscillator drives a divide-by-two circuit. Vertical interlace scanning (at 60 Hz) is obtained by further counting down the oscillator frequency. Two divide-by-five circuits, one divide-by-seven circuit and one divide-by-three circuit are used. Each division circuit is contained in its own MEMA package. The oscillator is assembled of discrete components and occupies approximately 0.34 cu in.

Digital circuits are used for the proper generation of control pulses. Integrated circuits, multivibrators and gates are packaged in MEMA's to form composite and noncomposite blanking pulses, and vertical, horizontal and composite sync pulses. Relatively conventional protection circuits protect the vidicon from failure of sync or sweep by biasing the vidicon cathode positive.

Full interlace scanning is used in the "Microeye" camera that employs the conventional 262.5 lines per frame. This nonintegral number of lines causes the first scanning field to end at the bottom center of the frame and the second scanning field to end at the bottom right of the frame. Commercial standard composite-video signals use equalizing pulses to compensate for this time interval. Originally, equalizing pulses were needed because direct-drive vertical-sync circuits were used, and equalizing was needed to obtain proper interlace. Modern television receivers interlace properly without them, but commercial transmitters continue this established practice.

It is in the employment of equalizing pulses that the miniature camera deviates from standard television practice. It was found that the absence of equalizing pulses causes no degradation of the picture and they were eliminated to conserve package volume. However, future units will include this feature to make it completely compatible with commercial television practices.

Vertical sweep is accomplished with the discrete-component Miller integrator. The output drive is synchronized to the basic vertical-oscillator frequency, as is the horizontal sweep generator. Both sweep generators are coupled through power stages to the deflection yokes.

(Continued)

TV Station (Cont'd)

The three primary camera-operating controls, beam, target and video gain, are fixed. Beam current and video gain are matched to the vidicon that is used in the unit. Target voltage is a function of the incident illumination on the vidicon, and a light-sensing circuit is employed to supply the proper target voltage.

The Transmitter

The transmitter is a single-transistor RC-controlled oscillator packaged in cordwood fashion. The oscillator is modulated by the signal from the line driver. When licensed, the transmitter may drive a whip antenna and satisfactory signals may be obtained at distances up to 110 ft.

The Power Supply

The second largest volume contained within the unit is required by the power supply. The power supply is a preregulated d-c to d-c converter. Utilizing wood packaging techniques, the power supply developes eight distinct d-c voltages for the unit. It supplies −2v, +4v for the integrated circuits; +12v for the discrete-component elements; +12v for the video amplifier, and 6.3v, +100v, +400v and +600v for the vidicon.

A toroidal transformer is used to accomplish two prime purposes. (1) Because the transformer coupling coefficient approaches unity, the physical size of the transformer is reduced. (2) The close coupling reduces the stray magnetic flux and its influence on adjacent circuits. The low voltages are individually transformed and rectified to reduce the power consumption of the system (approximately 11w). Power-supply switching transistors are heat sinked to the case of the unit to provide stable operation.

The proximity of the power supply to all other camera elements provides an interesting design problem. To minimize switching transients that cause picture distortion, the power-supply switching must be synchronized to the scanning rate. Switching occurs during blanking periods and causes no distortion. When the camera is turned on, this technique presents the proverbial "chicken or the egg" situation, because the sync pulses are not developed until power is applied. To circumvent this, the switching transistors "free run" at near blanking frequency until the oscillator is in operation.

The "Microeye" ultraminiature television system was developed by Bob Sussman, Ned S. Drago and Austin Bennett, members of the design team at Teledyne Systems, Los Angeles, Calif. ■

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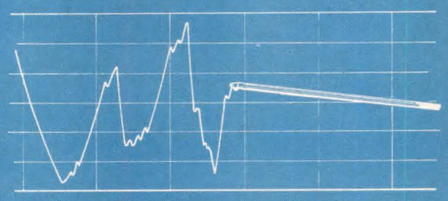

DATA

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Article titles, pages where they can be found and numbers to circle for free reprints are as follows:

"The Neglected Exclusive OR", p. 78 Circle No. **L61**

"Nomograph Finds Thermal Noise Voltage", p. 82 Circle No. **L62**

"Simplify Your Power-Factor Calculations", p. 84 Circle No. **L63**

"Know Your Magnetic Recording Head", p. 86 **Circle No. L64**

THE NEGLECTED EXCLUSIVE OR

Because it lends itself so well to one application, the extreme versatility of the exclusive OR function often is neglected. Here's a look at this interesting function, its algebra and its uses.

The exclusive OR ($A \oplus B$) and its inverse, the exclusive NOR ($A \odot B$), are no strangers to logical designers. Use of the exclusive OR in computers is so well established that is has been given the special name "half adder". Yet in spite of this familiarity, the exclusive OR's full potential seldom has been used. In the following sections, the logical basis for its use, including exclusive OR/NOR algebra, will be demonstrated.

Definitions

The exclusive OR ($A \oplus B$) is defined as either A or B but not both (**Table I**). The exclusive NOR ($A \odot B$) is defined as both A and B or neither A nor B. The Boolean equations for $A \oplus B$ and $A \odot B$ can be written many ways, several of the more useful are given in **Table II**.

It is possible to develop an algebra using the EX OR and EX NOR definitions with or without the AND and OR logical operations. The following list shows the basic theorems. Theorem 10 requires induction for its proof, while 1 through 9 can be proved by simple substitution.

From the above theorems the following rules can be derived:

1. If any variable is complemented or any operator inverted ($\odot$ to $\oplus$ or $\oplus$ to $\odot$), the function is complemented; e.g., $A \odot \overline{B} \oplus C = A \odot \overline{B} \oplus \overline{C} = A \oplus \overline{B} \oplus C$.

2. Any combination of variables (complemented or uncomplemented) and the operators ($\oplus$, $\odot$) will combine into either the even or odd parity function. For example, $A \odot B \oplus \overline{C} = A\overline{B}\overline{C} + \overline{A}B\overline{C} + \overline{A}\overline{B}C + ABC$ (odd parity).

3. To synthesize any even or odd parity function using EX OR/NOR gates only with any combination of complemented or uncomplemented variables, one variable at most need be inverted.

4. To determine if a function is even or odd parity, count the number of EX NOR ($\odot$) operators and sum this with the number of complemented variables. If the sum is odd, the function is even parity; if the sum is even, the function is odd parity.

5. From Theorem 10: $A \oplus B = \overline{A} \oplus \overline{B}$, $A \odot B = \overline{A} \odot \overline{B}$, and $A \oplus B \oplus C = A \odot B \odot C$.

EX OR Versatility

Any arbitrary Boolean function can be synthesized by using a collection of universal gates such as

(1) $A \oplus A = 0$	(1g) $A \odot A = 1$	
(2) $A \oplus \overline{A} = 1$	(2g) $A \odot \overline{A} = 0$	
(3) $A \oplus 0 = A$	(3g) $A \odot 0 = \overline{A}$	
(4) $A \oplus 1 = \overline{A}$	(4g) $A \odot 1 = A$	
(5) If $A \oplus B = A \oplus C$ or $A \odot B = A \odot C$ then $B = C$		
(6) $A \oplus B = B \oplus A$	(6g) $A \odot B = B \odot A$	Commutative
(7) $A \oplus (B \oplus C) = (A \oplus B) \oplus C$	(7g) $A \odot (B \odot C) = (A \odot B) \odot C$	
(8) $A \oplus (B \odot C) = (A \oplus B) \odot C = A \odot (B \oplus C) = (A \odot B) \oplus C$		Associative
(9) $A(B \oplus C) = AB \oplus AC = (\overline{A} + B) \oplus (\overline{A} + C)$	(9g) $A + (B \odot C) = (A + B) \odot (A + C) = \overline{A}B \odot \overline{A}C$	Distributive
(10) $\overline{A \oplus B \oplus C \ldots \oplus N} = \overline{A} \oplus B \oplus C \ldots \oplus N = A \odot B \oplus C \ldots \oplus N$		

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NAND and NOR gates. The EX OR/NOR gates, however, can synthesize even/odd functions only. The EX OR/NOR used in combination with either the AND or OR operators becomes in effect a universal gate such as the NAND or NOR. **Table III** shows the synthesis using EX OR and AND functions.

EX OR Circuits

Some basic circuits for implementing the EX OR

TABLE I

A	B	$A \oplus B$	$A \odot B$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

Table I—**Truth table** for the exclusive OR/NOR functions.

TABLE II

$A \oplus B$	$A \odot B$
$A\bar{B} + \bar{A}B$	$(A + \bar{B})(\bar{A} + B)$
$(A+B)(\bar{A} + \bar{B})$	$AB + \bar{A}\bar{B}$
$\bar{A}\bar{B}\ (A + B)$	$AB + (\bar{A} + \bar{B})$

Table II—**The more useful forms** of $A \oplus B$ and $A \odot B$.

TABLE III

$A \oplus AB = A\bar{B}$	$\bar{A} \oplus AB = \bar{A} + B$
$A \oplus \bar{A}B = A + B$	$A \oplus \bar{A}B = \bar{A}\bar{B}$
$A \oplus A\bar{B} = AB$	$\bar{A} \oplus A\bar{B} = \bar{A} + \bar{B}$
$A \oplus \bar{A}\bar{B} = A + \bar{B}$	$\bar{A} \oplus \bar{A}\bar{B} = A + \bar{B}$

Table III—**Combining the EX OR with the AND function** adds flexibility to the exclusive OR.

are shown in **Fig. 1**. These circuits are developed from standard gates (AND-OR-NOT-NAND-NOR).

If both complemented and uncomplemented variables are available, then a, b and c in **Fig. 1** can be reduced to three gates each. Although it is not usually done, one three-variable EX OR circuit can achieve a certain economy over two two-variable circuits. **Fig. 1d** shows one approach using three variables.

By the use of nonstandard gates (**Fig. 2**), the circuit realization can be simplified considerably. The actual circuit chosen must be scrutinized carefully, however, because a resultant loss of speed, noise immunity, fan-out or fan-in may occur with the use of nonstandard circuits. An interesting aspect of **Fig. 2c** is that no power is required for operation other than the input signals.

Uses of the EX OR

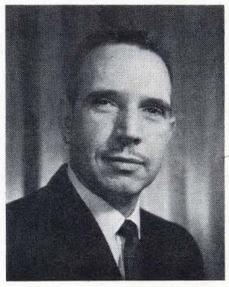
The exclusive OR is fundamental to arithmetic operations in computers. Each bit to be added in a register (after the first bit) usually uses two half adders with a carry. The logic of this can be seen from **Table IV**. Note that the sum column in **Table IV** is identical to the $A \oplus B$ column in **Table I**.

Although the principal use of the EX OR is as a half adder, this versatile circuit can be used in many other ways. A few of these are given below.

1. Consider input A to be a control input and input B a signal input. If A is held to logical 0, the output will be in phase with the input ($A \oplus 0 = A$). If A is held to logical 1, the output will be inverted from the input ($A \oplus 1 = \bar{A}$).

This affords a convenient method to output complement on command. This inversion property is useful in input/output devices where negative numbers are represented in complementary form. The function also can be used in self-erasing circuits of error-correcting codes.

2. When several EX OR circuits are combined ($A \oplus B \oplus C$), the output will be odd parity. By inverting one variable ($\bar{A} \oplus B \oplus C$), the output will be even parity. This is a convenient method to



Monty Walker attended the University of Kansas and started his engineering career troubleshooting fire-control systems in the Navy. Design responsibilities have included logic design for digital instruments and systems such as A-D converters, time-code generators and high-speed data-acquisition systems. He is now principally engaged in the logic modification of the Goldstone Deep Space Antenna. Prior to joining Dynamics, Mr. Walker served as an overseas representative for Lockheed Aircraft Corp., specializing in electronic countermeasures and ASW systems.

(Continued)

OR (Cont'd)

separate arbitrary functions into even and odd categories. It also can be used to compare two functions or the contents of two registers.

TABLE IV

A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Table IV—**Truth table for adder depicts** how the SUM column is exactly the same as A ⊕ B from Table I.

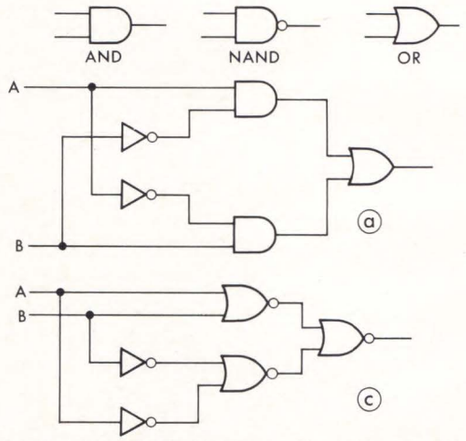


Fig. 1—**Exclusive OR circuits using standard gates.**

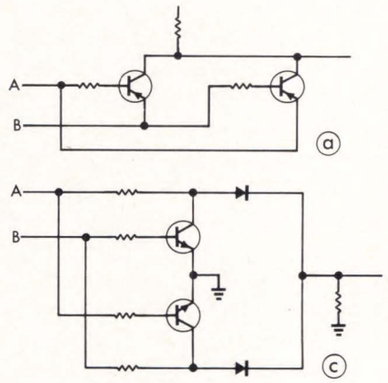
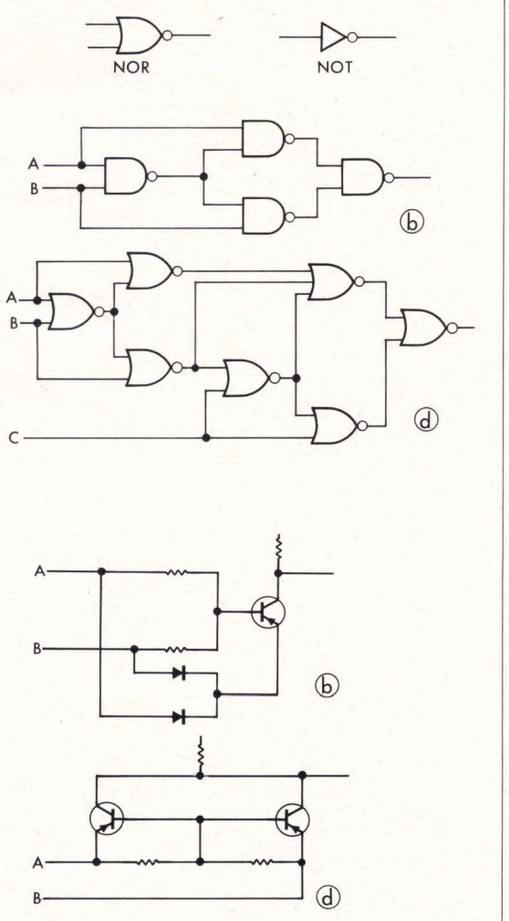


Fig. 2—**A variety of nonstandard circuits** for implementing the exclusive OR function.

Conclusion

The exclusive OR and its complement, the exclusive NOR, are extremely versatile circuits and can be used in many ways other than as elements in an adder. Unfortunately the circuit as a standard gate has had limited acceptance. Although some manufacturers package so-called exclusive OR gates, their functioning depends on both the complemented and uncomplemented variables being present. In spite of this need, logic simplicity can be achieved using these gates. ■



NOMOGRAPH

Given frequency, input C and amplifier input Z, only two operations are required to find the equivalent thermal noise voltage.

WALTER PIETRZAK, *JR., Straza Industries, El Cajon, Calif.*

When an amplifier is fed from a capacitive source, the spot (one frequency) noise is generated by the real part of the impedance. This nomograph reduces the calculation required to arrive at the noise value.

The impedance at the amplifier input is

$$Z = \frac{R - j\,R^2\,\omega\,C}{R^2\,\omega^2\,C^2 + 1} \tag{1}$$

The thermal noise is generated by the real part of this expression, which is

$$(REAL\ Z) = \frac{R}{R^2\,\omega^2\,C^2 + 1} \approx \frac{1}{R\,\omega^2\,C^2} \tag{2}$$

The mean square thermal noise voltage associated with the real part of Z is given by

$$\bar{e}^2 = 4\,k\,T\,df\,(REAL\ Z) \tag{3}$$

for this case

$$df = 1\ (spot\ frequency)$$
$$T = 25°C$$

Combining **Eqs. 2** and **3**

$$\bar{e}^2 = 4\,k\,T\,df\,\frac{1}{R\,\omega^2\,C^2} \tag{4}$$

Eq. 4 forms the basis for the nomograph.

Nomograph of equivalent spot thermal noise voltage of the parallel combination of a capacitor and an amplifier input resistance.

Using the nomograph:

1. Choose f, C and R (In the example f = 10 kHz, C = 0.001 μf and R = 1 megohm).
2. Draw a line between the chosen f and C.
3. Mark its intersection on the reference line.
4. Draw a line from the marked point on reference scale to the chosen R.
5. The intersection of that line with the $\bar{e}^2$ scale is the desired equivalent thermal noise voltage in db re 1v. ■

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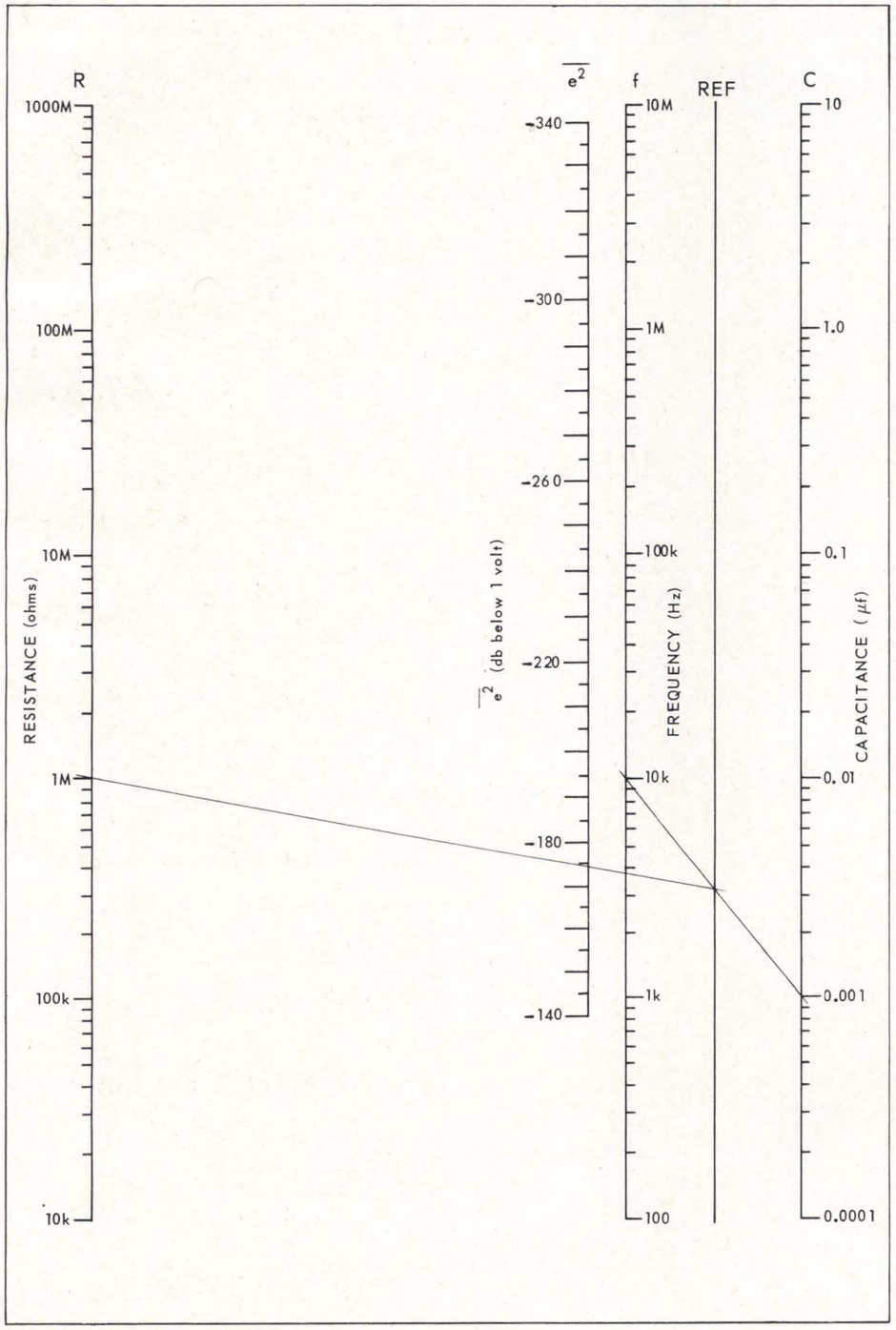
FINDS THERMAL NOISE VOLTAGE



SIMPLIFY YOUR

Want to determine in a rapid fashion the power factor of an inductive or capacitive circuit?

HUGO KOPPE, Correspondent in Holland

The power factor (cos ϕ) of a series RL- or parallel RC-network is given by the following relationships:

$$P.F.\ (ind) = \frac{R_S}{\sqrt{R_S^2 + (\omega L)^2}}$$

$$P.F.\ (cap) = \frac{1}{\sqrt{(R_p \omega C)^2 + 1}}$$

Example I: A-1h inductance in series with 100 ohms is supplied a 60-Hz power source. From the nomograph: $\phi = 75°9'$, $\cos \phi = 0.256$.

Example II: An inverter system operating at 2 kHz supplies a 100-ohm load in parallel with a capacitance of 0.05 μf. From the nomograph: $\phi = 3°36'$, $\cos \phi = 0.998$. ■

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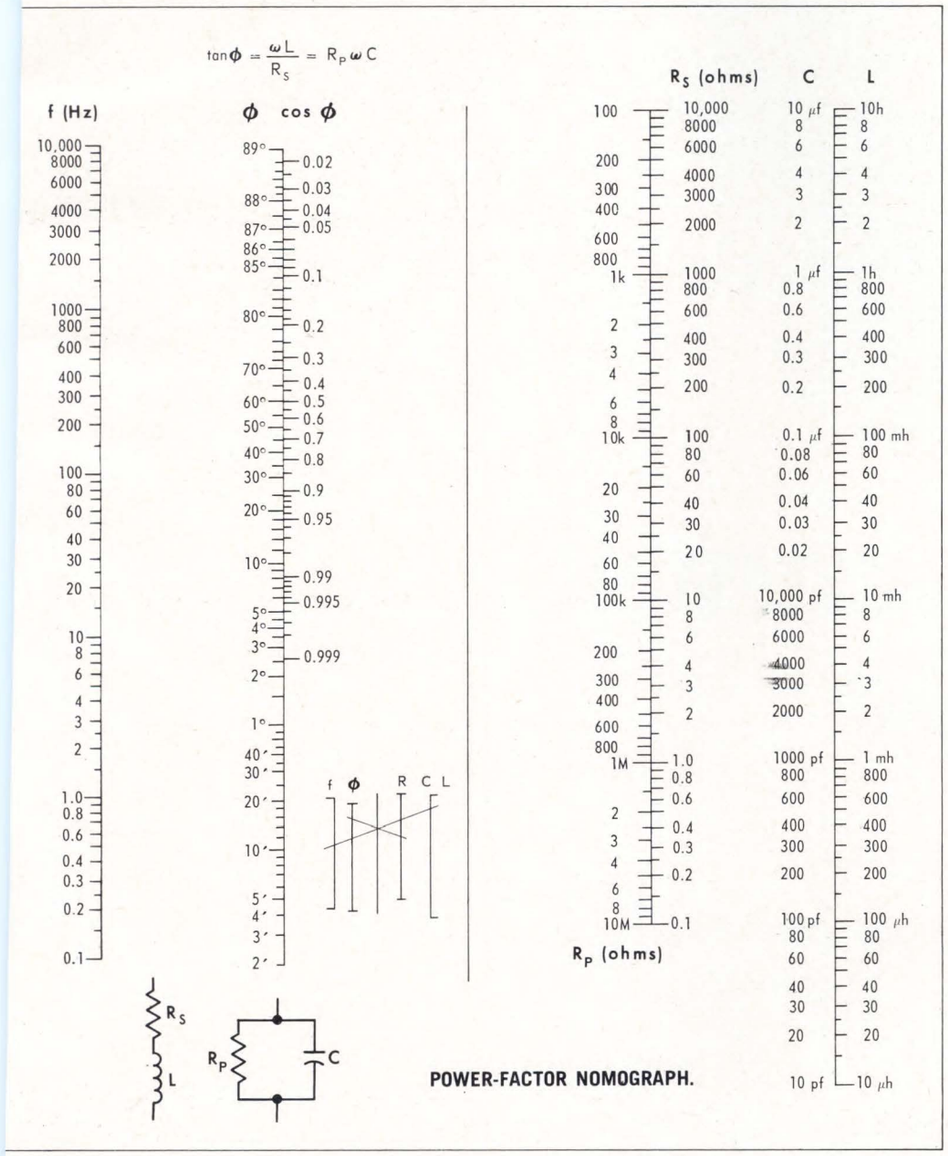
POWER-FACTOR CALCULATIONS



POWER-FACTOR NOMOGRAPH.

Know Your Magnetic Recording Head

This six-paragraph performance rundown, together with geometric definitions, is a valuable aid to describing the design and performance of the magnetic recording head.

SAM SHATAVSKY, Eastern Editor

One of the key elements in a magnetic recording system is its magnetic recording head—the transducer converting information from the electrical to magnetic, or magnetic to electrical state. The recording-system engineer often gives too little attention to the head or finds that he has omitted specifications needed by the recording head designer. Also, his electronic design may not take into account factors dictated by the magnetic recording head itself. Whether the system is analog or digital, this specification program should be of great assistance in carrying out a magnetic recording design effort.

This specification chart was developed by Ferroxcube Corp. of America, Saugerties, N.Y.

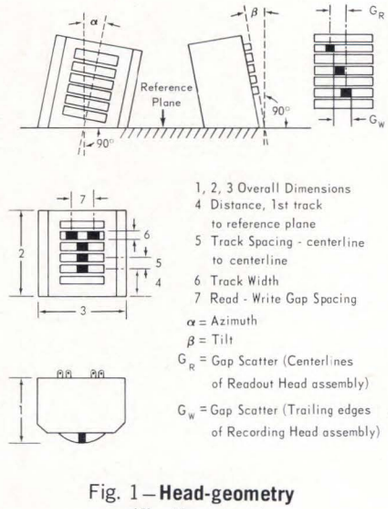


Fig. 1—**Head-geometry** specification drawing.

(Continued)

Recording Head (Cont'd)

I. Characteristics of the Recording Medium
- A Magnetic Coating Thickness
- B Magnetic Coating Flatness
- C Magnetic Coating Coercivity
- D Magnetic Coating Remanence

OR

Give corresponding commercial descriptions, such as: "XYZ Brand Recording Tape, Type ABC

II. Limiting Influences on Signals and Signal Patterns
- A Relative Speed (Head-to-Medium)
- B Flux Reversals per Inch
- C Readout Voltage (magnitude and duration)
- D Drive (Write) Current (magnitude and duration)
- E Inductance per Track
- F Q per Track
- G Crosstalk (maximum allowable between adjacent channels)
- H Resonating reactance presented by external circuit and cable

III. Fixed Elements of Head Geometry (Fig. 1)
- A Number of Tracks
- B Track Width
- C Track Spacing
- D Gap Scatter
- E Read-Write Gap Spacing
- F Contour of Head Surface
- G Outline Dimensions
- H Azimuth
- I Tilt

IV. Predetermined Elements of Recording Process Dynamics
- A Process (Drum, Disc, Tape, Magnetic Ink)
- B "Flying" Distance (Head to Medium)
- C Provisions for gimballing or mounting
- D Tape Width, Tension (Pressure)

V. Environment
- A Temperature Range
- B Humidity Range
- C Shock and Vibration
- D External Electrical Fields
- E Adjacent Head Assemblies

VI. Interface Electronics
- A Type (V.T., Solid-State)
- B Configuration (CC, CB, CE, A-C D-C Coupling)
- C Quiescent Operating Potentials (Supply, Signal)
- D Absolute Limits (Peak Voltages, Currents)
- E Impedance Levels
- F Speed of Response
- G Phase Shift

Six fundamental recording-head specifications. Items under each specification are check points. Limitation on characteristics should be avoided except when dictated by system requirements. Give maximum and/or minimum rather than absolute values. ■

For free 8½- by 11-inch reprint, CIRCLE NO. L64

ENGINEERING EDUCATION IN THE UNITED STATES

An EDN magazine survey.

OUR SURVEY

This special feature on education of electronic engineers has been many months in the making. When it was first proposed, we thought it would be quite simple. Talk to a few deans, a few engineers, a few employers and, before you can say "disestablishmentarianism", it's done!

Were we surprised? Well, to put it bluntly, it shook us up to learn that the academic community didn't distinguish between electronic and electrical engineers. And it bounced us around more than somewhat to find out that many of the educators didn't care to distinguish among electrical and mechanical, civil and aeronautical prior to graduate school. But what really spun our props was discovering that they cared so little about us as results of their handicraft that they rarely even asked our opinion of their work. You doubt this last complaint? Well, then, read what you've told us about yourselves.

We sent out several hundred questionnaires listing things that we thought you'd like to express your opinions on. They were sent to a random sample of our mailing list. The response, nearly 50 percent, was higher than we expected, indicating a lively interest in the topic.

Your replies have been tabulated for total response, geographical response and chronological—the latter related to date of most recent degree. We felt this to be of more interest than age. Our chronological groupings were:

I 1962-1967
II 1957-1961
III 1952-1956
IV Prior to 1952

The small size of the sample may prove distressing to those not familiar with the EDN audience. This survey is not meant to provide statistical certainty, but to indicate trends—an EDN goal. It must be kept in mind that our readers have all been carefully selected as representative examples of electronic design engineers, and that such a screening results in quite a restricted population—thus a small sample gains much by way of significance. Where interesting differences exist, either geographical or chronological, they are noted in the following text. We are assuming throughout that most of you are working in the same general region where you had your schooling.

YOUR ANSWERS

QUESTION 1: *Do you feel that the American schools of engineering today are doing a good job of training new engineers?* Yes, you do. Chart 1 shows that for all age groups, 65 percent credit the schools with a good job, while 31 percent think that they are doing a fair job. We think that the geographical distribution is interesting.

	East	Midwest	West	Country-wide
Excellent	5%	0	0	2%
Good	60%	69%	75%	65%
Fair	34%	29%	25%	31%
Poor	1%	2%	0	2%
	100%	100%	100%	100%

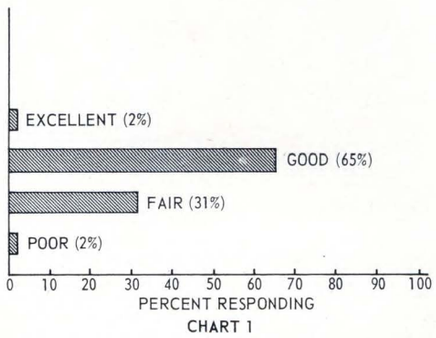


CHART 1

What kind of a job do you feel the American schools of engineering are doing in training new engineers?

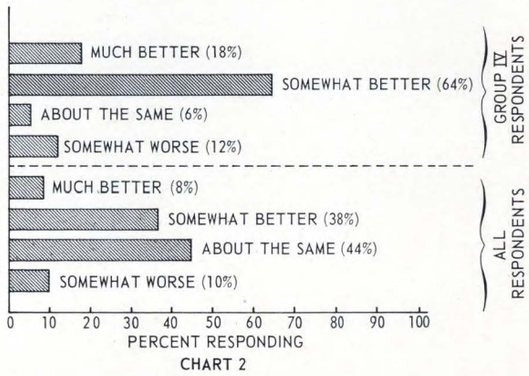


CHART 2

How does today's training of new engineers by the colleges compare to the professional training you received?

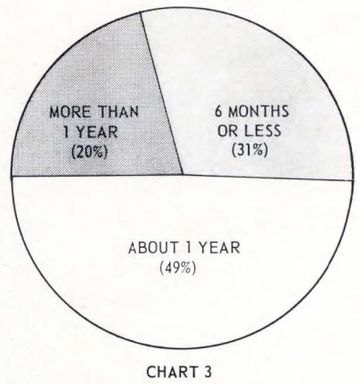


CHART 3

When is the newly graduated engineer's level of productivity adequate for the requirements of your company's engineering department?

Apparently, you feel that the quality improves from East to West!

QUESTION 2: *How does it compare to the professional training you received?* Most of you thought that the schools were doing as well or better than when you were a student. Those from the Midwest (52 percent) thought that their schools were doing quite a bit better, while more of our eastern readers (55 percent) thought their schools about the same. This correlates the East-West trend indicated under Question 1.

While you might expect that the old-timers might sour with age, the opposite is true. The upper half of Chart 2 shows the Group IV (prior to 1952) response, while the lower half delineates all replies. Groups II and III lie between Groups I and IV.

QUESTION 3: *Is the newly graduated engineer's level of productivity adequate for the requirements of your company's engineering department?* Now that's sumthin' stupid, no? Well, no, not really. There are schools that emphasize the practical aspects of analysis and testing such that their graduates can start productive work immediately. Others disdain the practical for the theoretical. Their products may require long training with hardware before they become productive. Chart 3 shows that most can be expected to need about a year of training before becoming full team members. Significant numbers of you, however, expect to have them producing in 6 months or less.

There was no regional variation indicated on this matter. The only group that varied from the pattern shown was Group III, those who have been away from formal education from 10 to 15 years. They felt that substantially more than 1 year would be required to bring a man into production—many thought 2 to 5 years.

QUESTION 4: *Is his training in the use of laboratory facilities sufficient for the level of performance*

TOM STEPHENSON, Western Editor

(Continued)

Engineering Education (Cont'd)

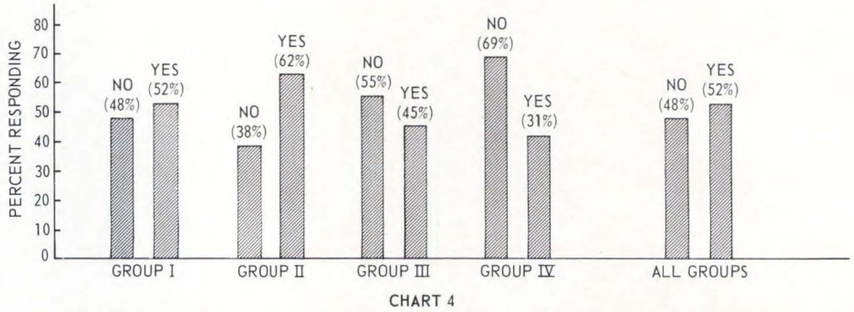


CHART 4

Is the recent graduate's training in the use of laboratory facilities sufficient for the level of performance expected of him as a beginning engineer?

expected of him as a beginning engineer? This is almost an even split, geographically and *in toto*. Chart 4 shows this result, but note the way the opinions vary chronologically. Could it be that the fellows who have been out of school from 5 to 10 years are hiding something from the chief about the performance of the newcomers?

QUESTION 5: *Is his level of competence at graduation in the following educational areas acceptable for your needs?* The response to this question was meant to measure preparation in mathematics, basic sciences, engineering labs, English and the humanities. There was no regional deviation.

Dr. George A. Hawkins, dean of Purdue University's engineering school, in his "Four Ages of the Engineer", speaks of engineers who fall prey to technological obsolescence. "These engineers have somehow failed to learn that education is a lifelong, self-imposed discipline. Eventually, they'll blame the university for their educational shortcomings."

Dean Hawkins continues, classing these engineers into different age groups much as we have done. According to him, the engineers blamed the universities for the following reasons at different stages of their careers:

Group I, "Not enough practical courses."

Group II and III, "Not enough math, physics, chemistry and engineering sciences."

Group IV, "Not enough courses in management and administration."

These observations concerning engineers faced with technological obsolescence are based on many years of experience on the part of the dean of the school that has graduated more engineers than any other in the world.

EDN readers are to be complimented on their uniformity of response to this question, on a chronological basis. They apparently realize a lack of emphasis in the nontechnical aspects from graduation on down through the years. They do not respond as Dean Hawkins predicts those would, who fail to keep up with their continuing education. Charts 5 and 5a show the results of this study.

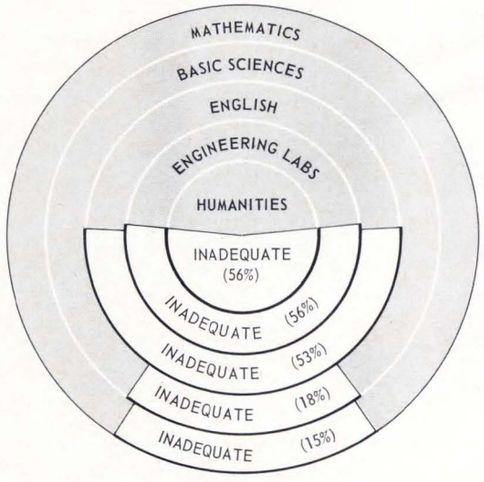


CHART 5

Is his level of competence at graduation in the following educational areas acceptable for your needs?

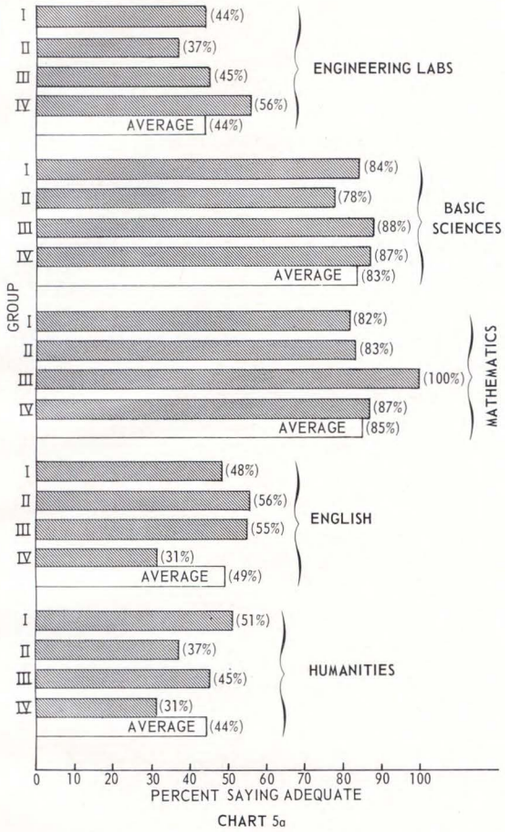


CHART 5a

Chronological distribution of data from Chart 5.

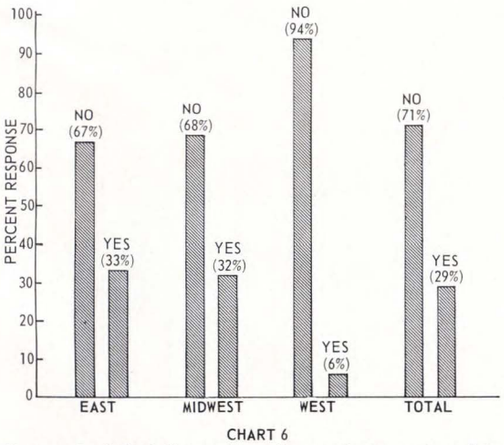


CHART 6

Do you feel that the engineering projects assigned to electronic engineering students prepare them adequately for the assignments they will receive as beginning engineers with your company?

(Continued)

Engineering Education (Cont'd)

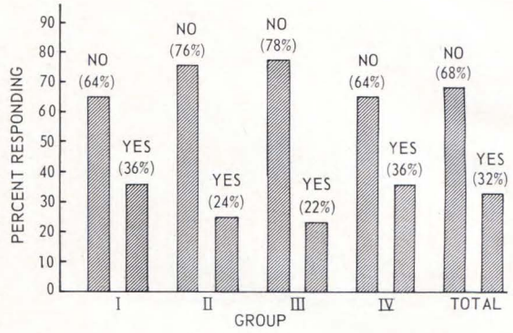
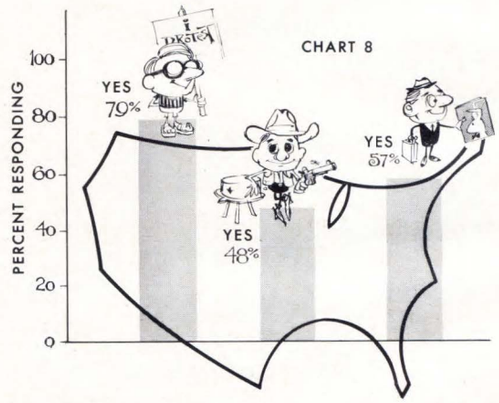


CHART 7

Is engineering training sufficiently industry-oriented?



Should schools of engineering concern themselves more with continuing education of graduate engineers?

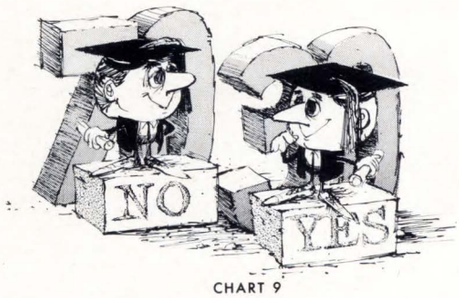


CHART 9

Do you agree that the first professional degree should be a 5-year Master's?

QUESTION 6. *Do you feel that the engineering projects assigned to students prepare them adequately for the assignments they will receive as beginning engineers with your company?* Those long out of school felt very strongly that engineering projects were weak (94 percent). The regional trend is shown in Chart 6. The overall response indicates that most of you feel our schools do not place enough importance on the project concept. There is more to be said on this subject later in the report.

QUESTION 7. *Is engineering training sufficiently industry-oriented?* This question is really related to the preceding one, and the results are essentially the same. Here, however, the middle two groups seem to feel more strongly about lack of industry orientation. You will find some of the comments included further along in the report quite revealing.

QUESTION 8. *Should schools of engineering concern themselves more with continuing education for graduate engineers?* The implied question here is really, "Do you think that you need graduate work?" And most of you feel that you do, as can be seen from Chart 8.

QUESTION 9. *Do you agree that the first professional degree should be a 5-year Master's?* You may not be aware of it, but there's a terrific flap over this going on in engineering education circles. (See editorial, this issue.) The idea seems to be that you won't really get your key to the washroom until you've attained a Master's degree, which will be squeezed up into a 5-year program. What do you think about this? See Chart 9.

QUESTION 10. *Have you ever been asked for your opinion of college curriculum by a college?* Remember, we

(Continued)

Engineering Education (Cont'd)

mentioned earlier that the academic community apparently didn't care what we as practicing electronic engineers thought of the quality of education today. This question and Chart 10 bring out the reason for our conclusion quite dramatically, we think. How long would you stay in business if you failed to ask your customers their opinion of your product? The regional shift is possibly indicative of a more conservative attitude on the part of the older schools.

QUESTION 11. *Are schools for engineers, draftsmen and technicians turning out new personnel for the industry in about the right proportions to fill your company's current needs?* We asked this question to get a feel for the direction our industry is going. The need, it seems from Chart 11, is for Bachelors' and the drafting/technician types. For job-seeking Master's-degree holders, try Horace Greeley to the minus one power.

QUESTION 12. *Do you feel that the so-called modern math is going to benefit our engineers of the future?* Absolutely no regional spread here. However, the chronological cross-section is quite interesting. It shows that those whom we would most expect to be fathers of children of elementary-school age react more favorably (Group II) to the new math. As they become a little older, however (Group III), it loses some of its allure. Too much helping with the homework, we presume. For all those "don't knows", we might add that modern math is just another name for engineering math, taught at a younger age. We refer you to an excellent publication called, "Modern Mathematics and Your Child", put out for $0.25 by the U. S. Government Printing Office, Div. of Public Documents, Washington,

Circle No. 108 on Reader Service Card for more information.

For immediate sales contact,

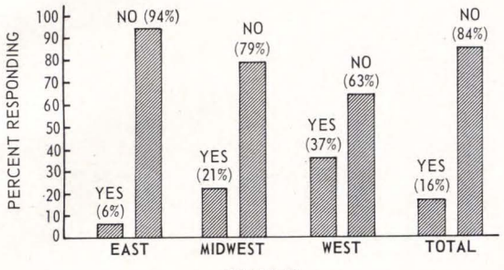


CHART 10

Have you ever been asked for your opinion of college curricula by a college?

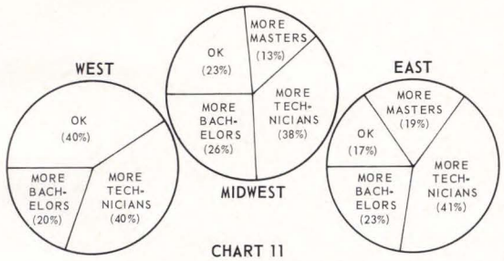


CHART 11

Are schools for engineers, draftsmen and technicians turning out new personnel for industry in about the right proportions to fill your company's current needs?

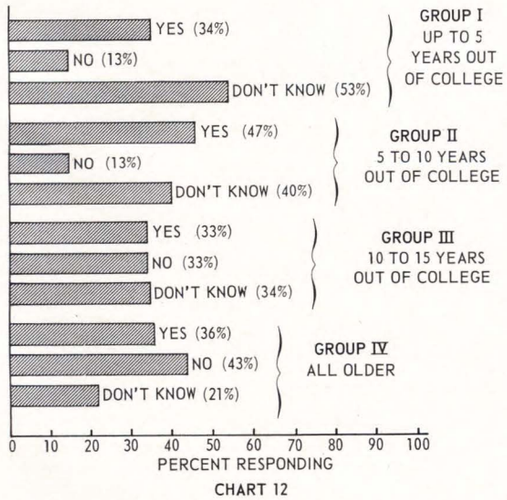


CHART 12

Do you feel that the so-called modern math is going to benefit our engineers of the future?

(Continued)

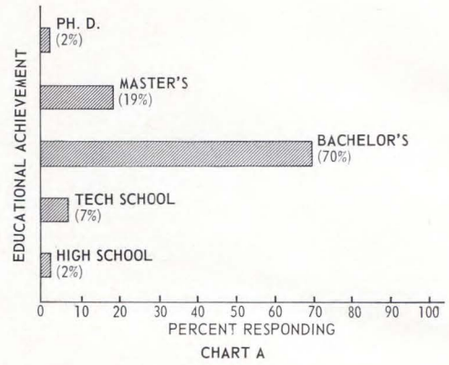


CHART A

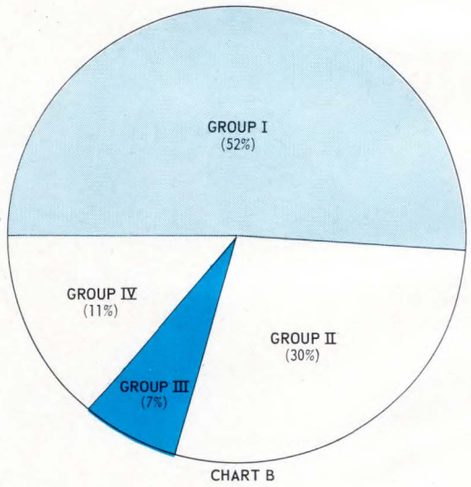


CHART B

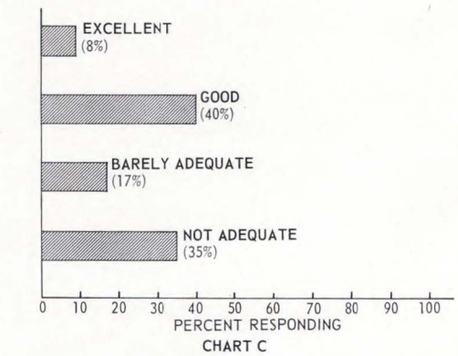


CHART C

Participant's Educational Achievement Profile.

Chronological Distribution of Participants.
Group I 0-5 years after college
Group II 6-10 years after college
Group III 11-15 years after college
Group IV Over 15 years after college

Did the school or schools from which you received your professional training prepare you adequately for your early assignments?

(Continued)

Engineering Education (Cont'd)

D. C. 20402.

Please note that EDN doesn't say that the modern math is bad or good —we just think that you should have an opinion.

The balance of this EDN Reader Survey dealt with identifying you, the participant. Chart A gives the range of your educational level. Your chronological cross-section, again by most recent diploma, is shown by Chart B.

In closing, coming around full circle, we asked you directly what we referred to obliquely in Questions 1 and 2.

Question C. *Did the school or schools from which you received your professional training prepare you adequately for your early assignments? Turn to Chart C for your verdict.*

YOUR COMMENTS

We requested your comments in two specific areas. We wanted to know how you felt engineering projects might be improved. We also wanted to know how you thought the student's industry orientation might be improved. Since these are related areas, the replies merged and can conveniently be classified. Recommendations based on your comments, and some of the comments themselves, follow:

A. *Engineering projects should be assigned individually. These should be designed to encourage original and practical thinking on the part of the student and should include cost analysis.*

"Curriculum should include more independent lab and design work."

"Projects should emphasize the basics."

"Model projects on real projects from industry."

"Get away from 'cookbook' experiments."

"Projects should be based on latest components."

"Practical projects involving value analysis, competition, worst-case analysis."

"More projects where student is left to make all decisions."

"Projects should make the student aware of the emerging technologies—at least by requiring some reading of the latest technical publications."

"Projects encountered are usually short-term and superficial. Give long-term ones, which must meet specs and a budget."

"Raise them (projects) above the level of technical fingerpainting."

B. *Emphasis on practical aspects should supplement present overconcentration on theoretical concepts.*

"More emphasis on practical limitations such as economics and marketability, i.e., the big picture."

"More engineering economy courses."

"More practical (not cookbook) lab courses."

"More emphasis on the application of the theory."

"There seems to be a desire to approach engineering from the strictly theoretical side without giving the student a solid feel for the practical world. Greater individual participation in practical lab work would be of great benefit."

"Projects and lab assignments are usually given to a team of several students. The one most familiar with instruments and equipment does the work and the others just take data."

C. *A higher degree of industry orientation is needed in order that instruction and instructors be kept current with the technology.*

"Let's get more instructors into industry during summer vacation."

"More cooperation is needed between educational facilities and industry."

"More industry involvement in program planning."

"Subjects should be taught with less of a historical and more of a modern orientation. Examples of present-day technology should be emphasized."

"—More solid-state electronics and system analysis. Less rotating energy conversion and archaic vacuum-tube technology."

D. *We need to have more co-op and on-the-job training programs.*

"Greater emphasis on co-op training —working while learning."

"Schools should require 1 year practical training at end of second year."

"The work-college split is one approach that keeps realism alive."

In these and other areas, a number of other meaningful comments were included in your replies. For example:

"Inability to detail components and industry practices prevents assignment of responsibility compatible with technical training."

"The fault lies somewhat with industry in that the engineer may frequently be misapplied. Industry must learn the value of proper manpower utilization. The schools can help by preparing students for the problems ahead. Some professional goals and the guidelines required to achieve them should be developed before the student enters industry."

"Less of the high-and-mighty, save-the-world attitude" (on the part of the young engineer).

"More electronics, less electrical."

"The practical side can only be learned in industry."

"The faculty should insure that students truly understand subject matter. This business of teaching enough material so students can pass the exams is not creating productive engineers."

"Generally, more than 75 percent of the graduates want to do R&D work. This is an unrealistic proportion in the industry work situation."

"More UHF-VHF experience would be helpful—above 100 MHz."

"All courses should be taught by 'educators'. The key is thinking, not just memorizing. Instructors today do not know how to teach thinking."

"Someone should tell the schools that not everyone works in R&D."

"The faculty must be too lazy, busy or indifferent to educate. All they do is pass courses."

"Eliminate labs and concentrate on lectures."

"This (industry orientation) is not a function of a university."

OUR CONCLUSIONS

We cannot say, as a result of this survey, that a crisis in quality of electronic engineering education looms in the offing. Fortunately, our training as engineers makes us maintain a continuing awareness of the condition of our profession. We know intuitively that it can only be improved by objective elimination of defects, defectives and obsolescences, in the sure knowledge that today's perfect system will become tomorrow's dodo bird.

As long as a significant dialogue continues between each element of the profession, we progress. The crisis will be upon us starting the day one segment closes its ears, or its mouth!

We wish to thank each of the many readers who helped with this survey. We expect to continue providing a forum where each of you may have the opportunity of presenting your opinions on current matters of interest. ■

Concerning Curricula

Are we so restricted by accreditation and licensing requirements that our colleges cannot teach what is needed? Yes, says this distinguished panel.

"Stephenson," remarked my old Engineering Drawing instructor (more years ago than I'll admit), "you'll never make it in engineering. You can't print worth a damn!" He may have been right, but I've made a living out of it for a good many years. (Aside to Editor: Not too good lately.)

Engineering curricula are about to undergo a revolution. You are vitally concerned, since your competition in industry will come increasingly from the bright golden boys who have brought new ideas from their schools with which to build tomorrow's machines. These youngsters are vitally concerned, for they will become increasingly aware that their college may not have equipped them adequately for their place in the profession and for their citizenship responsibilities. Your management is vitally concerned because only through a firm policy of careful selection can it maintain a stable of competent practitioners. And the industry as a whole is vitally concerned because of its responsibility for maintaining the climate of excellence it enjoys today.

The Engineer's Joint Council, which is taking a serious look at the overall situation, has made some very practical recommendations in a report called "Assessment of the Goals of Engineering Education in the United States" to management, to engineers, to colleges and to students. You owe it to yourself to spend a buck for your own copy of it, but we'll boil it down for you so that you'll know what you would be getting.

We are using an unusual technique that we hope you will enjoy. In order to get through to professional educators you have to be able to use their language. The report is written to leave no doubts in the minds of the educators as to the intent of the distinguished panel that wrote it. However, it is pretty heady language for us boys. We set out herein, for our mutual enlightenment, the summary of the report followed by what we think they meant to say.

I. *"There is a growing demand upon the profession of engineering to assume leadership in the constructive integration of technological change and human fulfillment. In a time of accelerating change, it requires a total reassessment of engineering education."*

We have to change our teaching of engineers because all hell has broken loose in industry and society.

II. *"As an instrument of national purpose, engineering education should provide the formal basis for preparing the nation's engineering manpower with the capability, knowledge, understanding and insight to fulfill the technological needs of society on a timely and effective basis. Such preparation should include the foundations for breadth of vision, leadership and statesmanship with appropriate disciplinary balance and flexibility to meet new tasks and opportunities."*

Our new engineers must be given a good technical background, but they also need training in leadership and statesmanship because engineering talent is needed in those areas.

III. *"There are a variety of useful patterns for institutional responsiveness to national engineering educational goals. Each institution should examine its resources and identify goals most suited to its own resources and capabilities."*

Look at what the other schools are doing and have done. Then decide what's the best yours can do with what it has.

IV. *"To prepare engineering students for rapid technological change and for growing responsibilities in industry and government, the emphasis in instruction must be placed more upon the development of the potential capacities and insights in the individual and less upon the transfer of generally prescribed content in standardization courses."*

Quit teaching the book and teach the kids.

V. *"Since engineering students vary widely in preparation, capacity, interest and potential contribution, it is contrary to sound educational policy to standardize curricula, degrees, methods or periods of instruction across institutions at the expense of flexibility, experimentation and wholesale diversity among and within institutions."*

These embryo engineers are not machines, so don't try to make them all alike. The only standard we recommend is variety. As the old lady said, "Chacun a son gout!" (Each to his own taste.)

VI. *"The educational process depends for its success upon close interaction between teacher and student. Steps should be taken to increase the opportunities for this interaction to occur to provide the essential guidance needed by the student in maturing as an individual, developing a sense of responsibility and a worthwhile set of values, and in becoming committed to ideals and a course of action."*

Don't write so many papers, or search so much research. Get in with the kids and find out what's happening. Don't fight 'em, join 'em. It will do you and them both good.

VII. *"Accreditation of schools of engineering in the future must be re-examined in light of the need for flexibility and diversity among institutions and programs. Standardization beyond a marginal limit of acceptability will retard rather than enhance the quality and effectiveness of engineering education."*

Your school is only as good as its ability to change for the better. Accreditation can result in stagnation.

VIII. *"To the extent that the licensing principle represents a restrictive influence on flexibility and innovation in engineering education, the principle itself and the laws on which it is based should be reviewed and modifications considered by the professional and technical societies concerned."*

Licensing of professional engineers is a millstone around the neck of a flexible

course of study and needs changing. Having a driver's license is only one qualification for driving.

IV. *"Engineering societies should review their role in the total spectrum of engineering education, research and practice, and should develop objectives and programs that are responsive to advances in technology and the needs of the profession and society."*

Engineering societies may be dropping the ball in keeping up with the times.

X. *"Learning is a lifetime process, continuing through all of the formal phases and extending throughout the years of professional practice. It includes the sum of all experience outside the classroom and instruction within. The goals of education should give recognition to this principle and emphasize the need to optimize a lifetime of learning. Such optimization should consider both the effectiveness of the precollege preparation and the means and methods of extending the postcollege educational process over the life span of the engineer."*

Learning is a continuing process and up to now we have not found a good way to continue teaching after school. Maybe we could start teaching engineering principles before college. ■

TOM STEPHENSON, Western Editor

WHAT TO EXPECT OF THE 1967 GRADUATE

For the smaller companies, more than ever, pick the right school before you hire the man.

TOM STEPHENSON, Western Editor

A polarization of schools teaching electronic engineers is just beginning to have an effect. Quite a few more 1967 graduates will profit from this divergence than have those of the pioneering years. Dr. Park (see box) tells us why innovations in education tend to move so slowly.

For the most part, the 1967 graduate comes to you bearing the same credentials as have those for the past several years. Short on practice, long on theory. Short on respect, long on criticism. Deficient in English, proficient in math. Good and bad, willing and shiftless. Whatever else, he will be shaven, shorn and sartorially competent. And he will not come to you from the campus activist groups—he's been kept too busy with the books.

A study of the catalogs from many schools across the country that teach electronic engineers helps us to define the poles. From what once was the nearly universal standard curriculum have issued two stalwart offspring—which we choose to christen the Industry-Oriented Program and the Flexible Program (**Fig. 1**).

We present the three representative curricula (**Fig. 2**) in detail to give you the feel of the *job awareness* of the Industry-Oriented Program, the *narrowness* of the Standard Curriculum and the *permissiveness* of the Flexible Program. None of the three is best for all students. All three are right for some. And none is unnecessary to the employer. But be sure you know the school before you hire the man. If the Standard Curriculum looks familiar to you, it should. It hasn't changed in over 30 years. We trust that course content has!

Many schools, and particularly the Industry-Oriented ones, are marching toward quarter system (**Fig. 3**), frequently to the tune of semi-hysterical chants of faculty protest. The advantages:

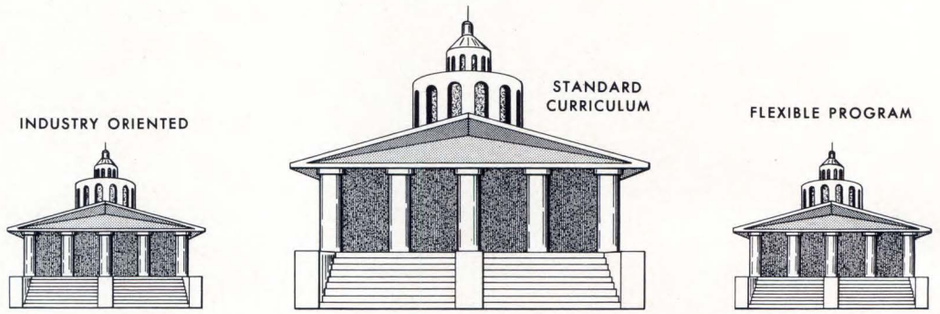


Fig. 1—**The trend in the electronic-engineer** education today is moving away from the monolithic structure of the standard curriculum.

• Better plant utilization • Equal-length quarters • No inter-term vacation to dispel continuity. These would seem to outweigh the disadvantages. Few businesses today could operate with part of their staff on vacation 2 months out of the year and the balance out for nearly 4 months!

During the course of our research into electronic engineering education, we talked with many people who are concerned with putting young engineers to work profitably. Their solutions, or lack thereof, might be helpful to you.

"I interview 30 to 40 prospects before I find one who has enough of a practical background to fit my requirements," says the chief engineer of a small assembly shop. "My main screening device is a written test for electronic technicians. It is pretty basic, but nine out of ten new engineers can't pass it."

Vice-president of a larger firm dealing largely in microwave components says, "We spend about 3 percent of our gross on recruitment. We've had to give up on the college level, though, because they don't teach microwave technology." "Further," he goes on, "we can not compete with the aerospace companies that give the kids 10 hours a week to go to school and pay them for it. Our crew works 50 or 60 hours a week. Frankly, we're pirates."

"We don't have much of a problem," muses the

"Decisions by the faculty, tediously arrived at, are apt to exclude the economic realities of the situation and only occasionally are more than a bolstering of the status quo. Imaginative solutions or innovations are rare indeed.

"Such novelties, however, do occur, perhaps once in 10 years per institution, and then they spread through the country, which is without any formal governance educationally speaking, but subject to fashions in education as in other types of styling. Some alterness to these trends gives an institution the appearance of progress or change."

Dr. Rosemary Park, now president of Barnard College, who will become Vice-Chancellor of UCLA this summer.

president of a medium-sized company that manufactures semiconductor test equipment. "We've worked out a program with a small, local, state college to turn out graduates tailor-made to our specifications. Not only do the kids work part time for us while they are in school, but their instructors also do consulting work for us on call. We even market a device developed by one of our young engineers as his senior project. Of course, I wouldn't tell you the name of the school!"

Then there's the brainchild of the personnel manager of a large military electronics company. He has worked out a project-oriented training course, which can continue as long as 18 months, for new engineers. The company hires all it can get from wherever it can get them.

"We've found that this method works for us," he told us. "It's expensive, but we get the men we need. Each incoming engineer is given a 6-week indoctrination period, during which time he moves through each of our engineering sections to learn what they do.

"He is then assigned to serve in the functional capacity of one of these sections on a project team —that function which seems to suit best his desires and background. He might, as an example, be named as the testing and reliability engineer.

"We choose one of the older members of the training school as project leader. We give him a low-priority, hardware-design assignment. He gets together with his team and they go through our company's project procedure from initial design to end product. Of course, they're closely monitored and advised by our staff; but you'd be surprised how good some of the equipment turns out.

"Washouts? Sure, about 25 percent don't make it for one reason or another. However, before we started this program we could find only about three-quarters as many qualified young men as we needed and lost a lot of them during the first 18 months.

"They stay in the training program only as long as they need it. Some of the fellows who have had a good practical background go on to regular jobs in 6 months, while some with a more theoretical

(Continued)

The 1967 Graduate (Cont'd)

INDUSTRY-ORIENTED CURRICULUM

FRESHMAN YEAR Subject	CREDIT (Quarter-Hours)* F	W	S
Basic Electronics	2	2	2
Basic Electronics Lab.	1	1	1
Automatic Program. Digital Computers	1		
Engineering Problems			1
Metal Processes		1	1
Welding Engineering		1	
General Chemistry	4	4	
College Algebra and Trigonometry	5		
Analytical Geometry and Calculus		5	3
General Physics			4
Composition	3	3	3
Health Education and P.E.	½	½	2½
Total	16½	17½	17½

SOPHOMORE YEAR Subject	CREDIT (Quarter-Hours) F	W	S
Electronics		3	3
Electronic Lab.		1	1
Fundamentals of Electrical Engineering	3	3	3
Electrical Engineering Lab.		1	1
Electronic Measurements	2		
Drafting for Electronics			2
Engineering Statics			3
General Physics		4	
Production Welding Processes	1		
Sheet-Metal Processes			1
Analytical Geometry and Calculus	3	3	
Differential Equations			3
Physics of Electricity and Magnetism	4		
Engineering Drafting	2	2	
Physical Education	½	½	½
Electives	3		
Total	18½	17½	17½

JUNIOR YEAR Subject	CREDIT (Quarter-Hours) F	W	S
Networks	3	3	3
Networks Lab.	1	1	1
Electronic Circuits	3	3	3
Electronic Circuits Lab.	1	1	1
Engineering Dynamics	3		
General Psychology			3
Electric Machines		3	
Thermodynamics		3	
Engineering Materials			3
Differential Equations	3		
Applied Biology			3
Principles of Economics	3	3	
Total	17	17	17

SENIOR YEAR Subject	CREDIT (Quarter-Hours) F	W	S
Electromagnetic Fields		3	
Microwave Engineering			3
Microwave Lab.			1
Digital Circuits Design	3		
Digital Circuits Lab.	1		
Communications Engineering			3
Communications Lab.			1
Control Systems Engineering	3		
Systems Lab.		1	
Senior Project	2	2	
Undergraduate Seminar (new trends in industry, job analysis, employment)			2
American Civilization	3	3	3
Literature or Philosophy	3		
Literature		3	
Electives	3	6	5
Total	18	18	18
Total all quarters	210		

*One quarter-hour equals 2/3 semester-hour.

Fig. 2—**Three typical courses** of study representing the mean and extremes encountered in schools teaching our electronic engineers today.

STANDARD CURRICULUM

FRESHMAN YEAR Subject	CREDIT (Semester-Hours) Term 1	Term 2
English Composition	3	3
Calculus and Analytical Geometry	3	3
General Chemistry	5	5
Electrical Engineering Orientation	1	1
Physics		4
Elective	3	
Physical Education	1	1
Total	16	17

SOPHOMORE YEAR Subject	CREDIT (Semester-Hours) Term 1	Term 2
Mechanics	3	3
Electrical Networks*	3	3
Calculus and Analytical Geometry	3	
Differential Equations		3
Electromagnetism and Radiation (Physics)	4	
Atomic and Nuclear Physics		4
Elective, Humanities or Social Sciences	3	3
Total	16	16

*May be moved to Junior year in some schools.

JUNIOR YEAR Subject	CREDIT (Semester-Hours) Term 1	Term 2
Electric and Magnetic Fields	3	3
Electric Networks	3	
Energy Conversion and Control		3
Electronics (finally!)	3	3
Electrical Lab.	3	3
Probability and Statistics		3
Science of Materials	3	
Elective, Humanities or Social Sciences	3	3
Total	18	18

SENIOR YEAR Subject	CREDIT (Semester-Hours) Term 1	Term 2
Problems in Personal and Professional Relations	1	1
Electrical Engineering Elective	3	6
Engineering Science Elective	3	
Electronics Lab.	3	3
Technical Electives	6	6
Elective, Humanities or Social Sciences	3	3
Total	19	19
Total All Semesters	139	

FLEXIBLE PROGRAM

General Requirements	CREDIT (Semester-Hours)
Chemistry	5
Physics	10
Calculus	8
Humanities and Social Sciences	12
Total	35
Departmental Requirements	
Circuit Theory	8
Electromagnetic Fields and Energy	4
Circuits, Signals and Systems	4
Fields, Forces and Motion	3
Energy Transmission and Radiation	3
Thermodynamics and Quantum Statistics	3
Electronics Lab.	3
Electromagnetic Lab.	3
Electricity and Magnetism	4
Modern Physics	4
Differential Equations	3
Advanced Calculus for Engineers	3
Unrestricted Electives	27
Thesis	–
Total Semester-Hours	110

The above requirements are not rigid. Some variations are routinely permitted. Others are considered on an individual basis.

(Continued)

The 1967 Graduate (Cont'd)

education may stay with the program for the full year and one-half. They all make good engineers."

He continued enthusiastically, "And one tremendous fall-out we hadn't planned on has developed. We don't have nearly as many calls for experienced engineers whom we used to have to go out and steal. Our section managers are getting what they need from the training program!"

So there you have it. Past performance, present status and hopes for the future. An obscure Illinois statesman summed up our conclusion many years ago with commendable brevity. "The dogmas of the quiet past are inadequate to the present."

A. Lincoln

EDN wishes to thank the many schools and individuals that have helped us in the preparation of this article. Space considerations, and in some instances a desire for anonymity on their part, preclude their mention. ■

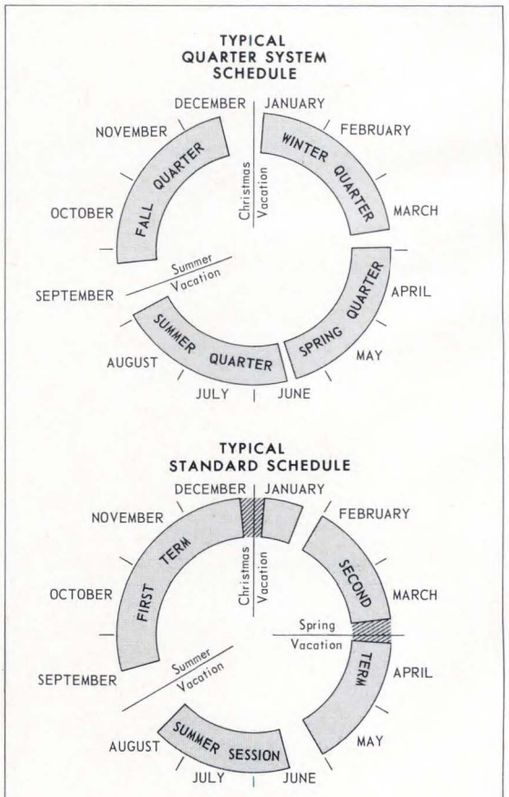
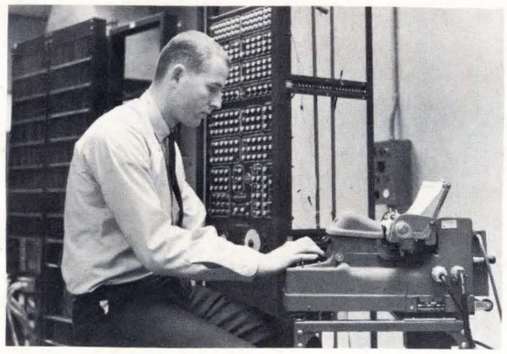
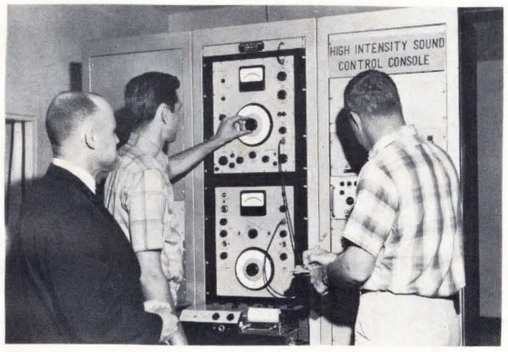


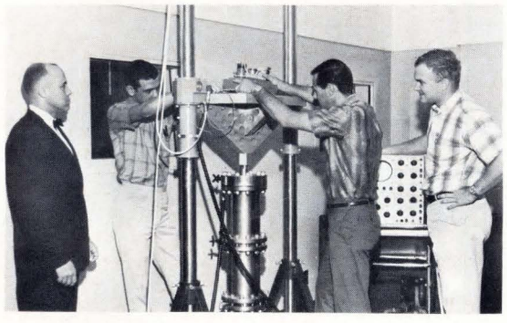
Fig. 3—**Comparison** of semester and quarter systems.



Mike Winters, senior at Cal Poly, Pomona, Calif., checking out prototype digital computer donated to school by RCA.



Jeff Linden and Dave Merrill, seniors, running acoustic shock test using California Polytechnic Institute's modern Environmental Test Laboratory facilities. Assoc. Prof. John McMillan looks on.



This is Cal Poly's version of "The Jerk", as demonstrated by seniors Jeff Linden, Jake Makedonsky and Dave Merrill for Assoc. Prof. John McMillan.

Resolution, noise, reliability, size, and linearity are the most serious deficiencies in today's precision potentiometers according to a new independent user study*. Well, at least that was the case before the Fluke 24A hit the streets.

Let's face it, our competitors are doing a good job continually upgrading their product to eliminate user criticisms. But no matter how you slice it, the conventional ten turn precision potentiometer has built-in design limitations that you simply can't engineer around.

On the other hand, our new Fluke 24A Vernier Precision Potentiometer does all the work a ten turn pot does in one and one-half turns and does it better. Here's what you get.

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Small Size. Only 1¼″ in diameter, the Fluke 24A will give you better resolution and other performance characteristics than any wirewound pot anywhere near this size.

Great Linearity. Terminal linearity is excellent with no off-set at either zero or 100 per cent. Over a wide frequency range there is zero phase shift.

More information. For complete information, please write Frank Partin, P.O. Box 7428, Seattle, Washington 98133. Phone (206) 774-2211. TWX: (910) 449-2850. In Europe, address Fluke International Corporation, Sophialaan 2, The Hague, The Netherlands.

FLUKE

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How The Boss Rates Your Performance

Three outstanding engineering managers tell what they look for.

How good a job are you doing? No one really knows but you. However, it helps to know where the chief looks when he wants to know more about your work. In these informative interviews, EDN discusses the rating of engineer performance with three experts in the field.

First we talked with Wilbur C. Myers, Director of Research at The National Cash Register Co., Electronics Div., plant in Hawthorne, Calif.

EDN—*"Will, do you find judging performance of*

engineers and scientists in the research area a difficult task?"

Myers—"Of course, it's difficult. However, we can approach the problem by establishing some boundary conditions. First, we are talking here about industrial research, with an end product in mind. We might state this as a theme: The primary responsibility of industrial research is to produce new ideas or technology from which engineering and product development can derive new products. A further responsibility of industrial research is to provide readily available technical support to any operating part of the organization that requires assistance."

EDN—*"You'd say, then, that research responsibility is not limited to the lab?"*

Myers—"Of course not. Paraphrasing John Donne, 'Industrial research is not an island unto itself.' It must go up through management, down through production and follow the product."

EDN—*"Mr. Myers, can industrial research be scheduled like production?"*

Myers—"Well, not with nearly such precision. However, we can establish performance objectives and a budget for a research program and set time goals for each milestone along the way. Then, as the program progresses, we'll have something to measure against. This also assists in rating the individual responsible."

EDN—*"What other yardsticks do you use in measuring individual performance in industrial research?"*

Myers—"Well, now we come to some intangibles. First, I think, is follow-through. Does the researcher keep in touch with his technical programs after they have moved from research into engineering and manufacturing? In other words, he must be alert continually to signs of technical trouble and be readily available to help out. Then there's the matter of professional respect accorded to him by his fellow workers clear down to the assembly line and field technicians. What do they think of his abilities? That's important input."

EDN—*"What about publication of professional papers or articles?"*

Myers—"I consider that to be of secondary importance. If it helps us document the job at hand, or if the employee is personally motivated to publish, that's fine, but to write papers just to impress others in the field is wasting time."

EDN—*"Is there anything else of a concrete nature that you watch?"*

Myers—"Yes, there is. In rating performance of both the individual and the research facility over the long haul, we look at the end results. For example, what is the ratio of academic successes to commercial successes? By this I refer to research that actually ends up, in one form or another, being useful in the company's products versus that which may result only in a technical report or publication. On a number of occasions I've had to terminate academically successful research programs and redirect the resources to more product-oriented programs. While this is one of the most difficult functions of a research director, it is also one of his most profitable and productive options."

EDN—*"Thank you for sharing your ideas with our readers, Mr. Myers."*

Next, for a different angle, we call on Nathaniel Robbins, Jr., Director of Engineering, Honeywell, Inc., Residential Div., Minneapolis, Minn.

EDN—*"First off, Nat, we want to thank you for helping us look at this problem."*

Robbins—"Not at all. As a matter of fact, my division manager recently asked me to come up

with a simple way of measuring the performance of our engineering department. This could be presumed to be a rather naive request unless you look at the need for it through the eyes of a division manager. That's when you realize the importance

of it."

EDN— *"You think, then, that a look at the departmental performance as a whole will help us to better evaluate individual performance?"*

Robbins— "Yes, we see this as having an impact on the individual engineer; knowledge of overall departmental performance improves his sense of urgency and strengthens his desire to follow through to a completely successful product."

EDN— *"Back to your manager's request, then."*

Robbins— "Well, his problem is that when he looks at the expenditure going into the engineering department he finds it a rather intangible quantity. He does not see a specific sales figure or a specific production figure, just a fairly substantial expense, resulting in a product line with which he may or may not be satisfied."

EDN— *"Let's hope he is. Can you give us an idea of the scale of engineering costs?"*

Robbins— "They may amount to between 3 and 10 percent of the gross sales dollar, and that's a lot of money compared to other costs of doing business. One wants to know if he is really getting his money's worth out of engineering."

EDN— *"And yet you can't do away with engineering."*

Robbins— "No, because the success of the division and of each person in it hinges largely on the achievements of the engineering department. Sales goals may depend in part upon a new product being introduced at a given time next year. If engineering is 6 months late getting into production, 6 months' worth of sales go down the pipe. Or, another angle, if engineering plans some cost-saving redesign on a current product and is late in introducing it, the profit objective may be missed."

EDN— *"We see what you mean by intangibles, Nat,*

TOM STEPHENSON, Western Editor

(Continued)

Performance (Cont'd)

but you had to do something, didn't you?"

Robbins—"Well, we are discussing job rating, aren't we? When we started our study we talked with several other companies. We called in management consultants. We even requested information from Stanford Research Institute."

EDN—*"What did you find out?"*

Robbins—"We were spinning our wheels. No one knew how to measure engineering performance, so it was obvious that we had to develop our own system. To do so, we had to define our objectives from scratch.

"It had always been my major objective to develop, and put into production, outstanding products. Products which our sales boys could brag about and which would benefit our customers."

EDN—*"Very commendable, but pretty hard to do, isn't it?"*

Robbins—"The problem comes from three sound business limitations. First, product design must be such that manufacturing costs do not price us out of the market.

"Second, the investment needed to develop, tool up and put into production must make economic sense. Spending $500,000 to start producing an item that will return $1000 a year is out of the question.

"The third limitation is on time. If yours is a seasonal product, introducing it at the tail end of the season is poor timing. Further, if a reduction in the production costs of a certain time is needed in order to remain competitive, it is needed now, not 3 years from now!"

EDN—*"So, we now have three parameters with which to start: manufacturing costs, startup investment and time; and engineering has quite an influence on each, doesn't it?"*

Robbins—"If they don't, no one does. Now, how do we fit these factors in? For a number of years we had used a management tool called a profitability index. Basically, it is a discounted cash-flow method of determining return on new product development investment. As you might expect, the three elements we just discussed are a part of the profitability index—plus two others—product volume and product price. These last two are more under the control of marketing, while the first three are controlled by engineering."

EDN—*"So, you put them together and what do you have?"*

Robbins—"I just happen to have a chart here (**Fig. 1**) which shows how we worked it out. We call in marketing and say, 'How many of these gadgets do you think you could sell next year, and what do you think they'll sell for?'

"Then, we look at what we in engineering estimate the investment will be to get into production,

$$\text{PROFITABILITY INDEX} = \sum \frac{(\text{Price} - \text{Cost}) \times \text{Volume}}{\text{Investment} \times \text{Time}}$$

$$\text{PERFORMANCE INDEX} = \frac{\text{Actual Profitability Index}}{\text{Planned Profitability Index}} \times 100\%$$

Fig. 1—**Departmental Performance Index** as figured by Honeywell's Residential Division. Unshaded factors are controlled largely by marketing. Those that are shaded are generally under engineering jurisdiction. A Performance Index of over 100 percent would be favorable.

cost of the product and time of production start. We are then in a position to establish a goal—a planned profitability index."

EDN—*"Then, down the road, how do you evaluate performance against the planned goal?"*

Robbins—"We simply divide the actual profitability index by what we had planned it to be. The resulting percentage figure is a measure of our overall division performance. If our performance is better than 100 percent, my division manager is happy. However, I may not be, because I can now go back to our original goal and find out, by setting volume and price at the initial estimates, how engineering actually performed."

EDN—*"You mean that marketing may have outdone itself and covered up your lack of adequate performance in engineering?"*

Robbins—"Exactly. Now this is not a precise concept, but it does give us a number to work with."

EDN—*"And your marketing manager has a number to evaluate his efforts with, also, doesn't he?"*

Robbins—"Yes, by holding the three engineering-oriented functions fixed, he can see how pricing and sales volume have affected the picture."

EDN—*"Nat, what you say listens good, but does it work?"*

(Continued)

Performance (Cont'd)

Robbins—"Well, it accomplished what we were after—a simple means of measuring engineering effectiveness, but its long-term managerial benefits remain to be proved. Actually, we went back over 28 key projects, back to early 1963. We were not using this performance index then, but we reconstructed the figures. Our engineering performance index on these projects averaged 92 percent. We had 12 projects that exceeded our expectations, 7 that were marginal and 9 busts."

EDN—*"But you are in a better position now to analyze why the projects failed to meet their goals, aren't you?"*

Robbins—"Oh, yes. Our real problem seems to be in controlling cost once the product goes into production. We've pinpointed it, though. There are two reasons involved. First, we need to get better actual cost data to our engineering people sooner so that they can take action to bring production costs back into line. And, then, we have to stop pulling our production engineers off the job as soon as it is well under way to pick up new projects. They must follow through aggresively and thoroughly to keep costs in line."

EDN—*"Nat, you said earlier that your main objective was to develop and put into production outstanding products. How do you evaluate your accomplishments in this regard?"*

Robbins—"While this analysis we've been talking about covers primarily engineering performance, it does not tell us how good our products are. We've set up a grading committee of five management team members to discuss merits or shortcomings of a product against a list of established criteria—including competition."

EDN—*"How did your 28 products stack up when this committee judged them against competition?"*

Robbins—"We didn't do too badly. Actually, we have had two considered by our committee to be outstanding, 11 excellent, 11 good, 3 fair and only 1 poor. Remember that this is a record of past performance, most of it accomplished before we developed this performance index concept. We are confident that we'll improve through better and faster costing and by watching production throughout the run more closely."

EDN—*"Again, how do you get back to rating the performance of the individual using this concept?"*

Robbins—"Well, I tend to look at it like this. We are measuring actual performance against a plan.

(Continued)

Performance (Cont'd)

Now, if performance does not come up to plan, then either our goal is too high or the performance is not good enough. Behind each of these numbers is a man. When he and I can both see that I am in trouble because of his number, we have come a long way down the road of mutually understanding my opinion of his performance. Does that answer your question?"

EDN—"*You make your point quite clear, Mr. Robbins; sir, indeed you do! And thank you again for all of your help.*"

Having looked into problems in research and production, we now move into the design area. Louis B. Horwitz, Corporate Director of Engineering for Beckman Instruments, Inc., Fullerton, Calif., spent some time with us.

EDN—"*Bernie, first let us congratulate you on your recent promotion. We know that you'll be much concerned now with judging engineer performance. Tell us, what do you look for in trying to learn how well an engineer does his job?*"

Horwitz—"It is always difficult to evaluate engineering from a design aspect; however, one way to look at it is from the customer's point of view. After all, if a customer does not accept a company's product, then there is very little income with which to support engineering development."

EDN—"*You're right, certainly, but it's an unusual approach.*"

Horwitz—"I don't think it is unusual at all. The essence of business is the customer's acceptance of your product. Let me show you some of the reasons I use this measure.

"Many engineering departments feel that, because the product sells, the engineering people have done a good job. This is not necessarily so. There are many very bad products on the market that sell very well. Hundreds of millions of dollars are spent annually by the American customer for home appliances, much of which buys some pretty bad engineering.

"I had a very interesting experience recently in purchasing a new dishwasher for my home. The salesman showed us what he considered his 'best machine'. What made it the best, he said, was the very 'excellent' manner in which the water overflow was handled. In many machines, he pointed out, if the drain pump is clogged, the machine will overflow onto the floor and in doing so the water will pass through the motor with the obviously detrimental effect of burning out the armature. His 'well-designed' machine was so constructed that the overflow would drain out on the floor without going through the motor. I suppose you could call that a step in the right direction. However, I feel that any appliance allowing an overflow onto the floor can only be classed as being badly engineered. It's hard to believe that for $300 a customer doesn't buy an overflow shut-off valve.

"At the other end of the spectrum, the American consumer has at his disposal what I consider to be the finest piece of engineering of its kind—the telephone. You can drop a telephone on a concrete floor and fully expect it to work properly when you pick it up. It is mistreated by almost everyone who uses it and yet operates most of the time. There is no great technical skill required to install it. It can be mass-produced at low cost, is functional in its appearance and meets the needs of its marketplace. It is, in essence, a well-engineered product."

EDN—"*What do you look for, then, in the marketplace, in judging engineer performance generally?*"

Horwitz—"As I just said, I look for a good product having value to the customer. That means it will serve the needs of a customer at an economical price without maintenance headaches. The customer exercises a quality judgment. If the product is well accepted in every respect, then we can look at the engineering organization as having done a good job."

EDN—"*Yes, but what about cost? Won't you drive customers to the competition if your costs run high?*"

Horwitz—"Not necessarily. The question is: Does the product have value? However, price competition is a factor that must always be considered. This really brings us to another measure of engineering performance and this is the ability of a company to produce a product at its targeted costs."

EDN—"*Can you put some numbers in here?*"

Horwitz—"Yes, I believe so. We judge the economics of putting out a new product by many standards, including the cost of putting it into initial production and how fast the unit cost drops as production continues. For instance, a 100-percent variance from a standard production cost is not uncommon the first time through. If, however, unit cost at start-up is 200 percent to 300 percent above final production run costs, then there is a problem."

EDN—"*What factors influence these costs that can be tracked back to the design engineer?*"

Horwitz—"Let's start with the change order. This probably represents one of the highest costs to a manufacturing organization in initiating new products. If you want to measure your engineering department, there are two ways to look at the change orders. One is very simple—count them. The other involves an analysis of how much you are spending in executing the changes. While you can never generalize about change orders, it is safe to say that on an initial production run most change orders result from inadequate initial design.

"Another way to consider engineering performance is to examine the number of sole source components. These will always cause difficulty and stand in the way of low-cost production. You can examine purchasing specifications. Are they adequate to enable the buyers to understand what is needed? Can they be relaxed to lower procurement costs? And don't forget labor costs in production. Is the product so designed that special skills are required to make it? If so, does it have to be this way?"

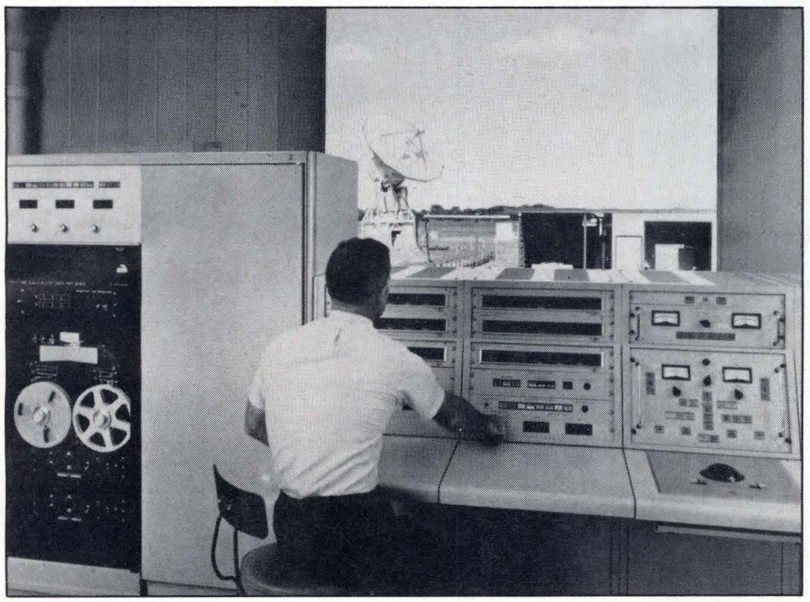
EDN—"*Where should the major effort be made to control cost and still produce quality products?*"

Horwitz—"I think the answer to this lies in spending sufficient time in engineering to insure a complete, well-thought-out design. In the long run, the little additional time and effort necessary to create a good design will be justified in eventual cost savings."

EDN—"*We extend our thanks to you gentlemen, for helping us get your ideas over to our readers, and especially the San Diego Council of WEMA for providing the opportunity of getting together.*" ■

Would you like
to be one of these

PROBLEM SOLVERS?



Apollo Astronauts Will Depend On This Solution

The Problem:
During the entire upcoming Lunar mission, a world-wide network of tracking stations must continuously maintain vital two-way communications with the Apollo spacecraft. Each station must locate the vehicle within seconds after its appearance over the horizon, whether in earth-orbit or trans-lunar coast.

The Approach:
NASA's Goddard Space Flight Center selected Collins to produce a new globe-circling communication system for Apollo. Employing 30-foot and 85-foot antennas, the ground stations will communicate with and track the spacecraft at both near-earth and lunar distances. S-Band up-links will be used for ranging, command and voice; down-links will carry ranging, telemetry and voice. Functions such as transposition and docking, mid-course correction, and lunar landing activities depend upon continuous maintenance of these links.

To establish this communication between each station and the spacecraft, a new generation of subsystems for antenna positioning and control had to be designed and interfaced into station systems.

The Solution:
Collins engineers designed and built digital antenna position programmers and servo-controlled hydraulic drive systems which permit the pointing of ground-station antennas — with an accuracy of 0.010 degrees RMS — to the predicted coordinate points of the spacecraft's appearance. Automatic acquisition by one ground station will take place while the preceding station still has contact with the spacecraft.

Two back-up techniques insure acquisition if the spacecraft varies from the pre-computed flight path. Wide beam-width auxiliary antennas, mounted on the main-antenna dishes, provide greater angular coverage for acquiring down-link signals. Additionally, a scan generator, in association with the servo system, may use any of four modes to sweep the antenna over the most-likely area of spacecraft appearance.

Work continues at Collins on the design of improved systems for space communication.

Over 40 Airlines Bought This Solution

The Problem:
To present aircraft flight director guidance information in a manner readily interpreted by the pilot on a display designed to be the focal point of an all-weather landing system.

The Approach:
Putting six primary information channels into one instrument in a conventional manner leads either to a number of loosely associated display elements requiring constant scanning and mental imagery, or to a clutter of superimposed displays with problems of parallax and discriminability.

An aid to rapid and correct interpretation is to make the display pictorial in form, symbolizing the spatial relationships of the real-world elements represented, but eliminating unnecessary detail.

The Solution:
The unique solution to this problem was to combine the pitch and roll steering commands, presenting them on the "V-bar" command pointer which moves in pitch and roll in a symbolic-pictorial manner, and which uses the depth dimension to advantage instead of trying to squeeze all the information into a two-dimensional display.

Custom Crystal Filters Designed As Standard Items

The Problem:
Meet widespread need for custom crystal filter designs in less than the three-months period normally required.

The Approach:
Develop computer-assisted design techniques which permit Collins to offer "special design" filters as standard product line items.

The Solution:
Data on a wide range of filter applications may be programmed into Collins' computer, which analyzes customer's parameters, furnishes bill of materials, and produces a performance curve. A tested prototype is delivered to the customer in one-third the time formerly required.

COMMUNICATION/COMPUTATION/CONTROL

COLLINS

COLLINS RADIO COMPANY

Collins is looking for
Problem Solvers in these

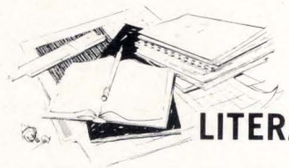
AREAS

Instrumentation Engineers
Communications Research Engineers
Flight Control Systems Engineers
Circuit Designers
Process Engineers
Electronic Packaging Designers
Systems Engineers
Microcircuit Designers
Production Plastics Engineers
Spacecraft Systems Engineers
Stress Analysis Engineers
Mechanical Engineers
Reliability Engineers
Technical Writers
Field Support Engineers
RF Systems Engineers
Antenna Design Engineers
Microwave Design Engineers
Scientific and Software Programmers
Industrial Engineers
Quality Engineers
Transmitter Design Engineers
Training Instructors
Crystal Filter Engineers
Maintainability Engineers
Component Evaluation Engineers
Assembly Foremen
Computer Instructors
Data Systems Analysts

If you'd like to help solve problems in any of these areas, we welcome your inquiry. Write to Manager of Professional Employment, Collins Radio Company, in Cedar Rapids, Iowa; Dallas, Texas, or Newport Beach, California.

An equal opportunity employer

Circle No. 884 on Special Engineering Placement card in back of magazine.



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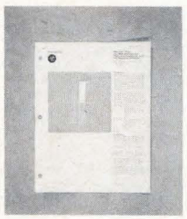
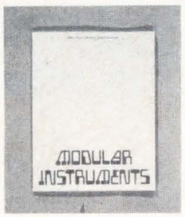


Magnetic Alloys. A four-page bulletin details the advantages and characteristics of "Hipernik" alloy. This 50-percent nickel-iron alloy combines relatively high initial and maximum permeabilities with high magnetic saturation. The booklet gives the basic physical, mechanical and magnetic properties of the alloy, along with typical magnetization and attenuation curves. Three grades of material, lamination, shielding and rotor, are described and a list of typical applications is included. Bulletin TD 52-162. Westinghouse Electric Corp., Materials Mfg. Div., Blairsville, Pa. 15717.

CIRCLE NO. 401



Modular Instruments. This 82-page catalog entitled "Modular Instruments" contains complete specifications on both the Designer Series and Research Series lines of modular nuclear instruments. Also included is a guide to assist the user in selecting the proper combination of modules for a specific application. A separate section describes input and output accessories that are used to complete the modular system. Nuclear-Chicago Corp., 333 E. Howard Ave., Des Plaines, Ill. 60018.

CIRCLE NO. 402

Logic Handbook. The revised "Logic Handbook" has been expanded to over 400 pages and includes an educational primer discussing digital logic, an analog-to-digital conversion handbook and application notes on the use of digital logic modules. Also included are detailed specifications for the enlarged "Flip Chip" module line and an enlarged hardware accessories section featuring the "Panelaid" and "Octaid" approach to assembly of common logic functions. Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

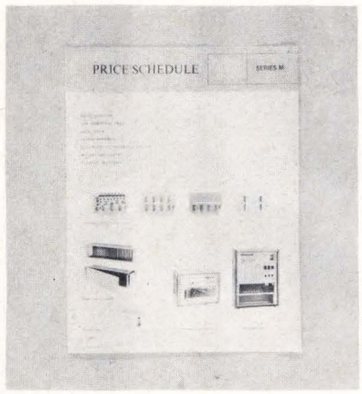
CIRCLE NO. 403

Integrated-Circuit Modules. A 25-page data bulletin describes the "EECoLogIC" line of integrated-circuit module cards. Included is application information describing general characteristics, specific circuits for counters, N/X division, and tips to eliminate slivers and noise pickup in the wiring. Listed are 135 types of circuit modules using both flat-pack and dual in-line DTL integrated circuits. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif. 92702. **CIRCLE NO. 404**

The free literature items listed in this section of **EDN** are arranged in alphabetical order for your convenience. Items are listed in the following order:

Alloys
Circuit Modules
Computer and Peripheral Equipment
Connectors
Dielectric Materials
Encoders
Firing Circuits
Hardware
IC Accessories
Instrumentation
Knobs and Dials
Measuring Equipment
Meters, Analog
Operational Amplifiers
Power Supplies
Printed Circuits
Production Equipment
Radiation Detectors
Recording and Readout Equipment
Relays
Solar Cells
Shielding
Switches
Temperature Measuring Devices
Terminations
Test Accessories
Test Equipment
Test Modules
Tubes

Circle No. 126 on Reader Service Card for more information.



Logic Cards. This brochure and price list on integrated-circuit logic modules includes information on 60 different logic cards, as well as power supplies, card files, card drawers, accessory parts, an automatic module tester, and an "experimenter" for breadboarding a system of up to 10 cards. Also included are a discount schedule and ordering information. Wyle Labs., Products Div., 133 Center St., El Segundo, Calif. 90245.

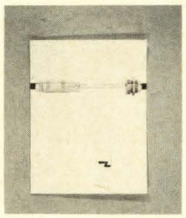
CIRCLE NO. 405

Small Computer Handbook. The "Small Computer Handbook", first published in November 1966, has been expanded to include a section of applications-programming examples in addition to original material covering a primer on the use of a digital computer; user handbooks for the PDP-8, PDP-8/S and LINC-8 computers, and a short-form catalog describing the company's products. Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754. **CIRCLE NO. 406**

PC Connector Guide. This 64-page guide describes and illustrates a wide-ranging line of printed-circuit connectors, enclosures and installation equipment. Described are suggested applications, mounting data, PC card layouts and complete specifications. The guide covers both plug-and-receptacle and card-edge connector types. Featured are contact terminations for wire wrap, crimp, tapered pin, tapered tab and solder. Elco Corp., Willow Grove, Pa. 19090.

CIRCLE NO. 407

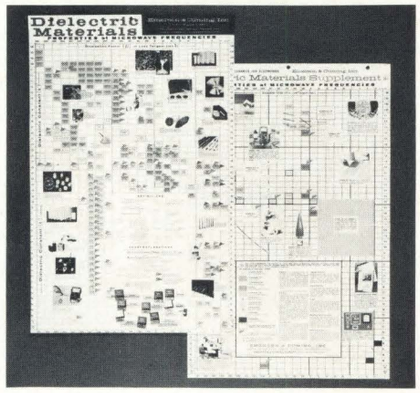
Connectors. A four-page short-form catalog covers a complete line of Swiss-made, precision-machined connectors. Eight standard sizes, from 1/4 to 1-5/8 inches in dia, are featured in the catalog. Contacts listed include single contacts, both coaxial and power, multicontact, multicoaxial contact and multicoaxial and power pin combinations. LEMO Div. of Frazar & Hansen, Ltd., 150 California St., San Francisco, Calif. 94111. **CIRCLE NO. 408**



PC Connectors. Eighty series of printed-circuit receptacles are illustrated and described in this 20-page catalog. Listed are connectors conforming to the latest revision of MIL-C-21097. Each series is represented by a detailed orthographic drawing, facilitating the drafting of specification control drawings by the user. Other specification aids include a connector type selector chart. Catalog UPCR-A. U.S. Components, 1320 Zerega Ave., Bronx, N.Y. 10462.
CIRCLE NO. 409

Relay Connectors. This first in a new series of condensed product catalogs covers a complete line of relay connectors. Included are details on a wide variety of subminiature crystal can relays and many variations of power relays meeting military and industrial applications. Also included are illustrations, schematic drawings, charts, and all pertinent information as to overall dimensions, contact layouts and available mounting styles. Catalog 60301C. Methode Electronics, Inc., Connector Div., 7447 W. Wilson Ave., Chicago, Ill. 60656.
CIRCLE NO. 410

LITERATURE



Dielectric Materials. Two handy charts for notebook or wall mounting show the dielectric constant and loss tangent at microwave frequencies of a host of materials. The values for the dielectric constant from 1 to 50 are given on the ordinate, while the values for the loss tangent between 0 and 1.0 are on the abscissa. Each material is located on the chart at its appropriate dielectric constant and loss tangent. The density and heat capabilities of each material also are shown. More than 300 materials are listed. Emerson & Cuming, Inc., Canton, Mass. 02021.

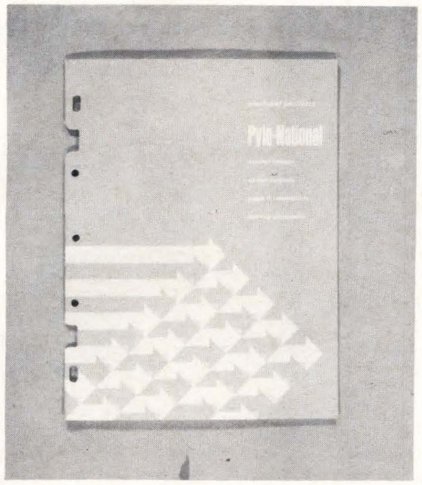
CIRCLE NO. 411

Four-Digit Decimal Encoders. Bulletin 66-15, four pages, describes a complete lines of shaft encoders with four-digit, decimally coded outputs. Included are detailed descriptions of electronic modules that transform the encoders into complete systems for digital display, data logging and set-point programming. Full specifications and price are given. Theta Instrument Corp., 22 Spielman Rd., Fairfield, N. J. 07006.

CIRCLE NO. 412

SCR Firing Circuits. Featuring more than 50 diagrams, waveforms and other illustrations, this 16-page handbook presents a basic study of SCR's and their control by magnetic amplifiers. Designated Bulletin 5001, the handbook covers single and 3-phase systems, high di/dt and high dv/dt conditions, protection of the firing circuit from failure, on-to-off ratio, sensitivity, gate pulses and many other elements important to the circuit designer's basic knowledge. Firing Circuits, Inc., Div. of Marathon Electric Mfg. Corp., Muller Ave., Norwalk, Conn. 06852.

CIRCLE NO. 413



Electrical Distribution Products. Catalog No. 67-R, 36 pages, covers an extensive line of electrical distribution products. Major product groupings cataloged include conduit fittings, circuit controls, plugs and receptacles and lighting equipment. The brochure clearly identifies the diversified line of products by illustration, part number, size, weight or service rating and price. The Pyle-National Co., 1334 N. Kostner Ave., Chicago, Ill. 60651. **CIRCLE NO. 414**

EMI Gaskets. A 70-page handbook/catalog covers the technology and devices used to seal waveguide flanges and electronic enclosures against both electromagnetic and fluid leakage. It contains all information needed to help engineers bring this difficult area under control. The handbook contains 15 tables of engineering data plus 24 technical illustrations covering every aspect of seal design or selection. Handbook W5460. Parker Seal Co., 10567 W. Jefferson Blvd., Culver City, Calif. 90230. **CIRCLE NO. 415**

Integrated-Circuit Accessories. This new catalog on digital components covers a variety of integrated-circuit products, including "Cambi-Cards" with a selection of permanent, semipermanent or temporary mounting provisions for in-line and flat-pack circuits. Details are provided on in-line sockets capable of mounting any standard in-line integrated circuit module with up to 32 leads. Flat-pack holders are listed in two types and can accept any standard flat microelectric package, with or without preformed leads. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138.
CIRCLE NO. 416

In fact, it was being thrown for a loss by laminated steel recording heads. Steel heads couldn't cope with high frequencies. Or measure up to gap definition requirements. Then we substituted the Indiana General Ferramic® O-6 ferrite.

High frequency ceased to be a problem. Our O-6 ferrite has a range through the high frequencies, and maximum permeability of 6000. Plus high saturation, low loss, and a high Curie point.

Gap definition improved, too. Ferramic O-6 has an extremely fine grain crystal structure. It can be manufactured in complex configurations to finishes in the micro-inch range, providing the close gap definition required for high signal efficiency. And, as a bonus advantage, Ferramic O-6 heads have an operating life 5 to 10 times longer than laminated steel.

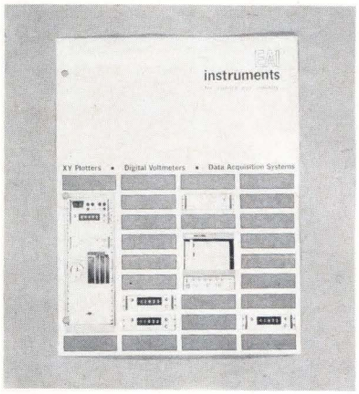
But the use of O-6 ferrite material isn't limited solely to video or audio tape heads. Its many advantages are equally applicable to disc, drum, and tape peripheral equipment for digital memory recording/reproduction processes.

You can get an instant playback of our Ferramic O-6 ferrite specifications by writing Mr. K. S. Talbot, Manager of Sales, Indiana General Corporation, Electronics Division/Ferrites, Keasbey, New Jersey.

INDIANA GENERAL

Instant video replay wasn't gaining ground until Indiana General got in the game.

LITERATURE



Instrumentation Catalog. Bulletin No. IC-66444 contains descriptive summaries of X-Y plotters, digital voltmeters, data-acquisition systems and other similar instruments. Brief specifications and descriptions of functions, prices and photographs are provided for solid-state digital voltmeters and digital volt-ohmmeters, reed relay scanners, a high-speed printer, a parallel-to-serial converter, several table-top and large X-Y recorders and data-logging systems. Electronic Assoc., Inc., West Long Branch, N. J. **CIRCLE NO. 417**

Control Knobs. A revised data sheet lists military specifications applicable to control knobs and other mechanical components made by the Raytheon Co. Components covered include control knobs, knob locks, shaft locks, panel brackets, fuse clips, binding posts, captive hardware, standard test jacks, printed-circuit test jacks, fixed-contact subminiature test jacks and snap-in contact subminiature test jacks. Illustrations of the various hardware types are included. Data Sheet MC-110. Raytheon Co., Industrial Components Operation, 465 Centre St., Quincy, Mass. 02169. **CIRCLE NO. 418**

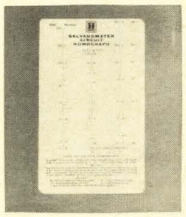
Clutch Spinner Knobs. Mil Spec clutch spinner knobs are described in a two-page data sheet. Designed to protect precision equipment, they feature a clutch mechanism incorporated into the knob that satisfies all the requirements of MS-91528 Rec. C. The data sheet, covering the entire series, contains a specification chart, dimensioned drawings and details on ordering by size, style, shaft-hole diameter, finish and torque. National Radio Co., 37 Washington St., Melrose, Mass. **CIRCLE NO. 419**

Circle No. 168 on Reader Service Card for more information.

Radiation Research and Measurements. A 16-page catalog contains information on instruments and accessories for basic and applied radiation research and measurement. Equipment discussed includes a continuous radiation source system, a nanosecond spectral source system, a pulsed ion laser, a radiometer, a trigger delay generator and an image converter camera. In addition to photographs and descriptions of each product, the catalog contains performance charts, illustrations and lists of reprints of pertinent published papers and application notes. TRW Instruments, 139 Illinois St., El Segundo, Calif. 90245.

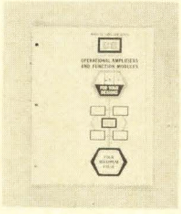
CIRCLE NO. 420

Galvanometer Reference Guide. A pocket-sized reference guide lists galvanometer characteristics and provides a nomograph to calculate related circuit values. The front side of the plastic design aid contains convenient tables listing all Honeywell M-Type galvanometers. Characteristics of both electromagnetic and fluid-damped galvanometers are given. On the back side is a handy galvanometer circuit nomograph for determining relationships between current, resistance and source voltage. Honeywell Test Instruments Div., 4800 E. Dry Creek Rd., Denver, Colo. 80217.



CIRCLE NO. 421

Amplifiers and Function Modules. A 16-page catalog describes several broad lines of analog and hybrid plug-in modules, including 22 new operational amplifiers, a line of instrumentation amplifiers, seven new function modules, a line of active filters, 11 power supplies and a broad line of accessories. Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706.



CIRCLE NO. 422

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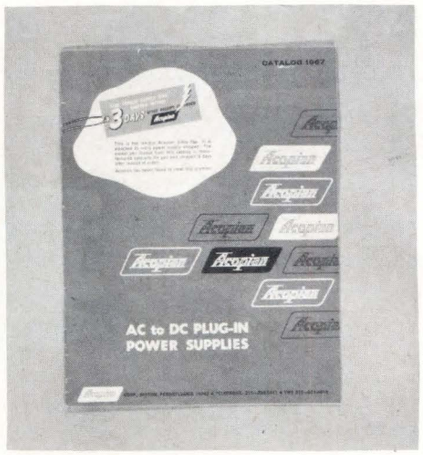
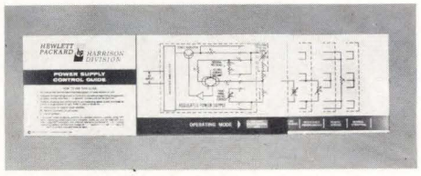
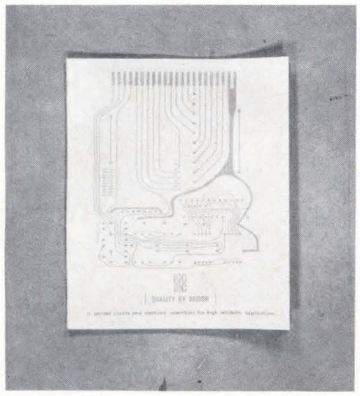


Plug-In Power Supplies. This 1967 catalog lists more than 62,000 different plug-in power supplies. Both single and dual units are listed, with nominal output voltages from 1 to 900v and output currents up to 3.0 amps. Applications include operational amplifiers, logic circuits, test equipment, integrated circuits and lamp and relay circuits. A continuously variable 1 to 30v lab power supply also is described. Acopian Corp., Easton, Pa. 18042. **CIRCLE NO. 423**

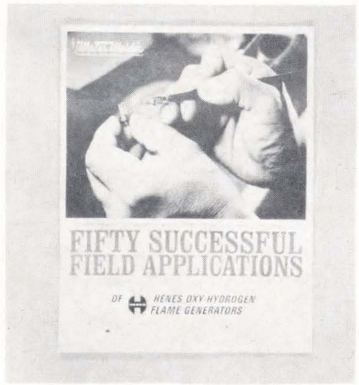


Power-Supply Slide Rule. This power-supply control and selection slide scale contains a slide section that illustrates eight different operating modes, such as autotracking slave, autoseries slave and resistance programming. A window permits the comparison of terminal designations on the control guide with corresponding designations on a basic power-supply schematic. It is then possible to perform strapping and connections to corresponding power-supply terminals. A guide on the back of the slide provides instructions for specific mode selected, general comments for all modes and a list of symbols. Hewlett-Packard/Harrison Div., 100 Locust Ave., Berkeley Heights, N. J. 07922. **CIRCLE NO. 424**

Multilayer Printed Circuits. An eight-page technical bulletin describes multilayer printed circuits and offers life and environmental test results. Photocircuits Corp., Glen Cove, N.Y. **CIRCLE NO. 425**



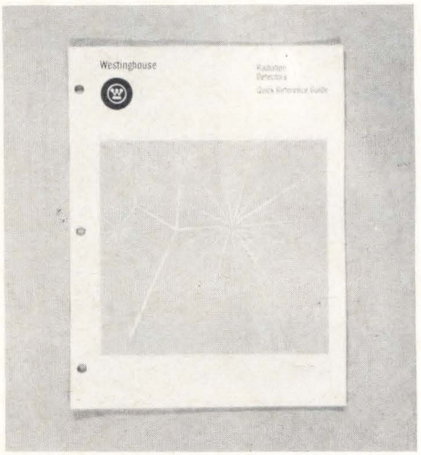
Printed-Circuit Techniques. Techniques for the design/production of printed circuits and assemblies for high-reliability applications are detailed in this 16-page technical booklet. It covers such critical design/production considerations as manufacturing methods, selecting electroplates to enhance electrical or mechanical properties, hints for specifying dielectric base materials, eyelet versus plated through holes, and a discussion of general design, production and functional parameters of multilayer circuit boards. Extensive charts are used to illustrate such data as current-carrying capacities of given circuit-pattern thicknesses and performance characteristics of base materials. Industrial Circuits Co., 23 Kulick Rd., Fairfield, N. J. 07006. **CIRCLE NO. 426**



Flame-Welding Guide. This 19-page guide discusses techniques for flame welding, soldering and brazing miniature parts. The guide is organized around 11 general applications areas and is accompanied by an illustrated listing of 50 specific field applications. Henes Mfg. Co., 4301 E. Madison St., Phoenix, Ariz. 85034. **CIRCLE NO. 427**

Circle No. 136 on Reader Service Card for more information.

LITERATURE

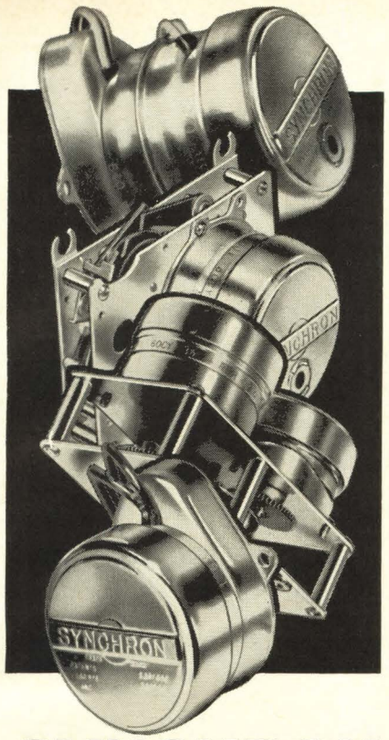


Radiation Detectors. A comprehensive 12-page reference guide describes neutron and gamma radiation detectors. It contains specifications and schematic diagrams for each detector type, along with a brief technical discussion of the theory and application. Charts show the operating ranges for each type, and a helpful diagram tells where and how each type should be used. Included are proportional and fission counters, ionization chambers, self-powered detectors, in-core devices, pulse detectors and gamma chambers. Booklet B-9259. Electronic Tube Div., Westinghouse Electric Corp., Elmira, N.Y. 14902. **CIRCLE NO. 428**

Recorders. A short-form catalog lists the complete line of XY and "Omnigraphic" style recorders. Included are several new products—the 6400 line of XY and XYY recorders, incremental plotters for use with computers, other incremental output devices and digital plotting systems. The catalog includes condensed technical descriptions, specifications and prices. Houston Omnigraphic Corp., 4950 Terminal Ave., Bellaire, Tex. 77401.

CIRCLE NO. 429

Recorders. A 20-page bulletin, ID-4736, makes it easy to select the most suitable recorder for any of many applications including measurements of volts, amps, power factor, watts, vars, frequency, motor horsepower output or speed. It includes a guide for specifying and applying recorders. Graphs are shown for plotting load-trend data and converting kilowatt input to horsepower output. General Electric Co., Instrument Dept., 40 Federal St., West Lynn, Mass. **CIRCLE NO. 430**



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EXPORT DEPARTMENT: 64-14 Woodside Ave., Woodside, N.Y.

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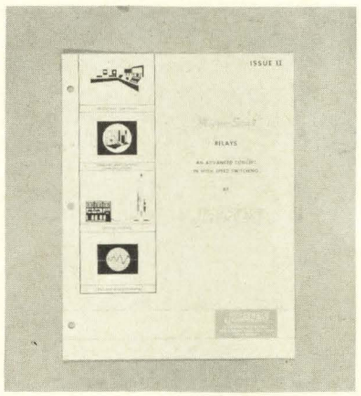
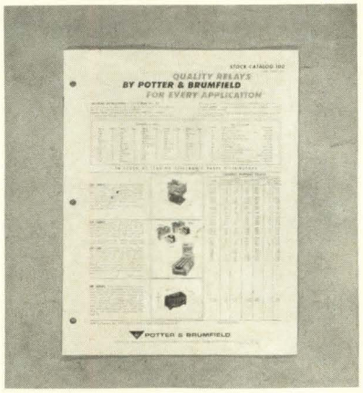


High-Speed Switching Relays. Catalog F-5604 provides relay and high-speed switching solutions for multiplexing, direct digital control and data sampling. Electrical and mechanical specifications for high-speed relays and packages designed for plug-in, printed-circuit board and wire-in applications are described. Application notes with relay drive circuit diagrams are provided. James Electronics, Inc., Components Div., 4050 N. Rockwell St., Chicago, Ill. 60618.

CIRCLE NO. 431

Time-Delay Relays. Bulletin 709 describes a line of solid-state, time-delay relays that feature a solid-state timing device and an electromechanical relay as the power-switching portion. The electromechanical relay can be an integral part of the device or external to it. Variable and fixed-delay types are listed in the bulletin in various ranges or fixed values and for various a-c and d-c supply voltages. Ohmite Mfg. Co., 3679 Howard St., Skokie, Ill. 60076.

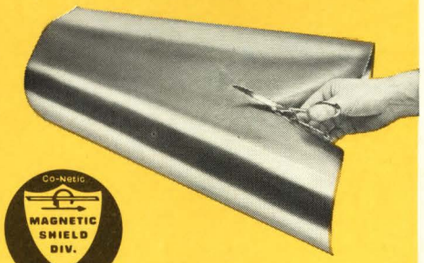
CIRCLE NO. 432



Relays. Sixty standard relays in more than 700 different contact arrangements and coil voltages are listed in Catalog 100. A noteworthy addition is a microminiature relay suitable for low-profile applications. Also of interest is a series of miniature dry reed relays. Other types listed include mercury-wetted contact, polarized, sensitive, special-purpose, telephone-type and power relays. Potter & Brumfield, Princeton, Ind. 47570.

CIRCLE NO. 433

MAGNETIC SHIELDING



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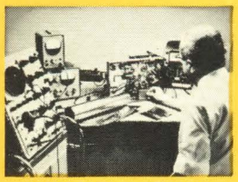

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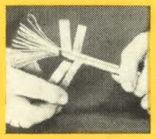

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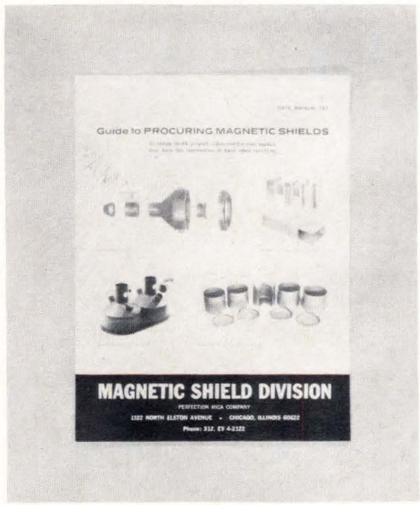
LITERATURE

General-Purpose and Power Relays. A six-page catalog lists general-purpose and medium-power electromechanical relays. In addition to providing a brief description of eight different types of relays, the catalog includes information on coil voltages, contact arrangements and power ratings. Also included are pictures and mounting information for each relay. Eagle Signal Div., The E. W. Bliss Co., 736 Federal St., Davenport, Iowa 52808. **CIRCLE NO. 434**

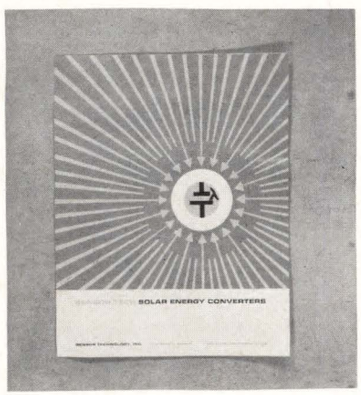
Relays and Solenoids. The 48-page catalog describes a line of relays and solenoids that includes more than 40 types. The catalog provides helpful selction, application and accessory information. Mossman-Elliott Corp., 202 Larkin Ave., Joliet, Ill. 60431. **CIRCLE NO. 435**



Magnetic Shield Guide. A time-saving four-page data manual, No. 187, is intended to help engineers obtain magnetic shields properly fabricated for the desired application. The manual illustrates numerous types and configurations of Netic and Co-Netic nonshock sensitive magnetic shields that have minimal retentivity and do not require periodic annealing. Magnetic and physical environment, shield configuration and performance requirements are among the topics discussed. Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago, Ill. 60622. **CIRCLE NO. 436**

Magnetic Shielding Gasket. Data Sheet EMC-064 describes "Teckmag", an effective EMI/RFI shielding gasket/strip for electronic equipment enclosures. The strip adheres magnetically to any ferrous surface and requires no adhesives, fasteners or attachment strips. It is available in 25-ft lengths or prepunched in 8-ft lengths to fit standard EIA cabinets. Widths are 1/2 to 3/4 inches. Technical Wire Products, Inc., 129 Dermody St., Cranford, N. J. 07016.

CIRCLE NO. 437



Solar Energy Converters. A four-page brochure on solar energy converters includes complete descriptions of the cell structure, functions of the converter, applications and uses, cell characteristics and design data, part numbers and specifications. Also included are illustrated diagrams on voltage-current, spectral response and power output variation with temperature. Sensor Technology, Inc., 7118 Gerald Ave., Van Nuys, Calif. 91406.

CIRCLE NO. 438

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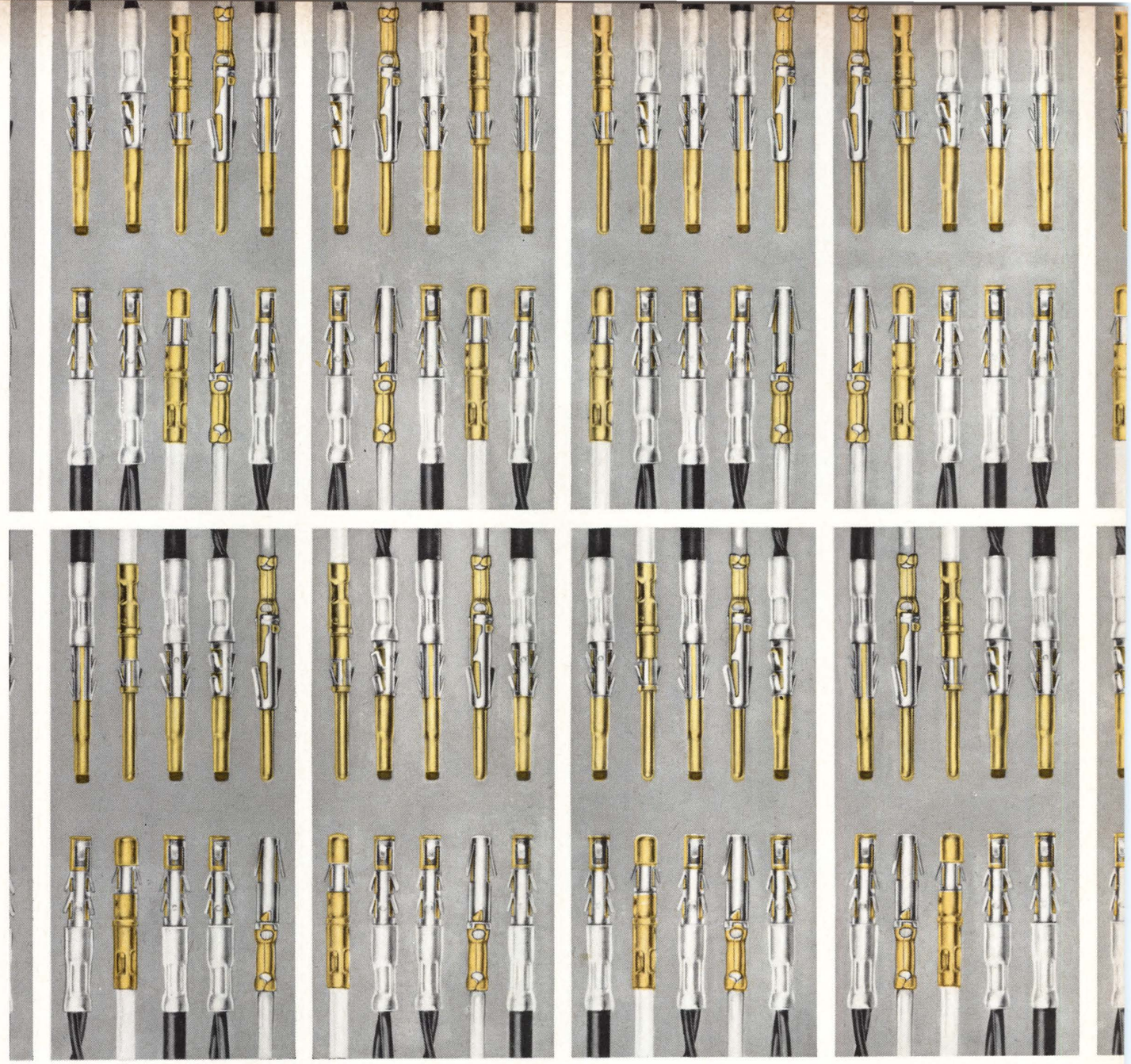
For immediate sales contact,



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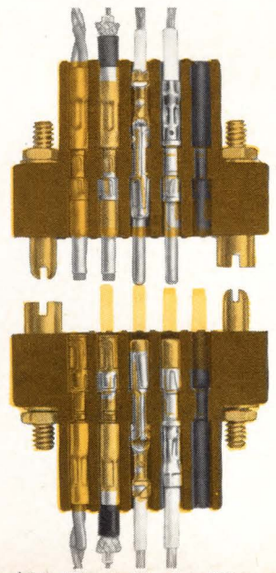
Get more details on how you can take advantage of the Burndy Trim Trio System—THE ACCEPTED METHOD OF INTERMIXING CONTACTS.



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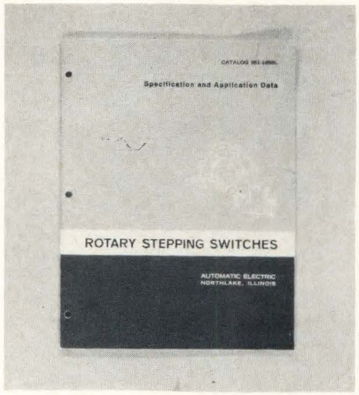
LITERATURE

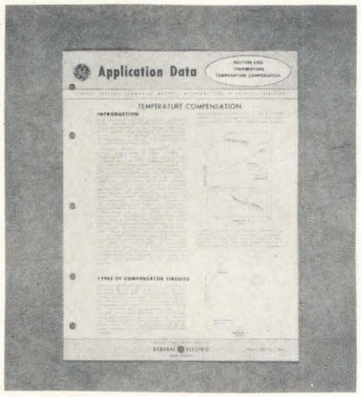
Illuminated Pushbutton Switches. Catalog 2007b, 24 pages, details a line of information display illuminated pushbutton switches, word indicator lights, indicating fuse holders and electronic control components. Included are product descriptions, their applications and uses, illustrations, detailed diagrams, optional features and mounting arrangements. Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. 92627.

CIRCLE NO. 439



Rotary Stepping Switches. A 36-page catalog features specifications and application information as well as mounting data on a wide variety of rotary stepping switches, including the Type 36 (12 point), and the Type 45 (normally closed). It concludes with sections on hermetic and protective enclosures and reference data. Circular 961-1698-L. Automatic Electric Co., Northlake, Ill. 60164.

CIRCLE NO. 440



Thermistors for Temperature Compensation. A four-page application data bulletin, Section 3702, describes the use of thermally sensitive resistors for a variety of temperature-compensation requirements. The publication contains descriptions of types of compensator circuits, explains unit curve solution methods and gives sample solutions and also discusses typical applications. General Electric Co., Magnetic Materials Business Section, Box 72, Edmore, Mich.

CIRCLE NO. 441

Pushbutton Switches. A 22-page catalog, Form No. PBS-1, describes an extensive line of pushbutton switches. It contains detailed information on the modular design of the switches and describes the basic module elements and assemblies as well as accessories. The catalog shows how the modules can be used to solve a variety of switching problems. Mechanical, electrical and environmental specifications are included, as well as dimensional drawings for three basic series of switches. Centralab, Div. of Globe-Union, Inc., 5757 N. Green Bay Ave., Milwaukee, Wis. 53201. **CIRCLE NO. 442**

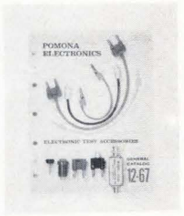
Coaxial Switches. A 12-page technical manual consists of a discussion on coaxial switches. Included are principles of operation, descriptions of basic design types and relative merits, contact arrangements and switching actions, operational differences, definitions of terms and performance characteristics. Also covered are drive methods, trade-off characteristics and a guide to the specification of coaxial switches. The discussion includes a comparison of the relative merits of electromechanical switches versus solid-state switches. Sage Labs., Inc., 3 Huron Dr., East Natick, Mass. **CIRCLE NO. 443**

Resistance Thermometers. Comprehensive information on platinum resistance thermometers in both free filament and weldable series is furnished in a 12-page data bulletin. Specifications for both series are included and a complete resistance-ratio versus temperature table is provided for the entire temperature range. Data Sheet PD 209, BLH Electronics, Inc., Waltham, Mass. 02154. **CIRCLE NO. 444**

RF Terminations. A line of RF terminations, ranging from convection-cooled to calorimetric waterloads, is described in an eight-page short-form catalog. Entitled "Coaxial and Waveguide RF Terminations", the publication lists convection-cooled dummy loads in finned or unfinned versions; dry-type, water-cooled loads, and calorimetric waterloads designed for use with thermopiles or differential thermometers to measure average power from a microwave source in compliance with MIL-E-1 requirements. Raytheon Co., Special Microwave Devices, 130 Second Ave., Waltham, Mass. 02154. **CIRCLE NO. 445**

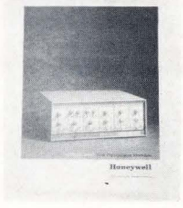
Circle No. 145 on Reader Service Card for more information.

LITERATURE



Molded Test Accessories. General catalog No. 12-67 describes a complete line of molded electronic test accessories. The 36-page publication includes more than 280 items. Included are molded patch cords, molded breakouts, cable assemblies, banana plugs, test leads, connecting leads, shielded "Black Boxes", socket savers and test socket adapters. Photographs, specifications, dimensions, schematics, operating ranges and prices are listed on all items. Pomona Electronics Co., Inc., 1500 E. Ninth St., Pomona, Calif. 91766. **CIRCLE NO. 446**

Test Equipment. A 16-page test equipment brochure, No. 2076, features Simpson's newest addition, a palm-sized VOM called the 160. Also included is a complete line of test instruments, including the 260 VOM's and adapters, vacuum-tube voltmeters, a recording VOM, general-purpose microtesters, scopes, temperature measuring instruments, plus carrying cases and other instrument accessories. Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill. 60644. **CIRCLE NO. 447**



Test Modules. This brochure describes the Series 2000 line of 20-MHz test modules. Designed for memory testing, telemetry timing and circuit evaluation, the units provide signal parameters for both bench testing and systems applications. The brochure explains features, specifications and prices for a trigger module, timing module, positive and negative current-driver modules and two enclosures (with and without power). Simplified function and logic diagrams are included. Honeywell, Inc., Computer-Control Div., Old Connecticut Path, Framingham, Mass. 01701.

CIRCLE NO. 448

Cathode-Ray Tube Guide. A 12-page quick-reference guide No. B-9260, lists a complete line of military and industrial cathode-ray tubes for radar display, computer readout and oscilloscope applications. It provides physical and electrical characteristics, including dimensions, typical operating conditions and resolution capabilities. Tube types listed include electrostatic focus and deflection, magnetic deflection in round sizes from 1 to 16 inches and magnetic deflection in rectangular sizes from 8 to 23 inches. Westinghouse Electronic Tube Div., Elmira, N.Y. 14902. **CIRCLE NO. 449**

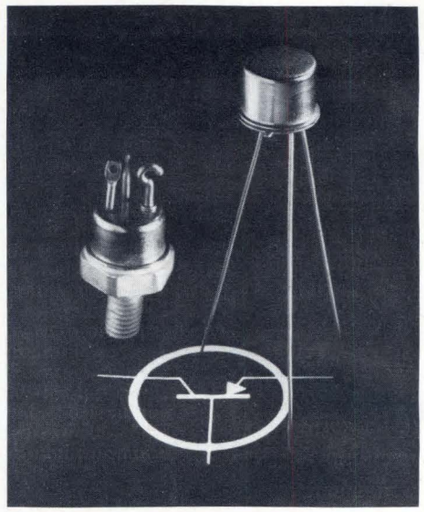
Industrial and Power Tube Guide. A 32-page technical guide represents the most complete up-to-date listing of hundreds of industrial and power tubes. It features an interchangeability listing that covers the most significant American electronic-tube manufacturers. It also contains specifications, base diagrams, and electrical characteristics of 740 tube types in 19 basic categories. Helpful technical information is provided about the function, construction and application of each tube category. Booklet B-9234. Westinghouse Electric Corp., Gateway 3, 19N, Pittsburgh, Pa. 15230. **CIRCLE NO. 450**

Microwave Tubes. "Advanced Microwave Tubes for Advanced Systems" is the title of this four-page short-form catalog. It lists a complete line of "CEM" and "ICEM" coaxial magnetrons, CW and pulsed crossed-field amplifiers and high-power noise generators. Varian Electron Tube & Device Group, Box B-138, 611 Hansen Way, Palo Alto, Calif. 94303. **CIRCLE NO. 451**

Microwave Tubes. Entitled "Metal-Ceramic VHF-UHF Triodes and Tetrodes", Bulletin No. ETD-4489 provides detailed information on the General Electric line of high performance coaxial transmitting tubes for advanced transmitter designs. Information contained covers VHF-UHF phased array and broadband conventional radar applications, AM/FM transmitters at 225-400 MHz, IFF interrogators and transponders, high-level, wide-range continuous-wave or pulsed-signal generators and other broad varieties of transmitting tube applications. General Electric Co., 1 River Rd., Schenectady, N.Y. 12305. **CIRCLE NO. 452**

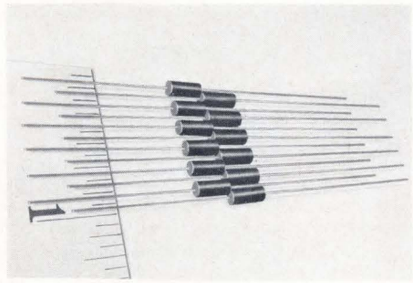
Circle No. 147 on Reader Service Card for more information.

NEW SEMICONDUCTORS



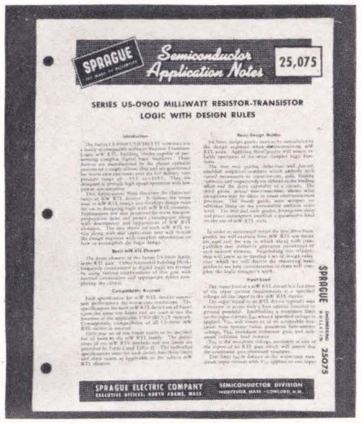
2N3200 series of silicon epitaxial pnp power transistors features a maximum V_{SAT} of 0.3v at 1 amp, maximum I_{CEX} of 0.1 μa to 100v, and typical h_{FE} of 45 at 1 amp. Units are available in a 40w, 7/16-inch hex stud package or an 8.75w TO-5 package. The 1-99 quantity price starts at $20. Crystalonics, Div. of Teledyne, Inc., 147 Sherman St., Cambridge, Mass.

CIRCLE NO. 453



Series "E" miniature silicon rectifiers measure only 1/4 inch long by 1/8 inch in dia, yet are rated from 100 to 1000 PIV. The rectifier current rating is 1 amp with a peak 1-cycle surge current of 70 amps. Reverse power-dissipation capability is 0.02w/sec. The units are transfer molded into one-piece silicone plastic cases. In large quantities, the prices range from $0.16 to $0.42 each, depending on rating. Sarkes Tarzian, Inc., Semiconductor Div., 415 N. College Ave., Bloomington, Ind. 47401.

CIRCLE NO. 454



Semiconductor Application Note No. 25075 contains a comprehensive summary of milliwatt resistor-transistor logic with design rules, noise margins, propagation delay and power consumptions along with a description of various applications. The note is available by letterhead request to the Technical Literature Service, Sprague Electric Co., 000 Marshall St., North Adams, Mass. 01247.

A complete line of avalanche silicon rectifiers is described in this 44-page catalog. The line includes diodes, power rectifier assemblies, "Rectipoint" assemblies, high-voltage rectifier tube assemblies, octal base assemblies and encapsulated assemblies. Catalog 311000. Syntron Co., 432 Lexington Ave., Homer City, Pa. 15748. **CIRCLE NO. 456**

Circle No. 149 on Reader Service Card for more information.

For immediate sales contact,

SC DATA

Following is a brief description of many of the products announced by RCA at the IEEE show in New York. More detailed information about each can be obtained by circling the accompanying reader-service numbers.

A 20w overlay transistor, Type RCA 40444, exhibits a typical gain-bandwidth product of 100 MHz at 3 amps and produces an output of 20w minimum with a 1w RF power input at 2.5 MHz. The device is an epitaxial silicon npn transistor packaged in the JEDEC-type TO-3 case. **CIRCLE NO. 457**

Monolithic integrated RF amplifier, Type RCA-CA3028, is packaged in an eight-lead TO-5 package, operates from a single 9 to 12v power supply over the temperature range −55 to 125C at frequencies from d-c to 125 MHz. Sample quantities are available at $1.55 each and production quantities will be available in the second half of 1967 at $0.98 each, 1000-up quantities. **CIRCLE NO. 458**

Packaged in plastic is the 2N5017 RF transistor that provides power outputs of 23w typical at 225 MHz and 15w minimum at 400 MHz. The device will operate from a 28v power source. The new package has all electrodes embedded in the top of the case, permitting circuit components to be placed as close to the chip as possible. Production quantities are available at $40 each. **CIRCLE NO. 459**

A family of 6-amp Triacs is available in either a TO-66 or TO-5 package. Two types for 120v operation are designated 40485 and 40429 and are priced at $1.50 each in 1000 quantities. Types 40486 and 40430 for 240v operation are $1.98 each. The 40485 and 40486 have surge protection up to 100 amps; the 40429 and 40430 have surge protection of 80 amps. **CIRCLE NO. 460**

Four n-channel, depletion-type silicon dual insulated gate field-effect MOS transistors are available for operation in the VHF/UHF frequency range. The TA7010 and 7045 are military types and the TA7153 and 2644 are for commercial applications. **CIRCLE NO. 461**

Epitaxial silicon npn power transistors, Types 2N5038 and 5039 are especially suited for switching-control amplifiers, power gates, switching regulators, converters and inverters. Both will switch 15 amps with a turn-on time of 0.5 μsec maximum and both have a power dissipation rating of 140w. **CIRCLE NO. 462**

The TA7003 microwave transistor will deliver 1w minimum power output at 2 GHz with 5-db gain and 30-percent efficiency. Sample quantities at $90 each are available. **CIRCLE NO. 463**

Six power transistors, designated 2N5034 through 37 and 40513 and 40514 are reported to be the highest power plastic transistors in the industry. The units are capable of delivering power outputs up to 83w. Four additional units rated at 36w also are included. They are the TA 7155 and TA 7156, the TA 2911 and TA 7137. **CIRCLE NO. 464**

CA3029 and CA3030 are operational amplifiers packaged in plastic for economy and feature a 14v p-p typical output. Units are packaged in a 14-lead dual in-line container and are priced at $5 and $5.75 each, respectively, in 1000 quantities. **CIRCLE NO. 465**

Commercial Engineering, RCA Electronic Components & Devices, Harrison, N. J. 07029.

Circle No. 152 on Reader Service Card for more information.

For immediate sales contact, circle No. 836.

The following new products were announced by Texas Instruments Incorporated at the IEEE show in New York. For more information on any specific device, circle the accompanying reader-service number.

The 2N5043 is reported to be the industry's first germanium transistor capable of operation over the full military temperature range of −55 to 125C. The device also possesses the lowest guaranteed noise figure of any transistor operating between 30 and 1000 MHz. It offers a common-emitter, 50-ohm insertion power gain (at 400 MHz) of 8.5db (minimum). Noise figure is 2.5 db maximum at 400 MHz and the minimum gain-bandwidth product (f_T) is 1.5 GHz. A modified planarization process that prevents the melting of the germanium dopants is responsible for the higher temperature operation. Price is $12.65 in 100-lot quantities.

CIRCLE NO. 466

2N4854 and 55 epitaxial planar silicon transistors are the first npn/pnp duals in TO-5 type packages to receive JEDEC registration. Packaged in a low-profile, six-lead package, the transistors are priced at $9 and $7.20, respectively, in 100-999 quantities. Units provide high-speed switching, general-purpose amplification (to 100 MHz) and are capable of 2w dissipation. **CIRCLE NO. 467**

Unijunction transistors, designated 2N4947-49 (TO-18 metal case) and 2N4891-94 (plastic-encapsulated), feature planar performance, application-tailored characteristics and economy prices. The metal-can devices range from $0.98 to $1.59 in 100-999 quantities, and the transfer-molded versions are priced from $0.72 to $0.85.

CIRCLE NO. 468

Sixty-three new TTL integrated circuits include a high-speed line, a low-power line, another complex-function circuit, an open-collector quadruple NAND gate and a quadruple NOR gate. Series 54H is the high-speed application line and Series 54L is for low-power applications.

CIRCLE NO. 469

Field-effect transistors featuring a number of "firsts" have been made available. These units include: the first plastic-encapsulated MOS-FET, the first high-voltage, plastic-encapsulated FET's, the highest performing tetrode FET's, the first matched FET pairs in plastic, the first dual FET's with matched output admittances, nine FET switches with the lowest ON-resistance.

CIRCLE NO. 470

TIP27 is a plastic-encapsulated silicon power transistor capable of 300v, 10w operation. The unit is capable of producing 2w of audio output (Class A) under direct-line operation. Price is $0.55 in quantities of 100-999.

CIRCLE NO. 471

Gallium arsenide Schottky-barrier mixer diodes, designated TIXVO8-19, feature a noise figure of 6 db at 9.375 GHz. The diode family consists of 12 devices in three package options and is priced under $60 per diode in quantities of 100.

CIRCLE NO. 472

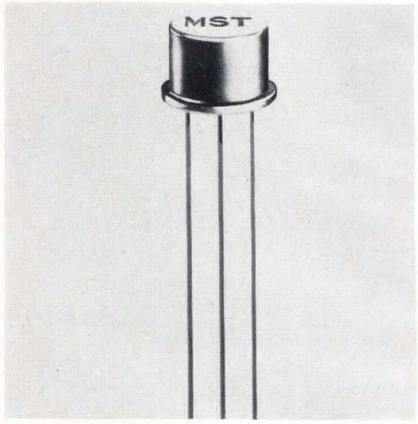
Silicon transistor, TIS71-72 is the first fundamental 4-GHz oscillator; at that operating frequency its guaranteed minimum output is 10 mw. In quantities of 25, cost is under $85. **CIRCLE NO. 473**

Texas Instruments Incorporated, Semiconductor-Components Div., Semiconductor Bldg., 13500 N. Central Expwy., Dallas, Tex. 75222.

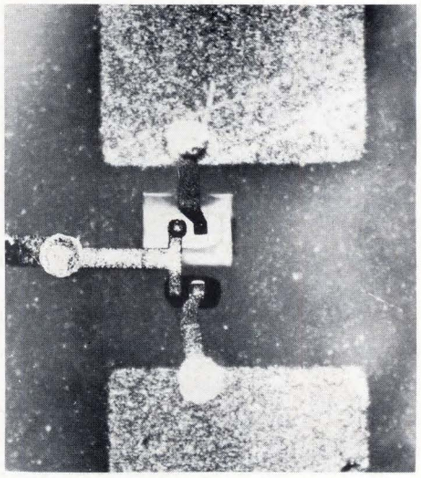
♦ **Circle No. 152 on Reader Service Card for more information.**

♦ **For immediate sales contact, circle No. 836.**

SC DATA



High-voltage silicon transistors, 2N5010 through 2N5015, feature breakdown voltages up to 1000v. The TO-5 device is rated 2w at 100C case and the $V_{CE(SAT)}$ rating on the 2N5015 (the 1000v unit) is a maximum of 1.8v (I_C equal to 20 ma and I_B equal to 5 ma). Prices for 100-999 quantities start at $6 for a 2N5010 and peak at $36 for the 2N5015. M.S. Transistor Corp., subsidiary of Silicon Transistor Corp., Garden City, N.Y. 11532. **CIRCLE NO. 474**



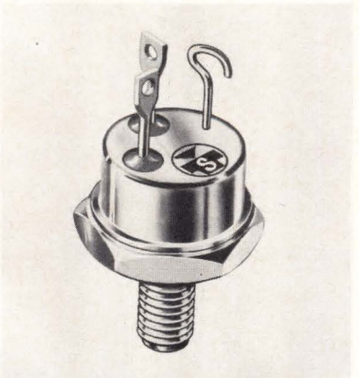
Beam-lead microwave Schottky-barrier diodes, 1/10 the size of normal microwave Schottky diodes, have been designed for the 10- to 750-MHz range and the 1- to 10-GHz range. Preliminary tests have shown that it is possible to obtain a 7-db noise figure at X band. The units, designated D5675M, will be premounted on a ceramic substrate 25 mils thick: unit costs are from $25 to $50 each, depending on desired characteristics. Sylvania Electric Products, Inc., 730 Third Ave., New York, N.Y. 10017. **CIRCLE NO. 475**

Doublers and center-tapped rectifier circuits ("ALPAC") feature aluminum cases to provide maximum thermal conductivity and guaranteed reliability. The units offer up to 15-amp average rectified current with PIV ratings from 50 to 600v. Case size is 2.25 by 0.344 by 0.375 inch. Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif.

CIRCLE NO. 476

Epitaxial gallium arsenide Schottky-barrier diodes, designated MS-1650-X and MS-1651-X, can withstand repetitive pulses of 10 ergs (2-nsec duration) at X band. At about 10 GHz, the 50-X unit has a single-ended noise figure of 7 db maximum; for the 51-X unit, this figure is 6.5 db. These ratings are based on an IF amplifier noise figure of 1.5 at 30 MHz. Respective prices for the diodes are $50 and $90 each. Micro State Electronics Corp., subsidiary of Raytheon Co., 152 Floral Ave., Murray Hill, N. J.

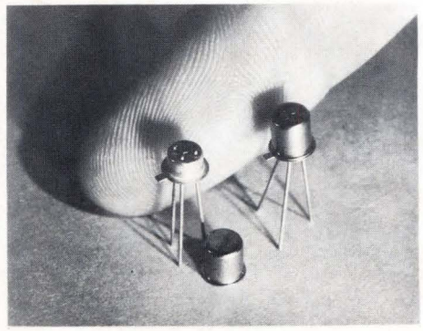
CIRCLE NO. 477



STT2650 through STT2656 are a series of planar triple-diffused npn silicon power transistors. The units range from 30 to 150v with a typical frequency of 25 MHz, 75w power dissipation and price range from $12 to $36 at the 100 level. Silicon Transistor Corp., Garden City, N. Y. 11530. **CIRCLE NO. 478**

Circle No. 155 on Reader Service Card for more information.

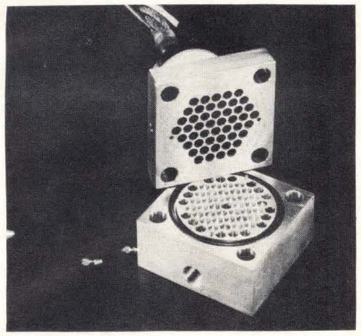
SC DATA



D5K1 complementary unijunction offers a set of characteristics having much superior stability than conventional unijunctions. Oscillators built with these devices have been shown to rival crystals for stability. An oscillator using a D5K1 was stable to 5 ppm/deg C when cycled from 25 to 85C. Low frequency oscillators can be built that will offer better than 0.5 percent accuracy from −55 to 150C. Stable oscillators also can be built with frequencies up to 100 kHz. The unit will be priced at $4.64 in quantities of 100 to 999. Sample quantities now are available. General Electric Co., 1 River Rd., Schenectady, N.Y. 12305. **CIRCLE NO. 479**

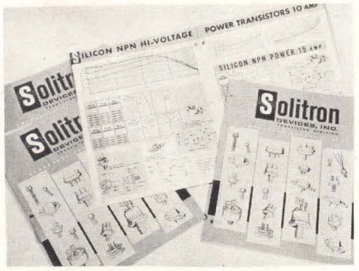
S8828J dual "D" or delay-type binary element has been added to Designer's Choice Logic (DCL) Series 8000. This series includes both high- and low-speed TTL and low-power DTL circuits, and offers 18 compatible circuits in 14-lead, glass-Kovar flat packs for operation over the full MIL Spec temperature range of −55 to 125C. The same unit, packaged in a dual in-line solid plastic pack, is being offered for narrower temperature range applications. The 100-up prices are $8.40 for the −55 to 125C S8828J TO-88 glass flat pack; $3.65 for the 0 to 70C ST828A plastic DIP, and $3.60 for the 15 to 55C SP828A plastic DIP. Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif.
CIRCLE NO. 482

Type 228 and 229 flat-pack, high-power thyristors pass up to 50 percent more current per junction than previous stud-mounted devices. Type 228 is rated 110 amps half-wave average and Type 229 is rated 230 amps half-wave average. Flat-pack thyristors have a unique mounting flexibility. The silicon wafer is cooled from both sides with an equal thermal impedance from junction to either face of the heat sink. This results in a forward- or reverse-polarity mounting capability. Westinghouse Semiconductor Div., Youngwood, Pa. **CIRCLE NO. 483**



Type 224 high-power thyristor is rated at 630 amps rms and is ideal for welding applications, power supplies and large motor controls. The unit is rated at 400 amps half-wave average, 630 amps rms through 1200v. The liquid-cooled heat sink requires a water flow of 1-1/2 gal/min. Westinghouse Semiconductor Div., Youngwood, Pa. **CIRCLE NO. 485**

Rectifiers encased in plastic are available in the lead mount with current ratings from 1.5 or 3 amps and peak reverse voltages of 50 to 1000v, or in the stud mount with current ratings from 5 to 40 amps and with peak reverse voltages of 50 to 600v. Prior to shipment all units are 100 percent tested for hermeticity by being subjected to a 2-hour, 15-psi steam bath. Westinghouse Semiconductor Div., Youngwood, Pa. **CIRCLE NO. 486**



A 28-page, three-color book features a manufacturer's line of silicon and germanium transistors used for military, industrial and commercial applications. The catalog's material is in a new and unique format that greatly broadens the scope of its use. Each family is presented in a separate section and includes typical h_{FE}, $V_{BE(SAT)}$ and $V_{CE(SAT)}$ curves, along with specification charts, outline dimension drawings and actual-size photos of the standard cases. Solitron Devices, Inc., 1177 Blue Heron Blvd., Riviera Beach, Fla. **CIRCLE NO. 487**

Circle No. 157 on Reader Service Card for more information.

DESIGN PRODUCTS

Quadrature Hybrid Comes On Board

How small can a microwave component get? Here's a contender—the size of a TO-18 can—that may be an answer to phased-array packaging problems.

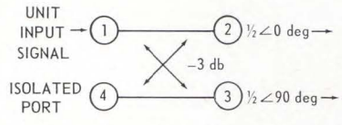


Fig. 2—**Quadrature hybrid schematic** and operational truth-table description.

	Input at Port No. 1	Input at Port No. 2	Input at Port No. 3	Input at Port No. 4
At Port No. 1	Input p	Output p/2, 0°	Output p/2, 90°	Isolated
At Port No. 2	Output p/2, 0°	Input p	Isolated	Output p/2, 90°
At Port No. 3	Output p/2, 90°	Isolated	Input p	Output p/2, 0°
At Port No. 4	Isolated	Output p/2, 90°	Output p/2, 0°	Input p

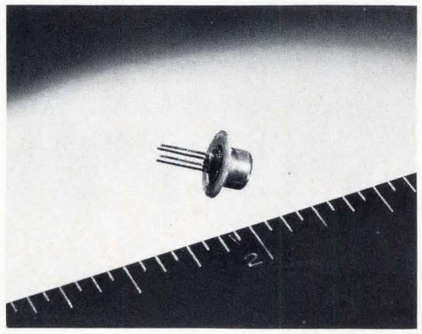


Fig. 1—**Subminiature quadrature hybrid** component in TO-18 size package. Operation is in any 10-percent bandwidth in the 1- to 5-GHz range with 23-db isolation, 50-ohm impedance at 5w average power.

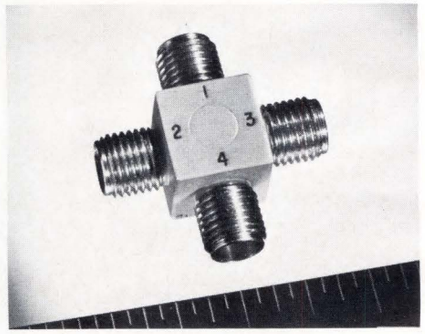


Fig. 3—**Quadrature hybrid pellet** encased in four-port connector housing, an alternate mounting method to PC-board pellet installation. The pellet form opens the way for new microwave-system applications.

Quadrature hybrid technology has progressed from the quarter-wave, parallel-plate configuration to the lumped-element subminiature equivalent, resulting in hybrids in a TO-18 can. This enables mounting the hybrid on a PC board, thus opening the way for important new microwave applications.

The quadrature hybrid in **Fig. 1**, a four-port device, accepts an input signal at any of its four ports, distributes half to a second port and half to a third port with 90-deg or quadrature-phase difference. The fourth port is isolated. Assuming that all output terminations are matched, the symmetrical "truth" table in **Fig. 2** can be constructed. These features have application in image rejection mixers, phase comparators, phase shifters, attenuators, SSB modulators, power-adding amplifiers, discriminating networks, power dividers and switches.

This subminiature accomplishment points the way to phased-array-system applications, **Fig. 3**, where microwave power must be divided among a multiplicity of channels with attendant physical space problems. The new hybrid in diminutive pellet form lends itself well to the solution of tight packaging assembly objectives. The operating frequency of this microwave device can be centered in the gigaHertz range.

This tiny quadrature hybrid element, known as the QHU-2 Series, was developed and is produced by Merrimac Research & Development, Inc., 41 Fairfield Pl., West Caldwell, N. J.

CIRCLE NO. 488

The new components listed in this section of **EDN** are arranged in alphabetical order for your convenience. Items are listed in the following order:

Adhesives
Attenuators
Battery Chargers
Capacitors
Connectors
Converters
Cooling Devices
Detectors
Displays
Fluidics
Knobs
Lamps and Lights
Loudspeakers
Meters
Motors
Optoelectronics
Oscillators
Paints
Photoelectric Devices
Potentiometers
Power Controls
Power Supplies
Relays
Resistance Standards
Resistors
Signal Processers
Silicones
Sockets
Switches
Tape
Temperature Controls
Temperature Measuring Devices
Timers
Transformers
Tubes

DESIGN PRODUCTS

Adhesives

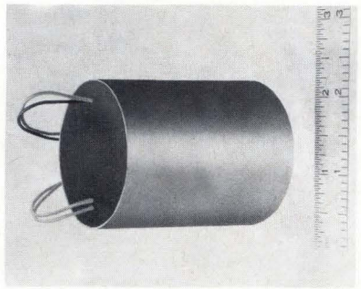
Low-Temperature Adhesive, "Eccobond" 32F, is a two-part epoxy adhesive that will set in a reasonable time at temperatures as low as 32F. It provides a strong watertight seal between metal flanges and concrete, and the presence of moisture does not affect the cure. It has been used to bond microwave absorbers to reflective surfaces in subzero temperatures. At room temperature "Eccobond" 32F will cure in about 24 hours, but at freezing point it requires about 2 days. Emerson & Cuming, Inc., Canton, Mass. 02021. **CIRCLE NO. 489**

Polyurethane Primers, Nos. XR-5136 and XR-5137, improve the adhesion of polyurethane resins to both flexible and rigid substrates. XR-5136 is a one-part, solvent-based primer designed for use with soft, flexible substrates such as urethanes, epoxies and neoprene rubber. XR-5137 is a two-part system for use with rigid substrates such as steel, aluminum, copper and glass. Tests have shown that in all cases bond strength exceeded the tear strength of the urethane. 3M Co., 2501 Hudson Rd., St. Paul, Minn. 55119. **CIRCLE NO. 490**

Attenuators

Attenuator Networks, Series T and H, provide both multiple input and output networks and tapped fixed networks. The multiple input and output networks are available with one input and up to 10 outputs, or up to 10 inputs and one output. The tapped fixed networks are housed in a choice of can sizes ranging from 1-3/8 to 1-3/4 inches in dia and 1 to 1-1/4 inches deep. A feature of this series is a selection of VU meter multiplier networks with resistor accuracy of ±2 to ±5 percent. RCL Electronics, Inc., 700 S. 21st St., Irvington, N. J. **CIRCLE NO. 491**

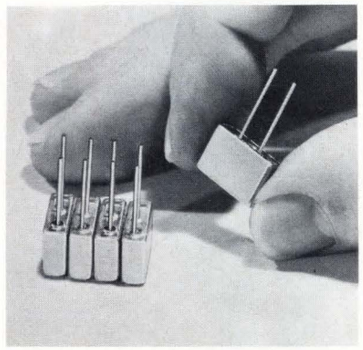
Battery Chargers



Nickel-Cadmium Cell Battery Chargers, Series C, are available in 24 models and operate from a 117v 60-Hz input. Eight single output voltages, 1.2, 2.4, 3.6, 4.8, 6,12,24 or 36v, are availabe, with ampere-hour ratings of 1.2, 2.3 or 4 for each of the eight output voltages. No damage is caused if the charger is left on indefinitely. Each unit charges at its rated current into a fully discharged battery, tapering to a safe charge rate when battery is fully charged. Berkleonics, Inc., 1221 S. Shamrock Ave., Monrovia, Calif.

CIRCLE NO. 492

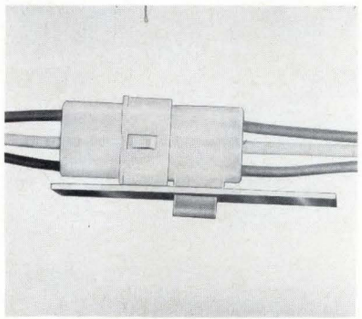
Capacitors



Metal-Encapsulated Tantalum Capacitors, F Series, are so small that 14 of them can be stacked in less than a cubic inch, making them ideal for printed-circuit board applications. These capacitors can operate in space or under water and at temperatures in excess of 250F. Working voltages are 6, 10, 15, 25, 35 and 50, and the series has a good high-frequency impedance performance. Union Carbide Corp., Electronics Div., Box 5928, Greenville, S.C. 29606.

CIRCLE NO. 493

Connectors



Three-Circuit Connector, has side-mounting ear molded into housing to provide fast and flexible panel installation. Connector contacts are crimped to leads and snap-lock into the nylon housing for fast, solderless assembly. The whole connector assembly is made of nylon, and positive polarity and secure connection is assured by a detent on the side of the housing. Multiple circuit units of up to 15 circuit combinations are available. Molex Products Co., 5224 Katrine Ave., Downers Grove, Ill. 60515.

CIRCLE NO. 494

Weston Model 1423 Integrating DVM

1μV Sensitivity at 50 MΩ for $1950.

FEATURES: *Strain gage and thermocouple type measurements are made with meaningful accuracy due to integrating and high sensitivity features of Model 1423. High common mode rejection allows low level measurement of potentials well above ground. Loading errors are reduced by 1000 times as compared to conventional DVM's.*

SPECIFICATIONS: *Accuracy: 0.02% ±1 digit. Common Mode Rejection: 150 db DC & 130 db at 60Hz—with up to 5K unbalance between input leads, and filter in use. Series (Normal) Mode Rejection: 60 db at 60Hz with filter. Overranging: 15% with fifth digit display. Display Time Control: From 4 reading/second to 1 reading/15 seconds. Overall Dimensions: 6½" x 14¼" x 16¼". Price: Bench mount, $1950; rack mount, $1995. Price subject to change without notice.*

Input Impedance & Sensitivity

Range	Input Impedance Minimum	Sensitivity
10.000 mV	50 megohms*	1 μV
100.00 mV	500 megohms*	10 μV
1000.0 mV	5000 megohms*	100 μV
10.000/100.00/1000.0 volts	10 megohms	1/10/100 mV

*Typical values twice as large

Contact **Weston Instruments, Inc., Weston-Lexington Division, 17 Hartwell Ave., Lexington, Mass. 02173**

WESTON® *prime source for precision . . . since 1888*

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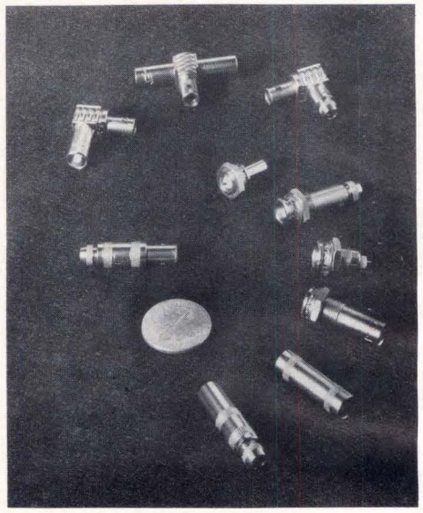
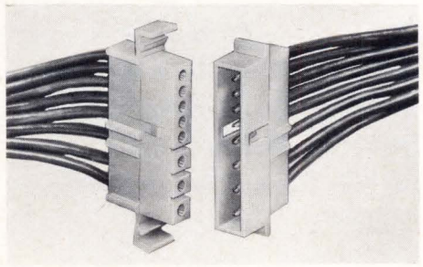
For immediate sales contact, circle No. 840.

DESIGN PRODUCTS



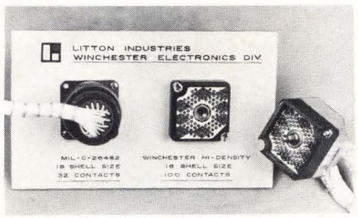
Subminiature Connectors, Series 00, are 1/4 inch in dia and are available in single-pin or coaxial versions. The single-pin model has a contact to ground test voltage of 1.8 kv and can carry 5 amps. Diameter is 0.051 inch. The coaxial model with a 50-ohm impedance has a contact to ground test voltage of 2.2 kv and can carry 2 amps. Both models feature a patented snap-latch, self-locking device with an optional safety lock. Frazar & Hansen, Ltd., LEMO Div., 150 California St., San Francisco, Calif. 94111.

CIRCLE NO. 495



High Capacity Connector is ideal for multiple-circuit connections in a small space where several circuits require high voltages. The unit features eight circuits in a flat, compact, nylon housing with excellent dielectric strength and positive polarity. Three of the circuits are rated for several thousand volts. Contacts are automatically crimped to the wires and snap-lock into the housing. Mounting lugs present simple but firm installation for panel applications, and housing design features interlocking detents for free mounting use. Molex Products Co., 5224 Katrine Ave., Downers Grove, Ill. 60515.

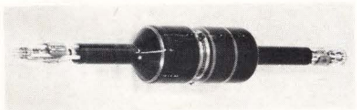
CIRCLE NO. 496



High-Density Connector, the SQC 100 P and SQC 100 S, will accommodate 100 standard 5-amp crimp, removable contacts, six polarizing pins and a center jackscrew. The connector shell is only 1.325 inch square. Center jackscrew allows closer side-by-side mounting of many more units because no hand clearance space around the connector is needed for installation or removal of the mating connector half. The turning jack is an integral part of the male half and the fixed jack is an integral part of the female half. The square connector occupies the same area as the box mount on a size 18 MS or AN shell. The connector is designed for use in controlled environment applications. Winchester Electronics, Div. of Litton Industries, Main St. and Hillside Ave., Oakville, Conn.

CIRCLE NO. 497

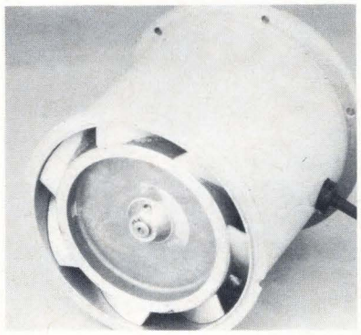
Converters



Double-Ended Scan Converter Storage Tubes, Types H-1161, H-1203 and H-1213, are designed to convert stored information written in one particular scanning mode either to a different scanning mode, or to the same mode scanned at a different rate. Read-write crosstalk is eliminated by shielding between the writing and reading sections. H-1161 is a 2-5/8-inch-dia tube that features two flooding guns, connected externally for parallel operation. This allows immediate erasure, or the control of the decay rate of stored information. Resolution is 800-TV lines at 50-percent modulation. H-1203, with 4-inch dia, and H-1213, with 3-inch dia, are designed to allow erasure of selected portions or of the entire storage target area. Information decay rate may be controlled by these tubes. Resolutions are 2000 lines for the H-1203 and 1600 lines for the H-1213, both at 50-percent modulation. Hughes Vacuum Tube Products, 2020 Oceanside Blvd., Oceanside, Calif. 92054. **CIRCLE NO. 498**

DESIGN PRODUCTS

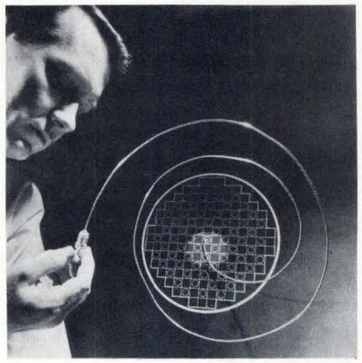
Cooling Devices



"Vaneaxial" Fan, Model VO50, is only 5 inches in dia and has a capacity of 175 cu ft per minute. Input voltage is 200v 3-phase at 400 Hz, and the unit is precision engineered to meet applicable military specifications for high temperature, vibration, shock, humidity and salt spray. Airflow reversal can be easily accomplished by turning the unit around. IMC Magnetics Corp., Marketing Div., 570 Main St., Westbury, N.Y. 11591.

CIRCLE NO. 499

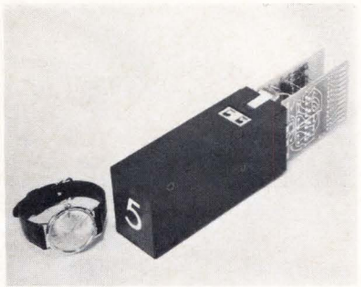
Detectors



Neutron Flux Detector, Model WX-30687, responds in approximately 10^{-14} sec and requires no external power supply. It is ideal for flux monitoring in reactor test loops or for flux mapping. It has a thermal neutron sensitivity of 1.4 $\times$ 10^{-21} amps/neutron/sq cm/sec. It has a sensitive emitter length of 34 inches, and the emitter wire is made of cobalt. Westinghouse Electronic Tube Div., Elmira, N.Y.

CIRCLE NO. 500

Displays

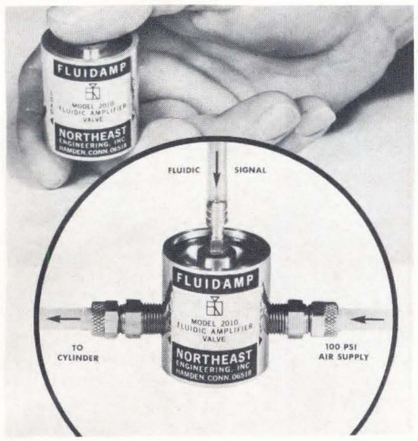


Solid-State Display requires an eight-line binary input (BCD code) and uses 10 outputs to drive 10 lamps, with a 12-output option available. Each character is 1-inch high and is automatically displayed on the back projection principle. The basic components are silicon controlled rectifiers, and each is designed with a forbidden-code rejection. Should an improper code be applied, a blank viewing screen is indicated. Industrial Electronic Engineers, Inc., 7720 Lemona Ave., Van Nuys, Calif. 91405.

CIRCLE NO. 501

DESIGN PRODUCTS

Fluidics



Fluidic-Amplifier Valve, Model 2010, has a response time of 10 msec and measures 1.36 inches in dia by 1.55 inches long. It will operate from signal pressure levels as low as 1-1/2 inches water column and as high as several psi. The unit is a normally closed, three-way valve. A control signal on the sensing diaphragm shuts off bleed air flowing through a nozzle and traps pressure in a cavity above the upper power diaphragm. This forces both power diaphragms downward, opening the load port to full line pressure and simultaneously closing the exhaust port. Release of the signal reverses the action. Maximum flow is 30 cu ft/min at 100 psi, adequate for operating air cylinders and motors directly. It is constructed entirely of aluminum, except for elastomeric parts, making it resistant to contaminants commonly present in shop air systems. Northeast Engineering, Inc., 3013 Dixwell Ave., Hamden, Conn. 06518. **CIRCLE NO. 502**

Sustained-Contact Fluidic Switch is designed for manually supplying input information to a fluidic control system. The switch, which is completely pneumatic and will operate from any standard regulated shop air supply, provides a continuous input signal to the control system. It operates on the back-pressure principle, in which supply air is continually fed to the switch. When the switch is in the OFF position, this air bleeds to the atmosphere. Turning the switch to the ON position closes the bleed vents, forcing the supply air to back up and flow out of the signal tube. This new switch eliminates the fluidic amplifiers necessary for the flip-flop circuit used in earlier similar switching systems. Air consumption of the switch is extremely small, varying between 1/2 and 1 cu ft per hour. Howie Corp., Fluidic Div., Noble and Jackson Sts., Norristown, Pa. **CIRCLE NO. 503**

For immediate sales contact,
Circle No. 841.

Semiconductors

NEW IDEAS IN APPLICATION AND DESIGN

■ ACCURACY UP, RFI DOWN WITH GE'S NEW LOW-COST A-C POWER CONTROL MODULE

"Zero-voltage switching" is the key. GE's new S200 synchronous switch power control provides much lower RFI levels than are possible with electromechanical thermostats or phase-controlled semiconductors. And it has high accuracy with control point repeatability better than ±0.5% of sensor resistance. Keys to this high performance are a monolithic integrated firing circuit and a Triac power control device. Its user need only provide power, a resistive load (such as a resistance heater), a variable resistance sensor and a reference control resistor.

Potential uses include any resistive load application where a-c power control is needed. S200 power control modules are available in ratings of 10 and 15 amps RMS, at 120, 240 and 227 volts RMS, 50 to 60 Hz, for controlling resistive loads up to 4150 W. Use with General Electric's new Man-Made® diamond thermistor permits sensing and control of temperatures to 450 C. Housing dimensions of the S200 power control module are roughly $1\frac{1}{16}$ by $2\frac{1}{8}$ by $3\frac{1}{8}$ inches.

Circle **Number 131** for full details on these new GE power control modules.

■ NEW ECONOMY POWER TRANSISTOR

Thermal dissipation.....1.2W (free air)
Beta holdup.....to 500 mA

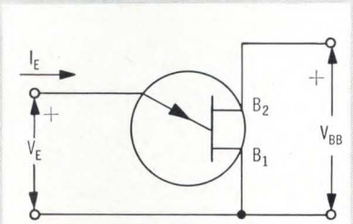
It's GE's D28A.

- P_T.....1.2 W at 25 C (ambient)
- h_{FE}..... 75–225 and 180–540 at 2 mA, 4.5 V 20 min. at 400 mA, 1 V
- BV_{CEO}....25 and 50 V
- $V_{CE(SAT)}$...0.05 typical 0.3 V (max.) at I_C/I_B= 50 mA/3 mA

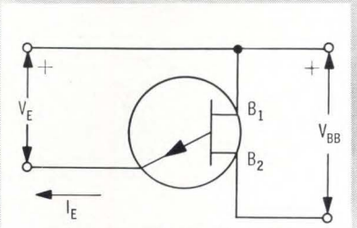
Other characteristics closely match those of the 2N3414-17.

All of this comes in a low-cost plastic package with three in-line leads that can easily be formed to a TO-5 pin circle. Price: less than 30¢ in volume.

Try D28A medium power silicon transistors for output stages in stereos and other phonographs, TV's, radios and other kinds of audio equipment. Or for oscillators, amplifiers, buffers and as drivers for very high power amplifiers. Circle **Number 132** on the magazine inquiry card.



Standard unijunction



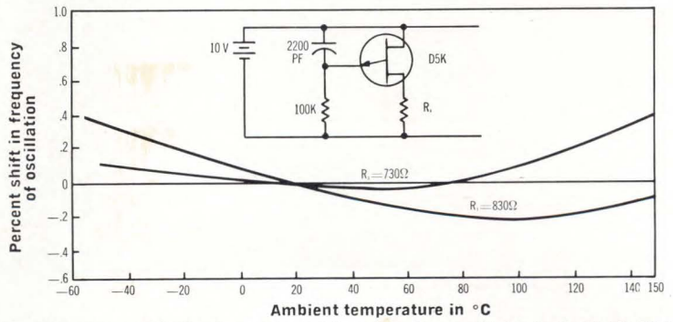
Complementary unijunction

Introducing the Complementary UJT for Improved Stability and Accuracy in Oscillator and Timer Circuits

It's an entirely new kind of unijunction called the D5K. General Electric's D5K has superior temperature stability and product uniformity through utilization of planar processing techniques. Its characteristics are like those of a standard unijunction transistor except that the currents and voltages applied to it are of opposite polarity.

With GE's D5K you can build oscillator and timer circuits with better than 0.5% accuracy from —40 to +120C. Its intrinsic stand-off ratio (η) is just 0.58-0.62 or ±3%. You save test costs by determining your best compensating resistor for temperature stability **at room temperature.** And the D5K gives you a low base 1 to emitter voltage drop at high current . . . permits generation of high output pulses with low base-to-base voltages.

GE D5K's are priced at $4.64 in 100-lot quantities. Take advantage of GE's continuing UJT leadership and superior application help. D5K's are available for both military and industrial uses. Circle **Number 133** for more information.



Frequency stability demonstrated by relaxation oscillator test circuit (CUJT only subjected to temperature change.)

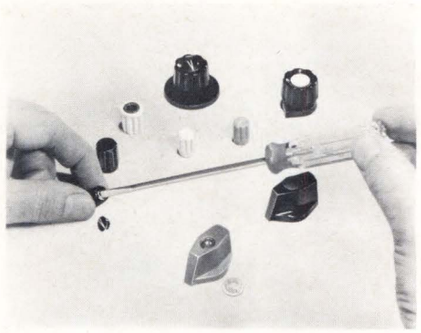
These are just three more examples of GE's total electronic capability. For more information call your GE engineer/salesman or distributor. Or write to Section 220-55, General Electric Company, Schenectady, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: Electronic Components Sales, IGE Export Division, 159 Madison Ave., New York, N.Y., U.S.A.

GENERAL ELECTRIC

220-55

DESIGN PRODUCTS

Knobs



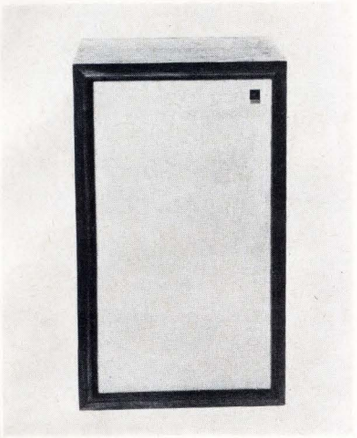
Clamping Collet Knobs, Series F112, feature a clamp-tight collet assembly to assure a reliable attachment. This allows a perfect fit in any radial position without any preparation or machining of the shaft. It also avoids any shaft abrasion of the setscrew. The cap is removable and the setscrew is conveniently reached by a screwdriver or socket wrench. Series F112 is currently available for standard shaft sizes. Amperex Electronic Corp., Component Div., Hicksville, L.I., N.Y. 11802. **CIRCLE NO. 504**

Lamps and Lights

Subminiature Indicator Lights, SIL Series, are designed for high-density display on small console panels. Both incandescent and neon lamps are available. In the neon version the current limiting resistor is housed within the lamp body. Body size is only 0.36 inch in dia by 0.25 inch long. It mounts from the rear with a knurled nut in a 1/4-inch hole on centers as close as 3/8 inch. Lenses are offered in a choice of 13 colors. TEC-LITE, Transistor Electronics Corp., Box 6191, Minneapolis, Minn. 55424. **CIRCLE NO. 505**

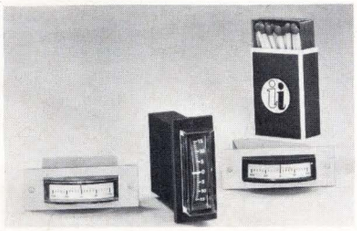
Indicator Light, Series 911, is available with either incandescent or neon midget lamps. A choice of cylindrical lenses, with or without internal diffusing rings and in a choice of six colors and clear colorless, is provided. Incandescent lamps may be supplied with voltages from 1.35 to 28v, with a 50,000-hour life rating. Neon glow lamps may be supplied for standard brightness or high brightness. Dialight Corp., 60 Stewart Ave., Brooklyn, N.Y. 11237. **CIRCLE NO. 506**

Loud Speakers



Controlled Impedance Speaker, Model S-11, is specifically designed for use with solid-state components. The S-11 speaker system incorporates a carefully limited impedance range for operation with solid-state components which give optimum performance over a narrow range of load impedance. The speaker system measures 24 by 14 by 11-1/4 inches. H. H. Scott, Inc., Maynard, Mass. 01754. **CIRCLE NO. 507**

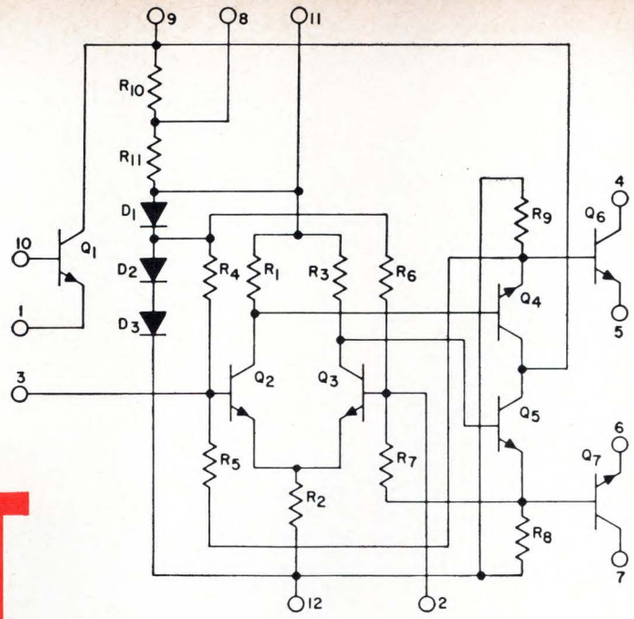
Meters

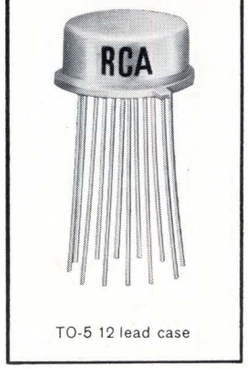


Edge Panel Meters, Models 1124, 1125 and 1126, are compact special-purpose meters with self-shielded moving-coil meter movements that eliminate magnetic interaction between adjacent meters. Model 1124 features a "Lucite" crystal and is ideal for edge-lighted panel applications in aircraft installations. The 1125 and 1126 feature RF shielding and are partiularly useful for portable RF equipment. The shielding is accomplished by a special case design and capacitive filtered terminals. All three models are available in either horizontal or vertical reading versions, with center zero or zero on either end of the scale. International Instruments, Inc., 8806 Marsh Hill Rd., Orange, Conn. 06477. **CIRCLE NO. 508**

RCA integrated circuits

RCA CA3020 LOW COST "UNIVERSAL" AMPLIFIER





TO-5 12 lead case

- High gain • Low level to P_{out} = 1/2 w
- DC to 6MHz • Price $1.75 (1,000+)

Here's a new answer to economics, packaging, and performance for a broad spectrum of audio and RF applications—RCA-CA3020, a multi-stage, multi-purpose amplifier on a single monolithic silicon pellet. CA3020 is useful in portable and stationary sound systems; in military, industrial, and commercial communications equipment; in servo-control systems and elsewhere. Available now for evaluation—and production line use. Write for Technical Bulletin and Application Note to Commercial Engineering, Sec. ICF-5, RCA Electronic Components and Devices, Harrison, New Jersey 07029.

Specification Highlights

- 58 db typical gain in audio applications
- —3 db bandwidth 25 Hz to 6 MHz (typ)
- Operates with single power supply +3 to +9 VDC
- Built-in temperature tracking with voltage regulator—stabilized operation over —55°C to +125°C range
- Single-ended input at 40kΩ (typ); push-pull differential input at 600Ω (typ)
- High maximum power output 550 mW (typ) @ V_{cc} = +9V
- Push-pull output
- Squelch flexibility—three methods for applying squelch

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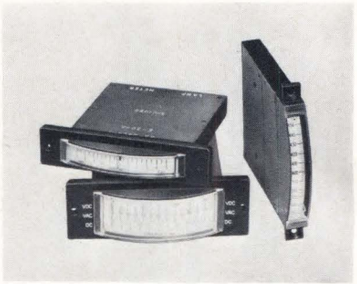
DESIGN PRODUCTS



Internally Illuminated Edge Meters, Series EMI-30, are 1/2 inch thick, 2.9 inches wide, extend 3.5 inches behind the panel and have 2.1-inch scales. Each meter weighs less than 6 oz and may be mounted on 1/2-inch centers. The meter movement is undamaged by acceleration shock as great as 240g, and continuous electrical overload (up to 500 ma) of 10,000 percent full-scale. The meters can be supplied in almost any special configuration including vertical, horizontal and multiple scales. Parker Instrument Corp., 200 Harvard Ave., Stamford, Conn. 06904. **CIRCLE NO. 509**

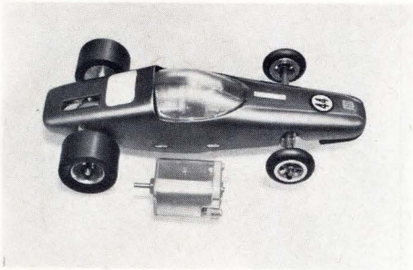
New Frequency Meters and Wattmeters are compact, low-cost and use taut-band suspension. Designed for panel mounting, these meters measure 3-1/2 and 4-1/2 inches. The frequency meter has an external transducer to measure a-c power frequency, with an accuracy of 2 percent of the frequency span. The transducer can be manually adjusted for the highest accuracy at normal frequency. The wattmeter also has an external transducer to measure a-c watts. This has a 2 percent overall accuracy in single-phase, three-phase three-wire, and three-phase four-wire units at 5 amps and 120v. Westinghouse Electric Corp., Relay-Instrument Div., Box 868, Pittsburgh, Pa. 15230. **CIRCLE NO. 510**

Microwave Devices

Air-Cooled Waveguide Loads operating over the UHF, L, S, C, X and K bands combine high power handling with light weight. Model LKuM1 dissipates 25w average power and weighs 4.8 oz and Model LCH100 handles 2000w of average power and weighs only 3.6 lb. The new range consists of 21 loads, all available in finned or unfinned versions. Raytheon Co., International Sales & Services, Lexington, Mass. 02173. **CIRCLE NO. 511**

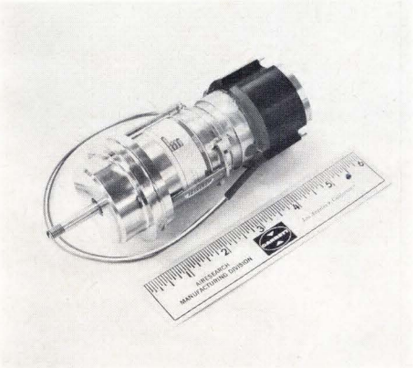
Circle No. 172 on Reader Service Card for more information.

Motors



Miniature D-C Motors, the 3ADM4, are designed for d-c and rectified a-c applications from 1.2 to 18v. The speed/torque characteristics can be varied to fit particular needs for applications such as battery-powered housewares and appliances, toys, home entertainment and photographic equipment and automotive accessories. At 12v, the tiny 1-1/2-oz motor will develop up to 1/10 hp, with 35-40 thousand rpm (no load speed), up to 10 oz-in of starting torque and efficiencies up to 55 percent. An available option of the new motor is replaceable brushes of optional composition. General Electric Co., Appliance Control Dept., Morrison, Ill.

CIRCLE NO. 512

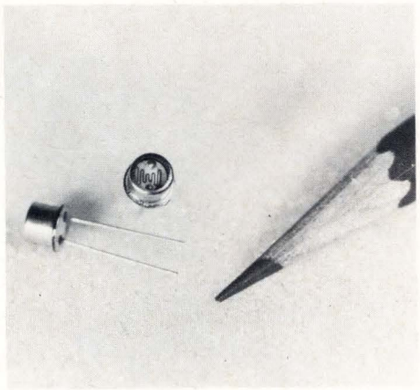


High Efficiency Brushless D-C Motor uses solid-state light emitters, detectors and power switches to achieve an efficiency of 75 percent and a speed of 5000 rpm in a small 10w motor. Operating voltage is 28v d-c, weight is 2-1/4 lb and the motor produces 2.7 oz-in of torque at 5000 rpm. The rotor is a permanent magnet field and the stator is the wound armature. A shutter controlling the light switches is attached to the rotor shaft. This shutter energizes the proper stator winding and produces the synchronized rotating field required for d-c motor operation. Under development are motors expected to operate at 85 percent efficiency at 30w outputs and 24,000 rpm. The Garrett Corp., AiResearch Mfg. Div., 9851 Sepulveda Blvd., Los Angeles, Calif.

CIRCLE NO. 513

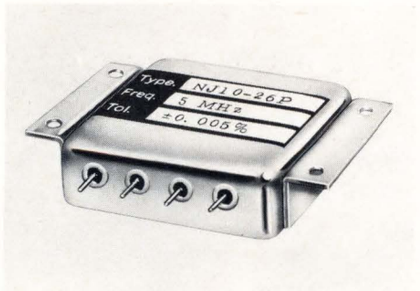
DESIGN PRODUCTS

Optoelectronics



Hermetically Sealed Photocells measuring less than 1/4 inch in dia are ideal for high-density photoconductor arrays. The cadmium sulfide cells are sealed in a metal-glass, TO-18 housing, 1/8 inch high and 7/32 inch in dia. They are rated for 50-mw power dissipation and are available in light/resistance ratings ranging from 3000 to 125,000 ohms at 2 ft-candles, with a dark/light resistance ratio of 100:1. Sylvania Electric Products, Inc., 730 Third Ave., New York, N.Y. 10017 **CIRCLE NO. 514**

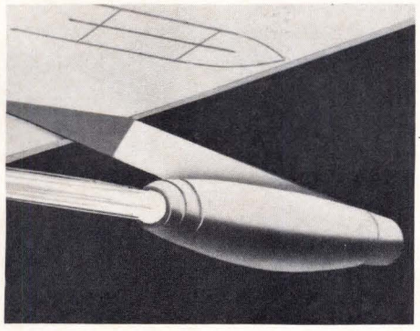
Oscillators



Miniature Crystal Oscillators, Series NJ, are ideal for printed-circuit board applications and also for driving RTL, DTL and T²L integrated logic. Frequency tolerance is ±0.005 percent from −20 to 60C in frequency ranges of 4 to 50 MHz, and typical output voltages are 3 to 6v peak. Dimensions are 1-1/2 by 1-1/2 by 1/2 inch. Numerous frequencies are available from stock. Accutronics, Inc., 12 S. Island Ave., Batavia, Ill. 60510. **CIRCLE NO. 515**

Integrated-Circuit Oscillator Module, "ICOM", gives ±0.0002 percent frequency stability at 450-MHz operation. This conforms with the new technical standards set by the FCC for channel width in the 450-MHz band. Stability is achieved instantly, without warm-up, and is maintained over a temperature range from −31 to 140F. The unit weighs less than 1/2 oz, occupies less than 1/2 cu in and consists of an integrated-circuit crystal oscillator, a channel guard tone modulator, a voltage regulator and a compensation circuit. General Electric Communication Products Dept., Box 4197, Lynchburg. Va. **CIRCLE NO. 516**

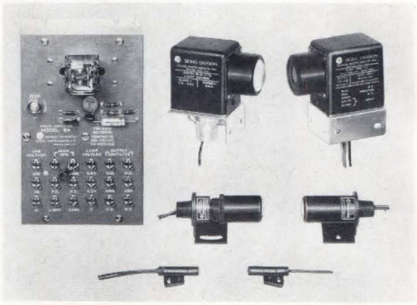
Paints



Ultrahigh-Temperature Paint, composed entirely of ceramic compounds and rare earth materials, will protect a variety of materials from −100 to 4400F. These paints produce an extremely hard, abrasion-resistant surface of very low porosity. They are water based and may be spray applied. Industrial Infra-Red, Inc., 157 Dayton Way, Sharon, Pa. 16146. **CIRCLE NO. 517**

DESIGN PRODUCTS

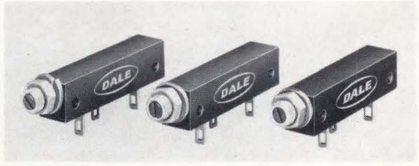
Photoelectric Devices



Photorelays, Series 8, comprise a complete line of integral and remote photoelectric systems for light-beam control of moving objects. They are ideal for mechanizing or automating such functions as materials handling, packaging, production or processing. Operation is at 600 or 1200 times a minute over ranges from below 12 inches to 25 ft. The high-speed models are capable of switching 5-amp resistive loads 1200 times a minute at 28v d-c/115v a-c, or 2.5 amps at 230v a-c. General-purpose types switch 10-amp resistive loads at 28v d-c/115v a-c, or 5 amps at 230v a-c, and operate 600 times per minute. Receivers provide SPDT or DPDT contact arrangements, operation from 115 or 230v a-c, 60 Hz. Two solid-state amplifiers are offered with the remote systems. One provides a 50-msec to 20-sec time delay and has a mechanical life of 10 million operations. Sigma Instruments, Inc., 170 Pearl St., Braintree, Mass. 02185.

CIRCLE NO. 518

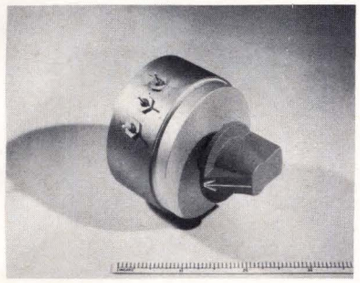
Potentiometers



Precision Trimmer Potentiometers, Models 1185, 1285 and 2185, are interchangeable with existing similar T-Pots, and feature gold-plated brass spade-type terminals for simple and reliable soldering. The 1/4-inch threaded lead screw shaft permits a variety of panel and outside-accessible installations. Model 1185 has a power rating of 1w and a resistance range of 10 ohms to 100 kilohms with ±10 percent tolerance. Model 1285 is a 1w, 10 ohms to 100 kilohms, ±5 percent tolerance, humidityproof trimmer for military applications. Model 2185 is a commercial version and has a resistance range of 10 ohms to 100 kilohms, ±10 percent tolerance and a power rating of 1w. Dale Electronics, Inc., Box 488, Columbus, Neb.

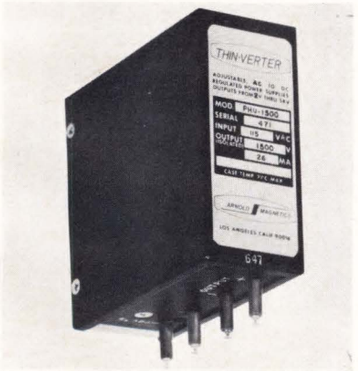
CIRCLE NO. 519

Power Controls



Solid-State Power-Control Unit, FPC-1, can control up to 1200w at 240v 60 Hz. Applications include phase control, temperature control, lamp dimming, d-c power or motor control, servomotor drive, machine control and welding control. A 400-Hz model is available for aircraft applications. Either parallel or series control can be provided. The unit weighs less than 5-1/2 oz and is only 2-1/4 inches in dia. Fairchild Controls, 225 Park Ave., Hicksville, L.I., N.Y. 11802. **CIRCLE NO. 520**

Power Supplies

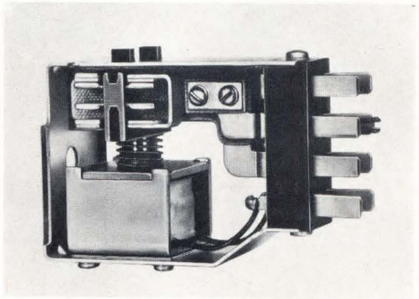


Miniature Power Supply, Model PHU, develops 40w output at 60 or 400 Hz from an input voltage of 115v, 50 to 500 Hz. The unit occupies only 21 cu in and uses the principle of high-frequency inversion directly from rectified line voltage to achieve a high power-to-size ratio. The output is electrically isolated from the input, and output voltages range from 2 to 5000v d-c. Each voltage selected is adjustable from +5 to −40 percent. Line regulation is 0.015 percent/volt, load regulation is approximately 1 percent and ripple is approximately 1/2 percent. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles, Calif. 90016. **CIRCLE NO. 521**

Circle No. 178 on Reader Service Card for more information.

DESIGN PRODUCTS

Relays



High-Current Relay, Model LA57, is a plug-in, DPDT double-break relay designed for extremely high in-rush current applications such as the continuous switching of tungsten lamp loads. The relay is capable of handling 15-amp tungsten lamp loads as well as resistive loads up to 50 amps at 120v a-c. It features a plunger-type solenoid that supplies a high contact force of at least 50 gm. It measures only 3-1/4 by 1-5/8 by 2-1/4 inches and is simply and ruggedly constructed. Tests indicate a minimum life of two-million operations under its fully rated 15-amp tungsten lamp load. Eagle Signal Div., E. W. Bliss Co., 736 Federal St., Davenport, Iowa.
CIRCLE NO. 522

Resistance Standards

Transportable Resistance Standards, Models SR104 and SR105, are designed for bench use and oil-bath operation, respectively. Model SR104 consists of a resistive element and an internal temperature sensor and provides a 10-kilohm starting point for resistance measurements. Model SR105 is similar but has a 100-ohm resistance standard. The 10-kilohm base value offers several advantages. It is an even four decades away from 1 ohm and 100 megohms, and by using the 100:1 transfer technique, all resistance values in this range can be accurately established within several parts per million relative to this single 10-kilohm standard. Electro Scientific Industries, Inc., 13900 N.W. Science Park Dr., Portland, Ore. 97229.
CIRCLE NO. 523

Resistors

Precision Wirewound Power Resistors, Series PR and LA, are for both military and commercial applications. Series PR power resistor is available in 7 RWR styles and 15 commercial styles with ratings between 1 and 15w. Series LA is a general-purpose power resistor available in 6 RW styles and 15 commercial styles with ratings from 1 to 18w. Shallcross Mfg. Co., Preston St., Selma, N.C. 27576. **CIRCLE NO. 524**

Signal Processers

Signal Processer, Model DCA8-2, gives high performance conditioning of low-level signal sources such as stain gages, resistance temperature transducers and thermocouples. An isolated internal power supply is provided for transducer excitation. The unit weighs only 5 oz and has a data output of 0 to 5v d-c. Grant Electronics, 2017 Glendon Ave., Los Angeles, Calif. 90025.

CIRCLE NO. 525

Silicones

High-Loss Silicone Sheet, "Eccosorb" GDS, is a flexible silicone-rubber material that prevents the flow of microwave energy. It is ideal for reducing backscatter or reflectivity of metal structures. It also can be draped over objects to alter reflectivity characteristics and can be used to modify radiation patterns of antennas such as dishes, horns and elements. It is impervious to moisture and can withstand temperatures up to 400F. It can be easily cut and thus has important applications as a gasket material providing both a microwave energy seal and a hermetic seal. Microwave Products Div., Emerson & Cuming, Inc., Canton, Mass. 02021.

CIRCLE NO. 526

Sockets

Test Socket, available in 3, 4, 6, 8, 10 and 12 contact arrangements, provides rapid testing of integrated circuits and transistors in TO-5 cases. The wiping gold-plated contacts are said to assure low contact resistance, even after 100,000 insertions. The "Teflon" body is designed for low cost and operating temperatures up to 150C. Augat, Inc., 33 Perry Ave., Attleboro, Mass.

CIRCLE NO. 527

Switches

Miniature Rotary Switches, Series 100, are completely enclosed to guard against exposure, contamination and production damage. Intermixed shorting and non-shorting arrangements are available, on single sections and between sections. Additional features include spacers, intersection shields, dual concentric switches with attached line switches or potentiometers, binary coded and high-voltage switches. Stackpole Carbon Co., Electro-Mechanical Products Div., St. Marys, Pa. 15857. **CIRCLE NO. 528**

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EDN MAGAZINE

ANNOUNCES ITS FIRST ELECTRONIC EXHIBIT TOUR TO 54 CITIES...JULY 10 TO NOV. 3

EDN 'hits the road' in a modern version of the trade show in which exhibits are taken to the engineer via mobile display vans. Through a series of local shows, the EDN Caravan brings operating equipment and manufacturer's representatives to the engineer's doorstep. In a matter of minutes, several vendors can be reviewed for latest product developments. Engineering groups can visit exhibits where operating problems can be simulated and questions answered. On-site locations make it easy and convenient for engineers to attend showing of the newest electronic products.

SOME OF THE FIRMS EXHIBITING:

- BABCOCK RELAYS
- BECKMAN HELIPOT
- ERIE TECHNOLOGICAL
- HUGHES WELDERS
- MASTER SPECIALTIES
- VSMF MICROFILM FILE

THE CARAVAN IS SCHEDULED TO VISIT THESE CITIES:

LOS ANGELES	HOUSTON	BALTIMORE	ALBANY	CHICAGO	SACRAMENTO
ORANGE COUNTY	NEW ORLEANS	PHILADELPHIA	ROME-UTICA	MILWAUKEE	LIVERMORE
SAN DIEGO	EGLIN A.F.B.	FT. MONMOUTH	SYRACUSE	ST. PAUL	OAKLAND
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EDN

THE ELECTRONIC ENGINEER'S DESIGN MAGAZINE

DESIGN PRODUCTS

Tape

"Mylar"-Reinforced Opaque Perforator Tape for photoelectric and electromechanical readers is now available in thicknesses from 0.0043 to 0.0015 inch. An exclusive laminating process gives the tape exceptional strength and dimensional stability. It is available in 11/16-, 7/8- and 1-inch widths in a full range of standard colors, and includes paper/"Mylar"/paper, "Mylar"/foil/"Mylar" and metalized "Mylar" combinations. Free sample rolls for testing purposes are available. Arvey Corp., 3500 N. Kimball Ave., Chicago, Ill. 60618.

CIRCLE NO. 529

Temperature Controls

Temperature Control, Model 1200, is ideal for ovens, baths, transport refrigeration, environmental test chambers and liquid nitrogen. It features a full 12-inch scale and a wide choice of ranges within −180 and 1000 degrees Fahrenheit or centigrade. Other features include single or dual switches (SPDT 15 amps), manual reset or high- or low-limit operations. United Electric Controls Co., 85 School St., Watertown, Mass. 02172. **CIRCLE NO. 530**

Temperature Measuring Controls

Proportional Temperature Controllers are entirely solid-state, including the power module, and are capable of handling power outputs as high as 300 kw in single-phase or 3-phase. Standard operating voltages are 115, 230 or 480v, and the temperature range may be as high as 2000F. Easy to read and interpret, the indicator is of the go/no-go type, providing a clear visual warning whenever the temperature deviates from a set point. Panel area required is 3-3/4 by 5-1/2 inches. Harrel, Inc., 16 Fitch St., East Norwalk, Conn. 06855. **CIRCLE NO. 531**

the sensitivity, long life, and of mercury-wetted contact relays

Now you can design around the same consistent and dependable characteristics provided by the CLARE Type HGSM Relay —in half the size! That means you can fit the Type HGSR into modern electronic systems, getting mercury-wetted contact relay action on printed circuit boards.

The Type HGSR will give you complete freedom from contact bounce and chatter, with input-output isolation and high speed which qualify it as an excellent input buffer to solid state circuitry. Or, if you need high power gain as an output device from solid state systems, the Type HGSR will give you gain up to 5000.

As scanner contacts in checkout systems, the Type HGSR can withstand hi-pot voltage of 1000 vac, with 1500 vac offered on special-order. Constant contact resistance (within ± 2 milliohms of initial value over 20-billion operation life) is extremely important in critical measuring circuits. For tape transport read-write head switching, the Type HGSR offers the remarkable combination of high speed and low contact noise generation without false signaling due to contact bounce or chatter.

Get the full story on the Clare Type HGSR, and you'll discover new opportunities for high-reliability circuits, handling low level to 100 va, ac or dc, for over 20 billion operations without derating.

CHOOSE THE PCB RELAY YOU NEED FROM CLARE'S COMPLETE LINE

	HGSR		HGSM				HGM
	Series 10000	Series 50000	Series 10000	Series 50000	Series 1000	Series 5000	
Dimensions (l x w x h)	1 9/16" x 17/32" x .400"		2 1/16" x 5/8" x .625"				3 13/64" x 3/4" x 3/4"
Contacts (Note 1) Action (spdt)	1 Form D	1 Form C	1 Form D	1 Form C	1&2 Form D	1&2 Form C	1&2 Form D
Ratings Switched load (max)	2 amp, 500 v, 100 va		2 amp, 500 v, 100 va				5 amp, 500 v, 250 va
Carry load (max)	5 amp, not switched		5 amp, not switched				10 amp, not switched
Inrush load (avg) 10 ms 10 sec 100 sec	20 amp 4 amp 2 amp		20 amp 4 amp 2 amp				50 amp 10 amp 5 amp
Circuit resistance (max) (Note 2)	20 milliohms		20 milliohms				35 milliohms
	Variation less than ± 2 milliohms from initial value over 20 x 10^9 operations (Independent of current or voltage)						
Operating voltage	Up to 90 vdc		Up to 90 vdc				Up to 90 vdc
Operate time (nom) at max coil power	1.0 ms		1.0 ms		1.2 ms single side stable 1.0 ms bi-stable (Note 3)		As low as 2.4 ms (Note 3)
Sensitivity Bi-stable	20 mw either winding of double wound coil		20 mw either winding of double wound coil		25 mw (Note 3)		As low as 550 mw (Note 3)
Single Side Stable	40 mw single wound coil, 80 mw either winding of double wound coil		40 mw single wound coil, 80 mw either winding of double wound coil		115 mw (Note 3)		
NOTES:	1. Except for very light loads such as thermocouples and strain gauges, contacts must be protected by a resistor-capacitor suppression circuit. 2. Measured at 6 vdc, 100 ma. 3. Depending on number of contacts.						

Clare also offers Mercury-Wetted Contact Relays for wired assemblies... as well as in printed circuit board assemblies, combined with other components mounted on pcb's supplied by Clare or customer. See Clare Manual 201D.

For complete data, write Group 5B8
C. P. CLARE & CO.
3101 Pratt Boulevard
Chicago, Illinois 60645

CLARE®

relays and related control components

Circle No. 184 on Reader Service Card for more information.

For immediate sales contact, Circle No. 844.

DESIGN PRODUCTS

Timers

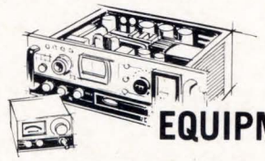
Portable Laboratory Stop Clocks, Models K15140 and K15150, can be started, stopped or reset by the front-mounted, three-position rocker switch or by a 6-ft remote control cable. A 3-amp timed convenience outlet permits outside circuits to be controlled and timed simultaneously. Model K15140 is calibrated in seconds and hundredths, has an inner scale of 0-60 sec and a sweep scale of 0-1 sec. Accuracy is ±20 msec per operation. Model K15150 is calibrated in minutes and hundredths. Inner scale registers 0-60 minutes and the sweep scale, 0-1 minute. Accuracy is ±0.005 minutes per operation. On each timer the inner hand is red and the sweep hand is black. Electrical requirements are 115v a-c, 60 Hz. Maximum power is only 3w (reset), 0.5w timing, and reset time is 3 sec maximum. A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn. 06720. **CIRCLE NO. 532**

Transformers

Ultraminiature Transistor Transformers, DO-T200 Series, are designed for printed-circuit applications and have the following electrical parameters: primary impedance 1000 to 200,000 ohms; d-c in primary 0 to 3 ma; secondary impedance 50 to 12,000 ohms; primary resistance 115 to 8500 ohms, and operating level 25 to 100 mw. The DO-T200 Series have a maximum diameter of 0.35 inch and a maximum height of 9/16 inch. The leads are 7/8 inch long and conform to the termination pattern of the TO-5 cased semiconductors and micrologic elements. Special modifications to customer requirements are available. United Transformer Co., 150 Varick St., New York, N.Y. 10013.
CIRCLE NO. 533

Tubes

Tetrode Power Tubes, Models 8679 and 8744, are designed for low distortion linear amplifiers for class AB, single sideband service. Both tubes are of ceramic and metal conical construction, forced-air cooled, and feature high linearity and minimum intermodulation distortion. The conical construction provides high mechanical strength, low inductance electrode connections and low thermal resistance paths for electrode cooling. The 8679 has an oxide coated cathode and is capable of dissipating 4 kw; the 8744 has a thoriated tungsten cathode and dissipates 10 kw. Plate voltages are 5000 and 6000v, respectively. Amperex Electronic Corp., Tube Div., Hicksville, L.I., N.Y. 11802.
CIRCLE NO. 534



EQUIPMENT

SWEEP GENERATORS

Master console accepts any combination of seven modules as needed. Present requirements can be supplied with off-the-shelf modules. Provisions for the future include wired connections and unwired, unused connections that can tie together all modular positions. Function modules now available are indicated in Fig. 1. Every discrete function of the instrument is a separate package. Space is available within the master console and inside each module for

Fig. 1
Sweep/signal generator system master console, showing following function modules in place: top, left to right.

- 5-500-MHz sweep oscillator, 100-kHz-500-MHz sweep width.
- 1-2000-MHz variable marker, with time sharing.
- Fixed marker, single and harmonic frequencies.
- RF output attenuator, 109-db/1-db steps, d-c

GO MOD

future modification and updating.

The instrument may be rack or bench mounted. It is 19 inches wide, 9 inches high and 17 inches deep. Telonic Instruments, Beach Grove, Ind., expect their Model 2003 to find wide application in laboratory use, as well as in future automatic and semiautomatic programmed production applications. **CIRCLE NO. 535**

- RF detector, 1 kHz-1500 MHz, with variable time constant.

And bottom, left to right:

- Basic rate/modulation controller.
- Display processor.

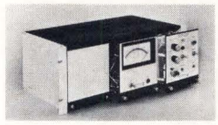
Other modules are available. Accidental module interchange will not cause damage.

EQUIPMENT

Amplifiers

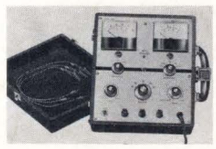
Sample and Hold Amplifier will, on command, take a narrow (approximately 3-nsec width) sample of the input, stretch, amplify and hold. The decay rate of the held analog voltage is less than 2v/sec. The Model SHA-3A samples and holds input signals up to ± 1v. Accuracy is 2 percent after correction for zero drift. The unit has an operating temperature range of 15 to 50C. Marquardt Industrial Products, 170 Eileen Way, Syosset, N.Y. 11791. **CIRCLE NO. 536**

Charge Type Amplifier, Model 2718, incorporates wide frequency and dynamic ranges to accurately measure shock impulses. Because the unit produces a directly proportional voltage output to a sensed input charge, long cables may be used without attenuating the sensitivity of pieozoelectric transducers. The Model 2718 can handle pulse durations as long as 600 μsec and as short as 33 μsec. It can operate with cable capacitance up to 100,000 pf and provides an internal sinusoidal calibration signal and calibrated dial sensitivity. Endevco Corp., 801 S. Arroyo Pkwy., Pasadena, Calif. 91109. **CIRCLE NO. 537**

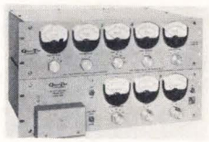


Analyzers

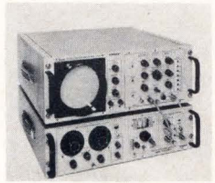
SCR (Thyristor) Analyzer, Model 240, gives rapid information on gate firing voltage and current, and on peak forward and peak reverse voltage and current. Readout is on two separate meters. Seco Electronics, Inc., 1001 Second St. S., Hopkins, Minn. 55343.
CIRCLE NO. 538

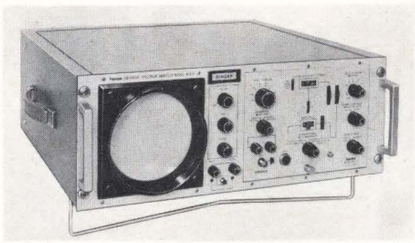


Noise Analyzer for IC's permits simultaneous noise measurements at five frequencies of 10 Hz to 100 kHz. The Model 2283/2181 may be used to measure anything from the thermal noise of a 10-kilohm resistor to a high-gain amplifier. Quan-Tech Labs., 43 S. Jefferson Rd., Whippany, N. J. 07981.
CIRCLE NO. 539



Spectrum Analyzer, Model SSB-50, gives panoramic display from 2 to 40 MHz. The unit can measure distortion, interference, spurious sideband, carrier level and noise to better than − 60 db from the peak reference level. An optional range extender increases low frequency response to 10 Hz. The Singer Co., Metrics Div., 915 Pembroke St., Bridgeport, Conn. 06608.
CIRCLE NO. 540





Video Module for use with "Panoramic" RTA-5 and TA-2 spectrum analyzers covers 1 kHz to 27.5 MHz. Specifications on the solid-state Model VR-4 include 200-Hz resolution, 30-μv sensitivity, 50-db linear dynamic range and ±1-db response from 1 kHz to 25 MHz. All amplitude and frequency readings are direct. The Singer Co., Metrics Div., 915 Pembroke St., Bridgeport, Conn. **CIRCLE NO. 541**

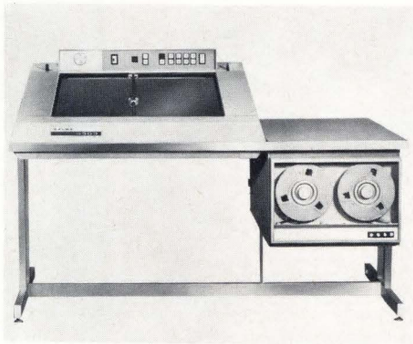
Microwave Spectrum Analyzer, a moderate cost unit, covers the span from 0.01 to 40 GHz. The Model SPA-100 has variable 0 to 100 MHz dispersion (optional 2-GHz model available later), 60-db on-screen log display and −75 to −100 dbm sensitivity. Singer Co., Metrics Div., 915 Pembroke St., Bridgeport, Conn. 06608. **CIRCLE NO. 542**

The new equipment listed in this section of **EDN** is arranged in alphabetical order for your convenience. Items are listed in the following order:

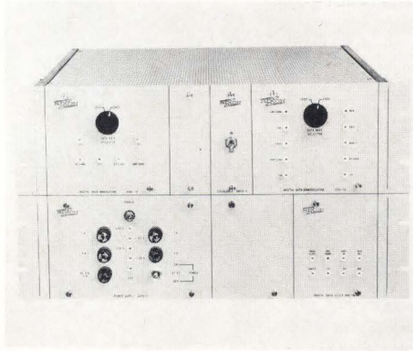
Amplifiers
Analyzers
Computer and Peripheral Equipment
Control Equipment
Converters
Counters
Meters, Analog
Meters, Digital
Microwave Equipment
Multiplex Equipment
Oscillators
Oscilloscopes and Accessories
Power Supplies
Production Equipment
Pulse Generators and Amplifiers
Recording and Readout Equipment
Signal Generators
Standards and Standardizing Equipment
Telemetry Equipment
Testers and Test Systems
Tools and Production Aids
Welding and Soldering Equipment
Miscellaneous

EQUIPMENT

Computer and Peripheral



Digitizer is a new device for reducing analog graphical data to digital magnetic tape for computer processing and analysis. The Model 303 incorporates variable interval programmed (VIP) digitizing which, in effect, achieves fine-resolution digitizing at coarse-resolution speed. Maximum tracing speed is 1875 inches/minute and basic resolution is 0.01 inch. The sampling interval varies between 0.01 and 0.15 inch with tracing stylus velocity. Calma Co., 346 Mathew St., Santa Clara, Calif. 95050. **CIRCLE NO. 543**

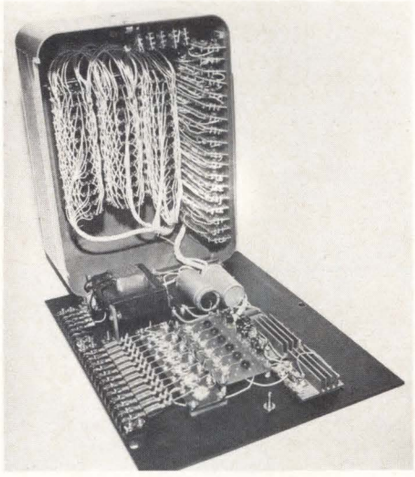


Data Set, PM-24, has high tolerance to delay and amplitude distortion. It will operate at 2400 bits per second in a bandwidth as narrow as 1200 Hz. This modular modem will transmit serial digital data at 2400 or 1200 bits per second over a telephone or other voice-frequency circuit between EDP equipment. The PM-24 is built to the EIA RS-232B computer interface standard. Rixon Electronics, Inc., 2120 Industrial Pkwy., Silver Spring, Md. 20904. **CIRCLE NO. 544**

Memory System uses integrated circuits and high-speed ferrite cores to achieve full cycle time of 500 nsec and basic capacity of 16,384 words of 36 bits each. The "2-1/2 D" IC Memory System is basically a marriage of the high-speed capability of linear select memories (2D or two wire) with the performance advantages of coincident-current memories (3D or four wire). The 22/12 high-speed ferrite cores have an exceptionally square loop and a switching speed of 220 nsec. They are mounted on aluminum plates that act as heat sinks to improve reliability. RCA Memory Products Div., 64 "A" St., Needham Heights, Mass. 02194.

CIRCLE NO. 545

Control Equipment



Multiple Output Programmer can initiate and terminate timing cycles with durations as low as hundredths of a second and up to 29.9 sec, to an accuracy of 1 msec. It can also accommodate any special requirements such as program holds or interrupts. Solid-state components and integrated circuits have been used to eliminate moving parts, assuring low maintenance time and long life. Leach Corp., Relay Div., 5915 Avalon Blvd., Los Angeles, Calif. 90003.

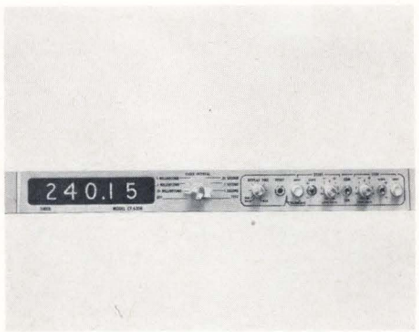
CIRCLE NO. 546

Converters

A-D and D-A Converters are versatile, low cost units. Included are a variable word length (up to 12 bits) general-purpose A-D converter (ADC-1) and multiplexer control (AMX-1) that will be offered as separate units or as a combined converter-multiplexer (Model CMX-1); a 10-bit integrated-circuit A-D converter (Model A-801) contained on one digital double "Flip Chip" module, and a 10-bit integrated circuit D-A converter (Model A-611), also on one double "Flip Chip" module. Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

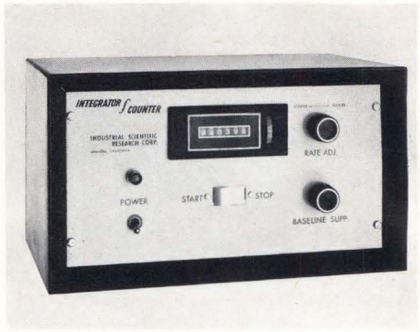
CIRCLE NO. 547

EQUIPMENT



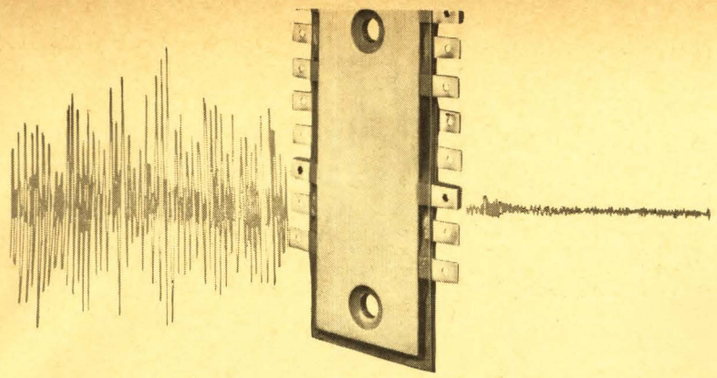
Time Interval Counter has d-c level gating. The Model CF-530R provides a wide variety of interval measurements such as pulse length, pulse spacing and time between electrical events. Start/stop d-c levels are adjustable from −30 to 30v with plus or minus slope control. A switch is provided for single-line or two-line gate inputs. Measurements of from 10 μsec to 100,000 sec are possible. Digital readout may be displayed for an adjustable interval, or the display may be held indefinitely until reset. Anadex Instruments, Inc., 7833 Haskell Ave., Van Nuys, Calif. 91406.

CIRCLE NO. 548

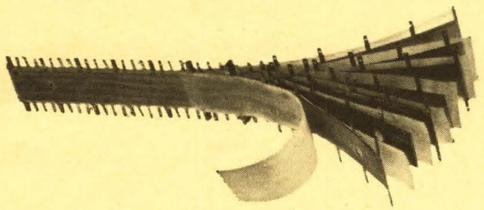


Integrator-Counter, Model IC-1033, measures time integral of low-level analog signals. Input sensitivity ranges are 0-50 mv, 0-100 mv and 0-1v d-c. Output counting rate is continuously variable. Both linearity and accuracy of this single-event integrator are ±0.5 percent of full scale. There is front panel or remote start-stop of integration cycle and zero offset correction. Industrial Scientific Research Corp., 2220 Howell Ave., Anaheim, Calif. 92805.

CIRCLE NO. 549



Laminated Bus Bars For Noise Reduction



Flat bus conductors laminated with Eldre's thin, rugged insulation will reduce electrical noises which cause havoc in high speed, solid state equipment. Lower the inductance and control the capacitance of your vital power distribution lines. Ground shields are interleaved with the voltage-carrying conductors so that effective shielding can be adequately provided. The terminations of each conductor, as shown, are for soldering but other types can be incorporated into the bus design. This compact and completely molded bus can replace a bulky harness and repetitive wiring.

Increase the reliability of your circuit with a bus system and obtain efficiency.

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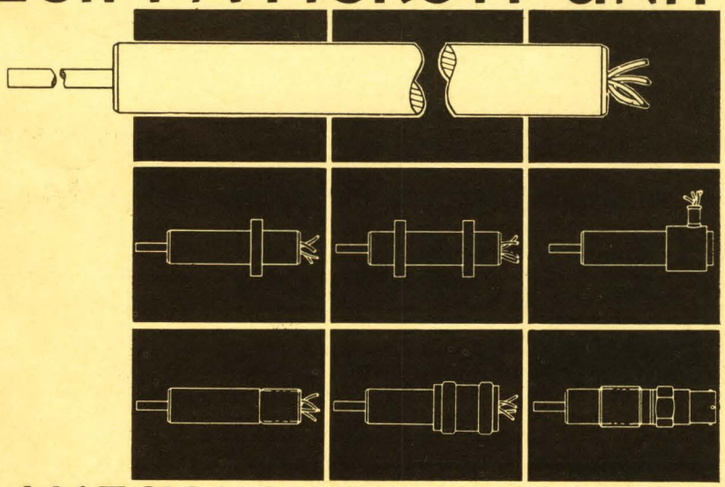

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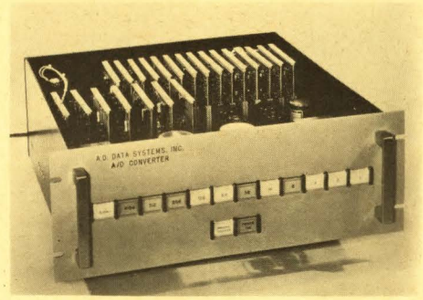
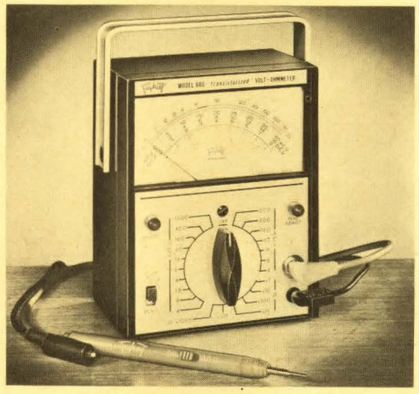


Analog-to-Digital Converters with conversion speeds to 2000 per sec are intended for computer applications compatible with incremental tape recorder speeds. The Series 013 converters have accuracies from 0.08 percent to 0.01 percent full scale ±1 count. Conversion rate is 50 μsec per bit, including polarity. Prices range from $1000 to $2900. A. D. Data Systems, Inc., 830 Linden Ave., Rochester, N.Y.

CIRCLE NO. 550

Meters, Analog

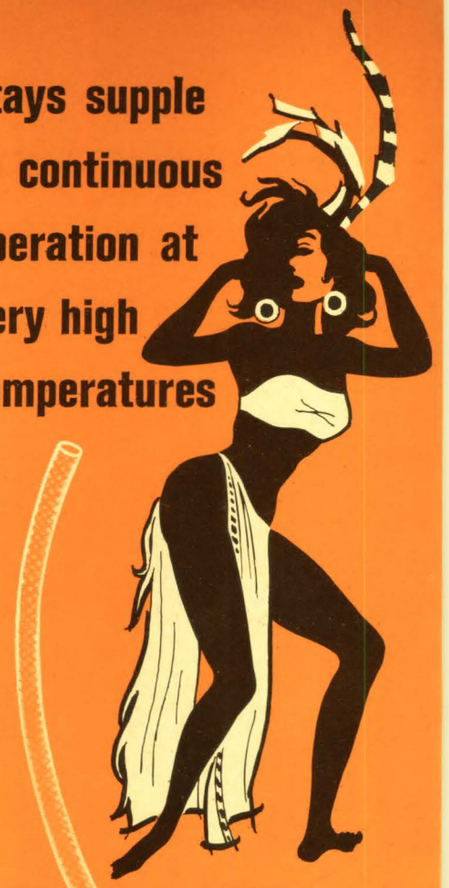


Transistorized VOM, Model 600, has simplified scale and FET input circuit for 11-megohm input impedance on d-c ranges above 0.8v. Full-scale ranges are 0.4 to 1600v d-c, 4 to 800v a-c and 1000 ohms to 100 megohms resistance. A single probe that switches to d-c or a-c and ohms, plus a d-c polarity reversing switch, give simplified test connections. Price is $78 complete with batteries (4000-hour normal battery life). The Triplett Electrical Instrument Co., Bluffton, Ohio 45817. **CIRCLE NO. 551**

Current Indicator and Integrator, Model A 308 C, is self-calibrating and has sensitivities variable from 1 ma to 3×10^{-8} amps for either positive or negative current measurement. The integrating rate is calibrated by a 10-turn precision potentiometer and the integral is displayed digitally. Both indicating and integrating values are accurate to 1 percent. Elcor, Div. of Halliburton Co., 2431 Linden Lane, Silver Spring, Md. 20910. **CIRCLE NO. 552**

Circle No. 202 on Reader-Service Card for more information.

Stays supple in continuous operation at very high temperatures



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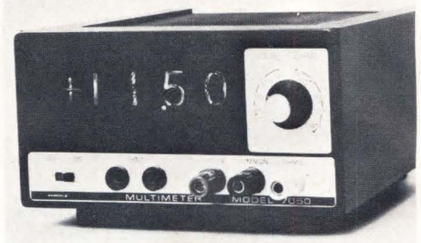
HIGH TEMPERATURE WIRE AND CABLE

EQUIPMENT

Meters, Digital

Proximity Voltmeter, Series 5050, gives noncontacting measurement from 1 to 1000v full scale at possible accuracy of better than 1 percent. With its Model 5051-25 high-resolution probe it can resolve circular spot charges as small as 0.075-inch dia. Response speed is rapid, with rise time of 10 to 90 percent in less than 10 msec. Electrometer Products Div., Victoreen Instrument Co., 10101 Woodland Ave., Cleveland, Ohio 44104.

CIRCLE NO. 553



An Accurate Digital Multimeter for less than $300! The Model 7050 is an integrating voltmeter that uses the dual-slope technique plus automatic comparison to an internal standard. Sampling speed is six measurements per second. Full-scale ranges cover from 1.5 to 1000v and 1500 ohms to 15 megohms. Input impedance is greater than 1000 megohms and the floating input may be operated 500v above ground. Display blinking is avoided by the use of readout storage. Fairchild Instrumentation, 475 Ellis St., Mountain View, Calif. 94040.

CIRCLE NO. 554

EQUIPMENT

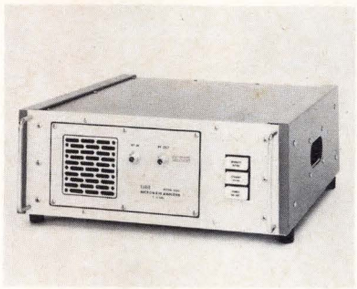
Digital Voltmeters, Model 400 Series, feature system compatibility with their BCD outputs and their ability to accept external trigger signals, to generate signals to trigger external data recorders and to provide direct readings in engineering units. Included are three- and four-digit models. The four-digit model provides full-scale accuracy of 0.05 percent, resolution of 0.01 percent and has 100-μv basic d-c sensitivity. Janus Control Corp., Div. of Tyco Labs., Inc., 296 Newton St., Waltham, Mass. 02154.

CIRCLE NO. 555

Digital Meter is a DVM, an integrator and a counter. The Model DM 5000 has d-c ranges from 100 mv to 1000v with 0.1-percent accuracy, 100-μv resolution and input impedance greater than 10 megohms. As a counter it offers rate, period and count modes of operation. Rate mode ranges are from 9.999 to 9999 kHz full scale. Technology, Inc., 7400 Colonel Glenn Hwy., Dayton, Ohio 45431.

CIRCLE NO. 556

Microwave Equipment



10w Mcrowave Amplifiers, Model 5000 Series, use PPM-focused traveling wave tubes to cover the frequency range of 1 to 11 GHz in four models. Gain is 30 db at both low signal levels and at the 10w level. "Total protection" circuits make possible reliable unattended operation. Alfred Electronics, 3176 Porter Dr., Palo Alto, Calif. **CIRCLE NO. 557**

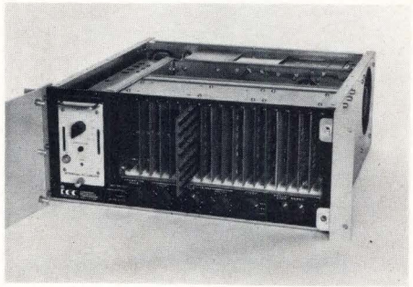
Convenience.

Color Coding Eases db Value Reading

These miniature fixed attenuator pads are color coded for db values of 1, 2, 3, 6, 10 and 20. An easy-to-read quality pad at the practical price of **$12.50.** The model FP-50 pads are designed for operation from DC to 2000 MHZ. Accuracy is better than ±0.3 db to 500 MHZ and ±0.5 db to 1 GHZ. Each pad is calibrated at two frequencies, 30 MHZ and 1 GHZ, with the calibration recorded on the body of the attenuator. Impedance of the FP-50 is 50 ohms and the FP-75 is 75 ohms. A wide range of connector types can be provided with BNC, TNC and type N. Units available from stock.

EQUIPMENT

Multiplex Equipment



Analog Multiplexer is a high-speed, low-level unit with FET switches and IC logic. Full-scale differential floating input ranges of the Series 500 are from ± 5 to ± 640 mv with a full-scale output of ± 10v. Maximum sampling speed is 40,000 samples per sec. Interstate Electronics Corp., 707 E. Vermont Ave., Anaheim, Calif. 92803. **CIRCLE NO. 558**

Oscillators

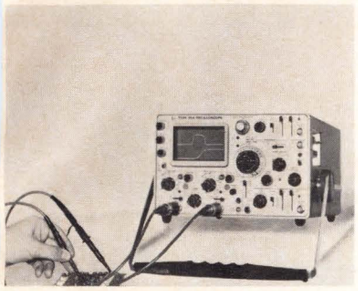
Precision Oscillator covers 10 Hz to 100 kHz and delivers 12v rms with constant 600-ohm impedance. The Model CVO has the unusual specification of 0.01 percent for frequency response, harmonic distortion, amplitude stability, cycle-to-cycle stability, frequency stability per hour and frequency resolution. Plug-in options include a voltage divider with 1-μv resolution, a nonsinusoidal function generator and a db attenuator. External accessories include a 120v amplifier and a digital readout. Weston Instruments, Inc., 614 Frelinghuysen Ave., Newark, N. J. 07014.

CIRCLE NO. 559

Oscilloscopes and Accessories

Digital Oscilloscope System combines Type 568 oscilloscope and Type 230 digital unit to provide up to 50 measurements per second, easy external programming, BCD data outputs and solid-state IC circuitry. Digital presentations can designate voltage measurements, time-difference measurements between similar pulses and time-difference measurements between percentages or voltages of pulse amplitudes. Tektronix, Inc., Box 500, Beaverton, Ore. 97005.

CIRCLE NO. 560



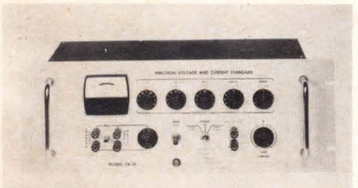
2.4-nsec 150-MHz Oscilloscope offers portability, dual trace and rugged construction. The Type 454 has a 5-mv/div dual trace vertical section, 150-MHz triggering, 5-nsec/div delayed sweep and solid-state design. The 2.4-nsec rise time and d-c to 150 MHz bandwidth are specified at the tip of the included 10X attenuator probe. There is provision for directly mounting high-speed cameras on the scope. Tektronix, Inc., Box 500, Beaverton, Ore. 97005.

CIRCLE NO. 561

Time Mark Generator, the "Multi/marker", delivers six crystal-controlled frequencies from 100 Hz to 10 MHz at better than ±0.007 percent accuracy, plus a 1v p-p calibrator output at better than ±0.5 percent. Battery powered and rugged, it can be plugged directly into an oscilloscope to calibrate the sweep and vertical amplifiers. Accutronics, Inc., 12 S. Island, Batavia, Ill.

CIRCLE NO. 562

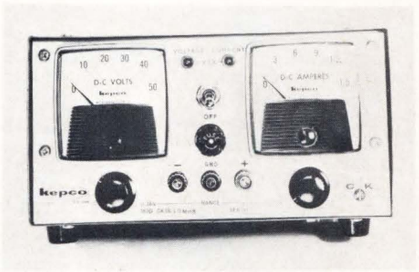
Power Supplies



Precision D-C Current/Voltage Source and Differential Voltmeter, Model CR-10-NR, has absolute accuracy of ±0.02 percent of setting with a stability of 0.001 percent for an 8-hour period. Maximum output current is 11.1110 ma with voltage compliance of 20v and resolution in 100-na steps. Maximum output voltage is ±11.1110v at 20 ma. The current mode is open-circuitproof and the voltage mode is short-circuitproof. Electronic Development Corp., 423 W. Broadway, Boston, Mass. **CIRCLE NO. 563**

Circle No. 217 on Reader Service Card for more information.

EQUIPMENT



Fast Slewing Current Regulators and unipolar d-c amplifiers have 0.1v/μsec slewing rate and more than 90-db open loop gain. The CK (HS) supplies are offered in five models from 0-5 to 0-60v and 0-8 amps to 0-500 ma. Kepco, Inc., 131-38 Sanford Ave., Flushing, N.Y. 11352. **CIRCLE NO. 564**

Production Equipment

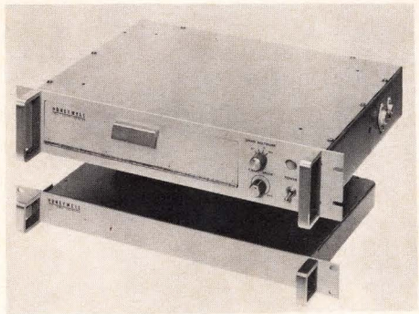
Vacuum Sputtering System, Model 3197, uses a tetrode to provide 10 times lower pressure, faster deposition rates and purer films. Metals, metal alloys and dielectrics can be deposited on a substrate at the rate of 1000Å per minute at pressures of 2×10^{-4} Torr measured at the base plate. Deposited material can be varied in thickness from a few angstroms to many microns. National Research Corp., subsidiary of Norton Co., 160 Charlemont St., Newton, Mass. 02161. **CIRCLE NO. 565**

Automatic Vacuum Station is portable and provides fast vacuums in 10^{-6} Torr range without requiring operator skill or decision. The "Port-A-Vac" is air and cryogenically cooled and thus requires no connection to water source. Materials Research Corp., Orangeburg, N.Y. 10962. **CIRCLE NO. 566**

Pulse Generators

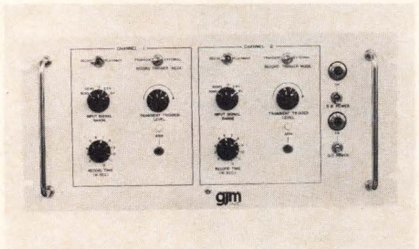
High-Power Pulse Generator has rise time of less than 10 nsec and fall time of less than 12 nsec. The Model 380 is a 5-kw unit that, when combined with a variable rise- fall-time control plug-in and high-current and high-voltage plug-ins, will deliver high power, clean waveform pulses with output voltages to 1000v, or output current to 100 amps into 0.5 ohm. Velonex, Div. of Pulse Engineering, Inc.. 560 Robert Ave., Santa Clara, Calif. **CIRCLE NO. 567**

Recording and Readout



Galvo-Printer (Model 1204) and companion Parallel-to-Serial Converter (Model 1207) are accessory units for the "Visicorder" oscillographs. The printer allows simultaneous recording of digital information using a single standard galvanometer, while analog records are being made. The converter unit can present the digital information in serial format. Printing rates of up to 2000 lines/sec are possible—more than 100 times faster than mechanical units. Honeywell, Inc., Test Instruments Div., 4800 E. Dry Creek Rd., Denver, Colo. **CIRCLE NO. 568**

TV Disc Recorder can store up to 1000 individual pictures indefinitely, yet they may be erased instantly if desired. The selection and instant display of any desired frame on one or more standard television monitors is done by dialing a three-digit number as on a telephone. Both recording and erasure can be performed automatically at a remote pushbutton control box. General Electrodynamics Corp., 4430 Forest Lane, Garland, Tex. **CIRCLE NO. 569**



Event Recorder, Model ER-200, makes a memory oscilloscope of any standard oscilloscope because of its ability to store and repetitively play back an event for display. Full-scale input ranges from 50 mv to 5v and the frequency range is 1 to 100 kHz. Triggering is internal or external. The incoming signal frequency-modulates the signal that is stored on a magnetic drum. Western Magnetics, Div. of GJM, Inc., 1733 Flower St., Glendale, Calif. 91205. **CIRCLE NO. 570**

EQUIPMENT

Signal Generators

Digital Frequency Synthesizer has output from d-c to 1.3 MHz in 0.01-Hz steps. The Model 3100A has built-in clock with frequency stability of 1 part in 10^9 per day. Harmonics are down at least 55 db, spurious signals at least 90 db; 20-μsec switching speed programmability is available as an option. Monsanto Electronics Center, 620 Passaic Ave., West Caldwell, N. J. 07006.
CIRCLE NO. 572

Standards and Standardizing

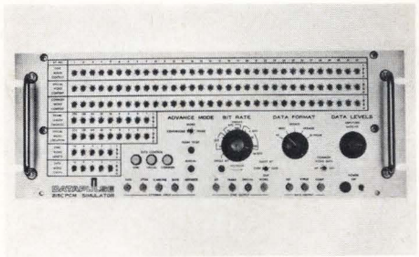
Precision D-C Current Source has full-scale ranges of 1.2, 12 and 120 ma and 1.2 and 12 amps, with a compliance of 10v. The Model DCS-105 has accuracy of 0.003 percent on the three low ranges, 0.006 percent on the 1.2-amp range and 0.01 percent on the 12-amp range. Temperature coefficient is 5 ppm/deg C. Specifications are very conservatively rated. Julie Research Labs., Inc., 211 W. 61st St., New York, N.Y. 10023.
CIRCLE NO. 573

Telemetry

FM Subcarrier Discriminator, Model FDS30, uses all solid-state circuits and passive filters. It is designed for use on all IRIG proportional and constant bandwidth channels. The discriminator can accommodate any center frequency from 300 Hz to 300 kHz and any deviation from ±2 to ± 40 percent. The design avoids "loss of lock" that is inherent in phase-lock-loop type discriminators. Airpax Electronics, Inc., Seminole Div., Fort Lauderdale, Fla. 33310.
CIRCLE NO. 574

Testers and Test Systems

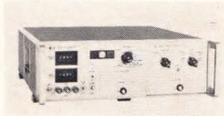
Low Cost Transistor Checker is a battery-operated Go/No Go unit that will show in two steps the transistor's polarity, whether npn or pnp, whether it is operational or faulty and the d-c beta. Price for the Model 20 is $19.95 in small quantities. Lucci & Co., 3216 Clark Rd., Sarasota, Fla. 33581. **CIRCLE NO. 575**



PCM Simulator can provide programmable and perturbable serial digital data in up to 512-word frames. The Model 215C features three independent word types, RZ or NRZ formats, clock rates to 1 MHz and provision for blanking and bit jitter. Frame program is controlled by binary toggle switches, selectable from 1 to 512 words. Datapulse, 509 Hindry Ave., Inglewood, Calif. 90306. **CIRCLE NO. 576**

Programmable Curve Tracer for semiconductor testing can perform up to five separate tests automatically on an individual semiconductor device at a single insertion. The Model 6200 B/P when combined with Model 3509B programmer makes a complete semiautomatic test station. Functions that can be programmed on the unit include: vertical and horizontal sensitivity, collector sweep range and polarity, two values of collector dissipation resistance and all base ranges. Polarity and manual 1-2 or 5 multiplier as well as normal and pulsed-mode operations also are possible. Fairchild Instrumentation, 475 Ellis St., Mountain View, Calif. 94040. **CIRCLE NO. 577**

IC Test System, Series 5000, combines accurate, high-speed d-c parameter measurements with a new dynamic digital time and voltage module (DTVM). Module features include 100 percent digitally programmable functions, digital readout of data, adaptability to any size monitor scope and inclusion of all active high-frequency measuring circuits in an analog feedback loop. Fairchild Instrumentation, 475 Ellis St., Mountain View, Calif. 94040. **CIRCLE NO. 578**

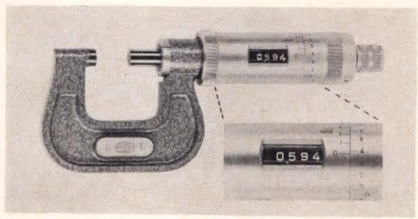


Two Limit Comparator allows high/go/low decisions on d-c voltage, a-c voltage, d-c current or resistance (depending on plug-in). The Model 3434A gives lighted indications to eliminate need for operator decision. Relay closures are provided. Comparison accuracies are typically better than ± 0.05 percent for d-c, ± 0.12 percent for a-c and ± 0.25 percent for resistance. The comparison circuits sample continuously at 15 decisions per second or upon command. Hewlett-Packard Corp., 1501 Page Mill Rd., Palo Alto, Calif. 94304. **CIRCLE NO. 579**

EQUIPMENT

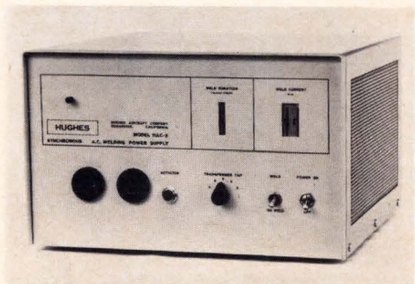
Hall Effect Test Set has electronic regulation of sample or control current between 1 ma and 1 amp. The Model 1000 is intended for measurement of the Hall coefficient of materials or the evaluation of Hall effect probes. The magnetic field can be adjusted quickly from low values to in excess of 10 kilogauss. A high-linearity Hall probe is included. Ohio Semitronics, Inc., 1205 Chesapeake Ave., Columbus, Ohio 43212. **CIRCLE NO. 580**

Tools and Production Aids



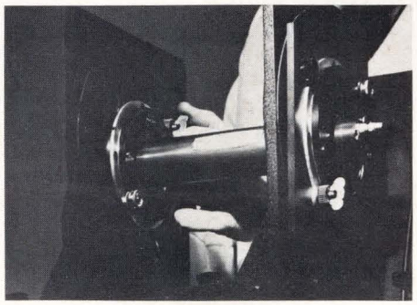
Micrometers have digital readout to 0.001 inch with parallax-free vernier readings of 0.0001 inch. Ranges are from 0 to 1 inch to 11 inches to 12 inches. All models are ratchet operated and have nonrotating measurement spindles. Carbide tips are standard. Price of the 0- to 1-inch model is $85. The Dyer Co., Oberlin, Ohio. 44074. **CIRCLE NO. 581**

Welding and Soldering Equipment

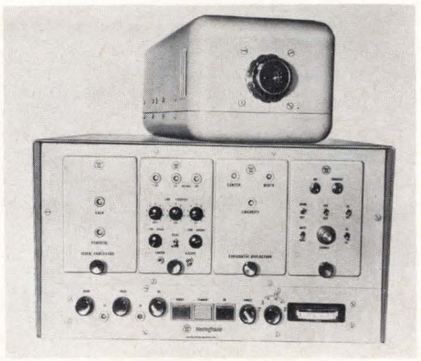


A-C Welding Power Supply has digital selectors for phase shift and pulse length. Pulse length of the Model HAC-2 is variable in 1/2-cycle increments from 1/2 to 5 cycles. The new supply is suitable for welding, brazing and reflow soldering. Hughes Welders, 2020 Oceanside Blvd., Oceanside, Calif. 92054. **CIRCLE NO. 582**

Miscellaneous



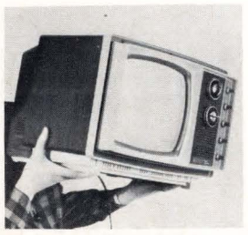
Laser Modulator, Model 10, is a multiple crystal device that operates at low modulation voltages. It has an operating bandwidth of 1 Hz to 100 MHz. Both temperature and piezoelectric effect have been reduced or compensated and as a result, frequency response is nominally flat across the entire bandwidth. Beckman & Whitley, 441 N. Whisman Rd., Mountain View, Calif. 94040. **CIRCLE NO. 583**



TV Camera System for low light-level applications, is 100 times more sensitive than an image orthicon camera. The "Secon" camera has a limiting resolution of 600 lines at 5×10^{-3} ft-candle photocathode illumination (200 lines at 5×10^{-5} ft-candle). and is available at any line scanning rate between 525 and 945. Westinghouse New Products Div., Box 8606, Pittsburgh, Pa. 15221. **CIRCLE NO. 584**

CRT Analyzer/Rejuvenator, Model CR-35, can check all black and white and color tubes, including 11-, 16- and 19-inch types. Test voltages are continuously variable and meter monitored. An SCR circuit is used in the heater voltage supply. Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio 44108.
CIRCLE NO. 585

Color TV is priced under $200, weighs only 24 lb and has a 60-sq-inch picture. An "in-line" picture tube allows simplified circuitry that gives improved reliability and reduced cost and weight. General Electric, Consumer Electronics Div., 570 Lexington Ave., New York. N.Y. **CIRCLE NO. 586**



Engineers Meet

MAY							JUNE						
S	M	T	W	T	F	S	S	M	T	W	T	F	S
	1	2	3	4	5	6					1	2	3
7	8	9	10	11	12	13	4	5	6	7	8	9	10
14	15	16	17	18	19	20	11	12	13	14	15	16	17
21	22	23	24	25	26	27	18	19	20	21	22	23	24
28	29	30	31				25	26	27	28	29	30	

SOCIETY FOR INFORMATION DISPLAY (SID), EIGHTH NATIONAL SYMPOSIUM AND EXHIBIT, May 24-26, Jack Tar Hotel, San Francisco, Calif. Contact: Jerry T. Lewis, Registration Chairman, Stanford Research Institute, Menlo Park, Calif.

13TH NATIONAL AID-ISA ANALYTICAL INSTRUMENT SYMPOSIUM, May 31-June 2, Statler Hilton Hotel, Los Angeles, Calif. Contact: Al H. Smallbone, Applied Research Labs., 3710 Clifton Pl., Glendale, Calif. 91208.

AMERICAN SOCIETY FOR QUALITY CONTROL, 21ST ANNUAL TECHNICAL CONFERENCE AND EXHIBIT, May 31-June 2, Palmer House, Chicago, Ill. Contact: Registration Chairman, American Society for Quality Control, 161 W. Wisconsin Ave., Milwaukee, Wis. 53203.

IEEE SYMPOSIUM ON MANUFACTURE OF INTEGRATED CIRCUITS, June 5, United Engineering Center, New York, N.Y. Contact: Miss B. S. Hines, Symposium Registration Coordinator, 7830 Hasbrook Ave., Philadelphia, Pa. 19111.

INTEGRAL ELECTRONICS TRAINING PROGRAM (ARINC Research Corp.), June 5-8, Orlando, Fla.; Sept. 18-21, Seattle, Wash.; Oct. 16-19, Toronto. Contact: Donald L. Rowe, Manager, Educational Programs, ARINC Research Corp., Annapolis, Md. 21401.

SEMICONDUCTOR MATERIALS AND TECHNOLOGY SHORT COURSE, June 5-9, Stevens Institute of Technology, Hoboken, N. J. Contact: Lynn J. Merrill, Asst. to the President, Stevens Institute of Technology, Castle Point Station, Hoboken, N. J. 07030.

MODERN ASPECTS OF COMMUNICATION THEORY SHORT COURSE, June 5-16, Purdue University, Lafayette, Ind. Contact: Prof. John C. Lindenlaub, School of Electrical Engineering, Purdue University, Lafayette, Ind. 47907.

SECOND SYMPOSIUM ON DEPOSITION OF THIN FILMS BY SPUTTERING, sponsored by American Vacuum Society and University of Rochester, June 6-7, University of Rochester. Contact: Roger D'Aprix, Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester, N.Y. 14603.

MICROWAVE EXPOSITION/67, June, 6-8, New York Coliseum, Contact: Austin G. Cragg, Microwave

Expositions, Inc., 100 Avenue of the Americas, New York, N.Y. 10013.

1967 Conference on Laser Engineering and Application (IEEE and Optical Society of America), June 6-9, Washington Hilton Hotel, Washington, D.C.

Precise Determination of Pressure/Depth in the Oceans Symposium (Marine Technology Society Oceanographic Instrumentation Committee), June 8, El Cortez Hotel, San Diego, Calif. Contact: Kenneth V. Mackenzie, Head, Deep Submergence Group, Scientific Dept., Code 3119, U.S. Navy Electronics Lab., San Diego, Calif. 92152.

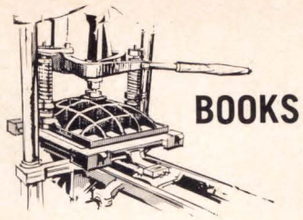
Third Annual IEEE International Conference on Communications, June 12-14, Minneapolis, Minn. Contact: Dr. Robert J. Collins, Technical Program Chairman, Dept. of Electrical Engineering, University of Minnesota, Minneapolis, Minn.

13th National ISA Aerospace Instrumentation Symposium, June 13-16, Hotel Del Coronado, San Diego, Calif. Contact: John A. Hughes, Convair Div. of General Dynamics, Dept. 961-1, Box 1128, San Diego, Calif. 92112.

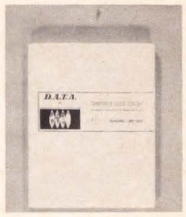
Engineering Seminar, Flat Cable—Present and Future, June 20, Hancock Auditorium, University of Southern California, Los Angeles. Presented by the Institute of Printed Circuits in cooperation with the School of Engineering, University of Southern California. Sponsored by EDN Magazine. Contact: Jim Rose, EDN Western Editor, 5670 Wilshire Blvd., Los Angeles, Calif. 90036. Phone: 213 933-9525.

Call for Papers

IEEE Electronics and Aerospace Systems Technical Convention (EASTCON '67), Oct. 16-18, Sheraton Park Hotel, Washington, D.C. EASTCON provides an annual national forum for the exchange of information on Aerospace and Electronics Systems Technology. The comprehensive technical program should be of interest to all engineers concerned with systems. The technical program will be selected to present the latest developments in theory, technique and equipment that are pertinent to the design and operation of electronic and aerospace systems. Contributed papers covering original work are invited in the following broad areas: Radar and Tracking; Communications; Signal Processing; Instrumentation; Navigation; Systems Engineering; Energy Conversion, and Integrated Electronics. Submit four copies of your abstract (about 500 words) by June 1 to: Dr. Donald R. Hagner, BELLCOMM, Inc., 1107 17th St., N.W., Washington, D.C. 20036.



BOOKS



Computer Logic Circuit Characteristics Tabulation

Fourth Edition; February-July 1967; D.A.T.A., Inc., 32 Lincoln Ave., Orange, N. J. 07050; $32.50, 1-year subscription U.S. and Canada; elsewhere, $33.50.

The versatility of D.A.T.A.'s tabulated information can be described best by listing the eight questions that can be answered by proper use of this material.

1. Looking for a circuit meeting certain electrical or mechanical requirements?
2. Need the characteristics of a type number?
3. Want to know the manufacturer(s) of one or more type numbers?
4. Need substitution possibilities for a type number?
5. Looking for the package configuration or dimensions of a type number?
6. Want to see the logic function and/or schematic of a type number?
7. Interested in the approximate price of a type number?
8. Are you puzzled to discover that the kind of circuit you want is not shown as such in the contents?

A small amount of homework will provide a solution for most circuit information needs that an engineer may encounter. We think you'll find the $32.50 cost is small compared to the value received.

Technical Report

The following report can be obtained by sending $0.70 to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

"Selected Electronic Circuitry—A Report", NASA SP-5046, contains 102 pages of information on the following solid-state circuits; amplifiers, oscillators, multivibrators, power supplies, wave shaping, temperature compensation, control and specialized computer. Each of the preceding categories is a complete chapter in which many types of circuits are discussed.

Engineers will find this book useful as a source of reference when quick look-up information is needed for a particular circuit configuration.

Communication Systems And Techniques

By Mischa Schwartz, William R. Bennett and Seymour Stein; McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N.Y. 10036; 618 pages; $16.50.

This is the fourth volume in McGraw-Hill's Inter-University Electronics Series and is written in three parts. Part 1 summarizes the fundamental aspects of modern communication theory and develops applications to pulse and CW systems. Part 2 deals with modern communications systems, including AM, FM and pulse modulation. Part 3 presents many theoretical aspects of digital signaling. Although the treatment is theoretical, emphasis is placed on explaining the models being employed and on techniques of performance analysis that lead to useful solutions. Much of the material is presented in highly sophisticated mathematical form; however, the text is studded with physical interpretations. Many summaries of significant results, as well as frequent charts and graphs, should make the book useful to engineers searching for solutions to their communications problems.

Antennas

By Lamont V. Blake; John Wiley & Sons, 605 Third Ave., New York, N.Y., 10016; 415 pages; clothbound; $6.95. Also available paperbound at $3.95.

Design engineers may find this book unique in that it is a complete text on antennas. The text fills the need for a book on antennas on the professional level, yet is comprehensible to the engineer who is not a specialist in the field of antennas.

Both antenna theory and practice are covered from the lowest frequency to the microwave ranges. The latest developments such as the log-periodic-broad-bandwidth antennas and low-noise, space-communications antennas are discussed.

Transformers For Electronic Circuits

By Nathan R. Grossner; McGraw-Hill Book Co., 330 W. 42nd St., New York, N.Y. 10036; 321 pages; hardbound, $14.

This book was written by a transformer design engineer to aid circuit, systems and standards engineers in the selection of transformers. It is not a design manual.

Such recent advances as conductive heat shields and evaporative cooling are treated, as is the use of new core materials like supermendur and ferrites.

Complicated equations and masses of design data have been avoided in keeping with the book's intended use. Emphasis has, instead, been concentrated on basic principles and fundamental relationships.

BOOKS

The Radio Amateur's Handbook, 44th Edition

Edited by Byron Goodman; American Radio Relay League, Inc., Newington, Conn.; 646 pages; $4.

The 1967, 44th edition of the "ARL" handbook represents a continuous annual publication since 1926. Almost 4 million copies have been bought not only by radio amateurs, but by engineers and students as well. The basic content of the book hasn't changed substantially over the years except to make necessary revisions to update information and introduce new concepts to keep abreast of the state-of-the-art.

For example, chapters on radio communications theory have been updated, equipment construction has been revised to include new designs, and information on vacuum tubes and semiconductors has been brought up to date. This last section, as has been the case in the past, provides one of the most complete listings to be found between the covers of any book. A 14-page index adds to the utility of this standard manual of amateur radio communication, construction and design.

Technical Reports

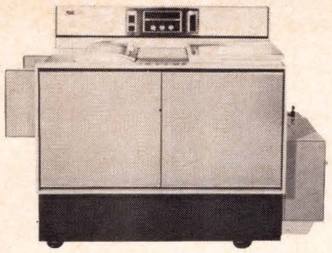
The following technical reports are available at $3 each. Copies can be obtained by sending order to Clearinghouse, U.S. Dept. of Commerce, Springfield, Va. 22151.

Integrated Silicon Device Technology, Vol. XI, Bipolar Transistors; J. R. Hauser; Research Triangle Institute; Durham, N.C.; AD-632 556.

This report is the 11th volume of a series of reports on integrated silicon device technology. The series is being prepared to aid design and process engineers. In this report, both bipolar transistor theory and the characteristics and design of transistors in IC's are discussed. Both small- and large-signal models are treated, and models for general impurity profiles in the emitter, base and collector regions are included. The report also includes a discussion of typical transistor structures, isolation problems, topological design and multiple transistor structures.

Integrated Silicon Device Technology, Vol. VI, Unipolar Transistors; J. R. Hauser; Research Triangle Institute; Durham, N.C.; AD-613 951.

This report discusses the theory and design parameters for FET's in IC's. The first two sections discuss theory and characteristics of junction and MOS devices. The next section covers design considerations for FET's in IC's. This includes isolation problems, topological design and compatibility. The last section discusses some possible circuit applications.



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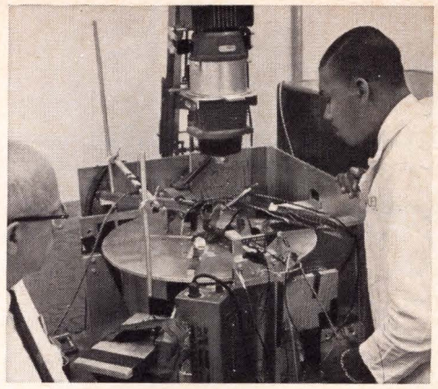

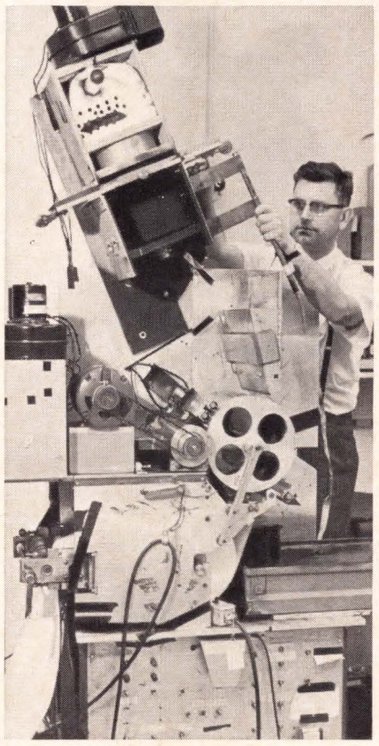

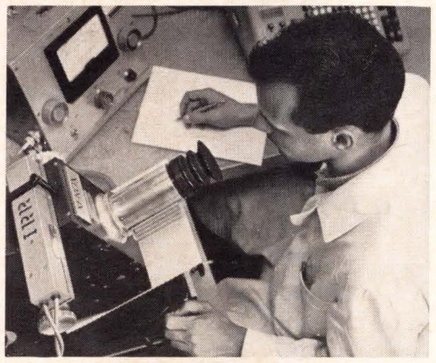

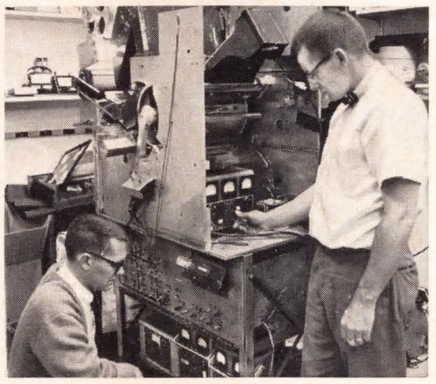

Engineers ...

The first regular production models of the Xerox 2400 were delivered in late 1965. This of course pegs its breadboard photos as "ancient history."

Then why drag them out now? Because we can't show you today's breadboards, as much as we'd like to.

But re-examine them in light of these facts about the 2400. Never before the 2400's introduction had it been possible to eliminate all distinction between office copying and short-run duplicating—to wed printing and imaging. Never before had a way existed to reproduce messages on paper as fast as this, as conveniently as this and as cheaply as this, without first creating a usable master (type, plate, stencil, etc.) from the original document. For with the 2400 it's just—pick a number from 1 to 499 ...push a button and 40 clean copies a minute with no steps between original and copies...except for some pretty unusual electrical/mechanical/optical processes quietly flying through their routines under the metal housing. With a kind of precision and reliability that only an engineer will fully appreciate.

Like we say, as breadboards go, the 2400 is definitely past tense. Some other things we're doing here – computer related data and document systems, for example – definitely aren't.

If you've been designing or developing complex servomechanisms, electromechanical systems, or specific products for graphic communications, major appliances, missiles or automobiles, we'd like to talk with you about some newer breadboards. The primary requirement is that, beyond your engineering degree, you can point to a record of achievement and demonstrate your ability to approach nonstandard problems in non-standard ways.

Specific openings are outlined at the left. If they suggest a community of interest, send us your resume.

You'll be doing some fancy breadboarding to make it look this simple.

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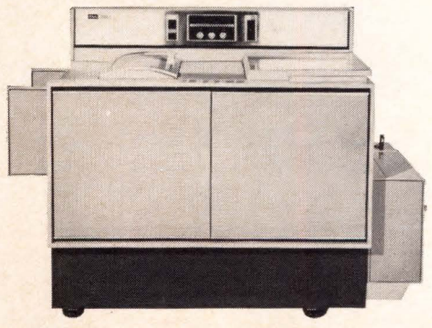


SIGNALS AND NOISE

Cost Analysis Reanalyzed

Gentlemen.

The article, "IC Reliability—What Does It Cost?", by H. T. Go in the March 1967 issue of EDN contains a couple of errors on p. 42 in the cost analysis of single and multicircuit arrays. In the cost equations, the initial term (the wafer-processing investment per chip) also should be divided by yield after encapsulation, as yield losses during encapsulation result in loss of processing investment as well as encapsulating investment. The resulting inequality for cost analysis is as follows:

$$\frac{C_p}{(n/N)\,Y_N\,Y_T} + \frac{C_e}{Y_T} < N\left(\frac{C_p}{n\,Y_n\,Y_t} + \frac{C_e}{Y_t}\right)$$

It should also be noted that there is a typographical error in the denomination of first term within the brackets on the right-hand side of the inequality. This term should contain Y_n, not Y_N.

Richart A. Stoltz
Processes & Systems
Technology
Westinghouse Electric Corp.
Pittsburgh, Pa.

Editor's Note: The author agrees with the corrections made by Mr. Stolz.

Overheard at IEEE

Three engineers listening to an IEEE paper presentation—the first one said, "The talk sure is windy." The second man replied, 'No, it's Thursday." The third engineer chimed in, "I'm thirsty, too—let's stop at the bar and have a drink."

More Mathematical Mumbo-Jumbo?

One of our authors, Monty Walker, has been observing the mathematical (?) games on these pages. He indicates that many more can be found in a book by E. A. Maxwell, "Fallacies in Mathematics", Cambridge University Press, copyright 1959, reprinted in 1961.

TWIRKS

Here's a tricky little puzzler that might amuse you. You are given the first word and the last word of a series, say TUBE and ZONE. By changing only one letter at a step, and making a new word at each step (no proper names allowed), arrive at the last word in a specified number of steps. For example, in four steps.

TUBE, TUNE, DUNE, DONE, ZONE

For another, HEAD to TAIL in five steps:

HEAD, HEAL, TEAL, TELL, TALL, TAIL

Now, try your luck with this one.

HATED to MISER in five steps.

We'll give you the answer to this one in next month's column. In the meantime, send us your solutions if you wish and also your TWIRKS. We'll print the best ones and credit you for them.

Driving Too Close?

Dear Sir:

I believe that the caption of the top photograph on p. 16 of the March 1967 issue of EDN ("Leave the Driving to Solid State") is in error. If it takes 1 nsec for a light signal to return to LADAR detector, I think the target is about 6 inches from the transmitter and not 100 ft.

T. H. Bridgeman
Cutler-Hammer
Deer Park, L.I., N.Y.

Editor's Note

We goofed. Actually the infrared light pulses travel from the transmitter at a speed of 1 ft/nsec. A round trip (target 100 ft away) takes 200 nsec, while one way, or the return trip, takes 100 nsec —not 1 nsec. Sorry!

Series Progression Problem

Question: What is the next number in the following series? 14, 23, 28, 33, 42, 51, 59, 68, 77, 86, 96, 103, 110, 116, ?

Answer: 125 . These are the Lexington Avenue subway stops on the New York IRT subway system. 125th Street is the stop after 116th Street when heading north. With luck, you'll get a seat.

Need a Resume? Sam's Our Man!

Sam Shatavsky, EDN's Eastern Editor, passed resume writing with flying colors. In the Great Resume Hoax conducted during the recent IEEE gathering in New York, by Careers, Inc., Sam's resume of a man with a strong background in "design of systems taking into account the role of the human being in the use of machines to meet an end functional objective" convinced 14 out of 18 professional recruiters that they would like to talk further to that designer. Sam's quantization of the centralized motivation elucidated in extraperceptionary terms won Rube Goldberg, cartoonist, an entry into 14 firms. That's real editing!

"Eclipse of the Sun"– A study in message transmission.

- Colonel to Executive

At 9 o'clock tomorrow there will be an eclipse of the sun, something which does not occur every day. Get the men to fall out in the company street in their fatigues so that they will see this rare phenomenon, and I will explain it to them. In case of rain, we will not be able to see anything, so take the men to the gym.

- Executive to Captain

By order of the Colonel, tomorrow at 9 o'clock there will be an eclipse of the sun; if it rains you will not be able to see it from the company street, so then, in fatigues, the eclipse of the sun will take place in the gym, something that does not occur every day.

- Captain to Lieutenant

By order of the Colonel in fatigues tomorrow at 9 o'clock in the morning the inauguration of the eclipse of the sun will take place in the gym. The Colonel will give the order if it should rain, something that occurs every day.

- Lieutenant to Sergeant

Tomorrow at 9 the eclipse of the Colonel in fatigues will take place by cause of the sun. If it rains in nice day; if it rains, then in the company street.

- Sergeant to Corporal

Tomorrow at 9 the eclipse of the Colonel in fatiques will take place by cause of the sun. If it rains in the gym, something which does not take place every day, you will fall out in the company street.

- Comments among Privates

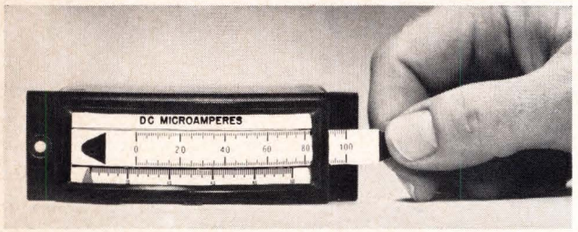
Tomorrow, if it rains, it looks as if the sun will eclipse the Colonel in the gym. It is a shame that this does not occur every day.

ADVERTISERS' INDEX

ADVERTISERS' INDEX

ADVERTISERS' INDEX

Simple, versatile, space-saving, noncontacting, fail-safe, easy-to-read, electronic control meter



We put a lot of fine-sounding adjectives in front of our electronic control meter. Because our reputation for leadership in contactless controls and edgewise meters stands behind it.

Consider versatility. We can supply a control meter to control virtually anything you can measure electrically. You can have it with either trigger or anticipating on-off control signals. With relays or other final control elements. With a wide choice of current, voltage, or temperature ranges. Or with slip-in interchangeable scales (above) for flexibility in breadboarding or testing applications. Even with an inexpensive plug-in adapter that completely rearranges your output signal format.

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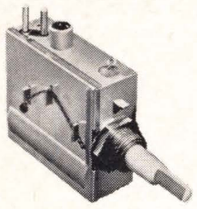
MITSUMI UHF TV TUNER



outrating international tuner standards!

Far outrating the FCC and VDE specifications, which are widely prevailing in the World as telecommunication standards, the MITSUMI UHF tuner only radiates spurious signals less than 33.5 dB below the reference field strength. Material, plating, soldering, as well as the proprietorial circuit design are the technical achievements by MITSUMI based on a long-term fundamental research.
By virtue of high compactness, light-weight, outstanding durability and overall use of silicon transistors, the MITSUMI TV-tuner has made possible of minimum frequency drift due to temperature variation. And also, the MITSUMI TV-tuner is made available to tube-type TV sets.

Specifications \ Model	UHF TV tuner U-ES12B for European channel	UHF TV tuner UK-A32 for American channel
Gain (dB)	−10 min.	−10 min.
Noise figure (dB)	16 max.	14 max.
Image ratio (dB)	35 min.	30 min.
IF rejection (dB)	55 min.	60 min.
Frequency stability	Temperature stability : 800 kc at 20± 30°C Voltage stability : ± 400kc at 11V± 1.1V	Temperature Stability : 300/700 kc at 25~65°C Voltage Stability : ± 100 kc at 11V± 1V
Outer dimensions (mm)	46.5 × 50 × 19	51 × 62.5 × 24.5

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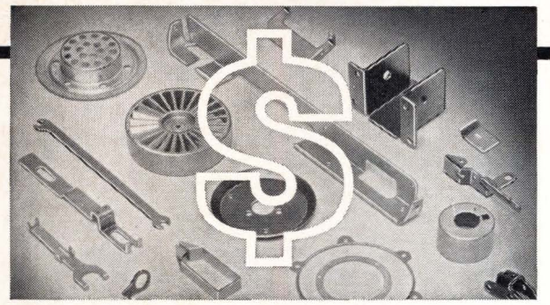

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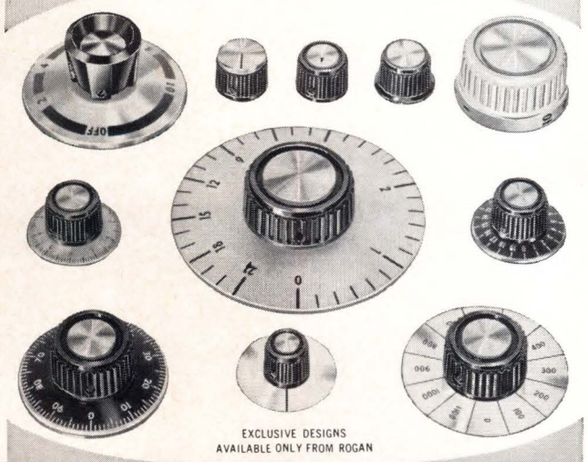

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