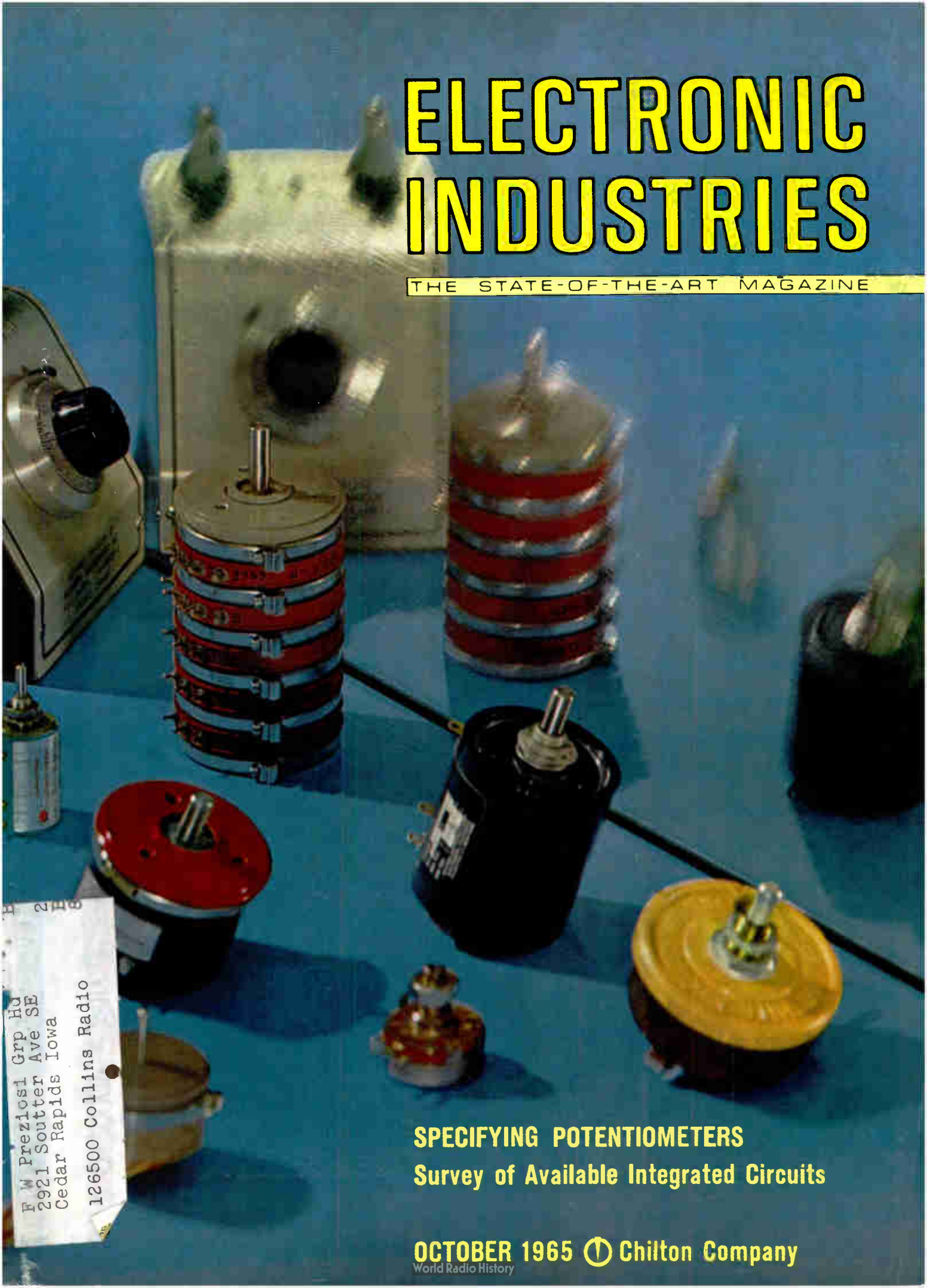

New sine-cosine pot design adds reliability to performance of non-linear functions

COUNT ON DALE for extra reliability in performing precise non-linear functions. These design features tell the story:

1. **3-DIMENSIONAL SHAPED CARD** is used as winding element instead of standard circular copper mandrel or flat card.
2. **DUAL WIPER COLLECTOR SYSTEM** allows wipers to be phased 90° apart to create necessary phase shifting.
3. **DUAL CONTACT WIPERS** assure continuous contact and noise-free operation.
4. **LINER-HOUSING CONSTRUCTION** combines the excellent dielectric strength and high temperature characteristics of a molded diallyl phthalate liner with the structural strength, stability and shielding properties of a precision machined anodized aluminum housing.

SINE-COSINE SPECIFICATIONS

3 MODELS:	**SC-11** (1⅛" dia.)	**SC-111** (1-1/16" dia.)	**SC-18** (1¾" dia.)
TOTAL RESISTANCE: SC-11 and SC-111 – up to 16K Ω per quadrant; SC-18 – up to 30K Ω per quadrant			
RESISTANCE TOLERANCE: Standard ±3%, Specials to ±1%			
FUNCTION CONFORMITY: ±1%			
POWER RATING:	**SC-11 and SC-111** Std. 2.0 W at 40° C Std. 1.0 W at 85° C		**SC-18** Std. 5.0 W at 40° C Std. 2.5 W at 85° C
OPERATING TEMP. RANGE: –65° to +125° C. (Derated to 0 at +125° C)			
STANDARD T.C.:	**Resistance Wire:** 0.002%/° C Max. **Potentiometer:** 0.010%/° C Nominal		
ENVIRONMENTAL: Dale Sine-Cosine models meet standards of MIL-R-12934 for Rotational Life, Acceleration and Shock, and Temperature Cycling; and MIL-STD-202B for Moisture Resistance, Humidity, Vibration and Salt Spray.			

Write today for ■ Sine-Cosine Data Sheet ■ Catalog B containing complete details on Linear Precision Pots and Trimmers.

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ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

Fuel Cells—Our New Power

THE RECENT SUCCESSFUL FLIGHT of Gemini-5 has provided a partial answer to our February editorial, "Why So Slow With Direct Energy Conversion?"

Contrary to the misimpression held by the public, the fuel cells aboard this craft are reported to have performed to specifications. This outstanding mission demonstrated the first operational use of fuel cells in aerospace and has enabled the United States to "break through the storage battery barrier." We now may also have somewhat of a lead over our Russian space competitors since they must still use batteries as power sources in their spacecraft.

The fuel cells aboard Gemini-5 were produced by General Electric. Dr. Arthur M. Bueche, GE's new vice president of research and development calls them the "first practical major power source to be developed since atomic energy." The company is now operating a fuel cell production line and officials have decided to produce and market these devices for earthbound applications as well. This program is expected to be underway by late 1966. Further research will continue and aims at developing new units that will run four times longer than the Gemini-5 cells. Also, these early 12 watt models may gradually be increased in both size and power.

Gemini's cell was designed to operate at 27 volts. During the flight it was the uncertain performance of the *total* fuel cell system that led to the conservation use of power by our astronauts. Flight Control minimized requirements at 8 to 10 amps. Later, as pressure built up, the cell produced 22 to 40 amps. Ground tests McDonnell Aircraft, prime contractor for the National Aeronautics and Space Administration's (NASA) Gemini program, had indicated that up to 50 amps could have been obtained. After the mission was over, however, Flight Control realized that the unit could have run at 2 kw.

In future fuel cells will provide a new source of portable power for electronic communications and control equipment. They can be used as a primary source in isolated or remote areas on land, on the sea, or under the sea. They also can be used as a secondary or emergency power source for installations now operating off regular power lines.

E. M. Cohn, head of electrochemical systems in NASA's Office of Advanced Research and Technology does not foresee completely definitive markets for fuel cells developing for another 10 to 15 years. Aside from the electronic applications, he looks forward to portable power packs that will operate industrial vehicles and hand tools. Delivery and fork-lift trucks could be made to run several shifts, lessening down-time needed for recharging batteries. New convenience could come with quick on-off fumeless power for lawn mowers and pleasure boats.

We can expect some further developments soon from the other two dozen or so competitors now engaged in this activity. Recently a fuel cell assembly was shown to the Army by Esso Research and Engineering Co. It directly converted methanol into 100 watts of electricity, without combustion. Several hydrogen cells are being evaluated by customers of United Aircraft's Pratt & Whitney division. Other leading competitors include Allis-Chalmers, Union Carbide, Texas Instruments, Ionics, and Westinghouse.

Certain scientists and engineers hasten to remind us fuel cells are still only on the threshold of development. They mention some $100 million spent by the Federal Government (including some $28 million in contracts with GE), but point out that it still remains for fuel cells to deliver power more efficiently, reliably, and economically. (NASA plans a program to obtain reliability and longevity data on fuel cell *systems.)*

We must learn how to squeeze more power out of fuel, how long cells will last, and how best to interconnect individual cells. These are difficult technical problems, to be sure, but we feel there is also much promise awaiting both producers and customers in this new power field.

Bernard F. Osbahr

New from Sprague!

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- Low dissipation factor (high *Q*) makes these capacitors extremely desirable where high current capabilities are required, as in SCR commutating capacitor applications.
- Low dielectric absorption (considerably lower than that of many other commonly-used film dielectrics) over a broad frequency/temperature spectrum makes Filmite 'K' Capacitors ideal for timing and integrating.
- Extremely high insulation resistance, especially at higher temperatures. Superior to many other commonly-used film dielectrics.
- Close capacitance tolerances—available to ±0.25%!
- Filmite 'K' Capacitors are excellent for critical applications including tuned circuits, analog and digital computers, precision timing and integrating circuits because of the unusual properties of the polycarbonate film dielectric.

Type 260P *Filmite 'K' Capacitors are metallized, utilizing non-inductive construction. They feature special self-healing characteristics, in the rare event of capacitor dielectric breakdown. Designed for operation at full rated voltage over the temperature range of −55 C to +105 C, these metal-clad capacitors are hermetically-sealed and are available with both standard and weldable wire leads or solder tabs in a variety of mounting styles.*

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OCTOBER 1965, Vol. 24, No. 10

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

COVER: To introduce the 3-part series on Potentiometers which begins in this issue, we have gathered together a representative selection of pots. Our thanks go to Allen-Bradley, Amphenol, Beckman Helipot, Dale, Fairchild Controls Division, International Resistance Co., Ohmite and Spectrol for their cooperation.

*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology

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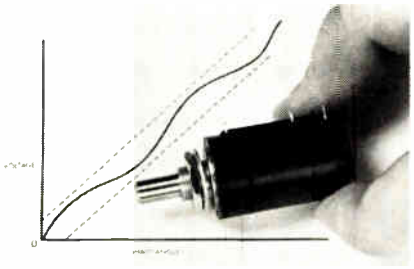
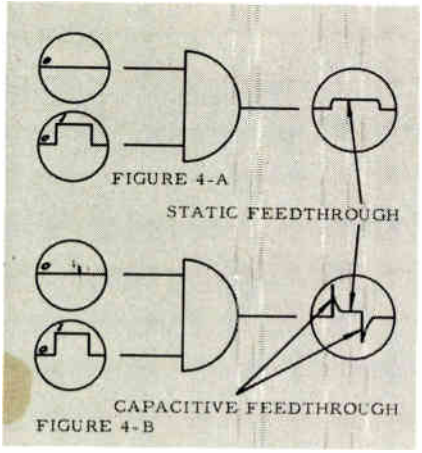
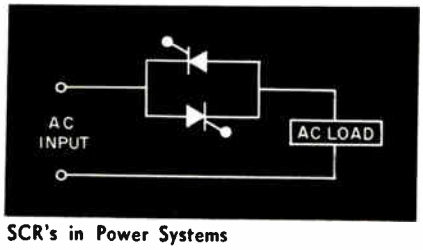
HIGHLIGHTS



Survey of Potentiometers

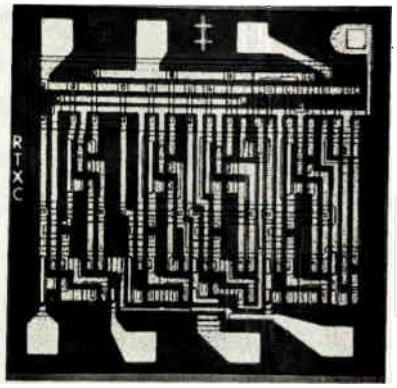


Testing Integrated Circuits



SCR's in Power Systems

Survey of Integrated Circuits



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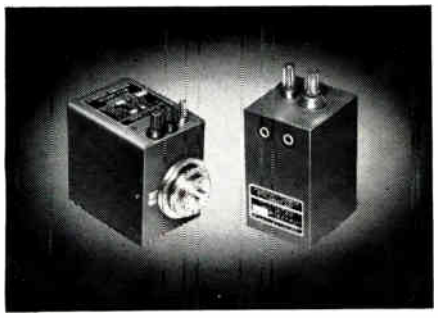
Capacitance Standards to Certified Accuracy of ±0.1% Developed by Sprague



A broad range of capacitance values from .001 μF to 100 μF, furnished to an accuracy of ±0.1% of the nominal values, are available in Styracon Precision Capacitors, components for highly precise electronic equipment as well as for laboratory standards of capacitance.

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For complete technical data, write for Engineering Bulletins 90,600 and 90,605 to Technical Literature Service, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

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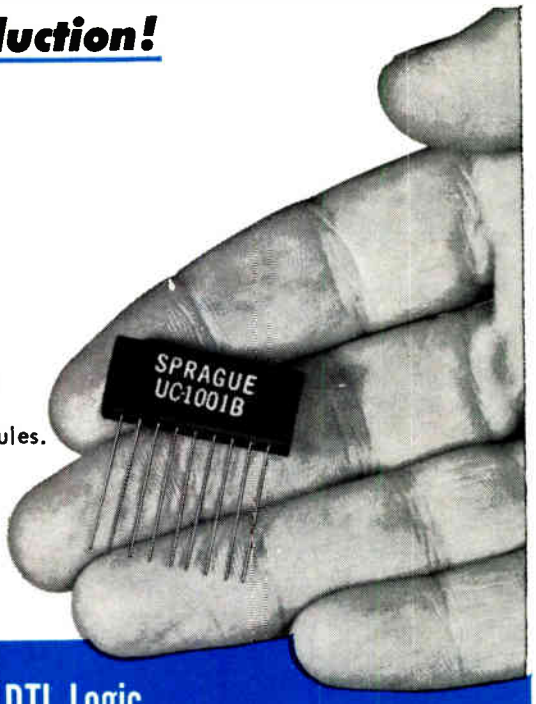


The NAND/NOR Gate shown here is one of a series of CERACIRCUIT DTL Logic Modules.

a compatible line of DTL Logic

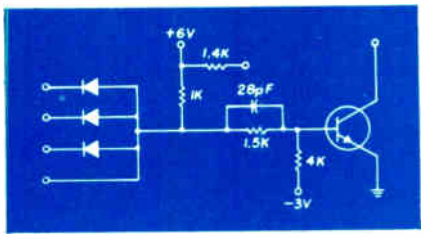
CERACIRCUIT®

THIN-FILM MICROCIRCUITS

5 Mc DTL LOGIC CIRCUITS

The basic member of the Sprague series of DTL Logic Modules is the UC-1001B NAND/NOR Gate (see schematic), with typical propagation time delay of 10 nanoseconds per stage over the broad temperature range of −55 C to +125 C. Other DTL Logic Ceracircuits include UC-1002B SCT Flip-Flop, UC-1003B Buffer-Driver, UC-1004B Exclusive OR/Half-Adder, UC-1005B 8-Diode Gate, and UC-1006B 5-Diode Gate.

To facilitate contact packaging and assembly on printed wiring boards, all 5 Mc DTL Ceracircuit Modules are encapsulated in one standard case, 1.0" wide x 0.4" high x 0.2" thick.



Circuit schematic, UC-1001B NAND/NOR Gate.

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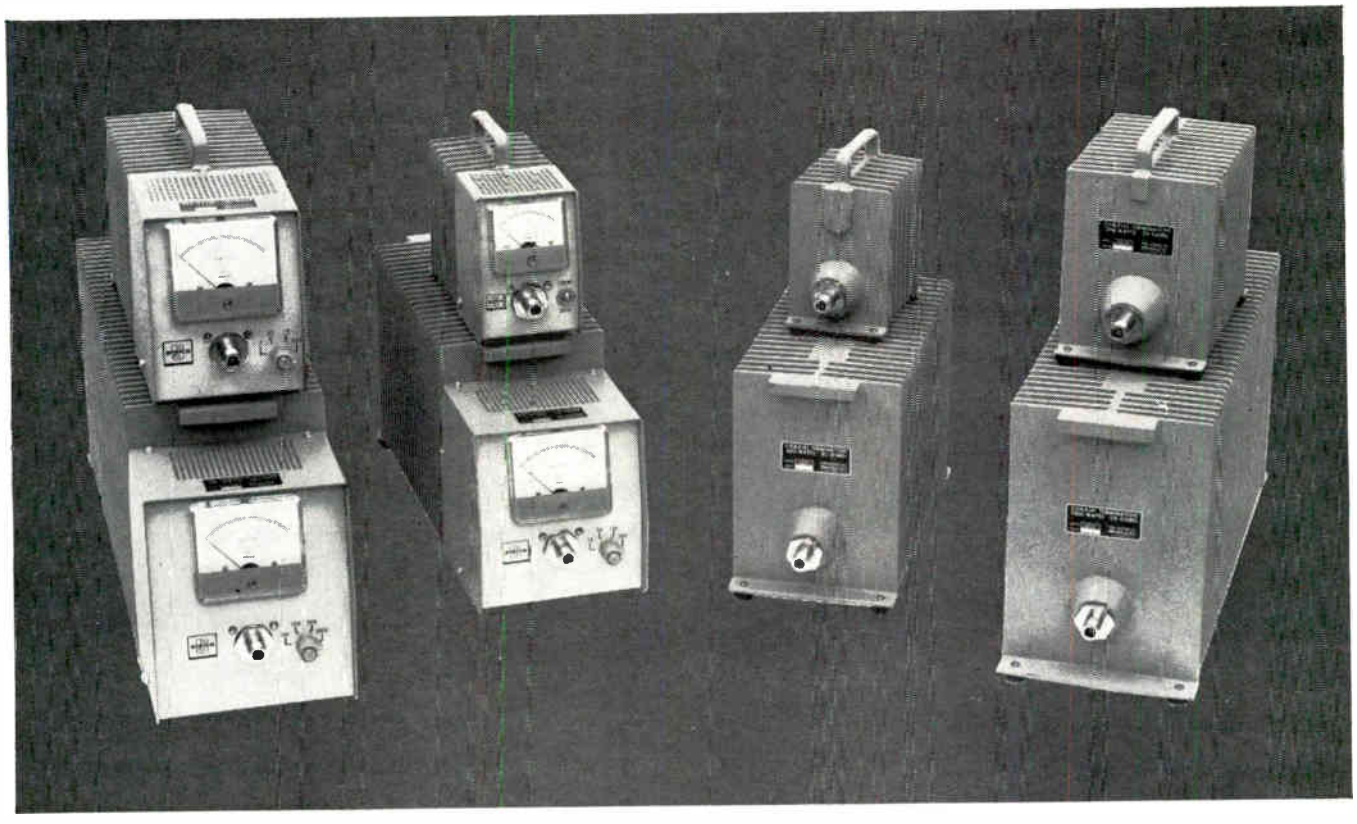
Sierra Wide-Range RF Wattmeters



and Low-VSWR Loads

Model 401A Termination Wattmeters, in four models (120, 250, 500, and 1,000 watts) offer unusually wide dynamic range. Single-knob switching of four power ranges (two ranges on 120-watt model) provides excellent versatility of application. For example, meter indications as low as two watts can be read on the 1,000-watt models. Terminations are sealed to prevent possibility of leakage. Eight different Twist-Off connector types (N, C, UHF, HN, LC, BNC, TNC, 1⅝" rigid line) can be fitted on in the field without factory calibration. Wattmeters require no external power or water connections.

401A-120 (watts) . . **$195** 401A-500 (watts) . . **$275**
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Model 160B Coaxial Loads deliver average power dissipation ratings of 150, 300, 600, and 1,000 watts. The four models provide low-reflection termination of a 50-ohm flexible or rigid coaxial line. They are ideally suited as dummy loads for transmitters operating up to 5,000 Mc, or as terminations for use with bi-directional power monitors. Terminations are sealed to prevent possibility of leakage. Can be used with eight different Twist-Off connector types (N, C, UHF, HN, LC, BNC, TNC, and 1⅝" rigid line).

160B-150 (watts) . . **$ 70** 160B-600 (watts) . . **$140**
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ELECTRONIC INDUSTRIES RADARSCOPE

Developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries

EXTERNAL CAVITY

Engineers at Sperry Rand have demonstrated CW operation of a neodymium-doped calcium tungstate laser whose optical cavity is external to the crystal. Here, Henry Aldag adjusts one of the mirrors placed outside the crystal. The company plans to use the laser as an oscillator in a study of coherent optical array methods.

A SOLAR SIMULATOR has been developed by RCA to accurately reproduce the sun's spectrum over long periods of time. Aside from space program use, it can perform accelerated tests on all kinds of material to learn how materials "weather." The simulator uses a positive carbon rod and a negative tungsten rod with dc applied. A gatling gun arrangement is used to continuously feed carbon rods for steady light over a long period.

ELECTRO-OPTICAL DEVICE that allows transmission of laser energy in only one direction has been developed by Westinghouse's Aerospace Division. Company researchers believe it to be the first such device that does not use the Faraday magneto-optical effect. Instead, it uses an electric field generated by a microwave traveling-wave structure.

21-INCH rectangular color TV picture tubes have been announced by both Admiral Corp. and Motorola, Inc. The new tube for Admiral will be made by National Video Corp. Color glass bulbs for the Motorola tube will be supplied by Owens Illinois Inc.

AN AMDAS SYSTEM (Automated Magnetic Data Acquisition System) will be built, installed and checked out by Electro-Mechanical Research, Inc., under terms of a contract with the U. S. Army Materiel Command. The system will be used to take magnetic "signatures" of various types of military vehicles. These would be recorded for computer analysis and later application to battlefield surveillance equipment design. The "signatures" or characteristics of various military vehicles will be measured and recorded by having the vehicles pass over magnetometer probes buried in the ground.

AUTOMATED LASER WELDING UNIT for use in industrial welding operations at speeds up to one firing per second has been announced by Lear Siegler, Inc. It is applicable to a variety of commercial welding operations, including assembly of electronic components. It is useful in restricted areas where space limitations prohibit the use of other welding methods. Automatic operation is achieved by combining a standard metalworking laser with a tape-controlled work handling stage.

A MATHEMATICAL MODEL which enables a computer to simulate a human lung has been reported by researchers from Columbia University and IBM. The experimental lung model is expected to be useful both in improving understanding of pulmonary diseases and as a teaching aid for medical students. A dynamic picture of gas exchange and blood flow in the lungs can be constructed using the model.

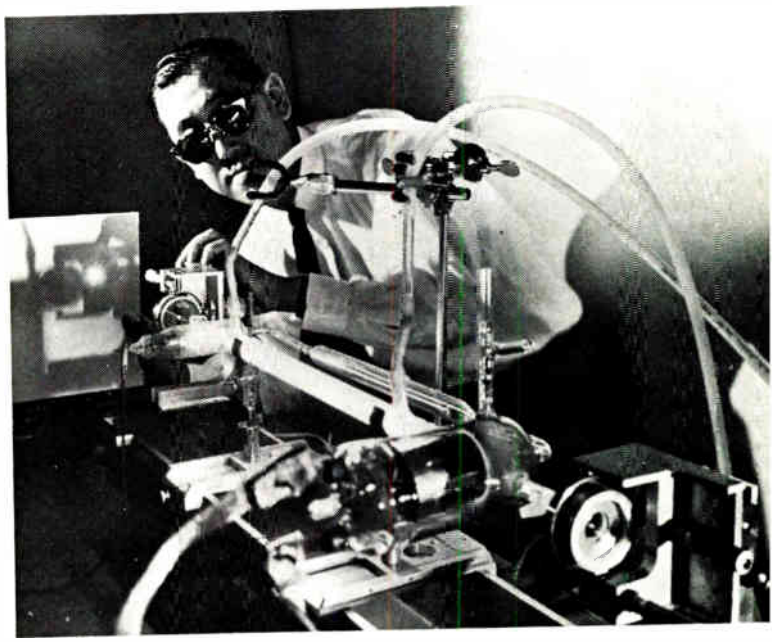
SENSITIVE RADIO RECEIVER developed by Sylvania improves reception of weak signals from communication satellites. It discerns and amplifies weak signals and screens out background "noise" or static. Circuitry in the receiver compresses or squeezes incoming signals by reducing frequency deviation, thus eliminating much background noise. A filter then screens out additional noise while allowing information to pass.

AUTOMATIC CONTROL of traffic and mass transit as well as interior environment of office and apartment buildings has been forecast by Dr. Raymond W. Ferguson of Westinghouse Corp. Dr. Ferguson told a technical session of a recent Electronic Convention that "One of the most significant areas of future potential for the technology of process control computer systems lies in the spread of this technology from the basic industries toward more consumer-oriented uses."

ANTENNA AND PROPAGATION NOTES from the recent International Antenna and Propagation Symposium held in Washington, D. C. California Institute of Technology will be using computers to control their group of radio astronomy antennas. When more than two antennas must be aimed and properly set up, the task becomes too great where only one man is using the system and still permit him time to make observations. The antenna drive will be a Ward-Leonard system. Massachusetts Institute of Technology's new Haystack System will be used to map the Moon with radar. They expect to learn about the Moon's surface, such as whether it is hard or soft, the depressions and hills, and their size. Tropospheric scatter interest is presently low. This has been attributed to the satellite programs which seem to be replacing the need for these systems. The most attenuation for coherent optical waves is caused by precipitation—fog, snow and rain. Heavy rain has a small effect on transmission. With large rain drops the radiation is scattered in a forward direction toward the receiver, with little side scattering. H. E. Bartlett of Radiation Incorporated described a new type feed system for antennas that are dielectric guiding structures. These structures use the phenomenon of Total Internal Reflection which reduces spillover and provides more uniform reflector illumination. They are placed between primary feed and reflector or sub reflector.

MEMORY STACK

Shown here is the memory stack for Honeywell ALERT computer which NASA will use to study guidance and navigation methods and to conduct hardware experiments on the X-15A-3 aircraft. Memory, made of microbiax elements, is electrically alterable nondestructive readout. I/C diodes are mounted in the center of the PC boards.



HOLOGRAM LASER

Ionized argon gas laser, which is main component of new light camera built by Electro-Optical Systems, Inc., is adjusted by a company engineer. Hologram or lensless camera permits an observer to actually look behind projected 3-D images. This laser makes hologram film exposures 10 times faster than previously possible.

MINIATURE MICROWAVE OSCILLATORS having 0.1 cu. in. have produced several milliwatts of CW at 1GC. These devices were developed at Standard Telecommunication Laboratories Ltd., in England. These devices are based upon the observations of an English scientist, J. B. Gunn. He noted that the application of a steady electric field above a certain threshold level to low resistivity GaAs caused charge carrier to break up into domains moving along a potential gradient at the carrier drift velocity. Heat removal was a restricting factor in making use of this finding. Epitaxial construction solved the problem. A substrate of semi-insulating GaAs about 100 microns thick has a 15 micron layer of GaAs with optimum properties grown for the active region. The effective cross sectional area for current path is determined by removing part of layer to form a narrow track 100 microns wide. Anode and cathode are formed by converting 2 parts of the track to n+ regions. A gap of original n material between them is left. This length determines frequency of oscillation.

LONG TERM OPERATION of gas lasers at current densities of 1000 a./cm.^{2} and power level outputs of over 100w. will result from confinement of the gas plasma by a set of cooled metal discs in place of the normal quartz or ceramic tube, according to Dr. J. Dane Rigden of the Perkin-Elmer Corp. Used in argon lasers, power outputs of 9 w. have already been achieved from plasma columns only 19 in. long. Advantages include use of the argon laser as a source in optical signal processors, high density high speed film recorders, beacons for space communication, and as a source for various types of spectroscopy.

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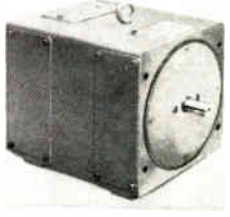

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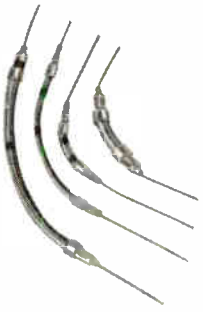


FLEXIBLE

wire-wound resistors exclusive with Clarostat. Wound on flexible core, use like wire for point-to-point connections. Insulated and coded.

1% WIRE-WOUND

resistors, Series CC features 20 PPM/°C. 1, 2, 3 or 5% resistance tolerance, in 3, 5 or 10 watt sizes.

STANDEE

resistors for mounting above chassis. Provides maximum heat dissipation. Available in a wide choice of design including multiple taps or separate resistance elements.

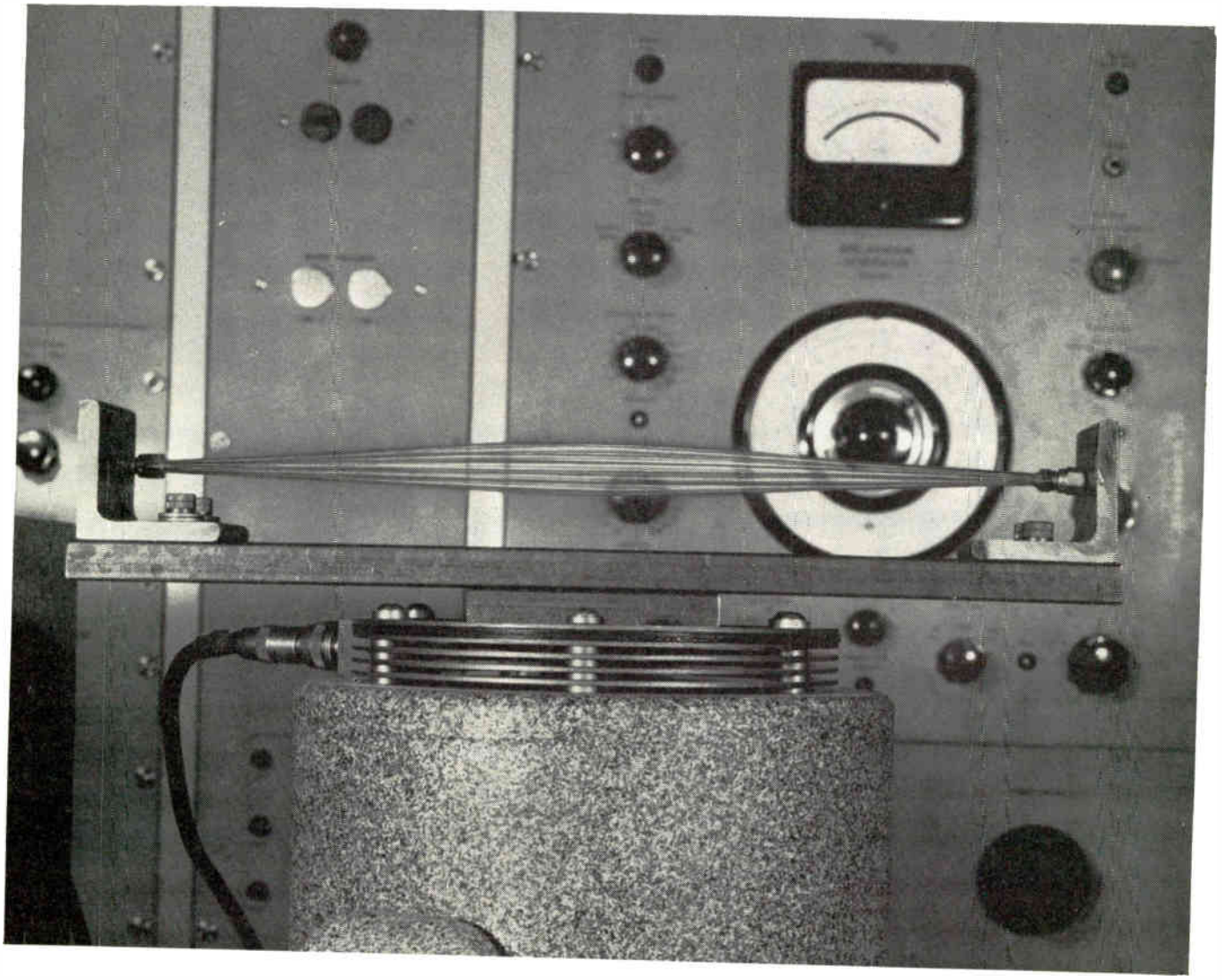
POWER RHEOSTATS

in 25 and 50 watt sizes. Resistance elements embedded in inorganic cement. Special wiper design for long wear. Will withstand overloads without damage.

Only Clarostat gives you that "across-the-board" completeness of line with consistent "top drawer" quality that customers have learned to depend on. For those tough industrial and commercial applications, as well as for those beyond-the-usual critical applications Clarostat's years of skilled know-how, advanced technology and superior quality can provide the immediate answer to your power wire-wound resistor requirements. Call or write today for a quotation on your specific needs.

CLAROSTAT

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE, U.S.A.



This miniature coaxial cable of ours was vibrated at resonance 7 hours before the sheath cracked. The best competitive cable lasted 55 minutes.

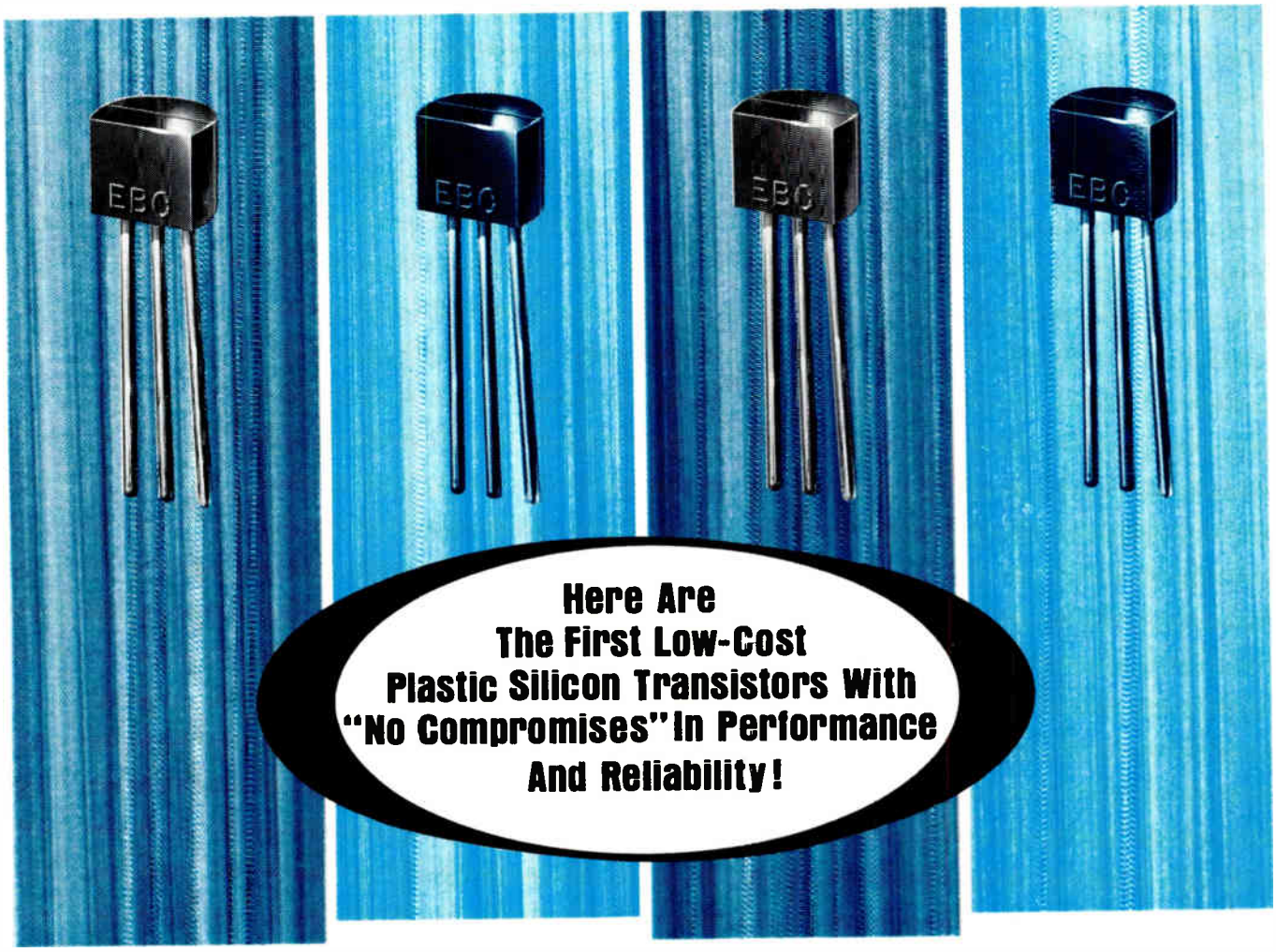
While flexibility is not the only consideration when you are specifying miniature coaxial cable, freedom to form to the needs of the application is a compelling factor in your choice. Think, for a moment, in terms of low noise amplifiers, microwave transmission, high speed computers and the wide range of black box requirements.

Here, then, is your answer. Miniature coaxial cable with a silver plated Copperweld inner conductor, a TFE Teflon dielectric and solid, practically indestructible copper sheath, in standard, 50 ohm impedances, diameters of .070″ and .141″, lengths from 12′ to 200′. Or, special diameters for your special needs.

Let us know if we can help you. Bulletin MC-1 with full details is yours for the asking.

PHELPS DODGE ELECTRONIC PRODUCTS
NORTH HAVEN, CONNECTICUT

Circle 8 on Inquiry Card



Here Are The First Low-Cost Plastic Silicon Transistors With "No Compromises" In Performance And Reliability!

Actual Size

There's a lot of "low-cost" transistors around these days that got that way by virtue of sacrifices in performance and packaging quality. That's why it's refreshing to find devices like Motorola's new 2N3903-6 series silicon annular Unibloc* plastic transistors — "no compromise" units that offer high performance with topnotch reliability . . . and at *low cost*, too!

Take, for instance, the rugged, high-pressure-molded plastic construction used to form the single-unit encapsulation of "Unibloc" devices. It provides a uniform, dense, solid plastic package free of voids (and leaks) in which moisture can accumulate. It also provides unusual physical strength for internal leads and connections and improved heat transfer characteristics. Because they use the solid transfer molded single-unit package approach, there can be no incompatibility between header and poured epoxy capping. (You may be familiar with the separation that sometimes occurs at the interface of a two-part plastic package under thermal cycling.)

Type	BV_{CEO}	h_{FE} @ 10 mA/1V	C_{ob} @ 5V	f_T @ 10 mA/20V	100-Up Price
2N3903	40V	50-150	4 pf	250 mc	$ .50
2N3904	40V	100-300	4 pf	300 mc	.55
2N3905	40V	50-150	4.5 pf	200 mc	.50
2N3906	40V	100-300	4.5 pf	250 mc	.55

But, reliability is only part of the "no compromise" story!

Each of these four new Motorola annular plastic transistors is a full-spec, full-performance device . . . with no compromises to cost.

For example, the 2N3903-6 series offers such features as:

- Gain (Beta) — Specified from 100 μA to 100 mA . . . and points in between!
- High Voltage — 40 Volts (BV_{CEO})
- Complete h-parameter specifications
- Completely specified switching limits . . . including t_r, t_d, t_s, and t_f!

You'll find the Motorola 2N3903-6 series literally sets the "performance standard" for low-cost transistors for industrial and consumer product applications.

You can also take advantage of the fact that this key series features device-to-device complements — the NPN 2N3903 and PNP 2N3905 and the NPN 2N3904 and PNP 2N3906.

One more point. They're made by the annular process. That means you get the low-leakage, long-term stability that will set your equipment performance apart from the crowd.

Try these devices in your most demanding circuits. Your local Motorola representative would be happy to supply samples for evaluation and complete specifications on each type.

*Trademark of Motorola, Inc.

MOTOROLA Semiconductor Products Inc.

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From Data/Cartridge

EVERY INCH A DATA RECORDER!

You'd never suspect its capacity for practical, down-to-earth data recording — from seismic to biophysical investigations — simply by admiring the slim lines of this new Data/Cartridge Portable Instrumentation Tape Recorder (Model D/C-1). You'd have to see it in action to appreciate the fact that it's a complete four-channel record/reproduce instrument fully equipped with instrumentation-quality FM or Direct Electronics.

Instrumentation Quality The 25-pound D/C-1 is every inch a laboratory-quality tape recorder. It provides up to four standard tape speeds, instantly switchable by front panel controls, and plug-in, solid-state electronics. Metal-faced, precision microgap heads permit up to four data channels. Virtually no holdback tension and gentle tape handling greatly extend the normal life of your tapes.

Uncomplicated The D/C-1 uses standard size Fidelipac® tape cartridges with ¼" wide Mylar tape in endless loops up to 1700 feet. You can load the recorder in a second, even with gloves on. No fussing with reels or special operator skills required.

No Mechanical Adjustments Gone are the brakes, holdback tension gadgetry and servo controls, tape-supply reel motor and other mechanical parts that could keep you tied up for hours with adjustment problems. You can concentrate on your application, instead of the recorder.

To record more data on this remarkable new cartridge recorder, address your inquiry to:

DATA/CARTRIDGE

161 Constitution Drive, Menlo Park, California 94025

Circle 10 on Inquiry Card

COMING EVENTS

October

Oct. 11-13: 1965 IEEE NATCOM (Communications Symp.), IEEE; Utica, N. Y.

Oct. 12-13: 3rd Annual Product Maintainability Seminar, ASQC; Sheraton Motor Inn, Phila., Pa.

Oct. 12-14: 1965 Protective Relaying Conf., IEEE, Univ. of Minn.; Univ. of Minn., Minneapolis, Minn.

Oct. 18-19: Systems Science Conf., IEEE; Case Institute, Cleveland, Ohio.

Oct. 18-20: 12th Nuclear Science Symp., IEEE; San Francisco Hilton Hotel, San Francisco, Calif.

Oct. 18-20: Joint Materials Handling Tech. Conf., IEEE, ASME; Pittsburgh Hilton Hotel, Pittsburgh, Pa.

Oct. 21-23: Symp. on Photography in Information Storage and Retrieval, SPSE; Marriott Twin Bridges Motor Hotel, Washington, D. C.

Oct. 25-26: 2nd Symp. on Consumer Electronics, IEEE; McCormick Place, Chicago, Ill.

Oct. 25-27: 4th Symp. on Discrete Adaptive Processes, IEEE; McCormick Place, Chicago, Ill.

'65-'66 Highlights

Nat'l Electronics Conf., Oct. 25-27; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 3-5, IEEE; Boston, Mass.

IEEE Int'l Conv., Mar. 21-24, 1966; Coliseum, New York Hilton, New York, N. Y.

WESCON, Western Electronics Show & Conv., Aug. 23-26, WEMA, IEEE; Sports Arena, Los Angeles, Calif.

Oct. 25-27: Thermionic Conver. Specialists Conf., IEEE; Del Webb Ocean House, San Diego, Calif.

Oct. 27-29: East Coast Conf. on Aerospace & Navig. Elect., AES, IEEE; Holiday Inn, Baltimore, Md.

November

Nov. 1-3: Industrial Static Power Conversion Tech. Conf., IGA, IEEE; Benj. Franklin Hotel, Phila., Pa.

Nov. 2: Western Appliance Tech. Conf., IGA, IEEE; Rodger Young Auditorium, Los Angeles, Calif.

Nov. 2-4: 1965 Int'l Space Electronics Symp., AES, IEEE; Fontainebleau Hotel, Miami Beach, Fla.

Nov. 3-5: Northeast Elect. Research & Eng. Mtg. (NEREM), IEEE; Sheraton-Boston Hotel & War Mem. Audit., Boston, Mass.

Nov. 3-5: Int'l Fall Data Processing Conf. and Business Expos., DPMA; Dallas and Adolphus Hotels, Dallas, Tex.

Nov. 16-19: Annual Conf. on Magnetism & Mag. Materials, AIP, IEEE; Hilton Hotel, San Francisco, Calif.

Nov. 18-19: Mid-America Elect. Conf. (MAECON), IEEE; Continental Hotel, Kansas City, Mo.

For the engineer who refuses to stagnate

HALF THE WORLD is half asleep! Men who could be making twice their present salaries are coasting along, hoping for promotions but doing nothing to bring themselves forcefully to the attention of management.

They're wasting the most fruitful years of their business lives . . . throwing away thousands of dollars they may never be able to make up. And, oddly enough, they don't realize — even remotely — the tragic consequences of their failure to forge ahead while time is still on their side.

Engineers, and other technically-trained men are particularly prone to "drift with the tide" because their starting salaries are reasonably high and promotions come at regular intervals early in their careers. It isn't until later — too much later in many cases — that they discover there are definite ceilings on their incomes.

Send for your free copy of "Forging Ahead in Business"

If you want to discover how to succeed while you are still young — if you want to avoid the heartbreak of failure in later years — send today for *"Forging Ahead in Business"* . . . one of the most practical and realistic booklets ever written on the problems of personal advancement.

"Forging Ahead in Business" was written for ambitious men who seriously want to get to bedrock in their thinking about their business future. If you feel it is meant for you, simply fill in and return this coupon. Your complimentary copy will be mailed to you promptly.

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Please mail me, without cost, a copy of *"Forging Ahead in Business."*

Name.....

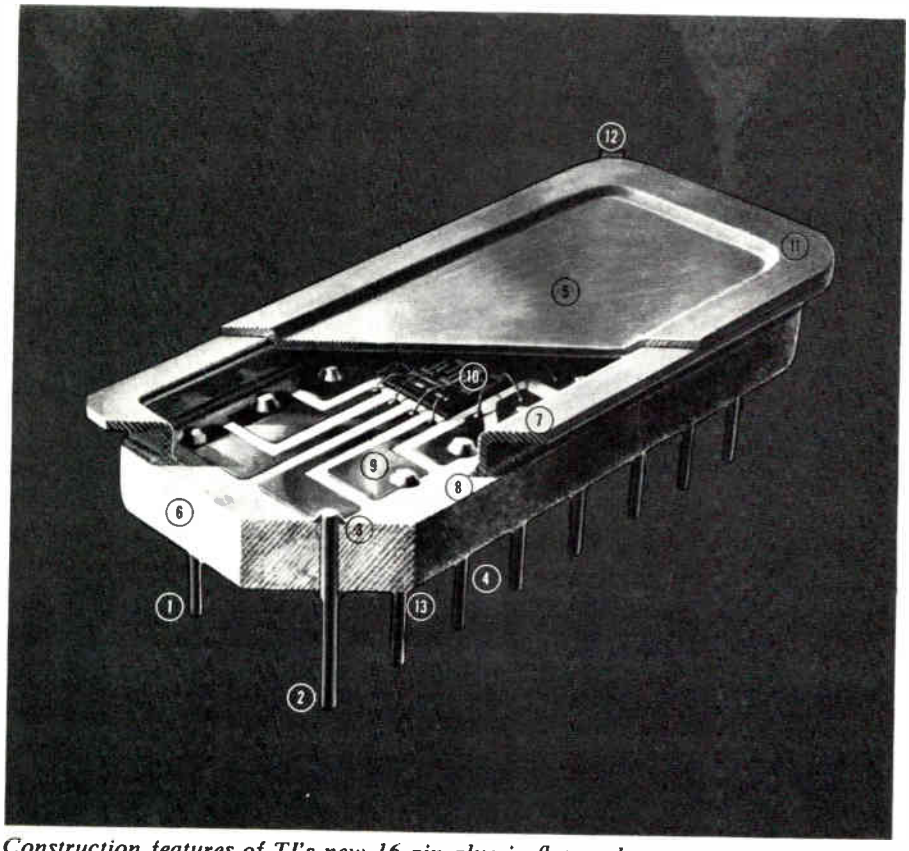
Firm Name.....

Business Address.....

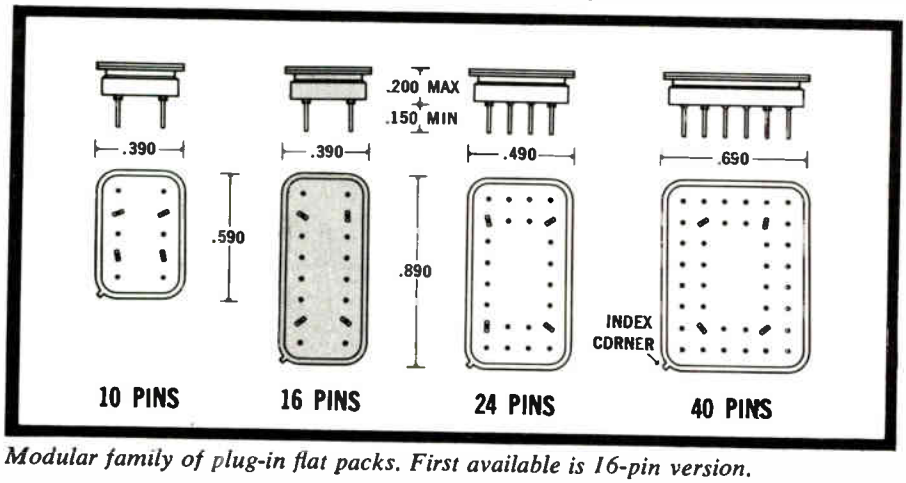
Position.....

Home Address..... Zip Code.....

New Plug-in Package Gives You Fast,



Construction features of TI's new 16-pin plug-in flat pack.



Modular family of plug-in flat packs. First available is 16-pin version.

Four new families of industrial integrated circuits — Series 70, 73, 74, and 1580 — are now available from Texas Instruments in an advance-design plug-in flat package for reduced equipment-assembly costs. The 28 new circuit types offered in this package provide low cost per logic function, and are designed for operation in a wide range of industrial environments.

The first in a series of modular plug-in packages is a 16-pin version, useful for multifunction logic networks of up to six circuits. Here are features: (numbers refer to cutaway illustration at left)

1. **Sixteen pins** enable you to obtain maximum economies inherent in today's multifunction integrated circuits. Pins are in two rows of eight, with rows a convenient 200 mils apart. Positive alignment of pins is assured for high-speed automatic or manual insertion techniques. Alignment tolerance is ±10 mils at end of pins.

2. **Pin spacing on 100-mil centers** is appropriate for fast, economical flow- and wave-soldering techniques and for wire-wrap connections.

3. **Round-pin cross-section** is full 20-mil diameter (±2 mils) for strength and rigidity. Pin diameter is compatible with standard PC-board drill fixtures. Pin length is 150 mils, leaving ample soldering space under ⅛" PC board. Despite their rigidity, pins are not brittle, will withstand at least four 90-degree bends using a one-lb. weight — exceeding TO-5 requirements.

4. **Pins beneath package** provide maximum rigidity, prevent electrical contact between pins of adjacent packages. With pins projecting from the bottom, additional rows of pins can be added while maintaining same modular length and same form-factor.

5. **Package size—390 by 890 mils**—is convenient for handling during test and assembly. Packages can be mounted at maximum density on 400-mil centers, side-by-side, and 900-mil centers, end-to-end.

6. **Aluminum-oxide ceramic substrate** provides strength and good thermal-dissipation properties. Also provides electrical isolation, pin-to-pin and pin-to-package.

7. **Rugged, flanged sides** provide easy-grip handling without touching pins.

8. **Brazed ceramic-to-metal seal** assures that package will withstand external helium pressure of 100 psi with hermeticity of 50 x 10^{-8} cc/sec. Also withstands thermal shock — cycling between −55° and +300°C, and cycling between boiling water and ice water. More than 3,000,000 similar ceramic-to-

For TI Integrated Circuits Low-Cost Assembly

metal seals have been applied to TI's TO-50 packages produced for Minuteman and other programs over the past four years.

9. Metallization pattern on face of ceramic makes possible short, reliable bonds to the integrated-circuit bar.

10. Integrated-circuit bar is recessed in a well, resulting in straight-line bonds to raised bonding pads, with no sags or loops.

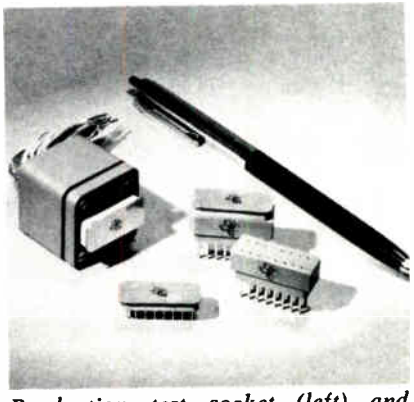
11. Metal lid is securely sealed with transistor-type "one -shot" resistance weld. Fast, reliable weld means an economical package.

12. Flange tab at corner of package provides indexing at a glance.

13. Stand-off, 45 mils high, allows easy clean-out of flux beneath package, assures good solder contact through PC-board holes.

A major feature of TI's plug-in package is its modular approach, including versions with 10, 16, 24, and 40 pins. See dimensions at lower left. The larger packages are designed to accommodate the more complex logic arrays to be seen in coming months.

Plug-in flat packs shown mounted at maximum density. Units are easily handled and inserted through PC board.



Production test socket (left) and breadboarding sockets (right) are being developed for plug-in flat packs.

28 New Industrial Integrated Circuits Offer Low Cost per Logic Function

TI's new industrial logic families include eight Series 74 TTL networks, 13 Series 73 modified-DTL units, two Series 70 ECL gates, and eight Series 1580 DTL circuits.

Typical gate characteristics for each of the four logic families are listed in the table at right, All these circuits, except Series 70, are reduced-temperature (0° to +70°C) versions of established military integrated-circuit lines. They feature the same high performance, same high reliability, and same multifunction economies.

By fabricating two, three, and four circuits simultaneously in a single silicon bar, the cost-per-circuit-function is drastically reduced. Reductions are also obtained in the number of circuit packages, interconnections, and circuit boards — and in inventories, testing, and handling.

The new 16-pin plug-in flat pack is an option available at no additional cost, and is available for Series 70, 74, 1580, and most units in Series 73. The standard package for all four series is the 5-year-proved ¼" by ⅛" flat pack.

For additional information on TI's industrial logic circuits and the new plug-in packages, contact your local TI Sales Engineer or circle No. 25 on the Reader Service Card.

TYPICAL GATE CHARACTERISTICS OF TI's INDUSTRIAL LOGIC FAMILIES

Parameter	Series 73	Series 74	Series 70	Series 1580
Propagation delay, nsec	30	13	5	25
Power dissipation, mw	10	10	40+	5
Fan-out	10	10	N/A	8
Noise immunity, mv	300	1000	250	750
Supply voltage, v	3 to 4	4.75 to 5.25	+1.25, —3.5	4.5 to 5.5
Temperature range, °C	0° to +70°	0° to +70°	0° to +70°	0° to +70°

TYPES AVAILABLE IN TI's INDUSTRIAL LOGIC FAMILIES

	Series 73 Modified-DTL NAND/NOR	Series 74 TTL NAND	Series 70 ECL OR/NOR	Series 1580 DTL NAND
J-K Flip-flop	SN7300 SN7301	SN7470		SN1590 SN1591 SN1593
Dual J-K Flip-flop	SN7302 SN7304			
Quad gate	SN7360	SN7400		SN1583
Triple gate	SN7331	SN7410		
Dual gate	SN7311 SN7330	SN7420 SN7440	SN7000 SN7001	SN1581 SN1584
Single gate	SN7310	SN7430		
Dual EXCLUSIVE-OR	SN7370	SN7450		
Expander	SN7320	SN7460		SN1580
Inverter, Buffer	SN7350			SN1582
"One Shot"	SN7380			

WASHINGTON TRENDS

DEFENSE BUDGET NEAR PEAK—Additional defense dollars voted by Congress to pursue the Vietnam war nudged the defense budget to $53.4 billion—second only to the record-breaking $74.6 billion military budget voted in fiscal 1944. The $1.7 billion supplemental request will be spent for many types of equipment, as well as for construction in Vietnam.

PATENT COMPROMISE LIKELY—A compromise is likely in the bitter battle over industry's "right to inventions" developed under federal contracts. A bill sponsored by Sen. John L. McClellan (D.-Ark.) chairman, patents subcommittee, would allow companies to keep patent rights but give the government free use of inventions. DOD is supporting the measure as a "proper balance" between private or public ownership.

WE'RE SWAMPED IN PATENTS—All advanced nations are swamped in applications for patents on new inventions, and about half of all applications are duplicates of papers filed in other countries. Assistant Secretary (for Science & Technology) of Commerce J. Herbert Hollomon proposes an international plan of exchange and cooperation aimed at weeding out duplication.

METRIC STUDY MOVES SLOWLY—The U. S. will not switch to the metric system without many compromises between industry and the backers of conversion. The first compromise came early when legislation calling for a three-year government study of the "advantages" of a switch was amended to include a probe of the "disadvantages." Industry also insists that it participate in the study. Industry, facing huge conversion costs and confusion in the switch, wants to make certain that problems are spelled out in the study results. The pressure for the U. S. to convert to the metric system gained strong impetus following Britain's recent decision to "go metric."

WEST COAST FAVORED—West Coast manufacturers and researchers will continue to get their lion's share of NASA contracts. There has been debate in Senate and House over the geographic dispersal of NASA contracts (Western states get most; East Coast areas next; Midwestern states get few if any). Congressmen from interior states fought hard for a clause requiring the spreading of NASA contracts across the nation. They were overridden by NASA bill managers, who hail from coastal areas and who naturally have no reason to disturb the existing pattern of contract distribution. The Midwest is an economic wasteland as far as NASA contracts are concerned, it was charged by Rep. J. E. Roush (D.-Ind.).

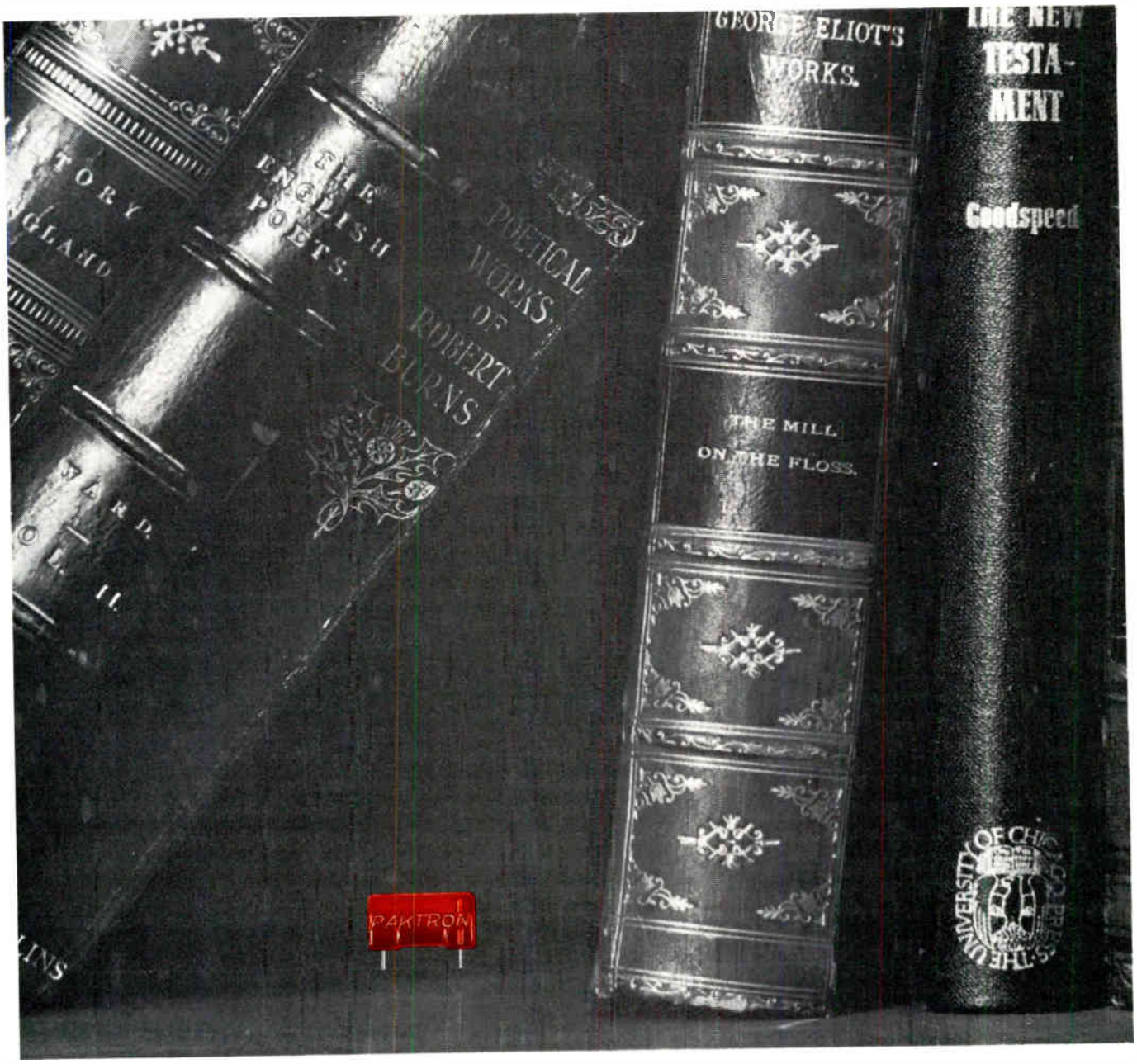
MORE COMSATS PLANNED—Success of its "Early Bird" communications satellite is leading COMSAT into plans for more advanced satellites. COMSAT (Communications Satellite Corp.) is asking industry to propose (beginning Oct. 25) an advanced spacecraft for a worldwide commercial communications system. (Early Bird links only North America and Europe.) The new satellite may be used either in a synchronous system at 22,300 miles altitude, or in a phased system at 6,000-12,000 miles altitude.

NEW ARMS-CUT STUDY—Government disarmament officials have ordered a study of the economic effects of shut-downs at 80 U. S. military bases. U. S. Arms Control & Disarmament Agency has signed a contract for the study with the University of Kansas. Results of the study are expected to serve as guidelines in future base closings. Chief concern is with economic impact of base closings on nearby towns and populations.

PERSONNEL RULES TIGHTENED—Defense Dept. plans to tighten rules on use of contract personnel retained by manufacturers holding defense contracts. The Pentagon believes it has been too lax in the discretion it has allowed contractors in hiring technical help for military contracts. The Pentagon's decision results in part from prodding by the U. S. Civil Service Commission. Some government employees complained they were performing the same work as non-government employees for less pay.

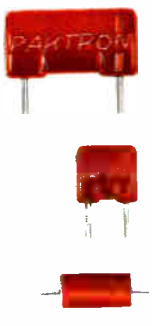
INTERFERENCE BILL STUDIED—The FCC and segments of the electronic industry failed to see eye to eye on legislation to solve the problem of interference from various devices early this summer. The issue stems from a measure sponsored by FCC to give it power to set regulations for the manufacture, sale, shipment, and import of such devices as garage door closers that often cause radio interference. Not all electronic makers oppose it, but many do because of the fear of increased government control of the industry.

MORE CONTRACTS TO SMALL FIRMS—An increasingly larger share of missile and space business is going to smaller firms. U. S. Dept. of Labor reports that larger firms (5,000 or more workers) are losing their relative share of missile and space contracts. In 1961, companies with 5,000 or more workers performed 58% of all space contracts. By degrees, this share has slipped to 52%. Conversely, manufacturers having between 1,000 and 5,000 workers on their payrolls increased their share from 33% to 35%. Firms in the 250-1,000 bracket increased from 8% to 11%.



ONE THING ABOUT CLASSICS . . . THEY NEVER CHANGE

PAKTRON® molded Classic$^{T.M.}$ capacitors stand the test of time. Hot or cold, it doesn't make much difference to a PAKTRON Classic$^{T.M.}$ capacitor. With the inherent stability of polycarbonate, PAKTRON Classic$^{T.M.}$ polycarbonate film/foil capacitors satisfy applications where minimum capacitance change with respect to temperature excursions is a design criterion. They are highly resistant to moisture, shock, vibration and contamination, and have passed many of the toughest electrical-environmental requirements. Dimensions are precise. All parts are certified and fully tested by PAKTRON. All this leads to the most important PAKTRON Classic$^{T.M.}$ capacitor feature . . . over the entire temperature range, PAKTRON Classic$^{T.M.}$ capacitors never change. Ask for samples.



PAKTRON® *Classic*$^{T.M.}$ molded polycarbonate film capacitors

- Working Voltage: 50 WVDC
- Tolerances: ±1%, ±2%, ±5%, ±10%
- Operating Temperature Range: −65°C to +105°C

PCR-700
.700 inches long. Capacitance values to 0.1 mfd.

PCR-330
.330 inches long. Capacitance values to 0.010 mfd.

PCA-375
.375 inches long, .200 inches dia. Capacitance values to .015 mfd.

"Remember, you're never more than a few feet away from a product of ITW"$^{®\,T.M.}$

itw

PAKTRON

DIVISION ILLINOIS TOOL WORKS INC.
1321 LESLIE AVENUE • ALEXANDRIA, VIRGINIA 22301

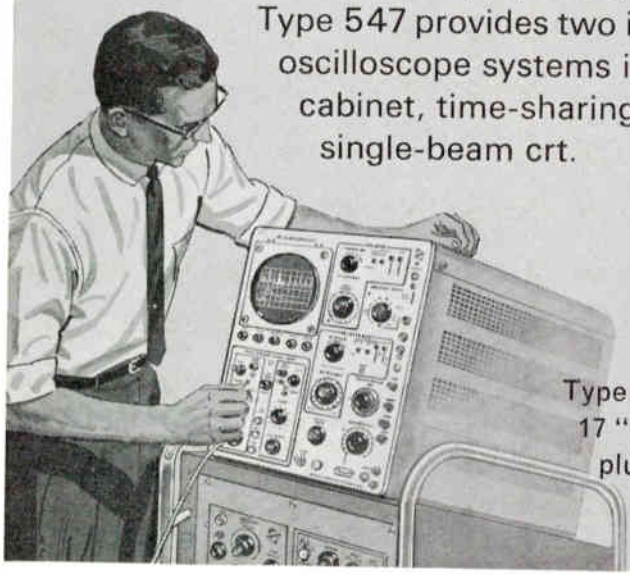
Circle 13 on Inquiry Card

Tektronix oscilloscope displays both time-bases separately or alternately

NEW TYPE 547 and 1A1 UNIT

DUAL TRACE	**DC-to-50 MHz 50 MV/CM** DC-TO-28 MHz, 5 MV/CM
SINGLE TRACE	**2 Hz-to-15 MHz 500 μV/CM** (CHANNELS 1 AND 2 CASCADED)

With automatic display switching, the Type 547 provides two independent oscilloscope systems in one cabinet, time-sharing a single-beam crt.



Type 547 also uses 17 "letter-series" plug-in units

Some Type 547/1A1 Unit Features

New CRT (with internal graticule and controllable illumination) provides bright "no-parallax" displays of small spot size and uniform focus over the full 6-cm by 10-cm viewing area.

Calibrated Sweep Delay extends continuously from 0.1 microsecond to 50 seconds.

2 Independent Sweep Systems provide 24 calibrated time-base rates from 5 sec/cm to 0.1 μsec/cm. Three magnified positions of 2X, 5X, and 10X, are common to both sweeps—with the 10X magnifier increasing the maximum calibrated sweep rates to 10 nsec/cm.

Single Sweep Operation enables one-shot displays for photography of *either* normal or delayed sweeps, including alternate presentations.

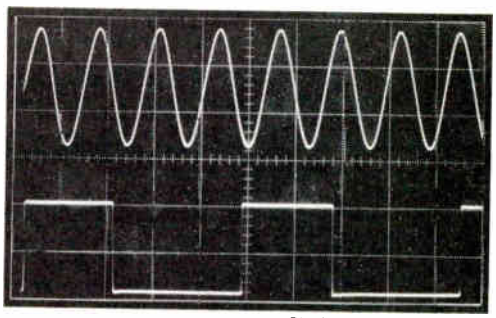
2 Independent Triggering Systems simplify set-up procedures, provide stable displays over the full passband and to beyond 50 MHz, and include brightline automatic modes for convenience.

Type 547 Oscilloscope $1875
(without plug-in unit)

Type 1A1 Dual-Trace Unit . . . . . $ 600

Rack-Mount Model Type RM547 . . . $1975

U.S. Sales Prices f.o.b. Beaverton, Oregon



Single-exposure photograph.

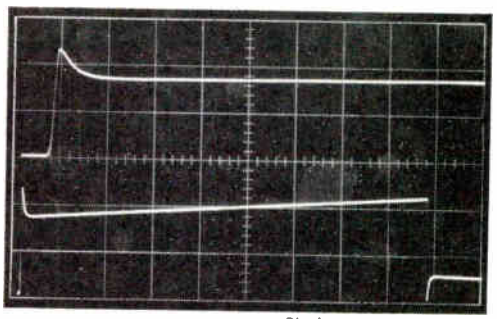
2 signals — different sweeps

Upper trace is Channel 1/A sweep, 1 μsec/cm.
Lower trace is Channel 2/B sweep, 10 μsec/cm.

Using same or different sweep rates (and sensitivities) to alternately display different signals provides equivalent dual-scope operation, in many instances.

Triggering internally (normal) permits viewing stable displays of waveforms unrelated in frequency.

Triggering internally (plug-in, Channel 1) permits viewing frequency or phase differences with respect to Channel 1.

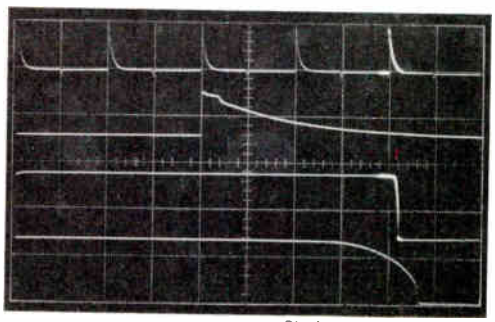


Single-exposure photograph.

same signal — different sweeps

Upper trace is Channel 1/A sweep, 0.1 μsec/cm.
Lower trace is Channel 1/B sweep, 1 μsec/cm.

Using different sweep rates to alternately display the same signal permits close analysis of waveform aberrations in different time domains.



Single-exposure photograph.

2 signals — portions of each magnified

Trace 1 is Channel 2/B sweep, 10 μsec/cm.
Trace 2 (brightened portion of Trace 1) is Channel 2/A sweep, 0.5 μsec/cm.
Trace 3 is Channel 1/B sweep, 10 μsec/cm.
Trace 4 (brightened portion of Trace 3) is Channel 1/A sweep, 0.5 μsec/cm.

Using sweep delay technique—plus automatic alternate switching of the time bases—permits displaying both signals with a selected brightened portion and the brightened portions expanded to a full 10 centimeters.

B sweep triggering internally from Channel 1 (plug-in) assures a stable time-related display without using external trigger probe.

For a demonstration, call your Tektronix Field Engineer

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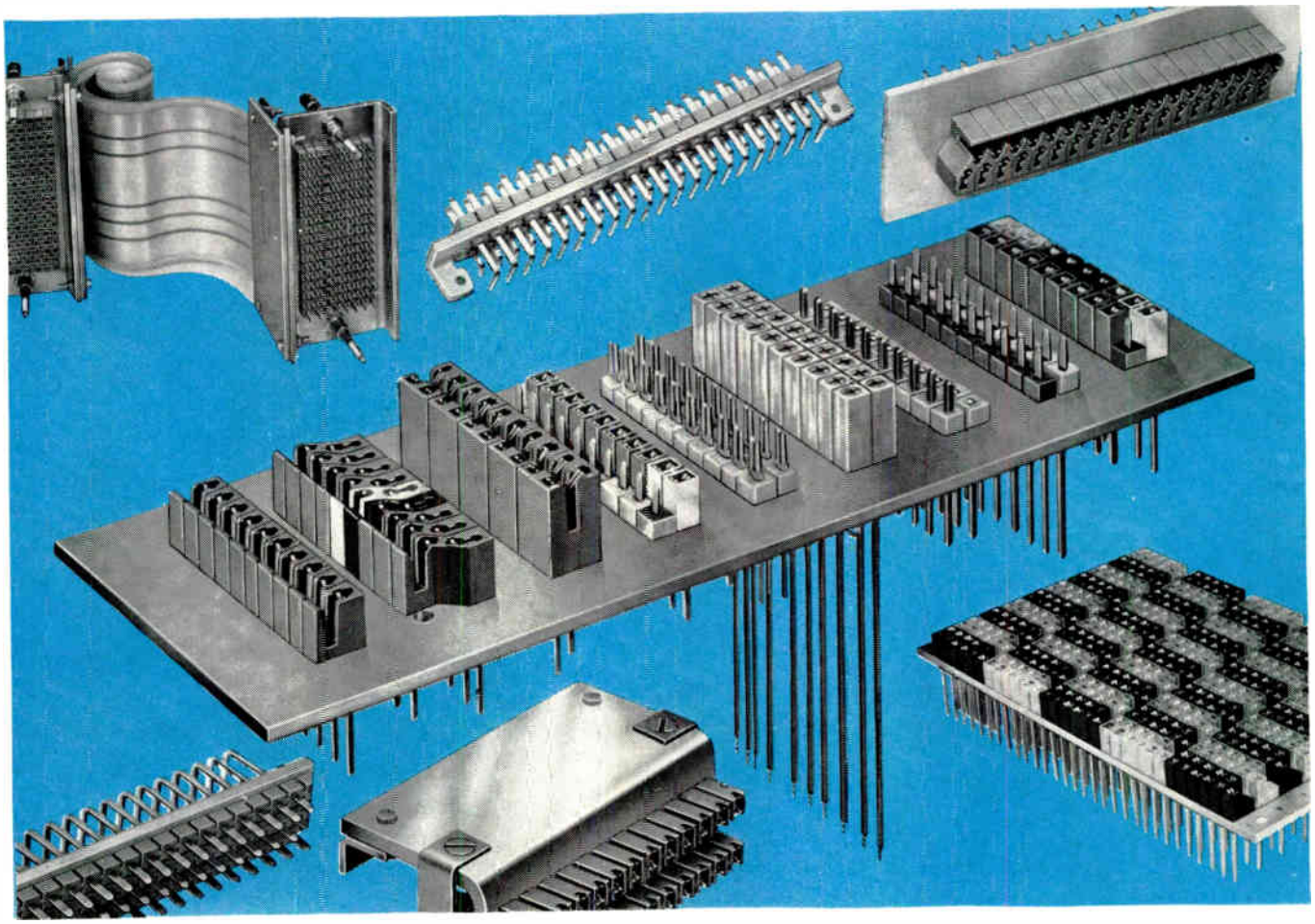
ELCO VARIPLATE*



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ELECTRONIC SNAPSHOTS

The Changing STATE-OF-THE-ART in the electronic industries

▲ **DASHBOARD CIRCUITRY**

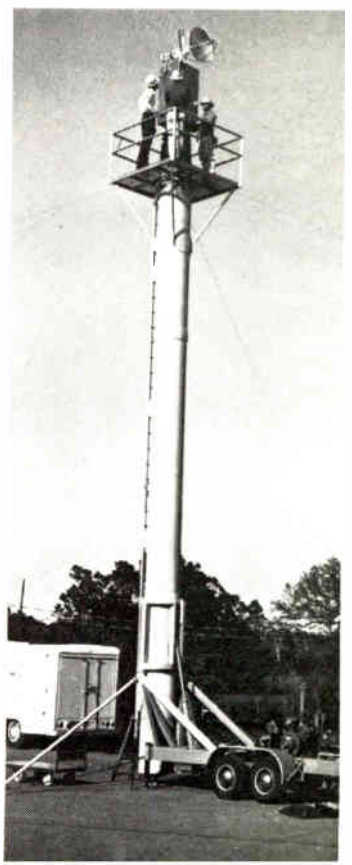
Foil in this auto dashboard circuit is .0015" thick. Clevite Corp., developer of high purity copper foil for the printed circuit, reports it is lead free, non-porous and non-oxidizing. The foil is widely used in telemetry, missile components and in data processing equipment.

▼ **ENDURANCE RUN**

Robert Speiser (left) Electro-Optical Systems, Inc., and James Wolters, NASA Lewis Research Center, examine electron bombardment engine of type that just completed extended endurance test over 2,610 hours in space simulation tests. The run gives second-generation thrustor "measurable status" as a propulsion source.

ANTENNA FOR RFI STUDY ▶

Telescoping tower antenna system, installed at Air Proving Ground Center, Eglin Air Force Base, by Electro-Mechanics Co., allows environmental tests of operational radars unaffected by site conditions, reports the firm. Six fiberglass sections extend up to 200 feet to support platform plus 500-lb payload.

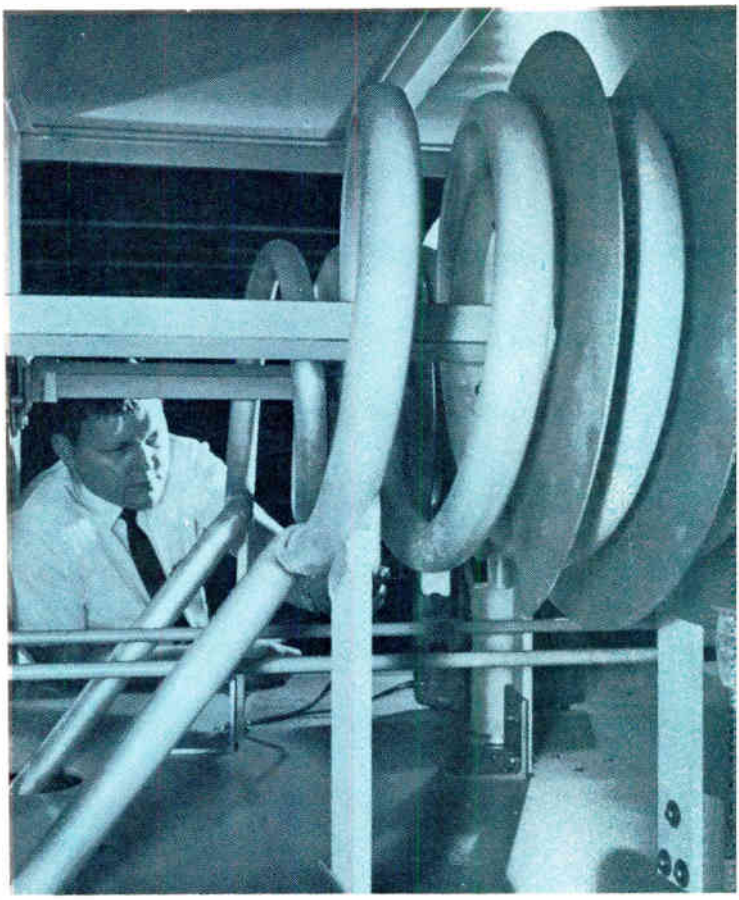


◀ **PROGRAMMED WIRE WRAPPER**

Machine automatically lays out wires on board or panel to be wired and makes wrapped joints at terminals according to a punched-tape program, both developed by Standard Telephones and Cable Ltd., London.

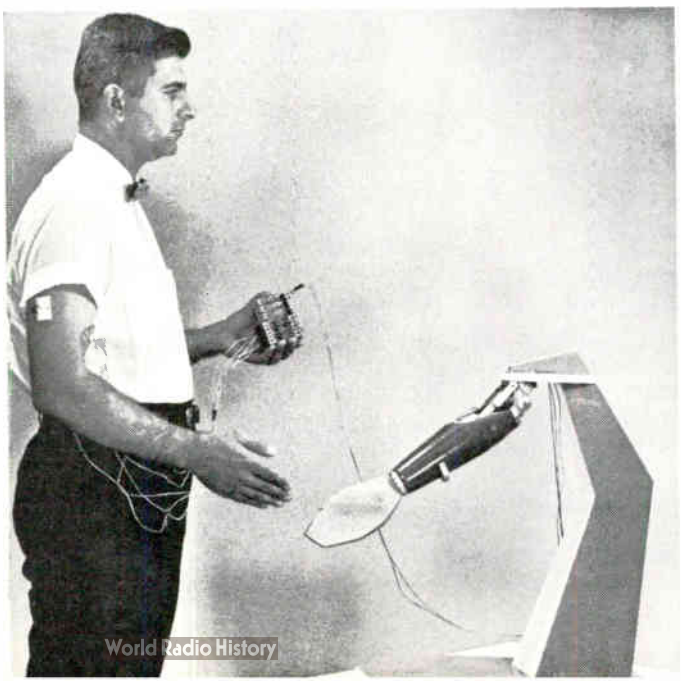
▼ **TO PENETRATE THE 'BAMBOO CURTAIN'**

Coil and sheath assemblies are vital parts of 250,000-watt transmitter, 10 of which are being built by Hughes Aircraft Co. for U. S. Information Agency. They will simplify automatic frequency changes.



▲ **OXYGEN MAKER**

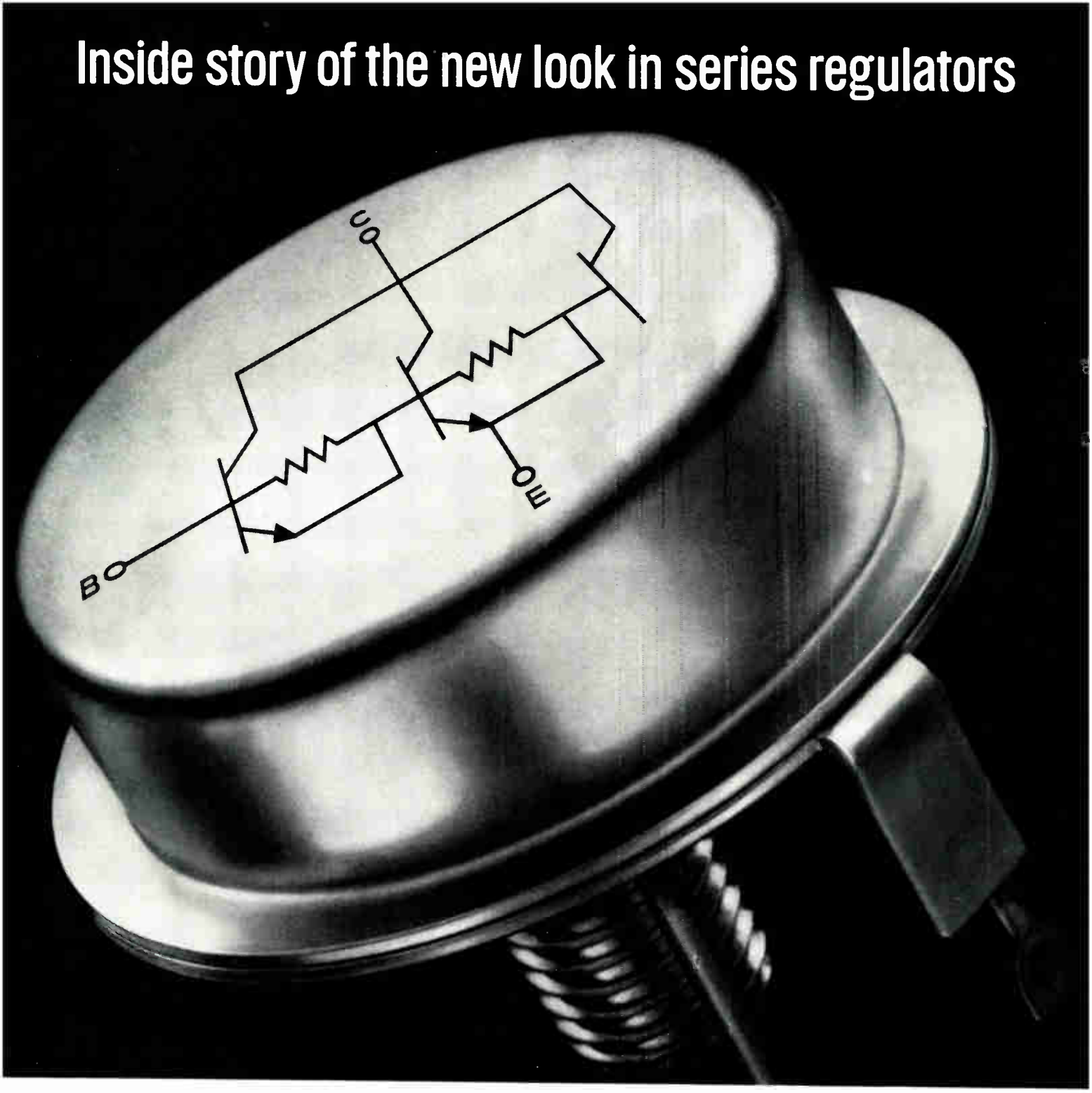
Experimental fuel cell system being assembled by Westinghouse researcher Harry Sherwin can generate pure oxygen from two waste products from human breathing. About 100 small tile-like fuel cells make up the oxygen-generator shown. Potentially, it may sustain man in deep space.



◀ **ARM MODEL**

Working model of artificial arm, by Philco researchers, that bends at elbow and turns hand, all by remote signals from living human muscles. Serge Minassian, scientist, simulates handshake.

Inside story of the new look in series regulators



Westinghouse power integrated amplifiers eliminate a complete driver stage.

Save space, improve reliability, cut costs with Westinghouse power integrated amplifiers. Types 2N2233 and 2N3477 provide exceptionally high gain at high power levels—h_{FE} = 400 at 10 amps I_C, V_{CE} = 200 volts and P_D = 150 watts. Single and double ended packages provide complete design flexibility. Check these exclusive features:

- Hard soldered junctions eliminate thermal fatigue.
- Large emitter-base area puts an end to secondary breakdown.
- True monolithic construction stops runaway leakage.

SINGLE ENDED	DOUBLE ENDED	V_{CE}	h_{FE}
2N2226	2N3470	50	100 @ 10A
2N2227	2N3471	100	
2N2228	2N3472	150	
2N2229	2N3473	200	
2N2230	2N3474	50	400 @ 10A
2N2231	2N3475	100	
2N2232	2N3476	150	
2N2233	2N3477	200	

You can be sure if it's Westinghouse

Circle 15 on Inquiry Card

And, of course, reliability is assured by the exclusive Westinghouse Lifetime Semiconductor Guarantee.* For full information call your Westinghouse salesman or distributor, or write to the Westinghouse Semiconductor Division, Youngwood, Pennsylvania.

*Westinghouse warrants to the original purchaser that it will correct any defect or defects in workmanship, by repair or replacement f.o.b. factory, for any JEDEC-type silicon power semiconductor during the life of the equipment in which it is originally installed, provided said device is used within manufacturer's published ratings and applied in accordance with good engineering practice. This warranty is applicable to devices of the stated types shipped after March 9, 1964, until further notice. This warranty shall constitute a fulfillment of all Westinghouse liabilities in respect to said products. This warranty is in lieu of all other warranties expressed or implied. Westinghouse shall not be liable for any consequential damages. SC-2050

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Designed for filter, bypass, coupling and blocking applications.

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Compact modules of resistor-capacitor networks with 2, 4, 6 or 8 leads . . . with or without semiconductor elements.

THE term "ACTIVE" in the Erie organization identifies a total program encompassing the research, development and production of Advanced Components Through Increased Volumetric Efficiency for aerospace, military and commercial equipment.

Project "ACTIVE" now brings to electronics and avionics a series of high performance, subminiature components designed for applications where every cubic inch of space and every ounce of weight is critical to successful equipment performance.

These Erie components have been and are being designed into the circuitry of such demanding systems as Gemini, Apollo, Minuteman, Nike X, Telstar, Polaris . . . commercial computers, oscilloscopes . . . and many other applications where size, weight and dependable performance are vital. While the advanced products illustrated at left are in quantity production, a number of components are still in the concept stage, while others are at final evaluation ready for production.

Consider the problem-solving advantages Erie ACTIVE components can offer you in your quest for reliable, subminiature components. We suggest ERIE as your quality source. A collect call or letter to your nearby representative . . . or to Erie headquarters is all that is needed as the "first step."

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Advanced Components through Increased Volumetric Efficiency

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U. S. FIRMS EXHIBIT WARES AT SWISS ELECTRONIC SHOW

Fifty-one U. S. manufacturers from 13 states—including 30 firms new to the market—displayed their advanced electronic wares in September at the U. S. exhibit in the International Exhibition of Industrial Electronics (INEL) in Basel, Switzerland.

The U. S. exhibit was sponsored by the Department of Commerce Bureau of International Commerce.

Prospective buyers, agents, and distributors visiting U. S. company booths saw a wide variety of electronic products, including advanced monolithic hybrid and thin film microcircuits; conventional semiconductor devices and electronic components, and digital and analog computers. They also had an opportunity to discuss new electronic manufacturing processes used in the U. S.

60' EXHIBIT VAN TOURING U. S. AND CANADA

Interior view of Texas Instruments "Innovations in Technology" exhibit van now on 16,000-mile tour which will bring data on TI's new products to design engineers across the U. S. and Canada. Featured are some 55 running feet of exhibits and demonstrations.

OVERSEAS RADIOS INCREASE 18 MILLION, REPORTS USIA

There were some 286,000,000 radio sets in use in the world outside the United States and Canada at the end of 1964, reports the U. S. Information Agency. This total denoted an increase of 18,000,000 sets over 1963.

Of the sets overseas, 36% were in Western Europe; 21% in the Far East; 20% in Eastern Europe; 12% in Latin America and; 7% in the Near East and South Asia, and 4% in Africa, USIA said in its report.

The ratio of radios to population, exclusive of the United States and Canada, ranged from one set for every three persons in Western Europe to one set for every 40 persons in the Near East and South Asia area.

With an estimated 228,000,000 radio sets in the United States and 10,500,000 in Canada at the end of the year, the world total substantially passed the half billion mark in 1964, USIA said.

POLAND'S EXPORTS SINCE '60 MAY HIT $2.5 BILLION

Exports of electronic products from Poland have expanded steadily since 1960. Polish electronic exports are expected to reach a total value of 9 million pounds this year for the five years, or about $2,520,000,000.

According to recent reliable reports there are nearly 40 major electronic firms in Poland; they employ about 61,000 persons. Their production during 1965 may well reach 600,000 radios, 10,000 TV sets, 50,000 record players, and 12 million electron tubes.

COMPONENT SHIPMENTS SET NEW YEARLY HIGH IN 1964

Total factory shipments of electronic components in U. S. exceeded $4.1 billion in 1964, a gain of 4.5% over the 1963 level, and a new record, the U. S. Dept. of Commerce reports.

An increase of 15% in value of non-defense shipments partly offset a 16% decline in value of components for defense and other government end uses. Substantial unit increases in non-defense shipments were offset by continuing price declines which limited the overall growth in dollar value.

Contributing to the 1964 growth was a 51% increase in shipments of complex components. This reflected the continued trend toward packaged circuitry in both defense and non-defense applications. A gain of 21% in the value of total picture tube shipments resulted primarily from sales growth of color receivers, which amounted to 1.4 million units for the year compared with 800,000 in 1963. The increased TV receiver production also stimulated a 7% gain in the semiconductor industry despite a 20% decline of semiconductor shipments for defense use.

Nominal gains were made in 1964 over 1963 in the value of shipments of transformers, capacitors, quartz crystals and relays. Declines were noted in power and transmitting tubes, down 14%; connectors, down 7%; receiving tubes, down 5%; and resistors, down 2%.

Shipments of complex components, semiconductors and TV picture tubes, in continuing to climb, offset the downward trends in capacitors, resistors, and transmitting and special purpose tubes which peaked in 1962. These declines have been influenced by increasing competition in both defense and non-defense markets.

New procurement methods and new inventory controls in DOD combined with reduced military requirement heightened the competitive pressure, particularly for products such as power and special purpose tubes.

The increase in shipments of complex components, such as discrete component packages, thin film, hybrid and monolithic networks since 1959, is an indicator of the extent to which these devices are replacing conventional components in end-equipment design.

EDP SERVICE WILL SPEED TRADE DATA TO COMPANIES

Secretary of Commerce John T. Connor disclosed a program using computers to speed up and broaden distribution of commercial information to U. S. firms. Such data would include international sales and other business opportunities, tailored specifically to the needs of the companies.

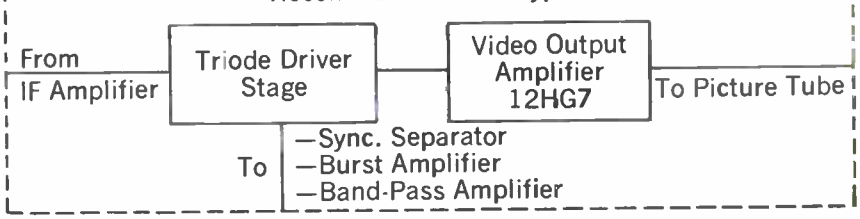
Of some 350,000 U. S. firms, Secretary Connor has asked those interested in international trade and investment to participate by registering in a new automated American International Traders' Index, basis of the expanded service.

The Index will provide the Department with a comprehensive data file of international traders. This will permit computerized matching of commodity and/or geographic interests of companies with specific items of trading information.

Now, you can eliminate one stage and reduce the number of components in your video-amplifier circuit with the new RCA-12HG7 COLOR-TV RECEIVING TUBE. This FRAME-GRID, Sharp-Cutoff Pentode offers these benefits to the circuit designer:

- *high transconductance*—32,000 *μmhos*—provided by the FRAME-GRID construction, permits you to drive the color-TV picture tube with only two stages of video amplification.
- *high dissipation capability*—10 watts (maximum) plate-dissipation rating eliminates the need for a series plate-circuit dropping resistor and its associated by-pass capacitor. Greater margin between maximum rating and usual operating values will contribute to greater reliability and longer life expectancy.
- *high plate current "knee" characteristic*—permits high output and good linearity over a "B" supply voltage range of 270 volts to 400 volts or more.
- *RCA Dark Heater*—reduces temperature and contributes to long life and dependable performance.

VIDEO AMPLIFIER
Recommended RCA Type



RCA's knowledge and experience in color television have led to the design and selection of tubes, such as the RCA-12HG7, which offer the color-TV set manufacturer *the best combination of price, performance and reliability on the market today.* For more information on the RCA-12HG7 and other RCA COLOR-TV RECEIVING TUBES, call your nearest RCA District Office or write RCA Commercial Engineering, Harrison, New Jersey 07029.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, NEW JERSEY

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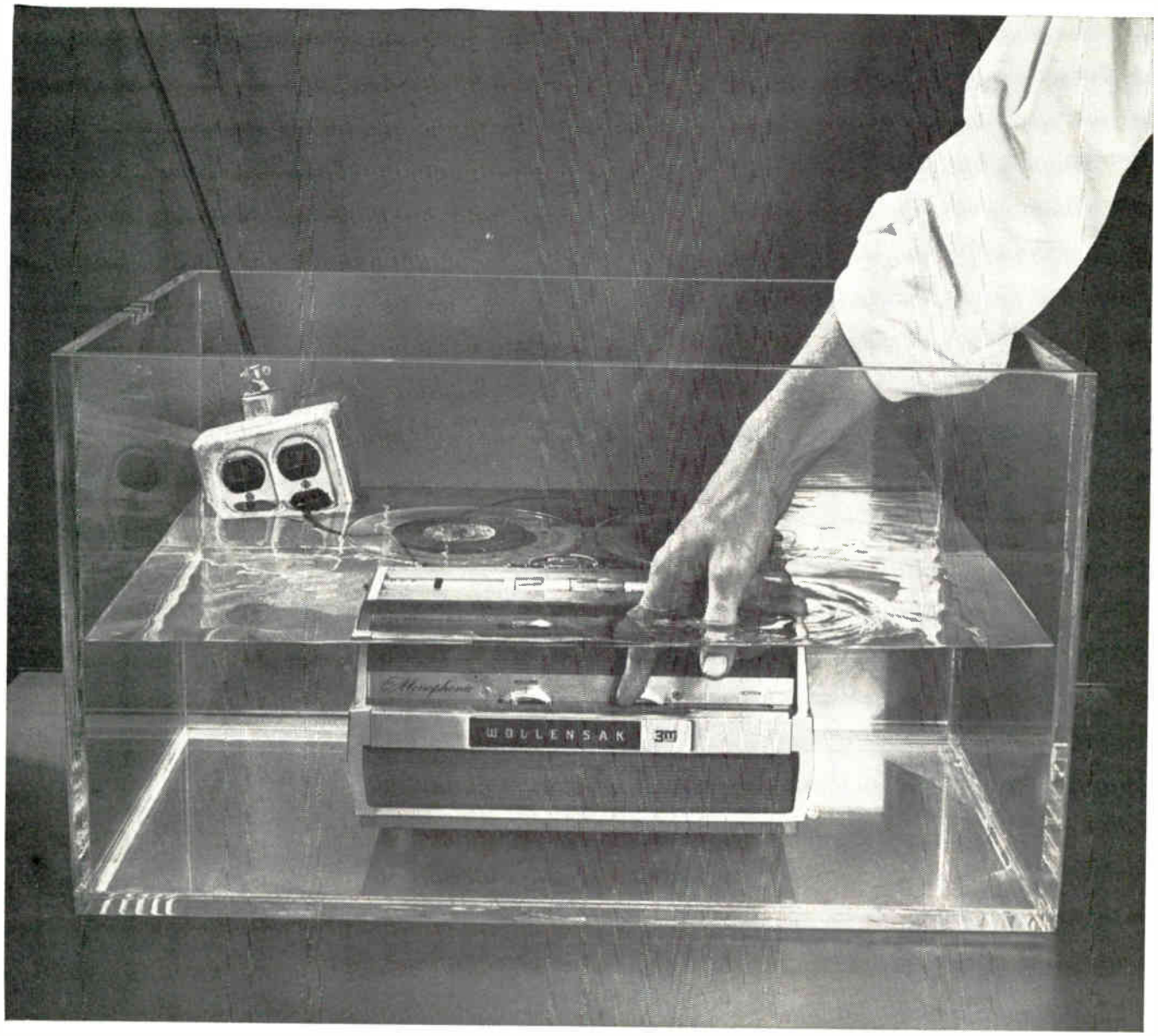

WHAT IS A TAPE RECORDER DOING IN FC-77 COOLANT?

Playing!

This traffic-stopping demonstration of the completely inert dependability of FC-77 coolant has been featured at several national electronic trade shows. An ordinary "right-out-of-stock" tape recorder is lowered into a tankful of FC-77, plugged into an electrical outlet and a hand reaches in and pushes the button to start a practically continuous concert that plays during the show.

All this time, recorder parts of steel, copper, chrome, plastic, rubber, elastomers, glass, nylon, adhesives, as well as recording tapes are directly immersed in FC-77 coolant. Nevertheless the recorder plays on. When at the end of a show, the player is removed from the tank none of its components are affected. How's that for "inertness"!

All members of 3M's fluorochemical coolant family have this exceptional compatibility with most materials (even at temperatures above the maximum permissible with other dielectric coolants). This "easy-to-get-along-with" coolant, incorporated into your system can bring about better reliability. *Want more?* These coolants have wide liquid ranges, excellent electrical properties, thermal and chemical stability, are non-flammable, non-corrosive, non-toxic. Write and ask about them, particularly our new, economical FC-77. 3M Company, Chemical Division, Dept. KCQ-105, St. Paul, Minn. 55119.

Chemical Division 3M COMPANY

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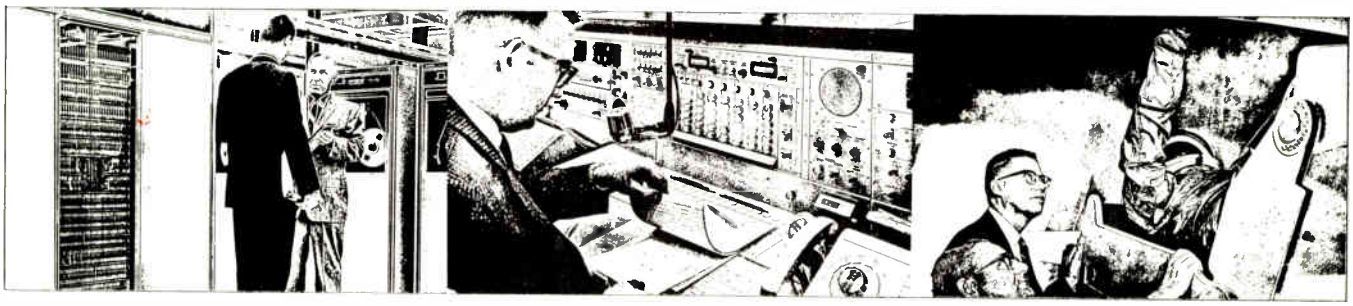

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SEND RESUME FOR PROMPT INFORMATION

RF SYSTEMS ENGINEERS — B.S.E.E. with experience in RF Systems including receivers, transmitters, and antennas in the VHF-UHF frequency range. Of specific interest is experience in phase locked loop receivers, high power transmitters, tracking (monopulse) antenna systems, and tracking system analysis. (Dallas)

RELIABILITY ENGINEERS (M.E. and E.E.) — M.E.'s to perform stress and dimensional analysis on antenna structures, hydraulic drive systems and electronic packaging. E.E.'s with experience in design and component application to handle qualification and acceptance test analysis and component engineering on high reliability space programs. B.S.E.E. or B.S.M.E. required. (Cedar Rapids)

INDUSTRIAL ENGINEERS—B.S.I.E. or B.S.-M.E. with industrial option. Should have experience in manufacturing methods and procedures, work station analysis, facilities planning or material handling. MTM application and training highly desirable. (Cedar Rapids and Dallas)

TRANSMITTER DESIGN ENGINEERS — Position involving design of high power transmitters and high voltage DC power supplies. Must be capable of applying filter theory to optimize design of high power transmitters. MF and HF frequency range. B.S.E.E. required; post graduate work desirable. Understanding of computer control of transmitter systems helpful. (Dallas)

ANTENNA DESIGN ENGINEERS — B.S.E.E. with experience with tracking antennas, aircraft, and space antennas, including antenna pattern and impedance measurements. Some openings for individuals with experience in HF and VHF measurement techniques. Background in network and electromagnetic theory is desirable. (Dallas)

FIELD SUPPORT ENGINEERS — Openings for field engineers with installation and check-out experience in one or more of the following: high density microwave systems, toll terminal equipment, cable and open wire multiplex, monopulse tracking techniques, phase locked loop receivers, parametric amplifiers, Cassegrain feeds, tropospheric scatter systems. Considerable travel involved; some outside continental U.S. and some without family. (Dallas)

COMMUNICATIONS SYSTEMS ENGINEERS (E.E.) — Electrical Engineers should be experienced in digital data transmission, airborne transportable or fixed station HF/SSB, or microwave communication systems. (Dallas and Cedar Rapids)

CIRCUIT DESIGN ENGINEERS — For design of general communications equipment. Prefer solid state and/or digital experience. Project assignments will involve HF through M/W frequency ranges in military, commercial or space programs. B.S.E.E. or M.S.E.E. required. Also solid state circuit design for airborne applications. Knowledge of operational amplifiers in consulting techniques desirable. (Cedar Rapids and Dallas)

MICROWAVE DESIGN ENGINEERS — Microwave Design Engineers with active development background in solid state RF sources; knowledge of wave guide techniques desirable. B.S.E.E. required. (Dallas)

MECHANICAL ENGINEERS — B.S.M.E. for equipment and systems design. Duties will include machine design, hydraulic circuit design, stress and dynamic analysis, hydraulic and pneumatic design, electronic packaging and production processes. (Dallas)

CRYSTAL FILTER ENGINEERS—To work in the challenging field of crystal filter development and/or crystal development. Minimum requirement B.S. degree but prefer M.S. or Ph.D. Two to four years minimum experience. (Newport Beach)

COMMUNICATION/COMPUTATION/CONTROL

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LETTERS

to the Editor

The Manager's Responsibility

Editor, ELECTRONIC INDUSTRIES:

I write with regard to the article by Mr. Roger M. D'Aprix, ("Needed: Better Technical Papers") in the April, 1965 issue.

Mr. D'Aprix accurately points out the basic problems with the quantity and quality of technical papers. However, I believe he has misplaced both the blame for the problem, and the responsibility for its solution; both lie with the engineering manager.

The working engineer—properly—depends on his manager for detailed guidance on what tasks should occupy his time, the priorities which various tasks assume, and the manner in which each task should be approached and accomplished. Technical articles and papers are tasks in the same sense that other engineering efforts are and they should receive the same well-qualified management. The manager is in a position to judge the likelihood of publishing descriptive material on a task in his group, the worth of publication to the company, the group, the individual, and the desirability of allocating manpower to the writing task. The existence of a technical writing group as staff support to both the manager and the engineer is an important aid. However, the basic responsibility is a line function of the manager. Both company management above, and the working engineer below, have the right to expect him to discharge this responsibility in the same professional manner as his design supervision responsibilities.

Dan M. Bowers
Digital Systems Section Mgr.
Potter Instrument Co., Inc.
East Bethpage Rd.
Plainview, N. Y.

Can You Help?

Editor, ELECTRONIC INDUSTRIES:

I just recently returned from a trip to the Far East, and in the course of my travels, I visited Okinawa. As you know, all of the Ryukyu Islands are a bit off the beaten path, particularly since the jet took over long-haul travel by air.

I was very much impressed by the people I saw in Okinawa, and by their industriousness. I was also impressed by the fact they are probably as skilful as the Japanese are, and possibly more so. In addition, I was impressed by the fact that they are Within the dollar bloc, since they use American currency exclusively.

I believe that you can do ELECTRONIC INDUSTRIES a big favor, and also help both the United States and Okinawa, which is an American protectorate, if you could take some interest in helping the Okinawans build up their technical competence in electronics, and become both an educational and a manufacturing center in this field.

I believe they probably need a first-rate technical library, and associated with it educational facilities for training engineers and technicians as a first step to such a goal. Admittedly, you couldn't do this for them, but many of your readers I am sure could contribute books and possibly other kinds of help, and many of our manufacturers might be able to help in the establishment of such an educational center in return for help in the establishment of Far-East branches there. These branches probably would not be subject to difficulties of the kinds presently being encountered in Japan.

I am sending a copy of this letter to the Director of Educational System, Naha, Okinawa, hoping it will reach the right individual.

Dr. Keats A. Pullen, Jr.
Ballistic Research Laboratories
Aberdeen Proving Ground, Md.

Our Thanks . . .

Editor, ELECTRONIC INDUSTRIES:

We want to thank you very much for the excellent color reproduction of the Ballantine Model 355 in your Wescon issue.

A. W. Parkes, Jr.
President
Ballantine Laboratories, Inc.
Boonton, N. J. 07005

ARMCO NONORIENTED ELECTRICAL STEELS

	Hot-Rolled	Cold-Reduced	Cut Lengths	Coils	Surface Insulation‡‡
TRAN-COR® A-6	FP	—	x	x	Standard, core plate, No. 4, CARLITE®
*TRAN-COR M-14	FP	—	x	x	
DI-MAX® M-15	FP	—	x	x	
DI-MAX M-19	FP	FP	x	x	
DI-MAX M-22	FP, SP	FP, SP	x	x	
DI-MAX M-27	FP, SP	FP, SP	x	x	
DI-MAX M-36	FP, SP	FP, SP	x	x	
DI-MAX M-43	—	FP	x	x	

FP—Fully processed; SP—Semi-processed

**No. 4 insulation not available on TRAN-COR M-14*
‡‡Surface insulation FP only.

You can design and fabricate to your exact needs with Armco Nonoriented Electrical Steels

Armco Nonoriented Electrical Steels offer you a broad range of physical and magnetic properties. They enable you to design, with greater precision, everything from large rotating machines to the smallest servos.

For example, Armco TRAN-COR® A-6 is ideal for audio transformers, servos, and 400 to 1200 cps generators. It provides a core material with high permeability at low and moderate inductions, almost uniform properties in all directions, and good punchability.

Armco DI-MAX® M-15, ideal for high efficiency equipment, offers an effective combination of superior permeability at high inductions, excellent space factor, and punching quality that prolongs die-life. To meet specific requirements of equipment calling for the basic properties of M-19 to M-43, you have the selectivity of DI-MAX grades hot-rolled or cold-reduced, fully processed or semi-processed, as listed in the table above.

The entire family of Armco Nonoriented Electrical Steels is available in a wide range of thicknesses and widths, with a variety of surface insulations, in coils and cut lengths. To help you make full use of this cost cutting selectivity, Armco has just published a new 97-page design manual containing basic information and design curves on Armco's Nonoriented Electrical Steels. Write today for your copy. Armco Steel Corporation, Dept. E-3405, P. O. Box 600, Middletown, Ohio 45042.

ARMCO STEEL ARMCO

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THE TRICK IS TO PRODUCE HIGH-QUALITY COLOR TV AT THE PRICE THAT WILL CRACK THE MASS MARKET WIDE OPEN

Like the well-known frame grid tubes developed by Amperex that forged the way for high-performance, low-cost black and white TV, Amperex now announces the right tubes for a similar "breakthrough" for color: 6KG6 horizontal output pentode; 6EC4 damper diode; 3BH2 high voltage rectifier diode. Competitively priced, they offer designers the opportunity of engineering low-cost color circuits without sacrificing reliability, since *they need only 240-270V B supply voltages.* With lower voltages and cooler operating temperatures, fewer components are required while built-in safety factors are retained for the desired quality.

The 6KG6 output pentode, designed for use in horizontal deflection circuits, has a Cavitrap anode for anti-snivet performance for all channel receivers. It offers 34 watt maximum plate dissipation and 1.4 amps peak anode current.

The 6EC4 damper diode, a matching companion to the 6KG6 for horizontal deflection circuits, provides 5600V PIV and 450 ma average cathode current.

The 3BH2 high voltage rectifier diode, offering 35KV PIV and 1.75 ma average cathode current, features a unique anti-corona shield for longer life and greater reliability.

For detailed data, prices and applications assistance on these and other tubes designed expressly for color TV, write to the company *still doing new things with receiving tubes:* Amperex Electronic Corporation, Semiconductor and Receiving Tube Division, Dept. 371, Slatersville, Rhode Island 02876.

IN CANADA: PHILIPS ELECTRON DEVICES, 116 VANOERHOOF, TORONTO

Amperex®

MONOLITHIC MEMORY MAY REPLACE FERRITE CORES

A HIGH-SPEED MONOLITHIC FERRITE MEMORY, which stores 4096 data bits, may replace conventional ferrite-core memories by eliminating much of the costly hand labor associated with the conventional cores. The monolithic unit, designated MF 2100, is batch processed. This eliminates the task of core-stringing and hand-wiring, which are the prime cost factors in the memory system. To simplify connector wiring, the device uses an integrated diode selection matrix (indexing circuits), which reduces the number of peripheral components.

A new production process uses tissue-thin layers of conventional ferrite material fired into a solid monolithic ferrite wafer 1 in. sq. and 5 mils thick. Each wafer contains 4096 theoretical cores, each with a 5 mil. diameter. The high-speed advantages of smaller cores provides a full-cycle time (read, delay, write) as low as 0.2 μsec. for a 64-word by 64 bit unit. Drive current requirements are less than those of present small-core coincident-current memories. Output voltages are equal to those of conventional core arrays—a distinct advantage over other bulk-fabricated devices which have very low output voltages.

Monolithic ferrite memory module is expected to replace hand-wired ferrite core memories in many computer applications.

In this device, two wafers are interconnected with an integrated silicon diode selection matrix of 128 diodes. This 4.5 in. x 3.75 in. module has a memory capacity of 4096 bits in two core/bit linear-select operation.

Monolithic construction makes possible the future design of fully integrated memory systems, and offers a packing density much higher than conventional memory assembly techniques. The MF-2100 is a product of Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J.

(More What's New on Page 116)

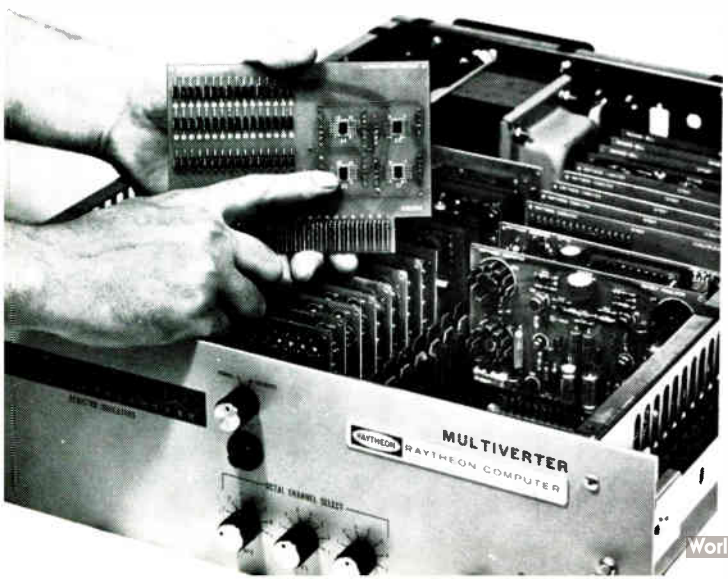
DATA SYSTEM IN A BOX

THE MULTIVERTER® COMBINES IN A SINGLE CHASSIS an integrated circuit multiplexer, and advanced sample and hold amplifier, and an analog-to-digital converter.

The device replaces three or more chassis normally required for the so-called analog front end in data acquisition and processing systems at considerable lower costs than conventional equipment. The system provides 12-bit data throughput at 50KC or 15-bit throughput at 30KC; system accuracy of 0.02%; data sampling aperture time of less than 100 nsec; input data voltage range of ±10 to ±128; and input impedance of 1000 megohms.

The integrated circuit multiplexer can operate to 1MC and displays zero offset characteristics. Each multiplexer card accommodates 16 input channels. Six cards for a total of 96 channels can be packaged in a single unit. The sample and hold amplifier has a 100 nsec. aperture time and settles in 4 nsec. to 0.01% accuracy. The Multiverter, a product of Raytheon Computer, Santa Ana, Calif., system can be used with a single sample and hold unit or with a sample and hold amplifier/channel for simultaneous parallel sampling.

The Multiverter, with integrated circuits, provides 50kc data throughput with 12- or 15-bit resolution. Accuracy is 0.02%.



Circle 21 on Inquiry Card →

SINGLE REJECTION CAVITY TYPE DIPLEXER—COMPARABLE TO A PACK OF REGULAR SIZE CIGARETTES IN SIZE

DOUBLE REJECTION CAVITY TYPE DIPLEXER

New Ultra-Compact UHF antenna diplexers

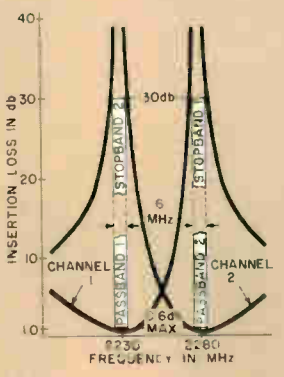
for use in the 2.2 to 2.3 GHz frequency range

■ Allen-Bradley high frequency laboratories are pioneering the development of antenna multiplexers for use at ultra-high frequencies. The two diplexers for the 2.2 to 2.3 GHz band shown above are representative of Allen-Bradley's high frequency capability. These diplexers are rugged—designed to withstand acceleration of 15 G's; shocks of 100 G's (1 msec.); and vibration of ±10 G's (30-2000 Hz). They're hermetically sealed for use at unlimited altitude and are stable over the temperature range from −50° to +170°F. The power handling capacity per channel is 20 watts.

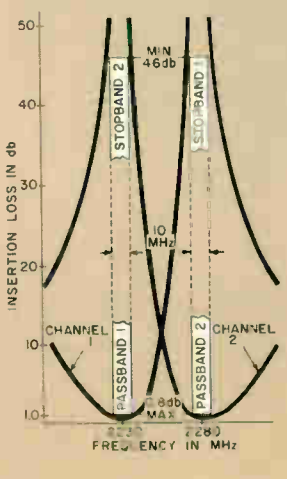
Allen-Bradley engineers will be pleased to work with you. Please write: Allen-Bradley Co., 222 W. Greenfield Avenue, Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont. Export Office: 630 Third Avenue, New York, N. Y., U.S.A. 10017.

TYPICAL RESPONSE CURVES

WITH ONE REJECTION CAVITY PER CHANNEL



WITH TWO REJECTION CAVITIES PER CHANNEL

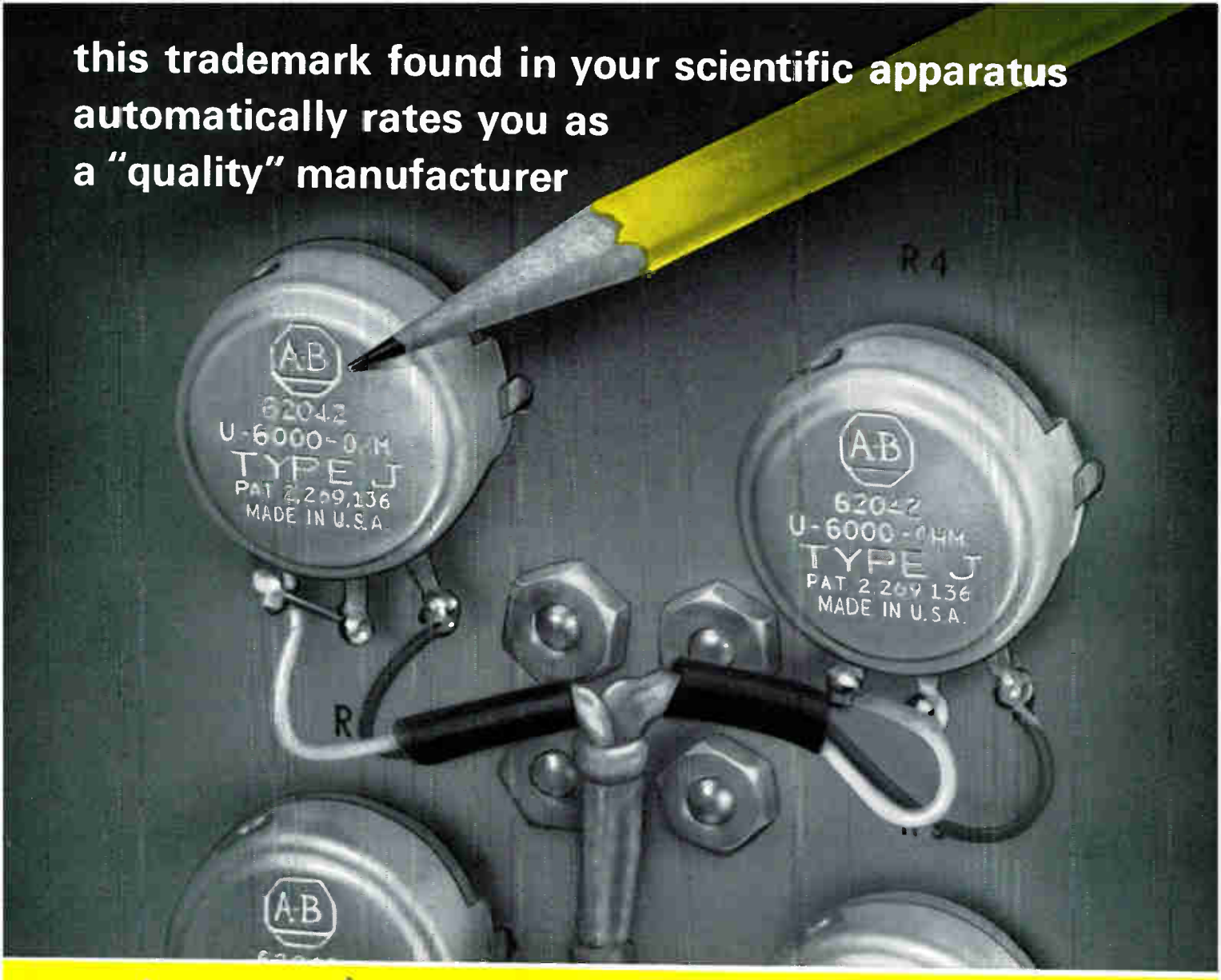


A-B QUALITY

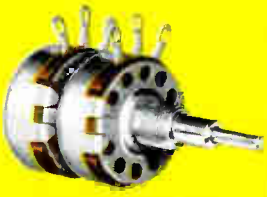
ALLEN-BRADLEY
QUALITY ELECTRONIC COMPONENTS

55-09-5E

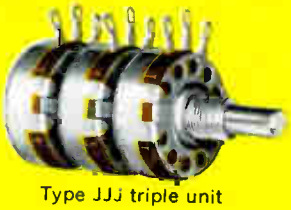
this trademark found in your scientific apparatus automatically rates you as a "quality" manufacturer



Type JS single unit with line switch

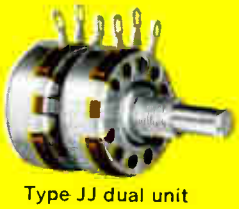


Type JJC dual unit with concentric shaft

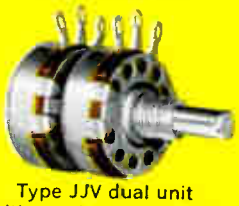


Type JJJ triple unit

Type JL single unit with lock busning



Type JJ dual unit



Type JJV dual unit with vernier adjustment

■ The A-B trademark on variable resistors is proof of design integrity—you have resisted the temptation of saving pennies by substituting marginal performing "entertainment type" controls. By thus assuring your customers of the "quality" of your apparatus, the extra price you pay becomes a good investment.

Allen-Bradley Type J variable resistors have a solid molded resistance element made by A-B's exclusive hot molding process. Operation is always smooth—there are never any sudden jumps in resistance during adjustment. Furthermore, the Type J exhibits an exceptionally low noise level when new—it becomes even lower with use. On life tests, the Type J will provide well over 100,000 complete rotational cycles with less than a 10% resistance change at the completion of the test.

For more details on the complete line of A-B quality electronic components, please write for Publication 6024: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ont. Export Office: 630 Third Ave., New York, N. Y., U.S.A. 10017.

56-10-5E

A-B

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

This is where the eagle sits

Look who stepped out of the Great Seal to wear a CMC Crusading Engineers' medal. Think he looks proud? You should see us! **He's on the first and only solid-state counter fully militarized to meet Mil Specs.**

If you want the safety of a counter providing full Mil Specs reliability at a price surprisingly close to a commercial counter, then check these specs: 0 to 100 Mc frequency range; oscillator stability of 1 part in 10^9; meets or exceeds MIL-E-16400, including appropriate temperature, humidity, vibration, shock, and RFI specs; built-in time interval measurement. Three militarized plug-ins available: 500 Mc heterodyne converter, 3 Gc heterodyne, and a 15 Gc transfer oscillator.

It may take some time, but you can probably expect copies of this counter from our creative competition at high-powered H-P and big, bad B. But they'll be copying the instrument originated and designed by CMC. State-of-the-art development of a fully militarized solid-state counter isn't the first or last technological coup for CMC. Add to it the first all solid-state counter, first all-silicon solid-state counter, first 10-line-per-second low-cost printer, first dual plug-in counter, and numerous others.

Write today for a complete spec sheet on our new Model 880 so you can compare when and if the others arrive on the market. And remember, we won't give you the bird, we'll give you a medal.

CMC

12976 Bradley · San Fernando, California · Phone (213) 367-2161 · TWX 213-764-5993

COMPUTER MEASUREMENTS COMPANY IS A LEADING DESIGNER AND MANUFACTURER OF ELECTRONIC INSTRUMENTATION TO COUNT, MEASURE, AND CONTROL.

TRIMMING POTENTIOMETER

In a sealed metal housing, ¼ in. in dia. and ¼ in. high.

Model 62P Helitrim® trimming potentiometer is designed for industrial/commercial uses. The cermet resistance element has total resistances from 10Ω to 1 megohm. The round, single-turn unit has 5/16 in. long botton pins on a 0.10 in. grid. The entire unit is sealed to permit encapsulation. Model 62P has a power rating of 0.5w. @ 70°C and an amb. temp. range of −25° to 125°C. Helipot Technical Information Services, Helipot Div. of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Circle 210 on Inquiry Card

LOG-LINEAR CONTROLLER

The RGLL-6 provides 8 features of control besides a continuous logarithmic pressure scale, 10^{-10} to 10^{-3} Torr, and a linear pressure scale covering 7 decades, 2×10^{-12} to 10^{-3} Torr. Control features include remote filament on-off operation, pressure control of 4 circuits at 2 different pressure points, and others. Pressure decades are indicated on an illuminated screen. Vacuum-Electronics Corp., Terminal Dr., Plainview, L. I., N. Y.

Circle 211 on Inquiry Card

VARIABLE RESISTOR

Combines stability, high power and compactness at a low price.

Series 550 Cermet resistor exceeds Mil-R-23285 (Navy) metal-film specs, and also exceeds Mil-R-94B. Advantages include extreme stability under severe environmental conditions, infinite resolution, low noise and long life, excellent h-f characteristics, exceptional overload capacity and no catastrophic failures. Complete protection against dust and dirt is provided by closed construction. Resistance range is 50Ω through 1 megohm. CTS of Berne, Inc., Berne, Ind.

Circle 212 on Inquiry Card

AUTOMATIC DRAFTING

Translates mathematical data into engineering drawings.

With this system an operator with a typewriter keyboard can directly control the alphanumeric operation of the drafting machine. The same keyboard permits the operator to change programs, revise operating subroutines and insert additional commands into the control memory. Punched paper tape, punched cards, or high-speed magnetic tape can be used to supply input data to the system. Flexibility of operation is further enhanced by the ability of the Expandable Stored Program (ESP) control to accommodate almost any input format. Airborne Instruments Laboratory, div. of Cutler-Hammer, Inc., Deer Park, L. I., N. Y.

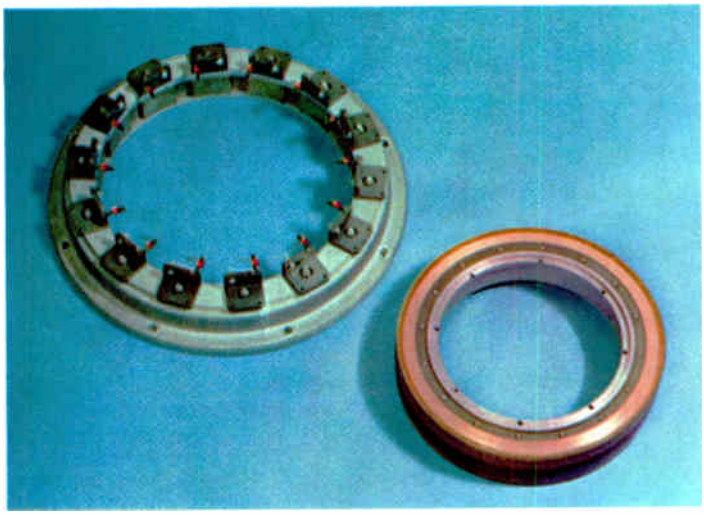
Circle 213 on Inquiry Card

PRESCALER PLUG-IN

Provides unambiguous direct reading of freqs. to 350MC.

The Model 5252A plug-in Prescaler uses digital divider circuits which can be switch-selected for input ranges of dc to 100MC, dc to 200MC, and dc to 350MC. The same operation automatically adjusts the gate time appropriately. Result is direct freq. readout, both in the visual display, and the binary-coded-decimal recorder readout. The prescaler, which is intended for use with the Hewlett-Packard Model 5245L Electronic Counter, uses digital dividers to reduce the applied freq. to the nominal counter range. This eliminates manual tuning as required by analog type freq. converters. Adjustments required at the front panel of this new plug-in are only for range selection and control of trigger level. The trigger level control selects either positive or negative going random pulses. Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304.

Circle 214 on Inquiry Card



HIGH TORQUE MOTOR

Delivers 35 oz./in. peak torque at stall. No-load is 2400 RPM.

Model 2375-050 dc torque motor has an outside dia. of 2.375 in.; inside dia. is 1.250 in.; and width is 0.500 in. Weight is 4.3 oz. Power at peak torque is 75w. Permanent magnet design eliminates fixed phase of field winding requirements. If a high level of magnetic saturation is provided, motor inductance and electrical time constant are greatly reduced. Magnetic Technology, Inc., 13735 Saticoy St., Van Nuys, Calif.

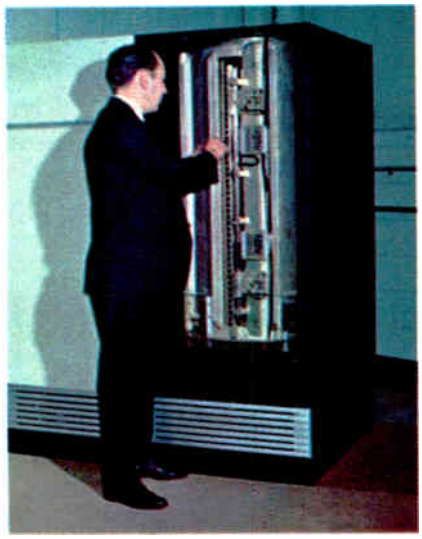
Circle 215 on Inquiry Card

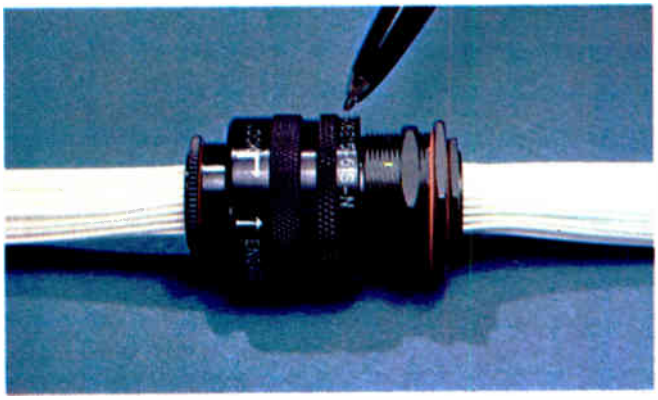
MASS MEMORY DRUM

Independent, simultaneous multiple access to entire data store.

The PhD-170 Positioning Head Drum system is not limited to writing in or reading out only a small portion of its total data-storage capability at any given time. Nor does its accessing capability depend upon an excessive number of heads and/or elaborate multiplexing selection and write/head circuits. Instead, the PhD-170 requires 43 heads which are discretely positioned and multiplexed to provide multiple simultaneous access to the entire memory. All the heads move together to any one of the 64 tracks under the control of a precision digital actuator—a linear positioning device with 64 discrete positions. Over 170 million bits can be magnetically recorded on the drum surface in 2752 separate tracks with a track-to-track access time of 30msec. This includes positioning and verification time. Bryant Computer Products, Div. of Ex-Cell-O Corp., 850 Ladd Rd., Walled Lake, Mich.

Circle 216 on Inquiry Card





HIGH-DENSITY CONNECTORS

Allows mating of high-density models with finger-tip pressure.

The Marc 53 series use a dual-positive locking device called Posilock. This eliminates accidental disconnect. These connectors also use the Posiseal sealing system which provides high environmental integrity. The connector series comply with the applicable requirements of Mil-C-38300, Rev. A. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

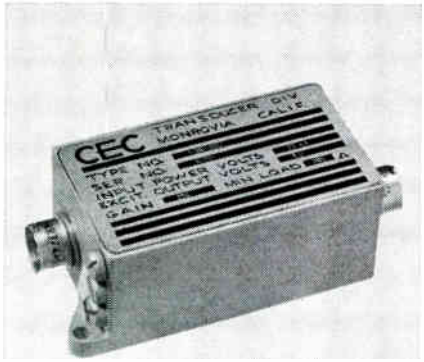
Circle 217 on Inquiry Card

MINIATURE ELECTRONICS REPORT

CEC

REPORT NUMBER 2

New miniature signal conditioners bring laboratory specifications to flight instrumentation



TYPE 1-361

TYPE 1-362

CEC's new 1-361 and 1-362 signal conditioning units provide a capability and versatility unmatched by any previous d-c amplifier and excitation supply. For the first time, miniature airborne units yield performance normally associated with large and complex ground support instrumentation.

The 1-361 contains a direct-coupled d-c amplifier with a ±10% adjustable gain of 250 and ±5% of full scale adjustable zero; a 5 volt d-c transducer excitation supply; and a d-c to d-c converter that gives 100 x 10^6 ohms d-c isolation from primary power input to excitation output and amplifier power. **The 1-362** is essentially the same as the 1-361 except that the amplifier gain is 125, and the transducer excitation is 10 volts d-c.

Significant advantages:

These units easily meet *and surpass* the rough environmental specifications of MIL-E-5272C. Reason: they employ welded modules which are hard potted in epoxy, interconnections that are further protected with humidity sealant, and external adjustments protected with "O"-ring type cap screws. This assures that the amplifier, converter, excitation supply and all peripheral adjustments are impervious to external environments.

The d-c to d-c converter and excitation voltage regulator modules of the 1-361 and 1-362 are the most advanced currently in use. A unique converter feedback feature, plus both copper and mu metal shielding, completely eliminates any interference "spikes" and ground loop problems due to stray electrostatic or electromagnetic signals.

So rugged and durable are these instruments, that the temperature range is a broad 0°F to +200°F.

In addition, the 1-361 and 1-362 may be plugged together with *any* standard CEC transducer.

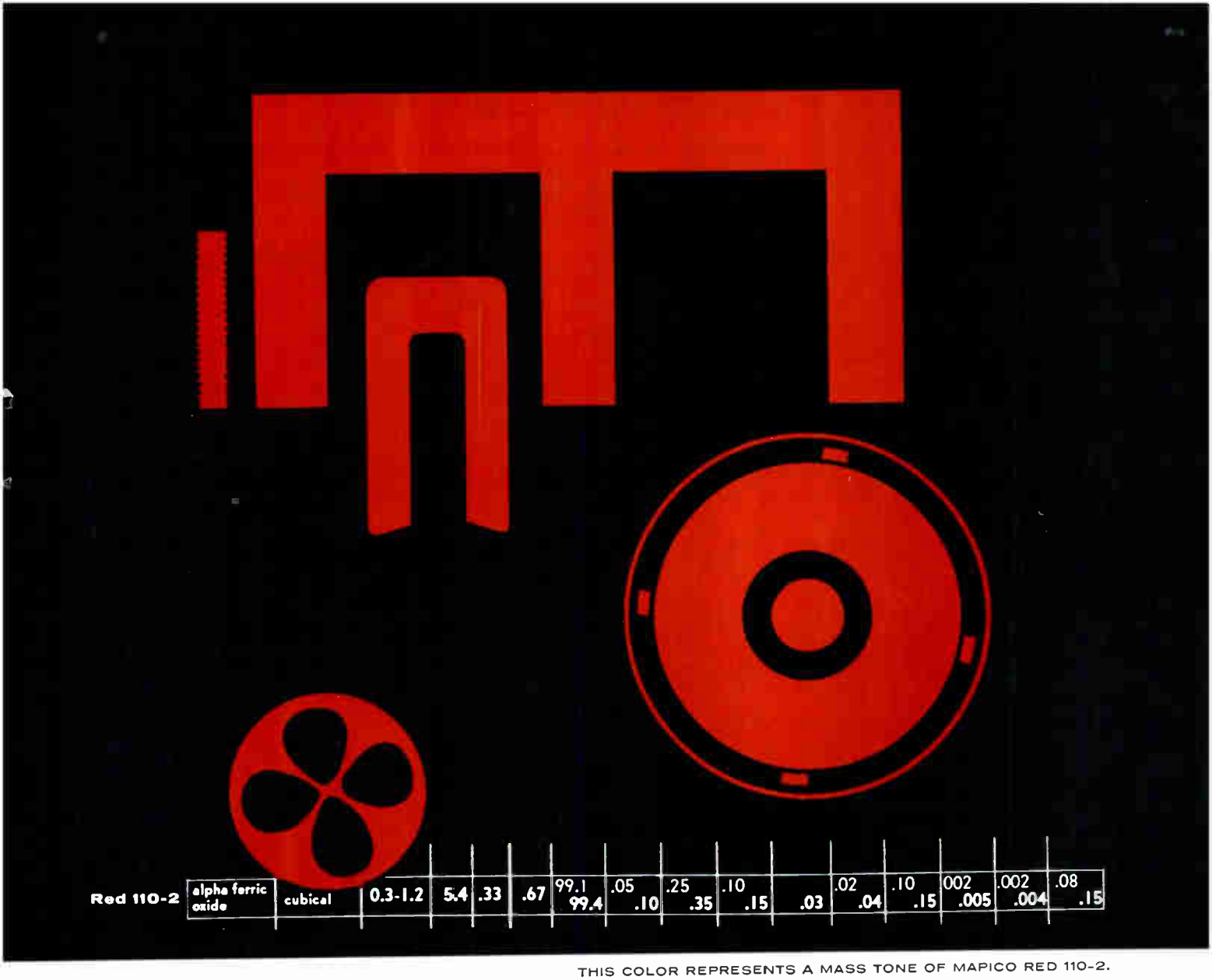
We believe that the extra expense that has gone into the manufacture of these new units is well justified by their outstanding reliability, durability and performance. Certainly, they are important additions to CEC's aerospace family of miniature d-c differential amplifiers.

Basic specifications:

- Input Impedance – greater than 1 x 10^6 ohms at d-c.
- Linearity and Hysteresis – combined effects do not exceed ±0.05% FS.
- Long-Term Zero Drift – less than ±10 microvolts, referred to the input in 8 hours at a constant 77°F.
- Thermal Zero Shift – within 0.005% FS/°F over the compensated temperature range.
- Thermal Gain Shift – within 0.005% FS/°F over the compensated temperature range.
- Thermal Excitation Voltage Shift – within 0.002% FS/°F over the compensated temperature range.
- Excitation Voltage Regulation – regulated within ±0.1% for a primary power input of 28 ±4 volts d-c.
- Vibration – 50 g from 5 to 2000 cps.
- Shock – 1000 g half sine wave with a duration of one millisecond.

For complete information about these advanced new signal conditioning units, call or write for the CEC Bulletins 1361-X3 and 1362-X3.

CEC
Transducer Division
CONSOLIDATED ELECTRODYNAMICS
A SUBSIDIARY OF BELL & HOWELL/PASADENA, CALIF. 91109
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND AND FRIEDBERG (HESSEN), W. GERMANY



THIS COLOR REPRESENTS A MASS TONE OF MAPICO RED 110-2.

Columbian Carbon focuses on the reduction of fluctuating characteristics in magnetic tape and ferrite components

It's a safe bet that product uniformity is a critical problem in your plant. Starting with extremely uniform raw materials goes a long way toward making your quality control problems considerably less difficult.

State of the art in ferrites advances at an extremely rapid rate. So do the requirements for iron oxides with pre-selected and controllable characteristics.

Columbian Carbon's Mapico® pure synthetic iron oxides are produced by a variety of carefully controlled methods, each designed to give a different shape, size and set of electronic characteristics. Uniformity from shipment to shipment is strictly held within pre-set narrow limits. Sixteen basic iron oxides are available in quantity.

Write for detailed specs. Or tell us about your particular application and special requirements. Columbian Carbon Company, Mapico Iron Oxides Unit, 380 Madison Avenue, New York, New York 10017. Branch offices and agents in principal cities.

COLUMBIAN CARBON COMPANY

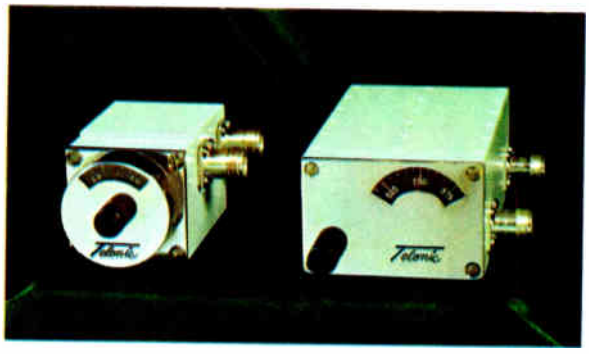
Circle 24 on Inquiry Card

BAND-PASS FILTERS

Covers freq. range of 50MC to 4GC in octave steps.

Series TTA miniature, tunable band-pass filters offer a choice of 3-section or 5-section response. It uses 0.03db ripple Chebichev design with capacitively-loaded, iris-coupled helical and coaxial cavities. This design permits a broad freq. coverage from 50MC to 4GC, full octave tuning and a choice of 3db bandwidths from 0.5% to 5%. The filters offer high Q cavities for minimum insertion loss. A unique loading network and tracking technique assures uniform electrical characteristics throughout the tuning range. Telonic Engineering Co., P. O. Box 277, Laguna Beach, Calif.

Circle 218 on Inquiry Card



MINIATURE CHAMBERS

Test chambers with −100° to +400°F ranges, ½°F accuracy.

Models TC2 and TC4 have 200 and 400 cu. in. capacities respectively. They are ideal for small component testing. The 15 lbs. units feature proportional electronic temp. controls, resistance bulb sensors, built-in liquid CO_2 valves with filters, dual-range heaters, polished stainless steel interiors, low density foam insulation, and rugged aluminum housings. CO_2 consumption @ −100°F is less than ½ lb./hr. Units operate from 115vac, 1 phase. The Gyrex Corp., 3003 Pennsylvania Ave., Santa Monica, Calif. 90406.

Circle 219 on Inquiry Card

EASY-READING METERS

New bezel improves lighting and gives soft undistorted readout.

All DigiTec instruments are now being furnished with a new, improved bezel that provides a 300% greater viewing angle and new, improved lighting that gives a soft, undistorted readout. This new look is available on all digital dc voltmeters with ranges from 10mv to 1kv; on all thermistor, platinum bulb and thermocouple digital thermometers with measurements from −390° to +2000°F; and on the digital printer, clocks and scanners. United Systems Corp., 918 Woodley Rd., Dayton, Ohio.

Circle 220 on Inquiry Card

CIRCUIT PACKAGES

The availability of a complete line of integrated circuit logic packages, including peripheral equipment, has been announced by Microsystems Components, 5353 Topanga Canyon Blvd., Woodland Hills, Calif. Eighty-four products, including integrated circuit logic cards, power supplies and analog elements, including A/D and D/A converters, are available. All are packaged on 2 x 3¼ in. cards. Compatible mounting hardware, power supplies, and other accessory equipment are available. Newest elements to be added to this line include functional logic cards—a dual 4-bit shift register, presetable up-down reversing counters and others. Also included are special analog elements and subsystems.

Circle 221 on Inquiry Card

CAPACITANCE BRIDGE

This automatic capacitance bridge measures capacitance and loss in ½ sec. without a single control being manipulated. Here the automatic bridge and data printer are shown recording dielectric changes at cryogenic temps. Dissipation factor is automatically tracked and printed out as the test probe is placed in and out of contact with liquid nitrogen. As the temp. comes to equilibrium, the readout values become constant. General Radio Co., West Concord, Mass. 01781.

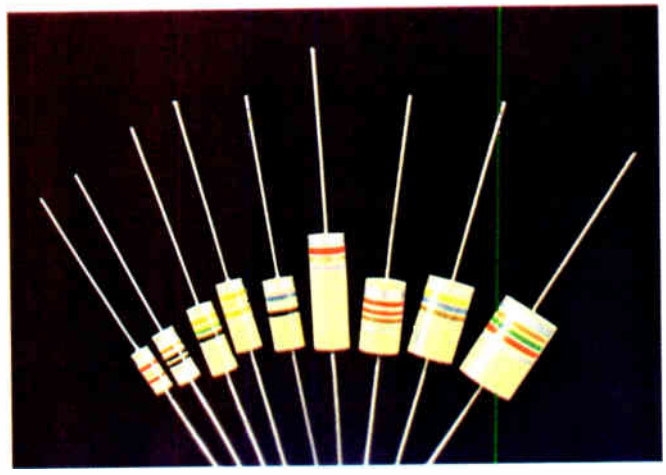
Circle 222 on Inquiry Card

LOW-COST FAN

Delivers 100CFM and sells for less than $4.00 in quantity.

The Skipper fan requires no holes for mounting hardware because it requires no mounting screws. The fan inserts into the same hole required for the air flow and it is secured by a keeper ring. It mounts easily anywhere on any panel thickness or panel material, including glass. Its 38-db (SIL) noise level makes it suitable for computer rooms, test areas or other areas where quietness is required. The fan operates up to 140°F (60°C). When lubricated regularly, it will run for more than 5 yrs. Rotron Mfg. Co., Woodstock, N. Y.

Circle 223 on Inquiry Card



R-F CHOKES

This expanded series r-f chokes, with inductance values from 0.15μh to 10mh, is manufactured and color coded in accordance with Mil-C-15305C. All MS series chokes are 100% tested to further assure conformance to specs. Epoxy molding gives excellent protection against all environmental conditions to provide a high level of reliable performance. J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif. 90003.

Circle 224 on Inquiry Card

WELDING STATION

Automatically welds flat packs to printed-circuit boards.

This numerically-controlled unit combines a parallel gap micro welder and micro positioner in an integrated system. The air actuated welding head is mounted over the work-holding fixture on the positioning table. The system prepares programming tapes by visually positioning the work to be welded using the manual controls. At each set of coordinates a button is pushed which punches out the complete block of data onto the tape. Vertical motion of the welding head is also stored on the tape. In addition, changes in the welding schedule may also be programmed on the tape to suit different materials or different size component leads. This simple procedure makes the device suitable for short runs as well as volume production. Welding speeds of up to 3 connections/sec. are possible with this system. The accuracy of any commanded coordinate location is within ±0.001 in. The repeatability is ±0.0005 in. Arvin Systems, Inc., Dept. DMP, 506 S. High St., Yellow Springs, Ohio 45387.

Circle 225 on Inquiry Card

SAVE $2.00* PER RELAY AND GET EXTRA CONVENIENCE TOO!

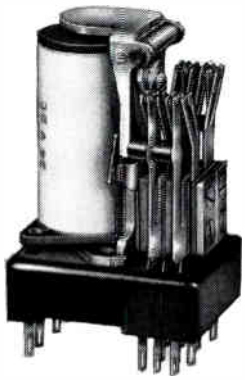
WIRE THIS

This precision-built socket starts you off to a savings of nearly $2.00* per installed LS telephone-type relay when you specify our relay-socket-cover combination instead of a similar relay with factory-wired, octal-type plug. Also (1) you have the convenience of a plug-in component, and (2) you can use a relay having more contacts than octal-type plugs will accommodate.

Two sizes of sockets are available. The 16-pin smaller one (1.39" x 1.71") accepts relays with contact arrangements from 1 Form C to 4 Form C. The larger 28-pin one (1.39" x 2.11") will take relays with contact arrangements up to 8 Form C. Each size socket has four coil terminals for single or dual coil relays.

**Approximate. Based on single lot price. Savings depend on contact arrangements.*

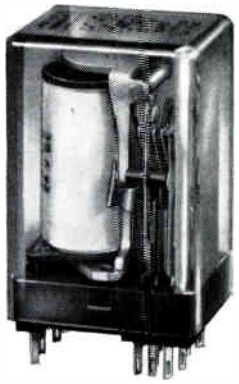
PLUG RELAY IN



Plug the LS into the socket . . . just as you would a vacuum tube. The relay's tab terminals mate snuggly with the socket, will hold the relay in place under normal conditions. When the relay is mounted horizontally, or when vibration is a problem, two banana plugs or two machine screws may be used.

A choice of cadmium or gold plated socket terminals is available . . . and the pierced solder terminals are designed also for AMP-78 taper tab connectors.

SLIP ON DUST COVER



The transparent, high impact, high temperature resistant dust cover fits over the socket nearly flush with the chassis. Covers as well as sockets of either size may be purchased separately. With socket and cover, the LS relay is designated the LSP . . . a sparkling addition to this series of reliable telephone type relays.

Here is a neat, modern, cost-reducing approach to using the reliable, versatile LS relay. Better send for complete information today.

LS SERIES ENGINEERING DATA

GENERAL

Description: Medium coil telephone type relay with bifurcated contacts.

Time Values:
AC: Operate: 3 to 15 milliseconds. Release: 3 to 15 milliseconds.
DC: Operate: 5 to 50 milliseconds. Release: 5 to 140 milliseconds.

Precise time values depend upon coil power and contact arrangement.

Operate and release time delay slugs and fixed or adjustable residuals are available for DC relays.

Expected Life: 100,000,000 mechanical operations minimum.
Contacts: 100,000 operations minimum at rated load.
Temperature Range: −55°C to +85°C standard (+105°C available on special order).
Weight: Approximately 3¼ ozs. (open).

CONTACTS:
Arrangements: AC: Up to 12 springs (6 per stack-4 movables). DC: Up to 24 springs (12 per stack).
Material: ⅛" dia. twin palladium is standard for bifurcated contact arms. Gold-alloy, other contact materials, and single contacts are available for specific applications.
Rating: AC: 4 amps @ 115 volts AC, 60 cycle resistive (open relay @+25°C). DC: 4 amps 28 volts DC resistive.

COILS:
Voltage: AC: To 230 volts 60 cps. DC: To 220 volts.
Resistance: DC: 55,000 ohms maximum.
Power: AC: 4.37 voltamps. DC: 65 milliwatts per movable arm minimum, 5 watts maximum @+25°C.
Duty: Continuous.

STANDARD P&B RELAYS ARE AVAILABLE AT LEADING ELECTRONIC PARTS DISTRIBUTORS

POTTER & BRUMFIELD

Division of American Machine & Foundry Company, Princeton, Indiana
In Canada: Potter & Brumfield, Division of AMF Canada Ltd., Guelph, Ont.

NOW 2 LITTLE DANDYS WITH 3 BIG DIFFERENCES

Newest Little Dandy Soldering Iron from American Beauty has higher wattage and larger tip than famous original, and has a green handle for easy identification by operators.

SAME FEATURES FOR BOTH

Combination of low price and American Beauty quality.

Ruggedness to stand production-line conditions. Working heat in 2 minutes. Longest-life heating element with non-ceramic insulators.

Molded handles, impervious to oil, perspiration. Unbreakable crystal, aerated fingertips, guaranteed cool. Unprecedented handling ease, balance. Non-roll design.

Plug-type tips. 30-second replacement of every major part, including heating element.

Three wattage options for each (No. 3110: 25, 30, 35—No. 3112: 40, 50, 60). 18 tip options each. 2- or 3-wire super-flex, melt-proof cords.

"PARAGON" QUALITY

TIPS RECOMMENDED

American Beauty's "Paragon" quality, clad tips bring same kind of advance to precision soldering that carbide bits brought to high-speed drilling work.

They have many times the life of old-style tips, re-tin themselves, are flake-proof, and remove easily for replacement. "Paragon" quality tips are optional at extra cost on most irons, including Little Dandys.

NEW, BIGGER LITTLE DANDY SOLDERING IRON INTRODUCED BY AMERICAN BEAUTY

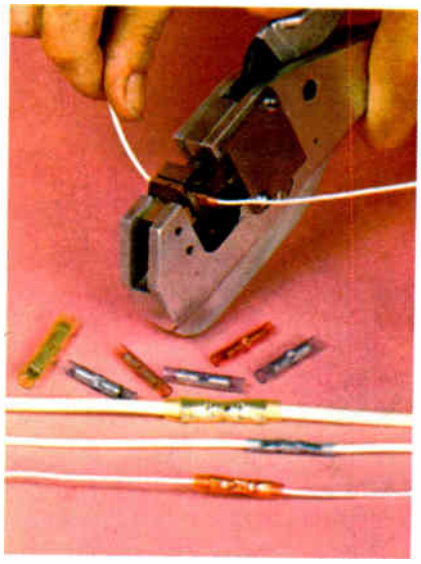
In late 1964 American Beauty brought out a new kind of miniature soldering iron, combining unprecedented features and quality at an economy price. Called the Little Dandy No. 3110 it soon became the fastest selling miniature iron in the history of the industry.

Now a larger Little Dandy, the No. 3112, is available. The No. 3112 has wattage options up to 60W, a high-capacity ¼" tip. It has a green handle so operators can easily tell it from the No. 3110 (which has a gray handle).

The new Little Dandy is now stocked by all American Beauty Distributors.

American Beauty Division, American Electrical Heater Company, Detroit, Michigan.

American Beauty



PRE-INSULATED SPLICES

Easy visual inspection and color coding. Conforms to NAS 1388.

A new line of pre-insulated splices, called Insulink, has insulation that features a high degree of transparency. This permits easy inspection of wire, solid insulation shrouds for trouble-free wire insertion, and color-coding to provide size identification. The splices accommodate a wire range from #22 through #10, and is designed for splicing flexible cable in aircraft and electrical manufacturing. The line is particularly adaptable to telemetry and ground-support systems. Splices have 1-piece construction of tin-plated electrolytic copper covered by nylon insulation, insuring high reliability. Burndy Corp., Norwalk, Conn.

Circle 226 on Inquiry Card

CORONA TEST SET

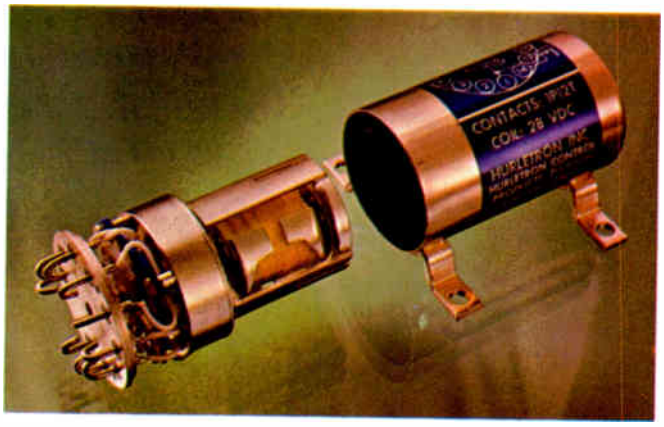
For measuring corona in terminals, connectors, harnesses, etc.

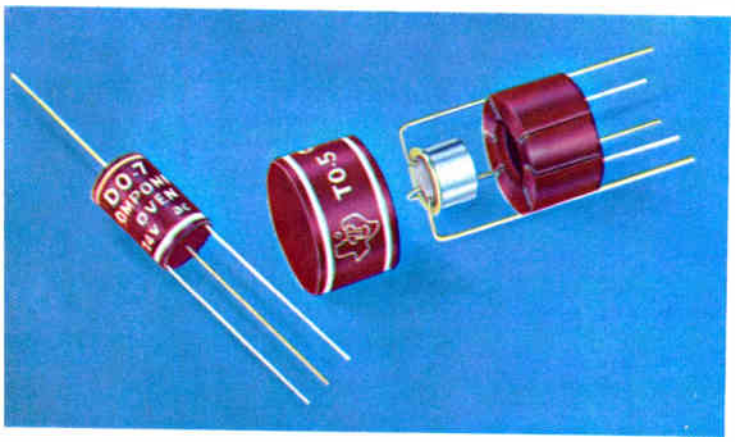
Model 4074 is a 10kv corona test set consisting of an ac corona-free Hypot with a pick-up network and a corona detector-calibrator (Model 8563). The Hypot features: 10 kv @ 0.25kva (25ma) with an output voltage crest factor better than 5%. Output is continuously variable from 0 to 10kv. The corona detector oscilloscope has a vertical amplifier sensitivity of 3MC/in. at max. gain. Amplifier sensitivity ranges are 3/10/30/100mv/in. The corona calibrator superimposes controlled spike on the corona display. The indicating meter is calibrated in picocoulombs with ranges of 0-1/10/100/1000. Associated Research Inc., 3758 W. Belmont Ave., Chicago, Ill. 60618. Circle 227 on Inquiry Card

AEROSPACE STEPPING RELAY

Allows contact transfer on application or release coil power.

Subminiature stepping switch meets or exceeds the requirements of Relay Spec. Mil-R-6106 Class B8, including 3ϕ loads with case grounded. The driving mechanism is a true rotary solenoid coupled to a spring-loaded latch and pawl mechanism, and is capable of transferring contacts either on application or release of coil power. Actual contact switching is done by programmed dumb-bell rolling contacts across stationary contacts, which are imbedded in diallyl phthalate or silicon glass contact deck. This rolling contact exerts high point gram pressures, yet as it rolls it presents a cooler contact material at each new switch point. This cooler contact surface coupled with fast transfer time extinguishes the arc more rapidly than normal sliding contacts. Hurletron Inc., Hurletron Control Products Div., 750 W. Rivera Rd., Whittier, Calif. Circle 228 on Inquiry Card



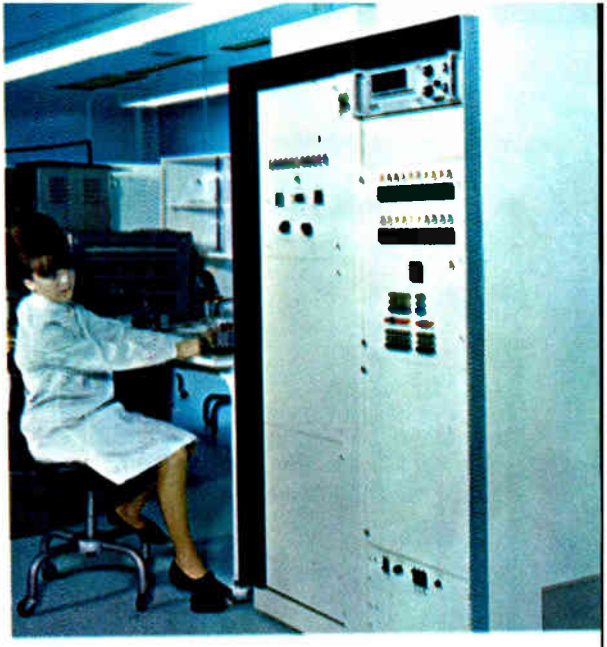


MINIATURE OVENS

Controls temp. of transistors and diodes for high performance.

Components packaged in DO-7 and TO-5 envelopes can now be temp. stabilized at low cost with a small, self-regulating oven. The oven provides temp. control without using conventional heater, thermostat or controller. The electronic component fits into a cavity in the oven where it is held in close thermal contact with the oven wall. To maintain constant temp., current to the oven is inverse to temp. variations. Line voltage variations have little effect on the stabilized temp. A 10% voltage change will produce less than 1°C control temp. change. The solid-state oven operates on 24vac/dc. It has fast warm-up, max. of 3 min. from −55° to 120°C with no temp. overshoot, and is noise-free. Power requirements are ¼w @ 100°C amb. to 2½w. @ −55°C in still air. Metals & Controls Inc., div. of Texas Instruments Incorporated, 34 Forrest St., Attleboro, Mass.

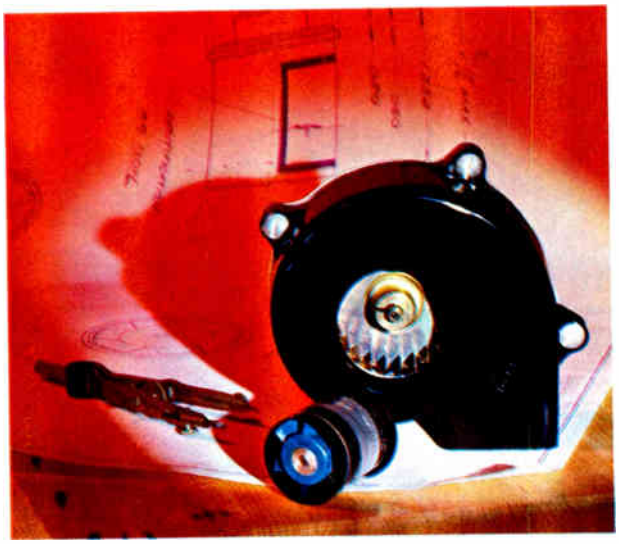
Circle 229 on Inquiry Card



INTEGRATED CIRCUIT TESTER

Measures fan-in, fan-out, leakage currents, thresholds, etc.

Model 1000 is a flexible, high-speed instrument for fully automatic testing of integrated circuits and similar multi-terminal devices. Testing parameters are stored in the disc memories, and allow Go-No Go tests at a rate of 180 tests/sec. Testing may be done automatically or manually, and the operator may monitor the measured quantity of any selected test or verify all parameters of a selected test. A diagnostic program allows verification of tester operation in less than ½ sec. Aircraft Armaments Inc., 9000 Winnetka Ave., Northridge, Calif. 91326. Circle 230 on Inquiry Card



AIR MOVERS

Axial blowers with 10 CFM output to 500 CFM centrifugal blowers.

The tiny 1⅛ dia. x 1 13/16 in. max. length VAX-1 blower is available in ac and dc versions. The dc unit has an output of 11 CFM free air at 26vdc and 0.3a. Output of the ac axial blower is 12 CFM free air when operated from a 26vac, 400 CPS, 1-phase source. A-C unit operates from 115vac, 400 CPS by adding a 1.0 mfd series capacitor. The centrifugal blower shown is also available in ac or dc versions. D-C motor drives from 6 to 115vdc are feasible. The ac versions operate from 115vac to 230vac at 50, 60, or 400 CPS. Nominal airflow is 27 CFM free air with a 115vac, 400 CPS, 1 phase drive motor. Globe Industries, Inc., 2275 Stanley Ave., Dayton, Ohio 45404.

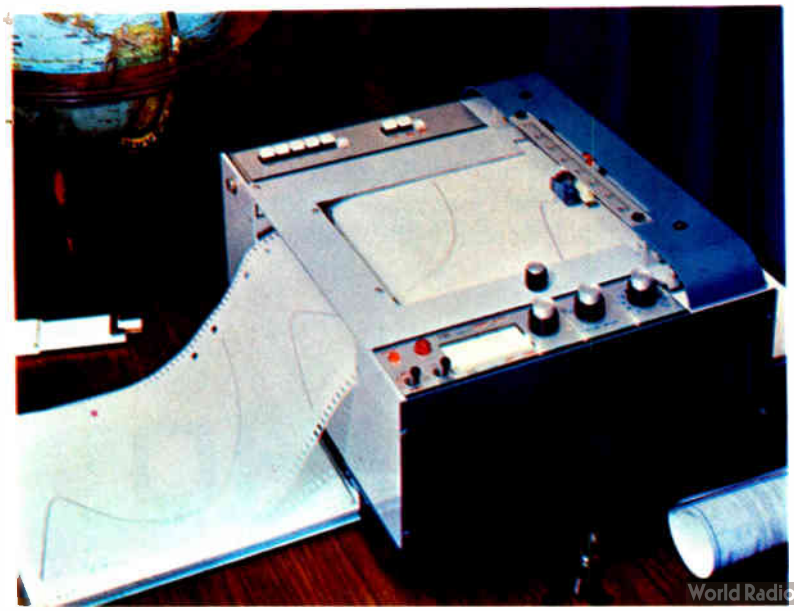
Circle 231 on Inquiry Card

TRANSISTOR TESTER

In-circuit testing of analog, ac, dc coupled transistor circuits.

The Model 970 Transistor Analyst uses an analysis technique of dc signal injection into the transistor stage to be checked. The unit meters the total power supply current in a sensitive, easily balanced bridge circuit. Go, No-Go indication of the transistor stage operation is shown on the meter. The low-ripple, 5a. power supply requires from 1.5 to 15vdc. It has an adjustable bias output which can be used either for bias voltage or to simulate the dc level from a photo-resistive bridge, potentiometer or other typical industrial transducer. Power transistors may be accurately tested out of circuit with currents up to 1a. The analyst also generates an AM or FM modulated, or unmodulated carrier freq. from 240KC to 2MC, 10 to 11.4MC and 88 to 108MC. B&K Mfg. Co., 1801 W. Belle Plaine Ave., Chicago, Ill. 60613.

Circle 232 on Inquiry Card



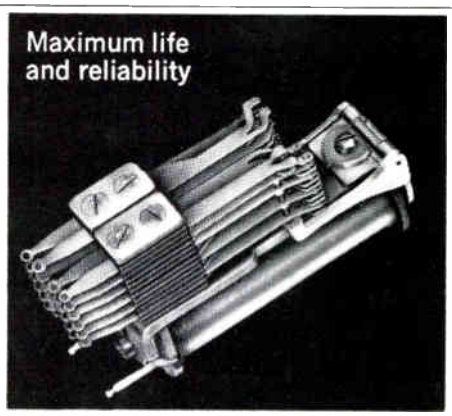
ALL PURPOSE RECORDER

Offers 6 modes of recording flexibility based on 2 new concepts.

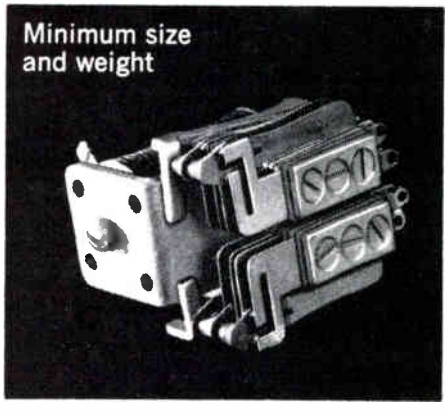
The 6 modes of recording flexibility of the Model 6520 Omnigraphic™ recorder is based on using 2 new concepts: (1) Chart paper is of the new Z fold-type, allowing all recording to be read like pages of a book. Each sheet is pre-numbered for easy reference; (2) Chart drive uses a bi-directional stepper motor rather than a synchronous motor or a servo amplifier/motor combination. A finite step advance is taken each time the motor is pulsed. These steps are so small that the resulting record appears smoothly continuous. For strip chart recording, a clock delivers pulses through the speed selector which is a selectable dividing circuit. The net result is a paper drive that runs forward or backward with a wide range of 144,000:1 with 18 selections. The servo-axis speed is 1/3 sec. full scale. It has 20 ranges from 1mvdc to 500vdc full scale. Infinite input resistance on all mv ranges is coupled with 0.15% overall accuracy. Slewing impedance is 3 megohms on mv ranges and 10 megs on volt ranges. Any signal can float to 200vdc above ground. Houston Omnigraphic Corp., 4950 Terminal Ave., Bellaire. Tex. 77401.

Circle 233 on Inquiry Card

One dozen good reasons for you to specify AE



CLASS B RELAY. Finest quality telephone-type. Provides hundreds of millions of operations under all mounting and service conditions — with unfailing contact reliability. Combines sensitivity, contact stability, and circuit adaptability. Bifurcated twin-contacts. Long or short armatures for wide range of practical timing. Also for quiet AC operation.



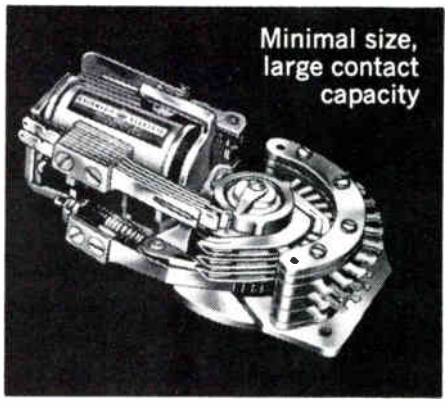
CLASS S RELAY. Miniaturized telephone-type for aircraft and similar applications. Small mass, low self-inductance. Provides high contact pressures and absolute contact reliability under extreme vibration, shock and humidity.

Buy from AE, and you never have to settle for a relay that's only "marginally" right.

You can choose *exactly*, from a line that's broad enough to give you what you're after — in weights, types, dimensions, configurations, mountings.

And you always get the benefit of AE's experience. Decades of experience in product design, manufacturing techniques, and methods of quality control.

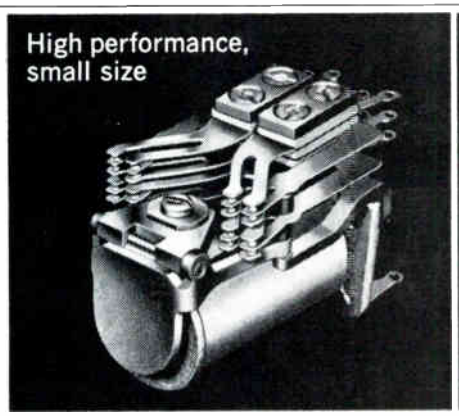
Want some helpful, detailed design information? Ask for Catalog 4071: Selection Guide to AE Relays and Switches. Just drop a line to the Director, Relay Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.



TYPES 40, 44, 80 and 88 ROTARY STEPPING SWITCHES. Small switches with large, flexible capacities. Fit almost any DC application. Provide swift, sure, impulse-controlled response . . . plus self-interrupted operation that's smooth and trouble-free. Up to twelve 10- or 11-point levels. Prewired, hermetically sealed units available.

AUTOMATIC ELECTRIC

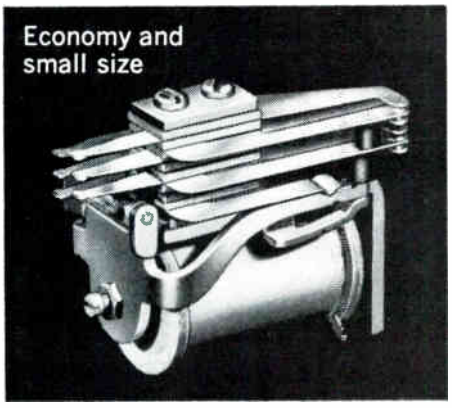
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E



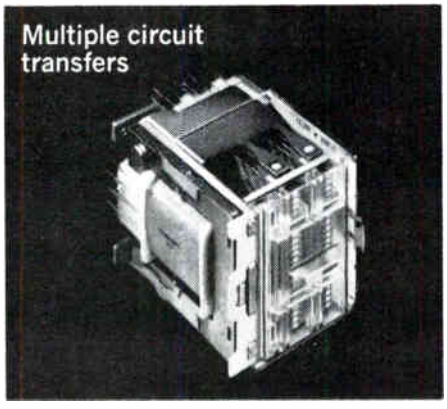
CLASS E RELAY. A lightweight space-saver with most of the features of the Class B. Life exceeds 200 million operations. Industry's widest terminal options: taper pin, integral socket, conventional solder, taper-tab, solderless wrap and printed circuit terminals.

CLASS A RELAY. Sturdy and dependable. Can be mounted in any position. The original "workhorse" telephone relay — recommended when the extremely high performance of the Class B is not mandatory.

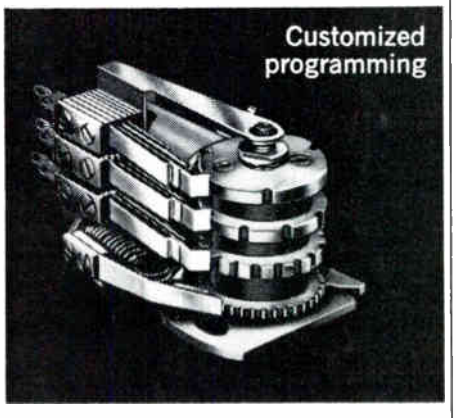
CLASS C RELAY. Incorporates many of the features of the Class B relay—but is only half as wide. Use where quality is a must, but space is at a premium. Quick- and slow-acting types, for operation at up to 150 volts DC. Two to twelve contact springs.



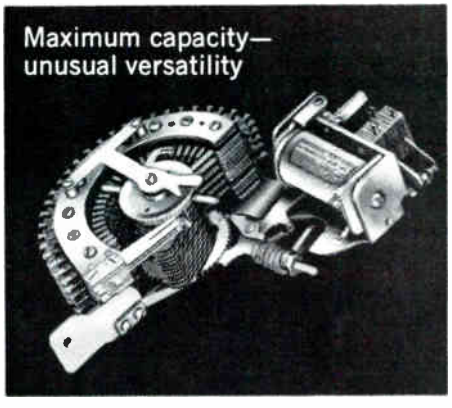
CLASS Z RELAY. Small and lightweight, but designed for service where flexibility is most important. Provides adequate coil volume to permit slugging for long operate and release timing. Four types for DC, one for AC, and two with snap-action contacts.



CLASS W RELAY. 17, 34 or 51 form C contact-spring combinations. Features low loss insulation, high insulation resistance. Extremely low inter-spring capacitance. Life in excess of one billion operations. Gold contacts available for low-level switching.

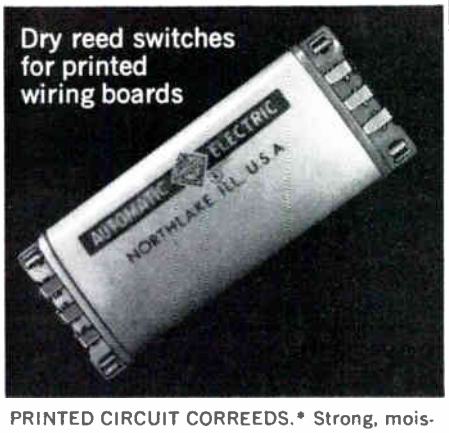


SERIES OCS RELAY. Compact and low in cost. For "packaged" programming: will follow or initiate a prescribed series of events at 30 steps per second impulse-controlled — or 65 per second self-interrupted. Much better than an interlock relay — when you're designing for shock, vibration or easy field maintenance.



TYPE 45 ROTARY STEPPING SWITCH. Larger capacity: up to twelve 25-point levels, eight 50-point levels. For any DC voltage up to 110, or 115 volts AC with rectifier. Can be impulse-controlled or self-interrupted. Available with normally open or normally closed circuits (Type 45NC). Also available as prewired, hermetically sealed units.

CLASS V MERCURY-WETTED RELAY. For computers, data processing and control equipment. Up to 200 operations per second. No contact erosion, no bounce. Over 1 billion operations without change, maintenance or adjustment. Can be operated within 30° of vertical. Polarized and nonpolarized versions. 1 pole to 4 pole double throw contact forms.

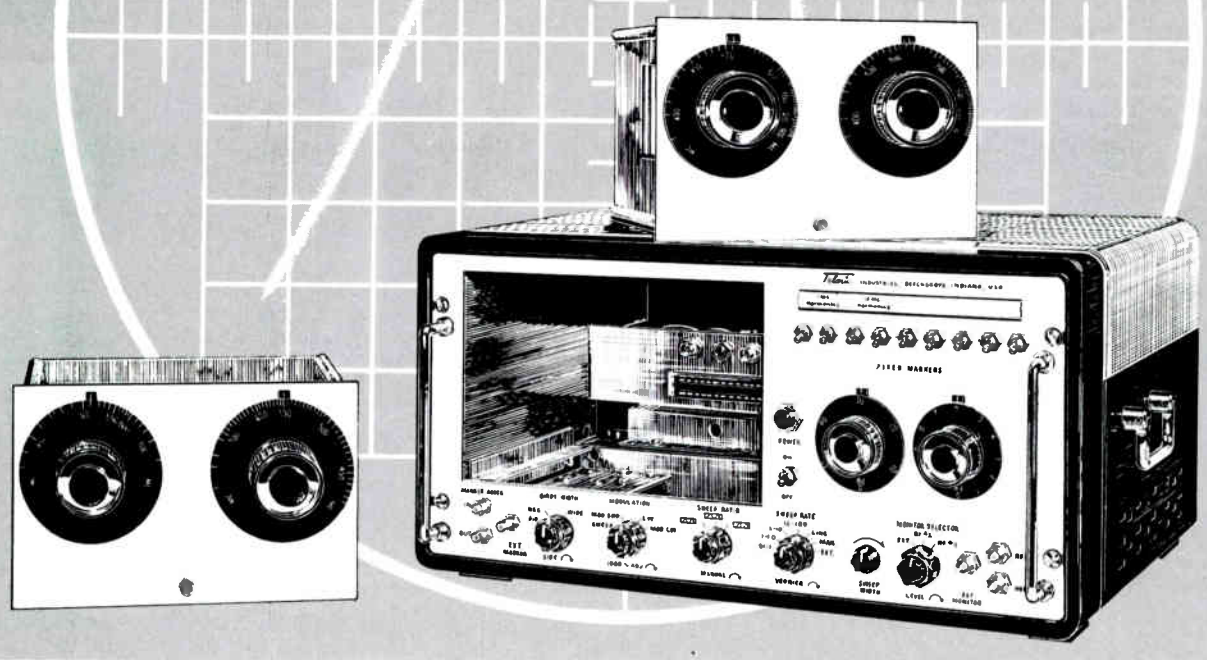


PRINTED CIRCUIT CORREEDS.* Strong, moisture-resistant, compact. Unstressed contact leads provide firm, positive connections. Glass-filled plastic bobbins prevent moisture absorption. Low profiles and magnetic shielding permit high density within standard PC terminal spacing (multiples of 0.200 inches). Available with 1, 2, 3 and 5 capsules and magnetic latching. Contact forms A, B, & C.

*U.S. Patent applied for

This is TELONIC Versatility...

A Sweep/Signal Generator for Audio to 3000 MC



As a major designer and manufacturer of RF instruments and components, Telonic once again leads the field with the introduction of the SM-2000 Sweep and CW Signal Generator. New from every standpoint, the SM-2000 provides unmatched versatility for laboratory or production operations. Now, with one instrument and several, interchangeable plug-in oscillators, an engineer can cover a frequency range from audio to 3000 mc.

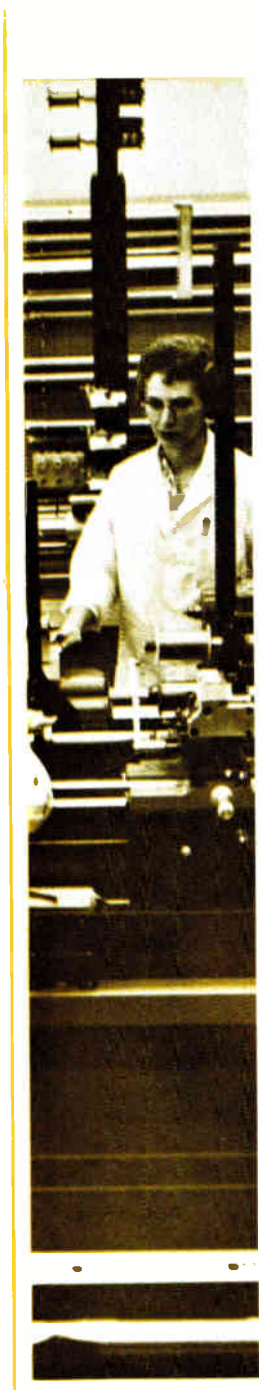
Telonic has designed 19 different oscillator heads for specific and general purposes that enable the user to change range of the SM-2000 in a matter of seconds. For general applications, only two plug-in units are necessary to cover frequencies from .5 to 2000 mc. And, in addition, the operator may select four different functional modes with the SM-2000—swept RF, modulated swept RF, CW, and modulated CW. He can set attenuation from 0 to 60 db in 1 db steps with the two built-in attenuators. He also has provisions in the instrument for use of an external marker, or for adding up to eight fixed, plug-in markers if desired.

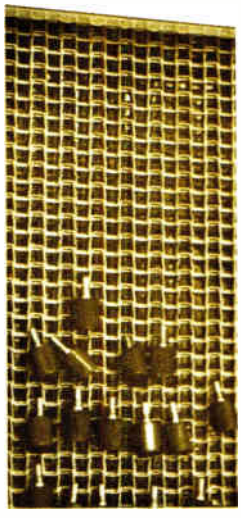
All these features are combined with the fine basic performance that has made the name Telonic synonymous with the best in RF instrumentation—low VSWR, high display linearity and excellent workmanship. If you would like more complete details on this new sweep generator please write for Technical Bulletin T-233.

Telonic Industries, Inc.

60 NORTH FIRST AVENUE BEECH GROVE, INDIANA PHONE (317) STATE 7-3231

BOURNS PRECISION POTENTIOMETERS

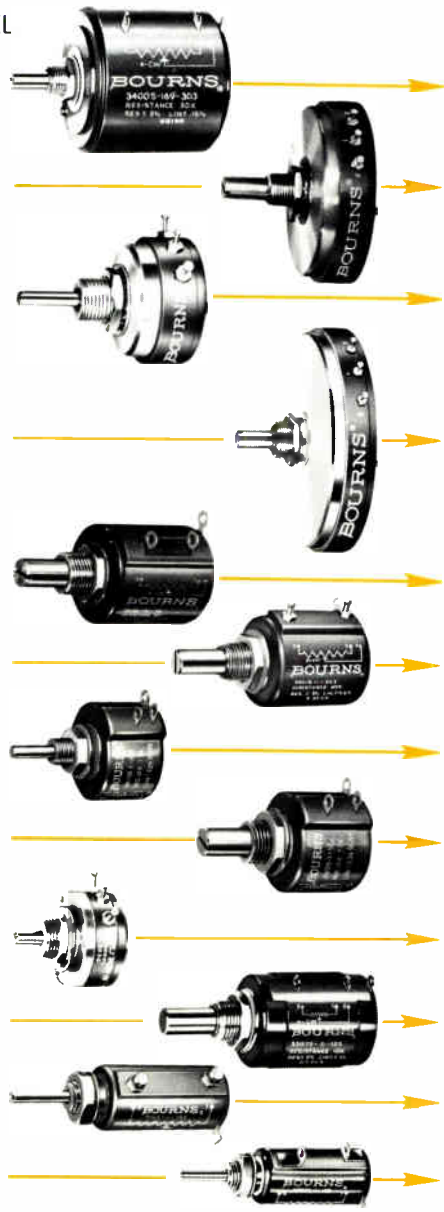




PRECISION POTENTIOMETER SHORT FORM CATALOG NO. 4 SEPTEMBER, 1965

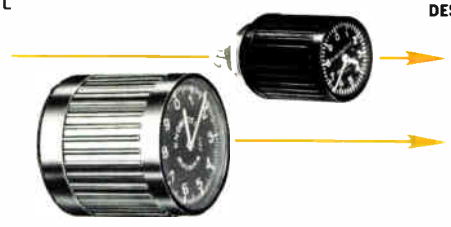
BOURNS, Inc. TRIMPOT DIVISION, RIVERSIDE, CALIF. 92507

BOURNS® BUSHING-MOUNT POTE



MODEL	DESCRIPTION	RESISTANCE (OHMS) ①	TOL (%)	LIN (%)	ELECTRICAL AND MECHANICAL ROTATION	MECHANICAL LIFE (CYCLES)	POWER (WATTS)	MAXIMUM OPERATING TEMP. RANGE (°C)
3400	1 13/16" dia., 10 turns	100-250K 500K 1 meg	±3	±0.15	3600° (+4°/—0°)	100,000	5.0 at 40°C	—65 to +105
3410	2" dia., Single turn	50-100K	±3	±0.3	350° (±2°)③	500,000	4.0 at 70°C	—65 to +125
3430	1 1/16" dia., Single turn	50-10K 20K-50K 100K	±3	±0.5	350° (±2°)③	500,000	1.5 at 70°C	—65 to +125
3440	3" dia., Single turn	100-100K 200K 500K	±3	±0.25	350° (±2°)③	500,000	6.0 at 70°C	—65 to +125
3500	7/8" dia., 10 turns	50-125K 150K, 250K 500K	±3	±0.2	3600° (+10°/—0°)	100,000	2.0 at 70°C	—65 to +125
3501	7/8" dia., 10 turns INFINITRON® Element	1K-500K	±5	±0.5	3600° (+10°/—0°)	500,000	2.0 at 70°C	—65 to +125
3510	7/8" dia., 3 turns	25-50K 100K	±3	±0.30	1080° (+10°/—0°)	100,000	1.0 at 70°C	—65 to +125
3520	7/8" dia., 5 turns	25-75K 100K 250K	±3	±0.30	1800° (+10°/—0°)	100,000	1.5 at 70°C	—65 to +125
3530	7/8" dia., Single turn	25-20K 50K	±3	±0.50	350° (±2°)③	500,000	1.0 at 70°C	—65 to +125
3507	7/8" dia., 10 turns	100 to 100K 250K	±5	±0.50	3600° (+10°/—2°)④	10,000	2.0 at 25°C	—55 to +105
3700	1/2" dia., 10 turns	50-100K 250K	±5	±0.25	3600° (+10°/—0°)	50,000	1.0 at 70°C	—65 to +125
3707	1/2" dia., 10 turns	100-50K	±5	±1.0	3600° (+10°/—5°)	10,000	1.0 at 40°C	—55 to +105

BOURNS KNOBPOT® (CLOCK FACE) POTENT



MODEL	DESCRIPTION	RESISTANCE (OHMS)	TOL (%)	DIAL ACC. (%)	DIAL REPEATABILITY (% V/R)	ELECTRICAL AND MECHANICAL ROTATION	MECHANICAL LIFE (CYCLES)	POWER (WATTS)	MAXIMUM OPERATING TEMP. RANGE (°C)
3600	3/4" dia., 10 turns	100-100K 150K, 200K 250K	±5	±0.5	0.1	3600° (+10°/—0°)	10,000	1.5 at 25°C	—65 to +85
3640	1 1/4" dia., 10 turns	100-250K 500K	±3	±0.1	0.05	3600° (+10°/—0°)	10,000	2.5 at 25°C	—65 to +85

① Special resistances are available above and below the standard range shown. Consult factory for price and technical information.
② Std Models exceed steady state requirements of MIL-STD-203, METHOD 103. Optional models are available meeting humidity cycling requirements of MIL-STD-202, METHOD 106.
③ Mechanical rotation continuous.
④ Electrical rotation only.

NTIOMETERS

HUMIDITY (MIL-R-12934C)	SHOCK	VIBRATION	PRICES 1-9	10-24	25-49	50-99	100-249
Yes	50G	10G	10.00 19.00 28.00	9.50 18.05 26.60	9.00 17.10 25.20	8.50 16.15 23.80	8.00 15.20 22.40
Yes	50G	15G	19.00	18.05	17.10	16.15	15.20
Yes	50G	15G	24.00 33.00 42.00	22.80 31.35 39.90	21.60 29.70 37.80	20.40 28.05 35.70	19.20 26.40 33.60
Yes	50G	15G	22.00 31.00 40.00	20.90 29.45 38.00	19.80 27.90 36.00	18.70 26.35 34.00	17.60 24.80 32.00
Yes ③	100G	20G	10.00 19.00 28.00	9.50 18.05 26.60	9.00 17.10 25.20	8.50 16.15 23.80	8.00 15.20 22.40
Yes ③	100G	20G	13.75	13.06	12.38	11.69	11.00
Yes ③	100G	20G	15.00 33.00	14.25 31.35	13.50 29.70	13.50 29.70	12.75 28.05
Yes ③	100G	20G	13.50 22.50 31.50	12.83 21.38 29.93	12.15 20.25 28.35	11.48 19.13 26.78	10.80 18.00 25.20
Yes	50G	15G	9.00 27.00	8.55 25.65	8.10 24.30	7.65 22.95	7.20 21.60
No	50G	10G	7.50 16.50	6.50 14.52	6.25 13.74	5.95 13.08	5.50* 12.09*
Yes	100G	20G	24.50 32.00	23.28 30.40	22.05 28.80	20.83 27.20	19.60 25.60
No	50G	10G	12.50	11.88	11.25	10.63	10.00

*100-499

IOMETERS

HUMIDITY (MIL-R-12934C)	SHOCK	VIBRATION	PRICES 1-9	10-24	25-49	50-99	100-249
Yes	50G	10G	20.52 30.24	19.00 28.00	17.10 25.20	16.23 23.91	15.20 22.40
Yes	50G	10G	20.52 30.24	19.00 28.00	17.10 25.20	16.23 23.91	15.20 22.40

BOURNS SERVO-MOUNT POTENTIOMETERS

MODEL	DESCRIPTION	RESISTANCE (OHMS)	TOL (%)	LIN (%)	ELECTRICAL AND MECHANICAL ROTATION	MAXIMUM GANGING (CUPS)	MECHANICAL LIFE (CYCLES)	POWER (WATTS)	MAXIMUM OPERATING TEMP. RANGE (°C)	HUMIDITY (MIL-R-12934C)	SHOCK	VIBRATION	PRICES 1-9	10-24	25-49	50-99	100-249
3450	2" dia., 10 turns	100-500K 1 Meg	±3	±0.15	3600° (+3°/—0°)	5	100,000	5.0 at 70°C	—65 to +125	Yes	50G	10G	20.00 29.00	19.00 27.55	18.00 26.10	17.00 24.65	16.00 23.20
3460	2" dia., Single turn	50-100K	±3	±0.3	350° (±2°)③	19	500,000	4.0 at 70°C	—65 to +125	Yes	50G	15G	21.00	19.95	18.90	17.85	16.80
3480	1¼" dia., Single turn	50-10K 20K-50K 100K	±3	±0.5	350° (±2°)③	19	500,000	1.5 at 70°C	—65 to +125	Yes	50G	15G	29.00 38.00 47.00	27.55 36.10 44.65	26.10 34.20 42.30	24.65 32.30 39.95	23.20 30.40 37.60
3490	3" dia., Single turn	100-100K 200K 500K	±3	±0.25	350° (±2°)③	8	500,000	6.0 at 70°C	—65 to +125	Yes	50G	15G	24.00 33.00 42.00	22.80 31.35 39.90	21.60 29.70 37.80	20.40 28.05 35.70	19.20 26.40 33.60
3550	⅜" dia., 10 turns	50-100K 150K, 200K 250K, 500K	±3	±0.20	3600°(+10°/—0°)	5	100,000	2.5 at 70°C	—65 to +125	Yes	100G	20G	20.00 29.00 38.00	19.00 27.55 36.10	18.00 26.10 34.20	17.00 24.65 32.30	16.00 23.20 30.40
3551	⅜" dia., 10 turns INFINITRON® Element	1K-500K	±5	±0.5	3600°(+10°/—0°)	5	500,000	2.0 at 70°C	—65 to +125	Yes	100G	20G	31.00	29.45	27.90	26.35	24.80
3560	⅜" dia., 3 turns	25-50K 100K	±3	±0.25	1080°(+10°/—0°)	8	100,000	1.5 at 70°C	—65 to +125	Yes	100G	20G	20.00 38.00	19.00 36.10	18.00 34.20	18.00 34.20	17.00 32.30
3570	⅜" dia., 5 turns	25-75K 100K 250K	±3	±0.25	1800°(+10°/—0°)	6	100,000	2.0 at 70°C	—65 to +125	Yes	100G	20G	18.50 27.50 36.50	17.58 26.13 34.68	16.65 24.75 32.85	16.65 24.75 32.85	15.73 23.38 31.03
3580	⅜" dia., Single turn	25-20K 50K	±3	±0.5	350° (±2°)③	24	1,000,000	1.0 at 70°C	—65 to +125	Yes	50G	15G	25.00 43.00	23.75 40.85	22.50 38.70	21.25 36.55	20.00 34.40
3750	½" dia., 10 turns	50-100K 250K	±5	±0.25	3600° (+10°/—0°)	0	50,000	1.0 at 70°C	—65 to +125	Yes	100G	20G	34.00 41.50	32.30 39.43	30.60 37.35	28.90 35.28	27.20 33.20

ACCESSORIES

FOR KNOBPOT POTENTIOMETERS

Part No. & Description	1-24	25-99	100-500	501-999
H-93 (3600) H-99 (3640) Snap-on Color Rings*	.35	.30	.25	.20
H-95 (3600) H-98 (3640) Stainless Steel Skirt	1.50	1.25	1.00	.75
H-97 (3640) H-103 (3600) Plastic Slip-over friction brake	1.25	1.07	.97	.90
H-100 MIL-SPEC 1-inch diameter slip-over Knob (Model 3600 only)	1.25	1.07	.97	.90
H-101 (3600) H-102 (3640) Stainless Steel Recessed Mounting Bracket	1.25	1.07	.97	.90

*Per FED. STD. 595

1-INCH TURNS COUNTING DIALS

Part No. Black	Part No. Clear	Shaft Dia.	Brake	1-9	10-24	25-99	100-249
H-411	H-461	¼"	No	7.75	7.36	6.98	6.59
H-412	H-462	¼"	Yes	8.95	8.50	8.06	7.61
H-421	H-471	⅛"	No	7.75	7.36	6.98	6.59
H-422	H-472	⅛"	Yes	8.95	8.50	8.06	7.61
H-431	H-481	3/32"	No	8.10	7.70	7.29	6.89
H-432	H-482	3/32"	Yes	9.30	8.84	8.37	7.91

½"-DIAMETER TURNS COUNTING DIALS

Part No.	Description	1-9	10-24	25-99	100-249
H-351	10-Turn, clock-dial readout. Accepts ⅛" or 3/32" Dia. shafts.	8.00	7.60	7.20	6.40
H-353	Adapter for shaft extensions	.50	.48	.45	.40
H-354	Turns Counting Dial with brake	8.50	8.08	7.65	6.80
H-355	Snap-on Color rings*	.35	.35	.30	.25

LABPOT™ POTENTIOMETER

MODEL 3660 LABPOT PRECISION POTENTIOMETER

A compact, dial-readout precision potentiometer designed as a convenient tool for a variety of laboratory applications. Incorporates Bourns exclusive KNOBPOT® potentiometer for high readability through its unique "clock-dial" face. Portable, lightweight, yet remains firmly in place when in use. Large five-way binding posts permit easy hookup of any kind of leads. Fused for protection against burnout. An extra fuse is provided inside for added convenience.

Specifications:

Std. Resistances 100Ω 1K, 10K, 100K (others available on request)
Resistance Tolerance ..... ±1%
Dial Accuracy ....20% 100Ω .15% 1K .10% 10K and 100K
Repeatability ... ±.05% voltage ratio
Operating Temp. Range ... —65 to +125°C
Power Rating ... 2.5W at room temp.
Mechanical Life ... 200,000 dial rev.
Weight ... ... 14 ounces
Prices ... 1-9 10-24 25-49 50-99 42.20 40.00 36.00 34.16

QUALITY DESIGN

The construction details shown in the cut-a-way drawings of the Model 3500 and 3600 are not necessarily descriptive of all models, but are typical of the design features found in Bourns precision potentiometers. These high-reliability features have evolved through Bourns long experience in the potentiometer field—specifically through the Company's capability in producing quality miniature parts, precision plastic moldings, and dependable seals.

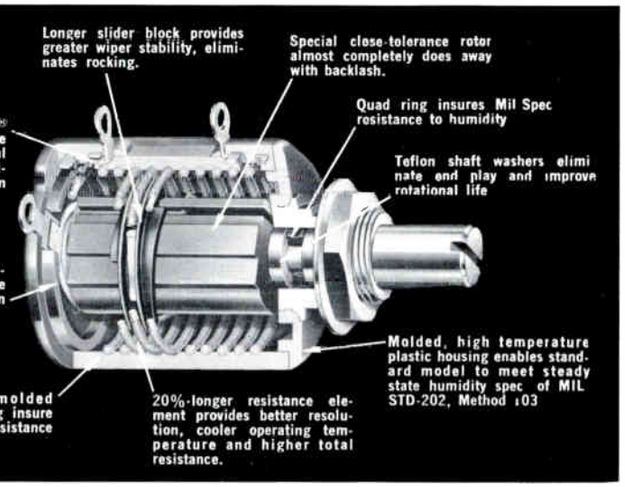
QUALITY CONTROL

All units are individually inspected to guarantee full conformance to all key physical and electrical specifications. Contact force (wiper and collector ring) is set on each unit to assure low noise levels and reliable performance for a minimum of 100,000 cycles or 2 million shaft rotations.

RELIABILITY ASSURANCE

A final measure of quality is Bourns Reliability Assurance Testing Program — the most stringent in the potentiometer industry. Random samples are selected from stock and checked for stability and performance under extreme conditions of cold, humidity, shock and vibration — each condition at the limit of published specifications. Load life and rotational tests are also performed. This unique reliability program is your final guarantee that Bourns components meet or exceed published standards of performance and reliability.

MODEL 3500



Longer slider block provides greater wiper stability, eliminates rocking.

Special close-tolerance rotor almost completely does away with backlash.

Quad ring insures Mil Spec resistance to humidity

Teflon shaft washers eliminate end play and improve rotational life

Exclusive SILVERWELD® termination—an indestructible fused bond between terminal and resistance wire — eliminates chief causes of precision potentiometer failure.

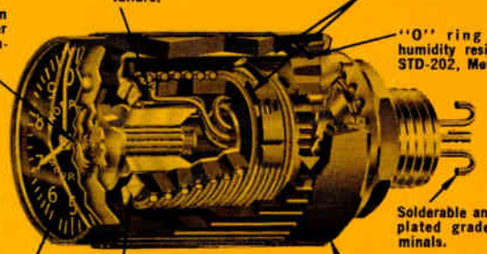
Double slip-ring contact provides larger contact surface and a double safety margin for vibration and shock.

Molded, high temperature plastic housing enables standard model to meet steady state humidity spec of MIL STD-202, Method 103

Element grooves molded within plastic housing insure perfect Helix for resistance element.

20%-longer resistance element provides better resolution, cooler operating temperature and higher total resistance.

MODEL 3600



Exclusive SILVERWELD termination — an indestructible bond between terminal and resistance wire — eliminates major cause of potentiometer failure.

Precious metal wiper and contact bar.

Gear driven clock mechanism coupled directly with wiper output provides continuous engagement, no backlash.

"O" ring seal insures humidity resistance per MIL-STD-202, Method 103.

Solderable and weldable gold-plated grade A nickel terminals.

Easy-to-read clock dial provides excellent readability and setting accuracy.

Precious metal commutator rings.

Rugged, high temperature plastic housing.

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OTHER PRODUCTS BY BOURNS

TRIMPOT® ADJUSTMENT POTENTIOMETERS

Model	Terminals*	Tolerance (%)	Power Rating (Watt)	Max. Operating Temp. (°C)	Adj. Turns	Humidity Proof (Mil Spec)	Size (Inches) H	W	L	Standard Resistance (Ohms)
200	L, S, P	±10	0.50	105	25	Steady State Only	5/16	1/4	1-1/4	10-100K
215	L, S, P	±20	0.25	125	22	Steady State Only	5/16	1/4	1-1/4	5K-5 Meg
260	L, S, P	±10	1.00	175	25	Steady State Only	5/16	1/4	1-1/4	10-100K
235	L, S, P	±20	0.25	125	22	Yes	23/64	19/64	1-11/32	5K-5 Meg
236	L, S, P	±10	0.80	125	25	Yes	23/64	19/64	1-11/32	10-100K
220	L, W	± 5	1.00	175	15	Yes	5/16	3/16	1	10-30K
224	L, S, P	± 5	1.00	175	22	Yes	5/16	3/16	1-1/4	10-100K
3000	P	±10	0.50	175	15	Yes	5/16	5/32	3/4	50-20K
3001	P	±20	0.20	150	15	Yes	5/16	5/32	3/4	20K-1 Meg
3010	L, P	± 5	1.00	175	25	Yes	5/16	9/32	1-1/4	10-100K
3011	L, P	±20	0.25	150	22	Yes	5/16	9/32	1-1/4	5K-5 Meg
3012	L, P	±10	1.00	175	25	Yes	5/16	9/32	1-1/4	2K-1 Meg
3051	L, S, P	±20	0.75	150	22	Yes	5/16	3/16	1-1/4	5K-5 Meg
3052	L, P	±10	1.00	175	25	Yes	5/16	3/16	1-1/4	2K-1 Meg
3053	L, P, S	±10	0.50	175	25	Yes	5/16	3/16	1-1/4	20-200, 2-200
3075	H, P, S, L	± 5	1.50	175	10	Yes	5/16	5/16	1-1/16	100-50K
3250	L, P, W	± 5	1.00	175	25	Yes	3/16, 7/32	1/2, 1/2	1/2, 1/2	10-50K
3251	L, P, W	±20	0.50	150	25	Yes	3/16, 7/32	1/2, 1/2	1/2, 1/2	20K-1 Meg
3260	H	± 5	0.2	175	11	Yes	11/64	1/4	1/4	10-20K

Model	Terminals*	Tolerance (%)	Power Rating (Watt)	Max. Operating Temp. (°C)	Adj. Turns	Humidity Proof (Mil Spec)	Size (Inches) H	W	L	Standard Resistance (Ohms)
3280	L, P, W	± 5	1.00	175	25	Yes	13/64	3/8	3/8	10-50K
3281	L, P, W	±20	0.5	150	25	Yes	13/64	3/8	3/8	20K-1 Meg
3300	P, S	± 5	0.50	175	1	Yes	5/16 dia. x 3/16, 5/16 dia. x 15/32			10-20K
3301	P, S	±20	0.25	150	1	Yes	5/16 dia. x 3/16, 5/16 dia. x 15/32			10K-1 Meg
3367	P, S	± 5	0.50	105	1	Steady State Only	1/2 dia. x 15/64, 1/2 dia. x 35/64			10-20K
3368	P, S	±20	0.25	105	1	Steady State Only	1/2 dia. x 15/64, 1/2 dia. x 35/64			20K-1 Meg
3257	L, P, W	±10	0.25	105	25	No	3/16	1/2	1/2	10-50K
271, 273, 275	L, S, P	±10	0.50	105	25	No	5/16	1/4	1-1/4	50-20K
272, 274, 276	L, S, P	±20	0.20	105	25	No	5/16	1/4	1-1/4	5K-5 Meg
3067	S, P	±10	0.50	85	15	No	23/64	9/32	1	50-20K
3068	S, P	±20	0.20	85	15	No	23/64	9/32	1	20K-1 Meg
207	L	±10	2.00	175	25	No	13/16	9/32	1-1/4	100-100K
3070	L	± 5	3.75	200	25	Yes	21/64	1/4	1-1/4	100-50K
209	L	±10	0.5 (each element)	125	25	No	5/16	1/2	1-1/4	10-50K
3040	W	±10	5.00	350	17	No	5/8	19/64	1-1/4	500-20K

*Key to terminal types: L = Insulated stranded leads, S = Solder lugs (includes panel mounting bushing on Models 3367, 3368, 3300S, A 3201J only), P = Printed circuit pins, W = Uninsulated wires (edge mounting 3250, 3251, 3280 & 3281).

†TRIMPOT, TRIMIT, E-Z TRIM, TRIMPOT, are Registered Trademarks of Bourns, Inc.

RELAYS AND TIME DELAYS

RELAYS

TIME DELAYS

	Model 3100	Model 3101		Model 3900	Model 3907	Model 3908
Size:	.2" x .4" x .6"	.2" x .4" x .6"	Time delay range:	0.1 - 200 seconds	0.1 - 200 seconds	0.1 - 200 seconds
Max. Oper. Temp:	125°C	125°C	Nominal voltage:	20 to 30 VDC	20 to 30 VDC	20 to 30 VDC
Contacts:	SPDT; Rating 1.0 amp resistive 26.5 VDC	DPDT; Rating 1.0 amp resistive 26.5 VDC	Life (min.) Output Contact rating:	10^5 cycles DPDT Relay 1 ampere resistive at 26.5 VDC	10^6 cycles SPST NO—Solid State 0.05 ampere resistive at 26.5 VDC, 120°C; 0.150 amp at 25°C	10^5 cycles DPDT Relay 1 ampere resistive at 26.5 VDC
Coil resistances:	50Ω to 2000Ω	65Ω to 2000Ω				
Pick-up sensitivity	100 milliwatts	160 milliwatts				
Vibration:	40 G standard, 3000 CPS	40 G standard, 3000 CPS	Ambient temp. range:	—55 to +120°C	—55 to +120°C	—40 to +85°C
Shock:	150G	150G				

MICROCOMPONENTS

	Resistor	Capacitor	Inductor	Transformer
Range	1K-200K	10 pf to .12 mf	0.1 Hy-66 Hy	400 CPS-250K CPS
Tolerance	±1% — ±10%	±10% & ±20%		
Temp Range	—65° to +150°C	—55° to +150°C	—65° to +130°C	—65° to +130°C
Rating	0.07Watt at 100°C	200 WVDC		50 MW at 1 KC
Size	0.1" x 0.03" x 0.05"	Variable	0.250" Cube	0.250" Cube
Environmental	MIL-R-10509D	MIL-C-11015C	MIL-T-27B	MIL-T-27B

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Now you can get custom micro-circuits from Bourns for virtually any application! Our total capability — conductive, resistive, capacitive and magnetic — can satisfy your custom circuit needs at lowest possible cost! Standard flat-pack configurations eliminate special tooling and insure rapid delivery.

VOLTAGE SENSORS

MODEL 3910 and MODEL 3917

Trigger voltage range:	0 to 1000 VDC	0 to 1000 VDC
Supply Voltage:	20-30 VDC	20-30 VDC
Life:	10^5 operations	10^6 operations
Output:	DPDT Relay	SPST NO—Solid State
Contact Rating:	1 ampere at 26.5 VDC	0.05 ampere at 30 VDC
Ambient temp. range:	—55 to +105°C	—55 to +105°C

QUADRATRON® EXPONENTIAL RESISTORS

Model 4100A-1-010

Bourns new QUADRATRON exponential resistor generates a multitude of nonlinear mathematical functions when used as an input or feedback element with DC operational amplifiers. Multiply and divide, and obtain square, square root, sine, cosine, and many other functions.

Gold-plated components
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Model 884 Wideband (dc to 100 kc) Floating, Guarded Amplifier . . .
Model 885 Wideband (dc to 10 kc) Differential, Isolated Amplifier . . .

high-gain/performance amplifiers for low-level, wideband systems at lowest cost. Completely transistorized, these state-of-the-art amplifiers use field-effect transistors in place of mechanical choppers to achieve lowest drift rate, freedom from microphonics and maximum reliability. Gain range to 3000 and a continuously adjustable 10-turn vernier control are provided as standard features. Two differential models with ±10 ma or ±100 ma output current from a low impedance can drive long lines, A to D converters, multiplexers, galvanometers or tape recorders. Transfer characteristic is optimized to provide wide frequency response with minimum overshoot, fastest settling and overload recovery times, and minimum phase shift. Common mode rejection is greater than 120 db with up to ±300 volts dc or peak ac common mode voltage.

All models have built-in power supplies, feature drift less than 1 μV per week, wideband noise less than 4 μV rms, linearity better than 0.02%. Can be used either separately or in the same rack module with Model 1155 Universal Signal Conditioning Unit or Model 890 Electronic Filter to form complete, isolated signal conditioning channels.

Model 885-135 Differential Amplifier to drive multiplexers, tape recorders and A to D converters.

GAIN RANGE: 1 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±5 volts at ±10 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 885-235 Differential Amplifier to drive data systems, long lines and galvanometers.

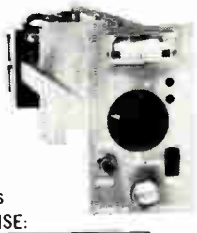
GAIN RANGE: 3 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±10 volts at ±100 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 1155 Universal Signal Conditioning Unit

Uses plug-in circuit cards to supply excitation or bias, attenuation, circuit completion, balancing, filtering and calibration. Used with low-level or high level signals from thermocouples, strain gages, resistance temperature sensors, thermistors, potentiometers and voltage sources. Can function separately or in same rack module with Models 884 or 885 Amplifiers or Model 890 Filter to provide complete conditioning, calibration and normalizing of transducer signals.

Model 141-102 Wideband DC Utility Amplifier to drive galvanometers and fulfill wideband dc amplifier requirements.

GAIN RANGE: 1 to 25
INPUT RESISTANCE: >10 megohms
OUTPUT: ±10 ma at ±10 volts
COMMON MODE REJECTION: >60 db at all gain settings



FREQUENCY RESPONSE:

RESPONSE:	±½%	±3.0%	-3 db point
FIXED GAIN POS:	dc to 20 kc	dc to 100 kc	500 kc

Model 120 Nanovolt Amplifier gives you high-gain/low-noise amplification for seismic transducer signals, cryogenic studies, thermocouple or strain gage signals.

GAIN RANGE: 200 to 1,000,000
BANDWIDTH: dc to 100 cps
NOISE: 0.05 μV rms
INPUT RESISTANCE: 1 megohm
OUTPUT LEVEL: 0 to ±5 volts at ±5 ma

Model 121Z Nanovoltmeter provides 0.1 μV full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field and in laboratories.

FULL SCALE RANGES: ±0.1 μV to ±100 mv
INPUT RESISTANCE: 1 megohm
ZERO SUPPRESSION: ±0.5 μV to ±5 mv
AMPLIFIER OUTPUT: Gain 30 to 3 million, delivers ±5 volts at ±5 ma
Overload Indicator

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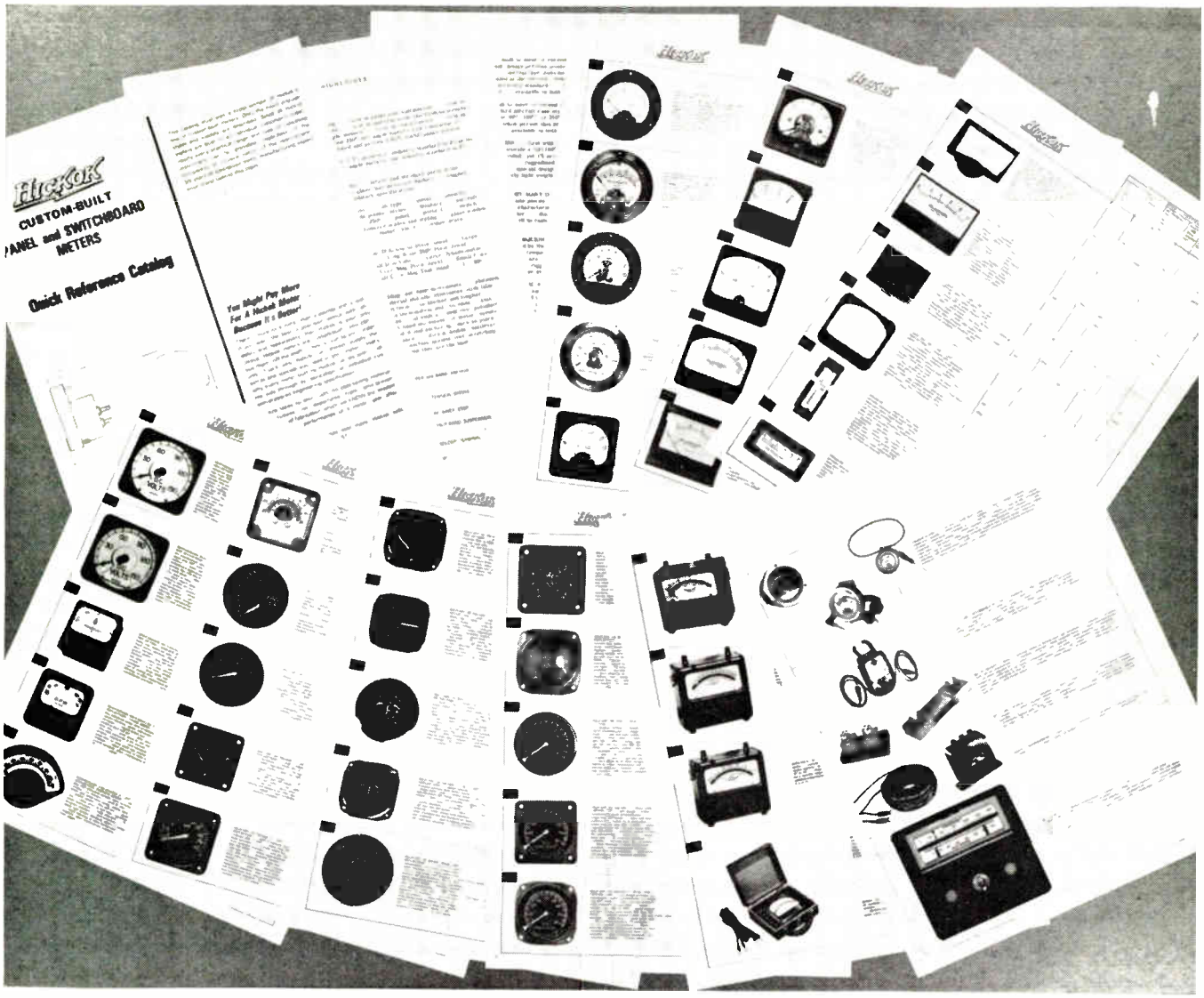

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1965 Survey Of Potentiometer Specifications

Part 1: Precision Potentiometers

THE PRECISION POTENTIOMETER is a mechanical electrical transducer dependent upon the relative position of a moving contact (wiper) and a resistance element for its operation. It delivers to a high degree of accuracy a voltage output that is some specified function of applied voltage and shaft position.

Precision potentiometers covered in this survey are rotary wirewound, non-wirewound, linear and non-linear types employing extended shafts that in operation are referenced by angular motion. Although the term "precision" as used, applies also to some rectilinear potentiometers and decade attenuators, these types will be included under Special Purpose potentiometers in a later issue. Rectilinear types give an electrical indication of linear displacement.

Parameters in Charts

The accuracy of the precision potentiometer is described to a good extent by its resistance tolerance, linearity and resolution, and in some cases noise, and how closely it maintains these characteristics under changes in environment. But there are many other characteristics and considerations. A document published by the Precision Potentiometer Manufacturers' Association provides a series of preferred inspection test procedures for measurement of precision potentiometer characteristics in accordance with the Industry Standard for Precision Potentiometer Terms and Definitions as revised and approved by the PPMA.

Resistance tolerance is expressed as the percentage deviation of the actual total resistance of the potentiometer from the total resistance as specified by the manufacturer. Values in some case ranging as low as a fraction of a percent.

Linearity, the most important factor for many applications, describes the straight line relationship between the potentiometer output voltage or resistance and the wiper travel or shaft rotation. The deviation is the linearity error. Independent linearity is used to describe most linear precision potentiometers. Independent Linearity (Best Straight Line) is the maximum deviation, expressed as a percent of the total applied voltage, of the actual function characteristic from a straight reference line with its slope and position chosen to minimize the maximum deviations over the actual electrical travel, or any specified portion thereof.

Conformity is a term used with non-linear potentiometers such as sine and cosine types, and sometimes with linear potentiometers. Terminal Conformity, which is the specification most often used, is the maximum deviation of the actual function output curve from a desired function curve extending between zero rotation and the theoretical test angle. This deviation is expressed as a percent of the applied voltage.

Independent linearity and conformity are used interchangeably in the charts, depending upon whether the pot is linear or non-linear, as indicated.

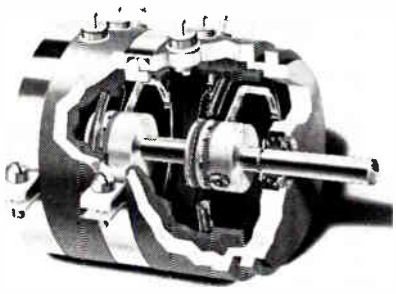
POTENTIOMETER SURVEY

Parts 2 and 3 will appear in future EI issues. Watch for them.

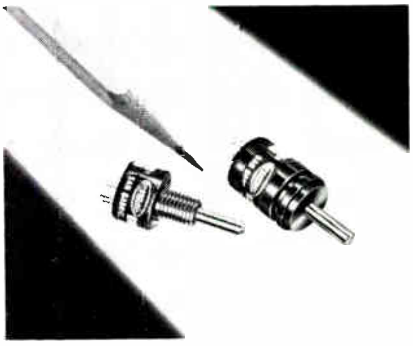
Part 2. General Purpose Potentiometers (Semi-precision, Industrial and Commercial Types)

Part 3. Special Purpose Potentiometers and Trimmers (Including Attenuators, Transducers, Measuring Pots, Power Rheostats, Power Dissipators)

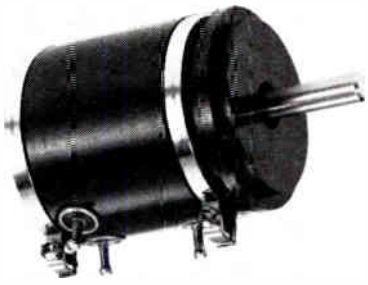
First in a series of special potentiometer reports identifying suppliers and listing available Mil Spec precision potentiometers and their characteristics, as compiled by EI editors.



Dale Model PS-09 is rated at 20KΩ, 200v.



Spectrol's model 140 has 1% linearity.



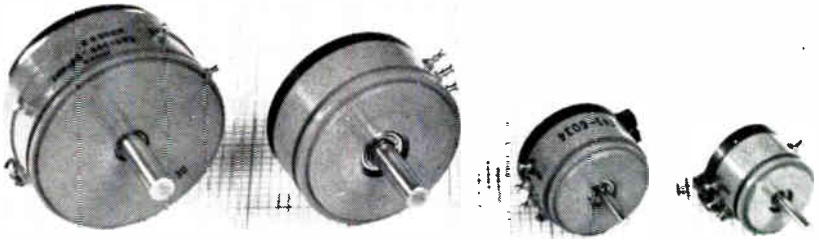
Bomar's 20-09 has a 0.0003% resolution.

Bourns' 3660 has a 0.010% resolution.

Resolution is a measure of the sensitivity of a precision potentiometer. It represents the smallest parts into which the slider mechanism can divide the resistance or voltage. In the case of wirewound pots, the theoretical resolution equals the reciprocal of the number of wire turns, expressed as a percentage, i.e., % Resolution = Voltage per turn of Wire ÷ Input Voltage x 100. For linear pots, this would be % Resolution = 1 ÷ Total Number of Turns x 100. In non-wirewound pots, the smallest increment of resistance change is so small that the resolution is generally considered as infinite.

Equivalent Noise Resistance (ENR) is an ohmic measure of the contact resistance in a potentiometer. Noise as defined by MIL-R-12934D is any spurious variation in the electrical output not present in the input, defined quantitively in terms of an equivalent parasitic, transient resistance in ohms, appearing between the contact and resistance element when the shaft is rotated or translated. The ENR is defined independently of the resolution, the functional characteristics, and the total travel. The magnitude of the ENR is the maxi-

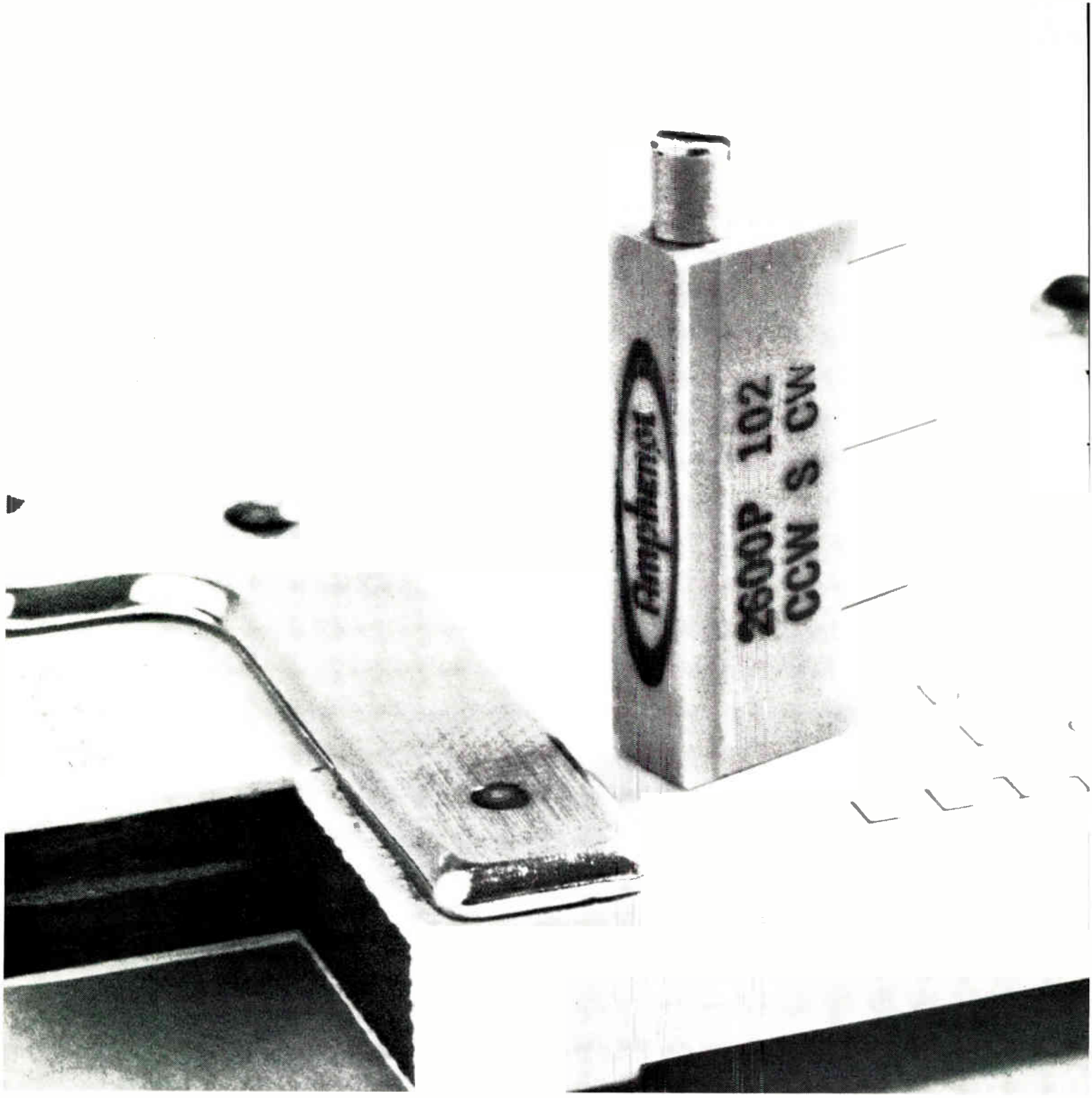
(*Continued on page* 68)



Type F78, by Fairchild, has up to 6 taps and a ½% linearity. Diameter is ⅞ in.

Model 7300, by IRC, uses rear terminals.

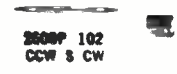
Daystrom 341 is a 10-turn pot. in 1x½ in.



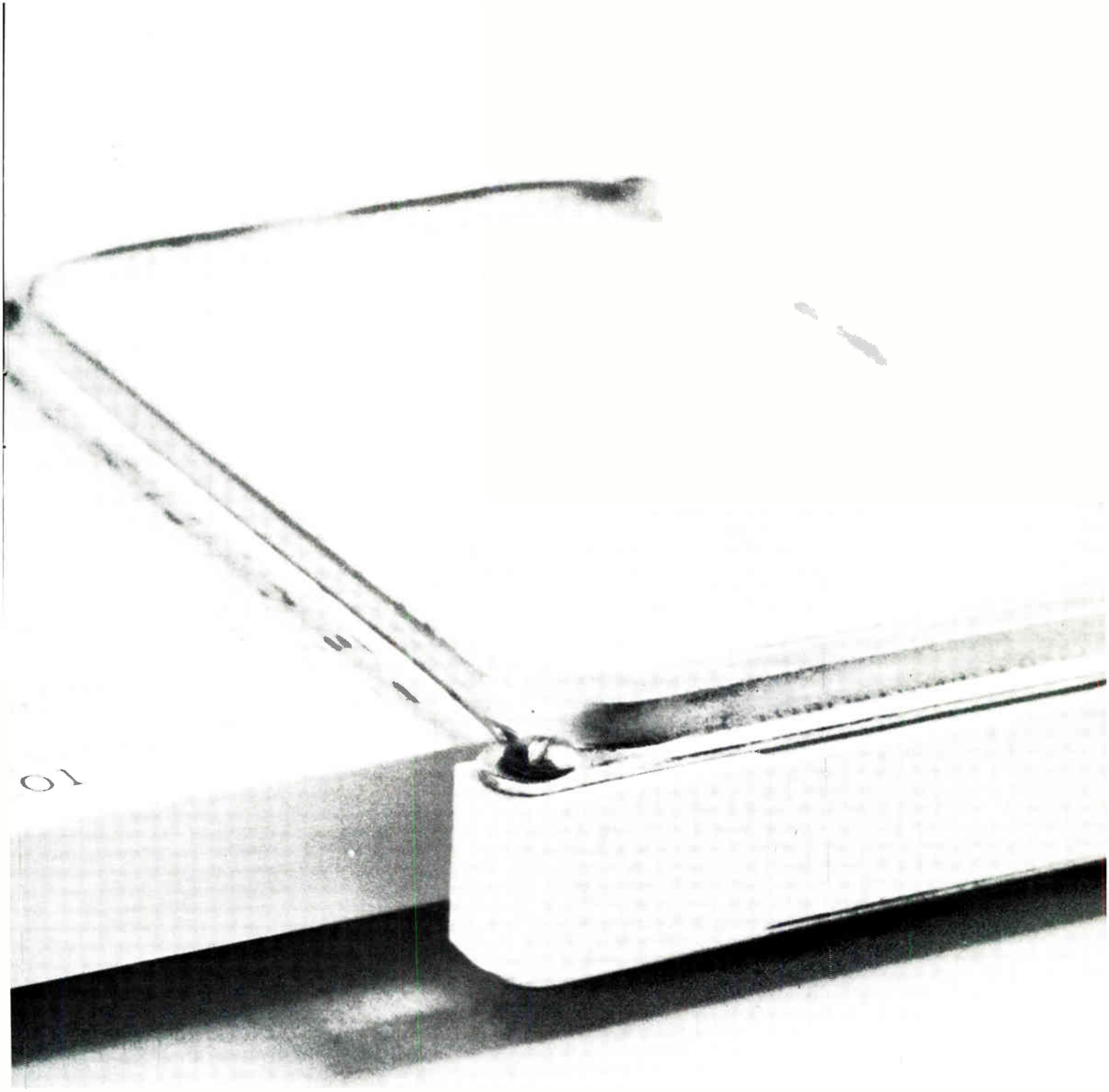
17 ways to design circuits better with this tiny $1.46 commercial trimmer

Check the list at right. This Amphenol 2600 trimmer rates 17 ways better than the next best commercial trimmer. All for less cost.

SIMPLIFIED DESIGN. Just 3/4" long and .04 ounce, the 2600 has only seven parts. By eliminating interconnecting parts, assembly is easy. We mass-produce the 2600—over 1 million this



Circle 36 on Inquiry Card



year—with big savings for you. (Even Amphenol's $2 humidity-proof 2610 costs only one-fifth as much as similar trimmers.)

53% BETTER RESOLUTION. Simplified design has eliminated mounting holes, so the mandrel runs the full length of the trimmer. Result: you get resolution from .22% to 1.78%—up to 53% better than competitive trimmers.

And you get Amphenol quality. Like silver-brazed terminations. Gold-plated external metal parts. A low-mass wiper that can't shift under shock or vibration. Self-lock lead-screw. And the exclusive ratcheting clutch that prevents end-turn damage.

OFF-THE-SHELF DELIVERY. You can get 2600's or 2610's right away from your local Amphenol Industrial Distributor's shelf stocks. Or call your Amphenol Sales Engineer. Or write us in Janesville, Wis.

Feature	Amphenol 2600	*Brand B 1 inch
Power rating	1 watt at 40°C	.5 watt at 25°C
Temp. range °C	−65° to +125°	−55° to +85°
No. of turns	20 Full turns	Only 15 turns
Humidity	MIL-STD-202A	No
Weight	.04 oz.	.10 oz. (approx.)
End settings	to 1.0%	to 2.0%
Dielectric strength	1000 vac	500 vac
Noise	100 ENR Max.	↑
Insulation resistance	100 Meg. Min.	↑
Shock	50 g's	↑
Vibration	20 g's	↑
Acceleration	50 g's	No spec.
Sand & dust	MIL-E-5272C	listed
Fungus	Non-nutrient	↓
Load Life	2000 hours	↓
Mechanical life	200 cycles	↓
Price (25-49)	$1.46 each	$1.54 each

*Sources dated 3/65, 5/63

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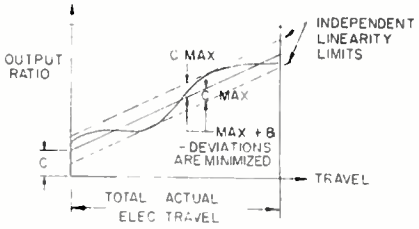
POTENTIOMETERS (Continued)

source to excite the wiper of the potentiometer which is rotated while the output is measured on an oscilloscope. The equivalent resistance is then calculated as: Noise $= \frac{E_{PN}}{0.001}$, where E_{PN} = "peak noise voltage." The test measures factors such as uniform contact resistance, resistance element cleanliness, chatter in contact design, surface oxidation on winding and compatibility of contact and winding.

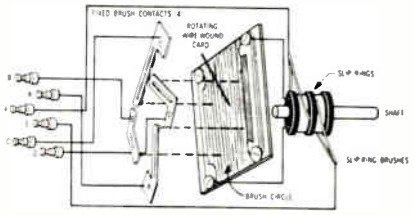


Independent linearity limits are shown with the output ratio vs. total elec. travel.

Output Smoothness

Some potentiometer manufacturers say there are other, more significant sources of noise than ENR which must be considered and whose effect must be measured, in order to determine a potentiometer's noise characteristics, particularly in servo systems. Here, because of feedback

(*Continued on page* 90)



Schematic of Gamewell flat-card sine-cosine potentiometers.

PRECISION POTENTIOMETERS

	Type No. or Series	Potentiometer	Wirewound	Carbon (C); Cermet (CT); Comp.(CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg.(S); Bush.Mtg.(B); Screw(SC)	P.C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Mil Type	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Ace Electronics Somerville, Mass. 02144	—	X	X						10	2K	5	.02	.1		150	8	X				T/L						.25-10	
	—	X	X		CP				100	10K	10	N	.1		150	4	X				T/L						.5-3	
Amphenol Controls Div. 120 S. Main St. Janesville, Wisc.	2440	X	X			C	1		10	50	5		1			3	X		B/S		T	M			.8	.87	
	2450	X	X			C	1		10	100	5		1			4	X		B/S		T				.6	1	
	2460	X	X			C	1		10	100	5		1			4	X		B/S		T				.8	1.4	
	2480	X	X			C	1		20	125	5		1			5	X		B/S		T				1	2	
	2490	X	X			C	1		20	200	5		.5			6	X		B/S		T				1	3	
	2130	X	X			C	3		10	50			.5			4	X		B/S		T				1	.87	
	205	X	X			C	3		10	50			.5			3	X		B		T				1.4	1.7	
	930	X	X			C	3		20	100			.25			3	X		B/S		T				1.3	2	
	2150	X	X			C	10		25	100			.25			3	X		B/S		T				1.4	.87	
	2100	X	X			C	10		25	120			.25			5	X		B/S		T				1.5	.87	
	2200	X	X			C	10		25	300			.5			5	X		B		T				2.1	1.8	
	205	X	X			C	10		1.15	300			.1			5	X		B		T				2.1	1.7	
	900	X	X			C	10		1	300			.1			5	X		B/S		T				2	2	
Analogue Controls, Inc. 200 Frank Rd. Hicksville, N. Y.	0501	X	X			C	1		2K	100	5		1		95	1	X	X	B/S		T				.37	.5	
	0610	X	X			C	10		2K	100	5		.5		95	2.5	X	X	S		T				2	.5	
	0901	X	X			C	1		2K	100	5		.5		95	1	X	X	S		T				.75	.87	
	0910	X	X			C	10		2K	100	5		.25		95	3	X	X	S		T				1.6	.87	
	1101	X	X			C	1		2K	100	5		.5		95	1.4	X	X	S		T				.56	1	
	1110	X	X			C	10		2K	100	5		.25		95	3	X	X	S		T				1.7	1	
	1501	X	X			C	1		2K	100	5		.3		95	2	X	X	S		T				.8	1.3	
	1701	X	X			C	1		2K	100	5		.25		95	4	X	X	S		T				.96	1.7	
	1801	X	X			C	1		2K	100	5		.25		95	5	X	X	S		T				.8	2	
	1810	X	X			C	10		2K	100	5		.1		95	5	X	X	S/B		T				2	2	
	3001	X	X			C	1		2K	100	5		.2		95	6.5	X	X	S		T				1	3	
	3010	X	X			C	10		2K	100	5		.07		95	10	X	X	S		T				2.2	3	
	3015	X	X			C	15		2K	100	5		.07		95	12	X	X	S		T				2.7	3	
	3040	X	X			C	40		2K	100	5		.05		95	15	X	X	S		T				5.3	3	
	5001	X	X			C	1		2K	100	5		.15		95	8	X	X	S		T				1.2	5	
	5020	X	X			C	20		2K	100	5		.02		95	30	X	X	S		T				3.5	5	
	MP10	X	X			C	1		5K	200	5		to .002			20	X	X	SC		T				5	10	
	MST150	X	X			C	1		2K	100	5		to .01		95	8	X	X	S		T		X		4.5	15	
Astro Electronics, Inc. 1160 E. Ash Ave. Fullerton, Calif.	T312	X	X			C			50	20	10	to .16			125	.2	X				L	M	X		.2	.3	1 gm
	7510	X	X			C	10		500	200	3		.25		125	3	X		B		T		X			.75	1.2
	8810	X	X			C	10		500	200	3				125	3	X		B		T		X			.87	1.2
	088-10	X	X			C	10	L/NL	10	200	3	to .02	.25		125	3	X		B/S		T		X			.87	1.2
	088-5	X	X			C	5	L/NL	10	50	3	to .02	.5		125	2	X		B/S		T		X			.87	.8
	088-3	X	X			C	3	L/NL	10	50	3	to .03	.3		125	1.5	X		B/S		T		X		1	.87	
	088-1	X	X			C	1	L/NL	10	50	3	to .06	.5		125	1.5	X		B/S		T		X		.7	.87	
	106-1	X	X			C	1	L/NL	250	100	3	to .06	.5		125	2	X		S		T		X		.7	1	
	131-1	X	X			C	1	L/NL	50	100	3	to .04	.5		125	2	X		S		T		X		.8	1.3	
	144-1	X	X			C	1	L/NL	10	125	3	to .05	.5		125	2.5	X		S		T		X		.8	1.4	
	175-1	X	X			C	1	L/NL	20	140	3	to .04	.3		125	3	X		S		T		X		.8	1.7	
	200-1	X	X			C	1	L/NL	20	150	3	to .04	.3		125	4	X		S		T		X		.8	2	
	300-1	X	X			C	1	L/NL	50	200	3	to .02	.3		125	6	X		S		T		X		.8	3	
Beckman Instruments, Inc. Helipot Div. Fullerton, Calif. 92634	TP/TSP	X	X			C	1	L	200	113			.5		125	1.2	X		B/S							.87	
	6103	X		CT		C	1	L	70	1K			.5		150	3	X		S							.87	
	5203	X	X			C	1	L	50	100			.5		150	4	X		S							1	
	6213	X		CT		C	1	L	50	1K			.5		150	5	X		S							1	
	6263	X			CP	C	1	L	1K	50			.5		125	1.5	X		S							1	
	G	X	X			C	1	L	5	30			.5		85	2	X		B							1.3	
	6351/53	X			CP	C	1	L	1K	75			.5		125	2	X		S							1.3	
	5433	X	X			C	1	L	150	110			.5		150	7	X		S							1.4	
	5600	X	X			C	1	L	15	215			.5		85	3.5	X		S/B							2	
	5623/27	X	X			C	1	L	100	50			.5		150	5	X		S							2	
	6603	X		CT		C	1	L	100	1K			.5		150	10	X		S							2	
	6651/53	X			CP	C	1	L	1K	75			.5		125	2.5	X		S							2	
	5700	X	X			C	1	L	25	145			.5		85	5	X		S/SC							3	
	5723/27	X	X			C	1	L	150	81			.5		150	9	X		S							3	
	5803	X	X			C	1	L	1K	80			.15		85	3.5	X		S							3	
	3803	X	X			C	1	L	100	22.6			.5		85	6	X		S							3	
	3903	X	X			C	1	L	175	36.6			.5		85	15	X		S							4	
	7246	X	X			C	M	L	10	50			.25		85	2	X		B							.87	
	7200	X	X			C	M	L	10	125			.25		85	1.5	X		B/S							.87	
	7233	X	X			C	M	L	300	92.8			.5		125	1.8	X		S							.87	
	7903	X	X			C	M	L	1K	125			.1		85	2	X		S		(AC Type)					1	
	4203	X	X			C	M	L	400	58			.5		85	2.2	X		S		(liquid filled)					1	
	A	X	X			C	M	L	10	648			.25		85	5	X		B							1.8	
	C	X	X			C	M	L	5	195			.5		85	3	X		B							1.8	
(Continued on next page)	7601, 3	X	X			C	M	L	100	650			.15		85	5	X		S/B							1.8	

Once you take the measure of Helipot trimmers, you'll use them as a rule

Here are some of the rules for measuring

What do you look for in trimming potentiometers? Probably the same things that Helipot has established in 20 years of leadership in precision pots. By almost any standard of measure, you get more in the broad line of Helitrim® trimmers. If force of habit has caused you to overlook the important facts below, take a minute to brush up. You'll be doing yourself a favor.

Measure for Mounting Styles. Sizes and shapes to meet any application. Leads, pins, solder lugs and various panel mounts. All pin configurations, too, so they'll fit anywhere any other trimmer will.

Measure for Resistance Range. From 10 ohms to 2 megohms in every model, widest range in the industry. Rugged cermet resistance element, too, that has it all over wirewound or carbon elements. The cermet element is immersible, shock resistant, free from sudden failure and offers essentially infinite resolution.

Measure for Price. Helitrim trimmers stretch to fit any requirement and price, from military models to commercial trimmers priced *below a dollar* in quantity. They're *all* priced competitively or *below* trimmers you may currently be using.

While you're measuring, don't forget availability. Helitrim trimmers are available from stock in large quantities, and there are 32 Helipot sales offices to serve you. Ask one for the new Helipot trimmer catalog.

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PRECISION POTENTIOMETERS (cont.)

	Type No. or Series	Potentiometer	Wirewound	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg. (S); Bush.Mtg.(B); Screw (SC)	P.C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Mil Type	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Beckman Instruments, Inc. (Continued)	9301, 3	X	X			C	M	L	30	193			.25		85	3	X		S/B								1.8	
	4711, 13	X	X			C	M	L	300	83			.25		85	4.5	X		S/B		(liquid filled)						2	
	7803	X	X			C	M	L	1K	200			.02		85	5	X		S		(AC Type)						2	
	4611, 13	X	X			C	M	L	800	277			.15		85	7.5	X		S/B		(liquid filled)						2	
	B/BS/BSP	X	X			C	M	L	40	2K			.5		85	10	X		S/B								3.3	
	D/DSP	X	X			C	M	L	60	3.3K			.5		85	15	X		S/B								3.3	
	E/ESP	X	X			C	M	L	125	5.3K			.5		85	20	X		S/B								3.3	
Bliss-Gomewell Newton Upper Falls 64 Moss.	RVG8	X	X			C	1	L	10	55	5	to .1	1		150	3.5	X		B/S		T		X		.75	.5	.3
	RVG10	X	X			C	1	L	15	40	5	.3	.5		150	2	X		B		T		X		.4	.6	.3
	RVG14	X	X			C	1	L	20	60	5	.2	.5		150	2	X		S/B		T		X		.8	.8	.7
	RVG14	X	X			C	10	L	250	300	5	.02	.25		150	5.5	X		S/B		T		X		1.4	.8	
	RVG18	X	X			C	1	L	65	140	5	.16	.5		150	5	X		S		T		X		1.4	1.1	
	G20	X	X			C	1	L	15	75	5	.25	.5		150	2	X		B/S		T		X		.5	1.2	
	RL270	X	X			C	1	L	15	75	5	.25	.25		150	2.2	X		S		T		X		.6	1.2	
	RL270	X	X			C	1	L	20	110	5	.16	.2		150	2.7	X		S		T		X		.6	1.6	
	RL270	X	X			C	1	L	30	150	5	.1	.15		150	4	X		S		T		X		.6	2	
	RL270	X	X			C	1	L	50	260	5	.07	.1		150	7	X		S		T		X		.6	3	
	RL270	X	X			C	1	L	110	600	5	.04	.1		150	10	X		S		T		X		.37	5	
	RVG17	X	X			C	1	NL		18			1.5			.75	X		S		T		X		.7	1	.6
	RVG18	X	X			C	1	NL	250	20	5		1			2	X		S		T		X		.9	1.1	
	RVG30	X	X			C	1	NL		16	5		.8			1.5	X		S		T		X		1	1.8	
	RL11	X	X			C	1	NL		16	5		.8			2	X		S		T		X		1.5	2.3	
	RL14	X	X			C	1	NL		35	1		.6			3.5	X		S		T		X		4.3	4.3	
	14C	X			CP	C	1	L/NL	500	20	10	N	.5		150	1.2	X		S		T		X		.8	.87	.5
	17C	X			CP	C	1	L/NL	1K	20	10	N	.5		150	1.5	X		S		T		X		.8	1	.7
	32C	X			CP	C	1	L/NL	1K	50	10	N	.3		150	3	X		S		T		X		1.3	2	3
	48C	X			CP	C	1	L/NL	5K	100	10	N	.25		150	5	X		S		T		X		1.3	3	5
	32MP	X	X			C	1	L/NL	100	475	1		.25			4	X		S		T		X		1.4	2	
Bolton Electronics Corp. 246 Pork Ave. Gorden City Pork, L. I.	900	X	X			C	1			100	30			.5			1.2	X		S/B						.68	.87	
	1100	X	X			C	1			100	40			.5			1.5	X		S/B						.68	1	
	1500	X	X			C	1			100	50			.5			2.5	X		S/B						.8	1.4	
	1800	X	X			C	1			100	65			.3			3	X		S/B						.8	1.7	
	2000	X	X			C	1			100	75			.3			4	X		S/B						.8	2	
	3000	X	X			C	1			100	100			.2			6	X		S/B						.8	3	
	500	X	X			C	1	L/NL	5K	50	to .1		to .1													.66	.5	
Bourns, Inc. Trimpot Div. Riverside, Calif. 92507	3400/50	X	X			C	10			100	1K	3		.15		105	5	X	X	S/B				X		1.7	2	
	3410/60	X	X			C	1			50	100	3		.3		125	4	X	X	S/B				X		.6	2	
	3430/80	X	X			C	1			50	100	3		.5		125	1.5	X	X	S/B				X		.9	1	
	3440/90	X	X			C	1			100	500	3		.25		125	6	X	X	S/B				X			3	
	3500/50	X	X			C	10			50	500	3		.2		125	2	X	X	S/B				X		1	.87	
	3501/51	X	X			C	10			1K	500	5		.5		125	2	X	X	S/B				X			.87	
	3510/60	X	X			C	3			25	100	3		.3		125	1	X	X	S/B				X			.87	
	3520/70	X	X			C	5			25	250	3		.3		125	1.5	X	X	S/B				X		.54	.87	
	3530/80	X	X			C	1			25	50	3		.5		125	1	X	X	S/B				X		.67	.87	
	3507	X	X			C	10			100	250	5		.5		105	2	X	X							1.1	.87	
	3700/50	X	X			C	10			50	250	5		.25		125	1	X	X	S/B				X		1	.5	
	3707	X	X			C	10			100	50	5		1		105	1	X	X								.5	
British Radio Electronics 1742 Wisconsin Ave. Washington 7, D. C.	CLR9600	X	X			C	1	L/NL	12.5	50	5		.01	100		5	X						X			1.8	8
Carter Mfg. Co. 23 Washington St. Hudson, Mass.	118F	X	X			C	1			100	25	to 1		to .25	100	150	3	X	X	S			M			.5	.87	
	118H	X	X			C	1			100	25	to 1		to .25	100	150	3	X	X	S			M			.5	.87	
	223	X	X			C		L/NL	100	50	to 1		to .14	100	150	3	X	X	S/B						.5	1	
	136	X	X			C		L/NL	100	100	to 1		to .1		125	3		X	S/B						1	1.6	
Clorostat Mfg. Co., Inc. Dover, N. H.	54-14M	X	X			C	1				20	5		1		125	2		X	S/B		T				.7	.87	
	54-17M	X	X			C	1				25	5		1		125	2.5		X	S/B		T				.7	1	
	54-26M	X	X			C	1				100	5		.5		125	4.5		X	S/B		T				.9	1.6	
	54-32M	X	X			C	1				130	5		.5		125	5.5		X	S/B		T				1.1	2	
	54-48M	X	X			C	1				200	5		.5		125	6.1		X	S/B		T				1	3	
	59M	X	X			C	10				100	5		.25			4.5		X	S/B		T				1.5	.87	
	62	X	X			C	10				100	5		.25			2		X	B		T				1.5	.87	
	42BM	X	X			C	1				100	5		1			3			B/S		T					1.6	
	62JA	X	X			C	10			100	100	5	to .01	.25			2			B		T				1.5	.87	1.3
	42-900	X	X			C	1			50	100	5	to .05	to .25		105	3			B		T					1.6	
	42JA	X	X			C	1			50	100	5		to .5		105	3			B		T					1.6	
	54-48J	X	X			C	1			1K	250	5		.2			6.1			B		T					3	

PRECISION POTENTIOMETERS (cont.)

	Type No. or Series	Potentiometer	Wirebound	Carbon (C); Cermet (CT); Comp. (CO)	Mer. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg. (S); Bush. Mtg. (B); Screw (SC)	P-C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S); Mil Type	Height (in.)	Width (in.)	Length (in.)	Dia. (in.)	Weight (Oz.)
Computer Instruments Corp. 92 Madison Ave. Hempstead, L. I., N. Y.	50	X		C		C	1		1K	150	10	N	1		150	1	X		B/SC		T				.7	.5	.5
	70	X		C		C	1		1K	250	10	N	.25		150	2	X		B/SC		T				.6	.8	.7
	100	X		C		C	1	L/NL	1K	250	10	N	.1		150	2	X		B/SC		T				.6	1	1
	150	X		C		C	1	L/NL	1K	250	10	N	.07		150	2	X		B/SC		T				.7	1.4	1
	170	X		C		C	1	L/NL	1K	250	10	N	.05		150	4	X		B/SC		T				1	1.7	3.5
	205S	X		C		C	1		1K	250	10	N	.05		150	3	X		B/SC		T				.7	2	2.5
	305S	X		C		C	1		2K	250	10	N	.03		150	4	X		B/SC		T				.7	3	3.5
	500	X		C		C	1		1K	250	10	N	.03		150	6	X		B/SC		T				1.8	5	23
	5000	X		C		C	M		10K	500	10	N	.1		150	2	X		B/SC		T				1.5	.5	1
	7800	X		C		C	M		1K	500	10	N	.1		150	2	X		B/SC		T				1.9	.8	1.7
	20000	X		C		C	M		5K	500	10	N	.02		150	4	X		B/SC		T				2.6	2	8
Dale Electronics, Inc. Columbus, Nebr.	PS09	X	X			C	1	L	500	20	3	to .06	.35	100	125	2	X		S		T	X			.67	.87	.6
	PS/SC11	X	X			C	1	L/NL	500	20	3	to .06	.35	100	125	2	X		S		T	X			.67	1.1	.8
	PS/SC111	X	X			C	1	L/NL	500	20	3	to .06	.35	100	125	2	X		S		T	X			.67	1	.8
	PS15	X	X			C	1	L	1K	50	3	to .03	.3	100	125	4	X		S		T	X			.8	1.6	2.5
	PS151	X	X			C	1	L	1K	50	3	to .03	.3	100	125	4	X		S		T	X			.8	1.4	2.5
	PS/SC18	X	X			C	1	L/NL	1K	50	3	to .04	.25	100	125	5	X		S		T	X			.8	1.7	3
	PS20	X	X			C	1	L	1K	50	3	to .03	.25	100	125	6	X		S		T	X			.8	2	4
	PS30	X	X			C	1	L	2K	100	3	to .02	.2	100	125	8	X		S		T	X			.8	3	6.5
Duncan Electronics, Inc. 2865 Fairview Rd. Costa Mesa, Calif.	1200	X	X			C	1	L/NL	20	150	5		.5	100	125	1.2	X		S/B		T	X			.6	.87	
	1300	X	X			C	1	L/NL	30	200	5		.5	100	125	2	X		S/B		T	X			.6	1.1	
	1500	X	X			C	1	L/NL	25	75	3		.5	100	105	3	X		S/B		T	X			.96	1.4	
	1600	X	X			C	1	L/NL	30	100	3		.5	100	105	4	X		S/B		T	X			.97	1.7	
	1700	X	X			C	1	L/NL	35	125	3		.5	100	105	5	X		S/B		T	X			.97	2	
	1800	X	X			C	1	L/NL	50	200	3		.5	100	105	7	X		S/B		T	X			.97	3	
	3201-3	X	X			C	10	L/NL	10	250	3		.25	100	105		X		S/B		T	X			1.4	.87	
	3204-6	X	X			C	3	L/NL	3	75	3		.5	100	105		X		S/B		T	X			1	.87	
	3207-9	X	X			C	5	L/NL	5	125	3		.5	100	105		X		S/B		T	X			1.1	.87	
	3602	X	X			C	10	L/NL	10	600	3		.25		105	7	X		B		T	X			1.9	1.7	
	3605	X	X			C	3	L/NL	5	180	3		.5		105	5	X		B		T	X			1.1	1.7	
	3701, 2	X	X			C	10	L/NL	100	830	3		.1		125		X		S/B		T	X			2	1.7	
	3704, 5	X	X			C	3	L/NL	30	250	3		.2		125		X		S/B		T	X			1.2	1.7	
Electro-Mec Instrument Corp. Watertown, Conn. 06795	9	X	X			C		L/NL		100		to .06	.5	100	125	1	X		S		T				.8	.88	.6
	11	X	X			C		L/NL		110		to .05	.5	100	125	1.2	X		S		T				.9	1	
	14	X	X			C		L/NL		170		to .03	.4	100	105	1.5	X		S		T					1.4	1.4
	18	X	X			C		L/NL		200		to .03	.3	100	100	2.2	X		S		T				.9	1.7	
	20	X	X			C		L/NL		230		to .02	.3	100	105	2.2	X		S		T				1	2	
	30	X	X			C		L/NL		370		to .02	.3	100	105	4	X		S		T				1	3	
	1395	X	X			C		L/NL		150		to .06	.5	100	105	1	X		B/S		T					1.1	
Electro Techniques 11301 E. Ocean Ave. La Habra, Calif.	875	X	X			C	10	L/NL	25	120	3		.2		105	3	X		B		T				1.5	.87	1
	RVS078	X	X			C	1		5	30	.3	to .09	.25		150	2			S/B		T				.8	.87	
	RVS100	X	X			C	1		5	30	.3	to .09	.25		150	2			S/B		T				.8	1	
	RVS106	X	X			C	1		10	50	.3	to .08	.25		150	2			S/B		T				.8	1	
	RVS112	X	X			C	1		15	75	.3	to .08	.25		150	2.5			S/B		T				.8	1.1	
	RVS131	X	X			C	1		25	100	.3	to .07	.2		150	2.7			S/B		T				.8	1.3	
	RVS144	X	X			C	1		25	150	.3	to .02	.2		150	2.7			S/B		T				.8	1.4	
	RVS175	X	X			C	1		30	200	.3	to .02	.2		150	3			S/B		T				.8	1.7	
	RVS200	X	X			C	1		30	250	.3	to .02	.12		150	5			S/B		T				.8	2	
	RVS300	X	X			C	1		50	500	.3	to .01	.1		150	7			S/B		T				.8	3	
Fairchild Controls 225 Park Ave. Hicksville, N. Y.	MF78	X	X			C	10	L	500	125	3	to .006	.2			2	X		B		T	X			1	.87	1
	F78	X	X			C	1	L	250	30	5	to .07	.5			2	X		S/B		T				.7	.8	.5
	F118	X	X			C	1	L	350	50	5	to .05	.5			2	X		S/B		T				.7	1	.7
	F134	X	X			C	1	L	800	100	5	to .03	.25			6	X		S/B		T				.9	1.7	2
	F200	X	X			C	1	L	1K	130	5	to .03	.25			8	X		S/B		T				.9	2	3
	F300	X	X			C	1	L	1K	200	5	to .02	.2			8	X		S/B		T				1	3	3
	752PS	X			CP	C	1		250	100	10	N	.5			1	X		S		T				.7	1	
	752PSC	X			CP	C	1	NL	500	20	10	N				1.5	X		S		T					1	
	754PSC	X			CP	C	1	NL	500	50	10	N				2	X		S		T					2	
	751P	X			CP	C	1		250	100	10	N	.5			1.3	X		S		T				.66	.87	.5
	749P	X			CP	C	1		250	150	10	N	.4			1.8	X		S		T				.86	1.4	2.5
	757P	X			CP	C	1		500	200	10	N	.35			2	X		S		T				.82	1.7	2
	743P	X			CP	C	1		500	300	10	N	.25			2.5	X		S		T				1.1	3	5
	751SC	X	X			C	1	NL	100	15	5					2	X		S/B		T	X			.9	.8	.5
	741SC	X	X			C	1	NL	250	12	5					2	X		S/B		T	X			1	1	.9
	754SC	X	X			C	1	NL	500	25	5					6	X		S/B		T	X			1	2	4
	743SC	X	X			C	1	NL	500	45	5	.15				8	X		S		T	X			1.4	3	9
	737	X	X			C	1	L/NL	1	250	5	.12				6	X		S		T	X			1	1.7	2
	747	X	X			C	1	L/NL	1	300	5	.09				7	X		S		T	X			1	2	3
	748	X	X			C	1	L/NL	2	375	5	.04				8	X		S		T	X			1	3	3.5
	743	X	X			C	1	L/NL	500	250	5	.5				4.5	X		S		T	X			.8	1.7	2.7
(Continued on next page)	746	X	X			C	1	L/NL	1K	340	5	.15				6	X		S		T	X			.9	3	5

PRECISION POTENTIOMETERS (cont.)

	Type No. or Series	Potentiometer	Wirebound	Carbon (C); Cermet (CT); Comp. (CO)	Mat. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(C)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg. (S); Bush. Mtg.(B); Screw(SC)	P-C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Mil Type	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (oz.)
Fairchild Controls (Continued)	749	X	X			C	1	L/NL	600	250	5	.28				4	X		S		T		X			.9	1.4	3.5
	757	X	X			C	1	L/NL	1	300	5	.15				6	X		S/B		T		X			.8	1.7	3
	754	X	X			C	1	L/NL	800	350	5	.28				8	X		S/B		T		X			.9	2	3
	977	X	X			C	1	L/NL	1K	50	5	.5				1.5	X		S		T		X			.68	.75	
	751	X	X			C	1	L/NL	200	100	5	.5				2	X		S/B		T		X			.68	.87	
	752	X	X			C	1	L/NL	300	150	5	.5				2	X		S/B		T		X			.66	1	
	906	X				C	3		100	70	to .01		to .1	90		1.5	X		S/B		T					1	.87	
	909	X				C	10		300	240	to .006		to .05	90		2.5	X		S/B		T					1.5	.87	
	934	X				C	3		200	140	to .01		to .1	90		1.5	X		S/B		T					1.1	1.7	
	931	X				C	10		600	500	to .004		to .03	90		5	X		S/B		T					1.7	1.7	
John Fluke Mfg. Co., Inc. P. O. Box 7428 Seattle, Wash. 98133	20A	X	(Slide-wire)			C			100	25	5	.02	.5	100		2	X		B		T		X			.76	1.2	
	21A	X	(Slide-wire)			C				50	5	.008	.5	100		3	X		B		T		X			1	1.3	
	22A	X	(Slide-wire)			C			1K	100	5	.02	.5	100		5	X		B		T		X			1.2	1.5	
	30A	X	X			C			1K	100	5	.002	.5	100		5	X		B		T		X			1.1	2	
General Radio Co. 22 Baker Ave. W. Concord, Mass.	971	X	X			C	1		2	20	5	to .2	2			3.5			SC		T					.62	1.2	.5
	972	X	X			C	1		50	50	5	to .2	2			5.8			SC		T					1	1.2	.75
	973	X	X			C	1		5	50	5	to .1	1			5.9			SC		T					.8	1.7	1
	974	X	X			C	1		10	100	5	to .1	1			9.4			SC		T					1.4	1.7	1.7
	975	X	X			C	1		500	100	2	to .05	.5			10			SC		T					1.1	2.7	3
	976	X	X			C	1		1K	200	2	to .05	.5			16			SC		T					2	2.7	4
General Scientific Corp. 1535 First St. San Fernando, Calif.	S1-750	X	X			C	1	L	10	50	5		.5			2	X		B		T					.5	.7	
	S1-100	X	X			C	1	L	10	50	5		.5			2.5	X		B		T					.6	1	
	S1-1312	X	X			C	1	L	50	50	5		.5			3	X		B		T					.7	1.3	
	S1-2000	X	X			C	1	L	10	100	5		.5			4.5	X		B/S		T					.8	2	
	S1-3000	X	X			C	1	L	50	150	5		.5			6	X		B/S		T					.8	3	
	M3-750	X	X			C	3	L	25	25	5		.5			1	X		B/S		T					.87	.7	
	M5-750	X	X			C	5	L	50	50	5		.5			1.8	X		B/S		T					1	.7	
	M10-750	X	X			C	10	L	100	75	5		.5			2.5	X		B/S		T					1.3	.7	
	M3-875	X	X			C	3	L	25	30	5		.5			1.5	X		B/S		T					.96	.87	
	M5-875	X	X			C	5	L	50	50	5		.5			2.3	X		B/S		T					1.1	.87	
	M10-875	X	X			C	10	L	100	100	5		.5			3	X		B/S		T					1.4	.87	
	M3-1000	X	X			C	3	L	25	50	5		.5			2	X		B/S		T					.96	1	
	M5-1000	X	X			C	5	L	50	75	5		.5			3	X		B/S		T					1.1	1	
	M10-1000	X	X			C	10	L	100	150	5		.5			4	X		B/S		T					1.4	1	
	M3-1812	X	X			C	3	L	25	125	5		.5			4	X		B/S		T					1.2	1.8	
	M5-1812	X	X			C	5	L	50	200	5		.5			5	X		B/S		T					1.4	1.8	
	M10-1812	X	X			C	10	L	100	400	5		.5			6	X		B/S		T					1.9	1.8	
	FS1-1000	X	X					NL	200	10	5		2			2	X									.8	1	
	FS1-2000	X	X					NL	300	25	5		1.5			4	X									1	2	
Giannini Controls Corp. 1600 S. Mountain Ave. Duarte, Calif.	85111	X				C			100	110	5		.25			1.5	X		B				X			1.3	1	.6
	85151	X				C			100	100	5		.25				X		B				X			1.3	1	.6
	85153	X				C			100	110	5		.25				X		B				X			1.3	1	.6
	85172	X	(Slide-wire)			C	1-40		50	10		N	to .05				X		S/B				X			2.3	1.8	
	85175	X	(Slide-wire)			C	1-10		50	10		N	to .05				X		S/B				X			1.5	1.5	
	85173	X	(Slide-wire)			C	10-40		1K	40		N					X		S/B				X			2.2	3.3	
	85176	X	(Slide-wire)			C	1-10		1	.1		N	to .005				X		S/B				X			1.8	1.8	
	85177	X	(Slide-wire)			C	1-40		50	10		N	.1				X		S/B				X			2.1	1.8	
Guidance Controls Corp. Commercial St. Engineers Hill Plainview, N. Y.	GC9	X	X			C	1	L		45		.06	.2				X		S		T						.9	
	GC11	X	X			C	1	L		60		.04	.15				X		S		T						1.1	
	GC15	X	X			C	1	L		75		.03	.15				X		S		T						1.5	
	GC18	X	X			C	1	L		93		.03	.12				X		S		T						1.8	
	GC20	X	X			C	1	L		100		.02	.1				X		S		T						2	
	GC30	X	X			C	1	L		200		.01	.08				X		S		T						3	
International Resistance Co. 401 N. Broad St. Philadelphia, Pa.	7300	X	X			C	10		100	100	5		to .25				2	X	B		T					1.5	.75	
	151	X	X			C	1		100	100	5		.5		125	3.5	X		B		T		X			.5	1.5	2
	5000	X	X			C	10		100	100	10	to .01	1		125	1.5	X		B		T					1.4	.5	
	5005	X	X			C	5		50	50	10	to .03	1		125	1	X		B		T					1	.5	
	7500	X	X			C	10		100	250	5	to .007	.5		125	3	X		B		T					1.6	.75	
	7505	X	X			C			100	125	5	to .01	.5		125	2	X		B		T					1.2	.75	
	1000	X	X			C	10		500	500	5	to .004	.5		100	4	X		B		T					1.9	1	
	1005	X	X			C	5		250	250	5	to .008	.5		100	3	X		B		T					1.3	1	
	1020	X	X			C	10		500	250	5	to .005	.5		100	2	X		B		T					1.3	1	
	1025	X	X			C	5		250	125	5	to .01	.5		100	1.5	X		B		T					.9	1	
	1215	X	X			C	15		500	450	5	to .003	.5		125	4	X		B		T					1.9	1	
	1220	X	X			C	20		1K	600	5	to .002	.5		125	5	X		B		T					2.2	1	
	8000	X	X			C	10		25	250	3	to .006	.2		125	3	X		B		T					1.2	.87	
	HD150	X	X			C	10		500	600	3	to .003	.25		100	5	X		B		T					2	1.5	
	HD155	X	X			C	5		500	300	5	to .006	.5		100	4	X		B		T					1.6	1.5	
	HD153	X	X			C	3		100	180	5	to .01	.5		100	3	X		B		T					1.2	1.5	
	H100MS	X	X			C	10		500	500	5	to .004	.5		125	4	X	X	B		T					1.87	1	
	H750MS	X	X			C	10		250	250	5	to .008	.5		125	3	X	X	B		T					1.6	1	

PRECISION POTENTIOMETERS (cont.)

	Type No. or Series	Potentiometer	Wirebound	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg. (S); Bush.Mtg. (B); Screw(SC)	P-C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Mil Type	Height (in.)	Width (in.)	Length (in.)	Dia. (in.)	Weight (Oz.)
International Resistance Co. (Continued)	H105MS	X	X			C	5		250	250	5	to .007	.5		125	3	X	X	B		T					1.3	.75	
	H755MS	X	X			C	5		100	125	5	to .01	.5		125	2	X	X	B		T					1.2	.75	
	HS750	X	X			C	10		250	250	5	to .006	5		125	3	X	X	B		T					2.2	.75	
	HS755	X	X			C	5		100	125	.5	to .01	.5		125	2	X	X	B		T					1.7	.75	
	7300	X	X			C	M		100	100	5		to .25		125	2	X		B		T					1.5	.75	
	H100MS	X	X			C	10		100	350	5		.5		125	4	X	X	B		T					1.8	1	
	H105MS	X	X			C	5		50	175	5		.5		125	3	X	X	B		T					1.3	1	
	H750MS	X	X			C	10		50	250	5		.5		125	3	X	X	B		T					1.6	.75	
	HS755MS	X	X			C	5		25	125	5		.5		125	2	X	X	B		T					1.1	.75	
	7501	X	X			C	1		50	25	5		1		125	1	X		B		T					.37	.75	
	8200	X	X			C	M		25	250	3		.2	100		3	X		S/B		T	M				1.2	.87	1.3
	151	X	X			C	1		15	100	5		.5		125	2.5	X		B		T		X				1.5	
Litton Industries Potentiometer Div. 226 E. 3rd St. Mt. Vernon, N. Y.	MD05	X	X			C	10	NL	60	30		to .015	to .04	100	125	1	X		S		T					1	.5	.6
	—	X	X	(dual)		C	3	NL		100		.01	to .05	100	125	1	X		S		T					1.5	.5	1.5
	MD09	X	X			C	10	NL	100	50	to .1	to .05	to .05	100	125	2.5	X		S		T						.9	
	—	X	X			C	20	L		10			.025	100	125	2.5	X		S		L					1.5	.9	2
	MCH11	X	X			C	10	L/NL		4		to .01	.035	100	105	2.5	X		S		T					2	1	2.5
	MS19	X	X			C	10		250	900	to .1	to .001	to .01	to 50	125	2.5	X		S		T					1.4	1.9	2.7
	—	X	X	(dual)		C	10	L		100		.005	.015	50	130	2	X		S		T					1.7	1.9	
	MD20	X	X			C	10		250	1.5K	to .1		.01	to 50	125	5	X		S		T					1.8	2	6
	—	X	X			C	10	L		2		.01	.01	100	125	5	X		S		T					2.6	2	
	MDU20	X	X			C	10		250	150	to .1		.01	to 50	125	2	X		S		T					.5	2	
	—	X	X			C	10	L		10			.02	100	125	2	X		S		T					.5	2	
	—	X	X			C	10	L		16.7		.008	.02	100	125	5	X		S		L					2.3	2	
	MD30	X	X			C	10		500	3K.	.1	.001	.006	to 50	125	8	X		S		T					2	3	14
	—	X	X			C	10	L		25		.004	.007	100	125	5	X		S		T					2	3	
	MJ19/20/30	X	X			C	10		10	.19	to 1	N	to .005	100	125	1	X		S		T						2	
	—	X	X			C	10			.05		N	.007	25	125	1	X		S		T					1.8	2	
	RC05	X	X			C	1		50	100	.1		.3	to 50	125	1.5	X		S		L/T					.5	.5	.2
	—					C	1	L		10		.09	.5	100		1.5	X		S		T					1.2	.5	.4
	RC09	X	X			C	1		50	125	.1	to .03	.15	to 50	125	2	X		S		T					.5	.9	.6
	—	X	X			C	1	L		20			.2	100	125	.9	X		S		T					.6	.9	.75
	RC11	X	X			C	1		100	160	.1	to .03	.1	to 50	125	2	X		S		T					.6	1	.8
	—	X	X	(6 gang)		C	1	NL		10		.2		100	125	1	X		S		T					3	1	
	RC18	X	X			C	1		100	250	.1	.02	.06	to 50	125	3.5	X		S		T					.7	1.7	
	RC20	X	X			C	1		100	300	.1	.02	.05	to 50	125	5	X		S		T					.7	2	3.5
	—	X	X	(3 gang)		C	1	L		3				100	125		X		S		T					3	2	
	RC30	X	X			C	1		500	600	.1	.01	.03	to 50	125	8	X		S		T					.7	3	
	—	X	X			C	1	NL		20		.04	.1	100	125	5	X		S		T					1.7	3	
	KC09	X			F	C	1	L	500	1K	10	N	.15	25	125	1.5	X		S		T					.5	.9	
	KC09	X			F	C	1	NL	250	100	10	N	.4			1	X		S		T					.5	.9	
	—	X			F	C	1	NL		5			.7		100	.5	X		S		L					.5	.9	
	KC11	X			F	C	1		500	1K	10	N	.1	25	150	1.5	X		S		T					.6	1.1	
	—	X		(dual)	F	C	1	L		10			.25	200	150	1	X		S		T					2.5	1.1	
	KC18	X			F	C	1	L/NL	500	1K	10	N	.05	25	150	3.5	X		S		T					1	1.7	
	—	X	(3 gang)		F	C	1	L		40			.15	400	150	1	X		S		T					2.6	1.7	2
	KC20	X			F	C	1	L/NL	500	1K	10	N	.03	25	150	4	X		S		T						2	
	—	X			F	C	1	NL		10			.15	200	150	2	X		S		T					2	2	
	KC50	X		(dual)	F	C	1	L/NL	500	1K	10	N	.01	25	150	6	X		S		T					1.9	5	
	—	X			F	C	1	NL		10		N	.01	250	150	5.5	X		S		T					1.9	5	
Logan Electronic Corp. 44 Breed St. E. Boston 28, Mass.	B5CP	X	X			C	1		10	250	2		.3		125	2	X		B		T		X			.6	.5	.25
	5SRP	X	X			C	1		10	250	2		.3		125	2	X		S		T		X			.87	.5	.25
	30SR	X	X			C	1										X		S		T		X				3	
	20SR	X	X			C	1										X		S		T		X				2	
	11SR	X	X			C	1										X		S/B		T		X				1.1	
Markite Corp. 155 Waverly Place New York 14, N. Y.	SL11/12	X			CP	C	1	L/NL	250	120	10	N	0.5		125	1.5	X		S		T					.6	1	.9
	SL15	X			CP	C	1	L/NL	300	150	10	N	.5		125	2.1	X		S		T					.7	1.4	1.8
	SL18	X			CP	C	1	L/NL	400	200	10	N	.5		125	3	X		S		T					.7	1.7	2.2
	SL20	X			CP	C	1	L/NL	500	250	10	N	.5		125	3.2	X		S		T					.7	2	2.7
	SL30	X			CP	C	1	L/NL	450	400	10	N	.5		125	5	X		S		T					.7	3	5.8
	BM/SM05	X			CP	C	1	L	100	30	10	N	1		125	.7	X		S		T/W					.5	.5	.1/.3
	BM/SM09	X			CP	C	1	L/NL	200	100	10	N	.5		125	1.4	X		S		T					.5/.7	9	.3/.6
	BM/SM11	X			CP	C	1	L/NL	250	120	10	N	.5		125	1.5	X		S		T					.5	1	.4
	BM14/14P	X			CP	C	1	L/NL	300	150	10	N	.5		125	2.1	X		S/B		T					.7	1.3	1.3
	BM/SM15	X			CP	C	1	L/NL	300	150	10	N	.5		125	2.1	X		S		T					.6	1.4	1.2
	BM/SM18	X			CP	C	1	L/NL	400	200	10	N	.5		125	3	X		S		T					.7	1.7	2
	BM/SM20	X			CP	C	1	L/NL	500	250	10	N	.5		125	3.2	X		S		T					.7	2	2.6
	BM/SM30	X			CP	C	1	L/NL	750	400	10	N	.5		125	5	X		S		T					.9	3	5.8
	9129	X			CP	C	1	L/NL	1K	600	10	N	.05		125	8	X		S		T					1.2	5	25
	NOTE: All SL Series Available in Sin-Cos																											
Maury Instrument Corp. 4555 W. 60th St. Chicago, Ill. 60629 (Continued on next page)	75M	X	X			C	1		50	100	5		to .2		135	2	X		B/S		T					.7	.75	.6
	87M	X	X			C	1		50	50	3		to .15		135	2	X		B/S		T					.7	.87	.7
	106M	X	X			C	1		50	50	3		to .1		135	2.5	X		B/S		T					.7	1	.8
	112M	X	X			C	1		50	50	3		to .1		135	2.5	X		B/S		T					.7	1.1	1

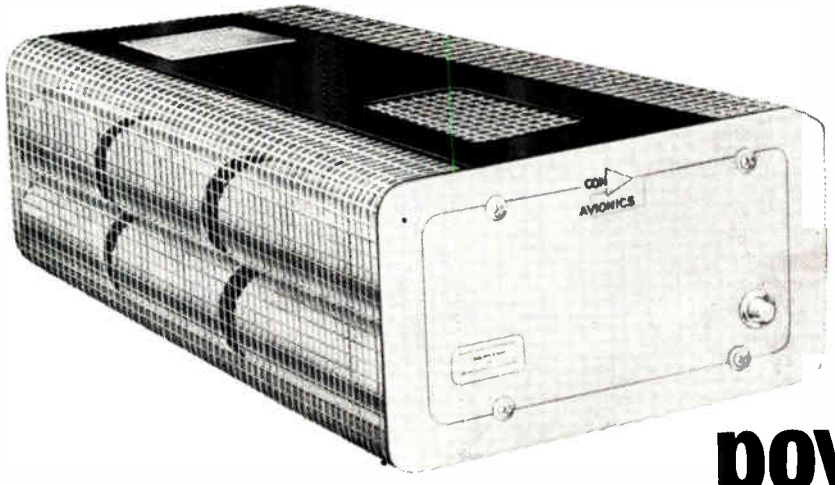
PRECISION POTENTIOMETERS (cont.)

	Type No. or Series	Potentiometer	Wirewound	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%) Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg. (S); Bush. Mtg.(B); Screw(SC)	P.C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Mil Type	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Maury Instrument Corp. (Continued)	131M	X	X			C	1		50	100	3		to .3		135	3	X		B/S		T					.5	1.3	1.5
	143M	X	X			C	1		50	100	3		to .1		135	3	X		B/S		T					.8	1.4	2.6
	162M	X	X			C	1		50	100	3		to .1		135	4	X		B/S		T					.8	1.6	3
	175M	X	X			C	1		50	100	3		to .07		135	4.5	X		B/S		T					.8	1.7	3
	200M	X	X			C	1		50	100	3		to .06		135	5	X		B/S		T					.8	2	4
	300M	X	X			C	1		50	100	3		to .06		135	7	X		B/S		T					.8	3	7
Mechotrol Div. Servomechanisms Inc. 1200 Prospect Ave. Westbury, L.I., N. Y.	11W	X			F	C	1		250	50	5	N	.5	300	200	2	X		B/S		T		X			.6	1	
	20W1	X			F	C	1		500	50	5	N	to .25	300	200	5	X				T		X			1	2	
Micro-Lectric Inc. 77 Gazza Blvd. Farmingdale, N. Y.	ML/MLU20	X	X			C	1	L	10	500	1		to .07		85	5			S		T					.9	2	
	ML/MLU20	X	X			C	1	NL	200	100			to .1		85	5			S		T					.9	2	
	ML/MLU11	X	X			C	1	L	10	200	1		.1		125	3			S		T					.75	1	
	ML/MLU11	X	X			C	1	NL	2K	50			.25		125	3			S		T					.75	1	
	ML9	X	X			C	1	L	10	100	3		.1		85	2			S		T					.68	.87	
	ML9	X	X			C	1	NL	2K	25			.5		85	2			S		T					.68	.87	
New England Instrument Co. Kendall Lane Natick, Mass.	55P	X			CP	C	1		1K	50	10	N	.75		100	.5	X		S/B		T					.65	.5	.5
	78P	X			CP	C	1		1K	50	10	N	.5		100	1	X		S/B		T					.65	.87	
	116P	X			CP	C	1		1K	50	10	N	.5		100	1	X		S/B		T					.65	1	
	156P	X			CP	C	1		500	20	10	N	.5		100	2	X		S/B		T					.62	1.3	
	158P	X			CP	C	1		1K	50	10	N	.5		100	2	X		S/B		T					1	1.6	
	300P	X			CP	C	1		1K	100	10	N	.5		100	5	X		S		T					.9	3	
	500P	X			CP	C	1		1K	100	10	N	.5		100	6	X		S		T					2.3	5	
	116W	X	X			C	1		100	150	5		.75	100	125		X		S/B		T					.8	1	
	176W	X	X			C	1		100	250	5		.5	100	125		X		S/B		T					.7	1.4	1.5
	158W	X	X			C	1		500	350	5		.5	100	125		X		S/B		T					.9	1.6	3
	200W	X	X			C	1		500	500	5		.4	100	125		X		S/B		T					1.2	2	4
	300W	X	X			C	1		500	750	5		.25	100	125		X		S/B		T					1.1	3	6
	200P	X			CP	C	1		1K	100	10	N	.5		100	3	X		S		T					1	2	4
	116FT	X			CP	C	1	L/NL	1K	20	10	N	.5			1.5	X		S		T					.5	1	
	176FT	X			CP	C	1	L/NL	1K	20	10	N	.5			2	X		S		T					.6	1.4	
	200FT	X			CP	C	1	L/NL	2K	20	10	N	.5			3.5	X		S		T					.6	2	
	55W	X	X			C	1	L/NL	100	50	5						X		S/B		T					.6	.5	.25
	SA/BA	X			CP	C	1		1K	10	10	N	1	100	125	1.2	X		S/B		T					.4	.87	
	SB/BB	X			CP	C	1		1K	10	10	N	.5	100	125	1.2	X		S/B		T					.4	.87	
	SC/BC	X			CP	C	1		1K	10	10	N	.25	100	125	1.2	X		S/B		T					.4	.87	
Peerless Instrument Co. 90-15 Corona Ave. Elmhurst, N. Y. 11373	311	X				C	1		10	20			.5		105	1.7	X		S/B		T		X			.67	.87	
	312	X				C	1		20	30			.5		105	2	X		S/B		T		X			.67	1	
	314	X				C	1		10	30			.5		105	2.7	X		S/B		T		X			.8	1.1	
	315	X				C	1		10	35			.5		105	3	X		S/B		T		X			.8	1	
	316	X				C	1		10	60			.3		105	3.5	X		S/B		T		X			.8	1.7	
	317	X				C	1		10	65			.3		105	4.5	X		S/B		T		X			.8	1.5	
	318	X				C	1		20	75			.3		105	5	X		S/B		T		X			.8	2	
	319	X				C	1		100	100			.3		105	7	X		S/B		T		X			.8	3	
	322	X				C	10		25	120			.25		105	3	X		S/B		T		X			1.5	.87	
	323	X				C	3		15	36			.3		105	1.5	X		S/B		T		X			1	.87	
	325	X				C	10		50	400			.25		105	8	X		S/B		T		X			2	1.8	
	326	X				C	3		15	120			.25		105	4.7	X		S/B		T		X			1.2	1.8	
	327	X				C	5		25	200			.25		105	6	X		S/B		T		X			1.4	1.8	
Precision Line Inc. 63 Main St. Maynard, Mass.	R6	X	X			C	1	L	100	30	5		.5	100	85	1	X		S		T		X			.65	.6	
	R9	X	X			C	1	L	100	50	5		.35	100	85	2	X		B		T		X			.37	.87	
	RP20	X	X			C	1	L/NL	5K	320	5		.5	100	85	1	X		SC		T		X			2	2	
	P16	X	X			C	1	L/NL	100	100	5			100	100		X		B		T					.9	1.6	
Roloro Corp, 61 Brightside Ave. E. Northport, N. Y.	SM18	X	(Slide-wire)			C	to 40		2	24	5	N	to .005	50		to 6	X		S				X			1.7	1.8	
	SM33	X	(Slide-wire)			C	to 40		4	50	5	N	to .002	50		to 9	X		S				X			2	3.3	
Samarius Inc. 300 Seymour Ave. Derby, Conn.	319	X	X			C	1		100	200	5		to .5	100	150	2	X		S/B		T		X			.5	.87	
	C050	X	X			C	1		1K	50	5		1			1.5	X		S/B		T					.5	.5	
	C078	X	X			C	1		1K	50	5		1			2	X		S/B		T					.5	.87	.5
	C116	X	X			C	1	NL	1K	100	5		1			2.5	X		S/B		T					.75	1	
	C158	X	X			C	1		1K	100	5		.5			4	X		S/B		T					.96	1.6	
	K175	X	X			C	1		5K	50	5		.5			3	X		S		T						1.7	4
	K200	X	X			C	1		5K	50	5		.5			4	X		S		T						2	4
	C178	X	X			C	1	NL			10		1			2.5			S		T						1.8	
	C300	X	X			C	1	NL			10		1			4			S		T						3	
	C200	X	X			C	1	L/NL	100	200	5		.5			4			S		T						2	
	HP500	X	X			C			1K	100	5		.5			12			SC/S		T					.6	5	
Spectrol Electronics Corp. 1704 S. Del Mar Ave. San Gabriel, Calif.	140	X	X			C	1		50	50		to .08	1	100	125	2	X		B		T		X			.3	.5	.1
	142	X	X			C	1		50	50		to .08	1	100	125	2	X		S		T		X			.6	.5	3
	162	X	X			C	10		100	50		to .02	.3		125	2	X		B		T		X			1	.5	1
	530	X	X			C	10		500	100		to .01	.25		105	3	X		B		T		X			1.4	.87	1.5
	100	X	X			C	1	L/NL	5	39	5	to .06	.5	100	105	2.7	X		B/S		T		X			.7	1.3	
	110	X	X			C	1	L/NL	5	30	5	to .07	.5	100	105	2	X		B/S		T		X			.47	1.1	
	120	X	X			C	1	L/NL	5	142	5	to .05	.5	100	105	2	X		B/S		T		X			.68	1	
	130	X	X			C	1		5	39	5	to .06	.5	100	105	2.7	X		B		T		X			.6	1.3	
	160	X	X			C	1		15	115	5	to .02	.5	100	125	2.5	X		B/S		T		X			1	.53	
	170	X	X			C	1	L/NL	5	49	5	to .06	.5	100	105	2.7	X		B/S		T		X			.7	1.4	

(Continued on next page.)

PRECISION POTENTIOMETERS (cont.)

	Type No. or Series	Potentiometer	Wirebound	Carbon (C); Cermet (CT); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Linear (L); Non-Linear (NL)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Noise (Ohms ENR)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg. (S); Bush.Mtg. (B); Screw(SC)	P.C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Miniature (M); Subminiature (S)	Mil Type	Height (In.)	Width (In.)	Length (In.)	Dia. (In.)	Weight (Oz.)
Spectrol Electronics Corp. (Continued)	190	X	X			C	1	L/NL	5	65	5	to .04	.3	100	105	3.5	X		B/S		T		X			.8	1.6	
	200 210	X	X			C	1	L/NL	5	65	5	to .04	.3	100	105	4.5	X		B/S		T		X			.8	1.7	
	230	X	X			C	1		5	350	5	to .03	.3	100	105	3	X		B		T		X			1	1.7	
	300/310	X	X			C	1	L/NL	5	85	5	to .04	.3	100	105	5	X		B/S		T		X			.8	2	
	400/410	X	X			C	1	L/NL	10	158		to .02	.3	100	105	7	X		B/S		T		X			.8	3	
	500 510	X	X			C	10	L NL	15	152	5	to .01	.25	100	105	3	X		B/S		T		X			1.5	.87	
	520	X	X			C	5		10	76	5	to .02	.25	100	105	2	X		B		T		X			1	.87	
	530	X	X			C	10		500	100	5	to .01	.25		105	3	X		B		T		X			1.4	.87	
	550	X	X			C	3	L/NL	5	45	5	to .03	.25		105	1.5	X		B/S		T		X			.9	.87	
	570	X	X			C	10	L NL	20	185	5	to .008	.25	100	105	3	X		B/S		T		X			1.5	1	
	700	X	X			C	1	L NL	5	109	5	to .07	.5	100	105	1.7	X		B/S		T		X			.68	.87	
	800	X	X			C	10	L/NL	20	519	5	to .004	.25	100	105	8	X		B/S		T		X			1.9	1.8	
	820	X	X			C	3	L/NL	15	119	5	to .02	.25	100	105	3.7	X		B/S		T		X			1.2	1.4	
	830	X	X			C	3	L/NL	15	155	5	to .01	.25	100	105	3	X		B/S		T		X			1.2	1.8	
	860	X	X			C	10		50	519	5	to .004	.25	100	105	8	X		B		T		X			2	1.8	
	870	X	X			C	10	L/NL	40	398	5	to .006	.25	100	105	6.5	X		B/S		T		X			2	1.4	
Subminioture Instruments Corp. 3236 Kansas Ave. Riverside, Calif.	560	X	X			C	1	L/NL	100	50	3		.5			2			S/B								.5	
	860	X	X			C	1	L/NL	100	200	3		.5			2			S/B								.87	
	960	X	X			C	1	L/NL	100	200	3		.4			2			S/B								1	
	1060	X	X			C	1	L/NL	50	250	3		.5			2			S/B								1	
	1160	X	X			C	1	L/NL	50	250	3		.4			2			S/B								1.1	
	1360	X	X			C	1	L/NL	25	300	3		.4			2.5			S/B								1.3	
	1460	X	X			C	1	L/NL	25	300	3		.3			2.5			S/B								1.4	
	1560	X	X			C	1	L/NL	10	400	3		.3			2.5			S/B								1.5	
	1660	X	X			C	1	L/NL	10	400	3		.2						S/B								1.6	
	1760	X	X			C	1	L/NL	5	500	3		.2						S/B								1.7	
	2060	X	X			C	1	L NL	5	750	3		.1			4			S/B								2	
	3060	X	X			C	1	L NL	5	1.5K	3		.1			6			S/B								3	
Technology Instrument Corp. 850 Lowrence Dr. Newbury Park, Calif.	PVR09	X	X			C	1	L/NL	200	50	5		to .25		125	1	X		S		T	M			.68	.9	1
	PVR11	X	X			C	1	L/NL	200	100	5		to .2		125	1	X		S		T				.68	1.1	1.2
	PVR15	X	X			C	1	L/NL	500	100	5		to .14		125	1.5	X		S		T				.87	1.4	3
	PVR18	X	X			C	1	L NL	500	100	5		to .12		125	1.5	X		S		T				.87	1.7	3
	PVR20	X	X			C	1	L NL	500	100	5		to .1		125	2	X		S		T				.87	2	4
	PVR30	X	X			C	1	L/NL	1K	200	5		to .06		125	3	X		S		T				.87	3	8
	D3-09	X	X			C	3	L/NL	1K	30	5				125	1	X		S		T	S			.68	.8	.7
	D5-09	X	X			C	5	L/NL	1K	50	5					1.2	X		S		T	S			.77	.8	.8
	D10-09	X	X			C	10	L/NL	1K	100	5					1.5	X		S		T	S			1	.8	1
	D20-09	X	X			C	20	L/NL	1K	200	5					2	X		S		T	S			1.4	.8	1.5
	D3-15	X	X			C	3	L/NL	1K	100	5					2	X		S		T				.8	1.6	2
	D5-15	X	X			C	5	L NL	1K	200	5					2.5	X		S		T				.9	1.6	2.5
	D10-15	X	X			C	10	L/NL	1K	400	5					3	X		S		T				1.1	1.6	3
	D3-20	X	X			C	3	L NL	1K	125	5					2.5	X		S		T				.8	2	2.5
	D5-20	X	X			C	5	L/NL	1K	250	5					3	X		S		T				.9	2	3
	D10-20	X	X			C	10	L/NL	1K	500	5					4	X		S		T				1.1	2	3.5
	RVBC2	X	X			C	1	L NL	100	150	5		.5		80	4	X		S		T		X		1.4	2	3
	TP09	X	X			C	1		50	20			2		125	2	X		B						.66	.87	
	TP11	X	X			C	1		50	20			1.7		125	2	X		B						.66	1	
	TP15	X	X			C	1		50	20			1.5		125	3	X		B						.66	1.4	
	TP18	X	X			C	1		50	20			1.2		125	3	X		B						.66	1.7	
	TP20	X	X			C	1		50	20			1		125	4	X		B						.66	2	
	P3	X	X			C	1		100	200	5		to .25		80	8	X		S						1.2	3.1	
Vaak Engineering Co. 129 E. "A" St. Upland, Calif.	RV R10	X	X			C	10		25	300	to .5		to .1		110	5	X		B		T				1.8	1.5	2.5
	RV R5	X	X			C	5		25	100	to .5		to .1		110	3	X		B		T				1.3	1.5	2.3
	RV/R3	X	X			C	3		25	100	to .5		to .1		110	2	X		B		T				1.1	1.5	2
	AV/A10	X	X			C	10		25	200	to .5		to .1		110	3	X		B		T				1.8	1	1.5
	AV/A5	X	X			C	5		25	100	to .5		to .1		110	2	X		B		T				1.3	1	1.3
	AV/A3	X	X			C	3		25	50	to .5		to .1		110	1	X		B		T				1.1	1	1.2
	750	X	X			C	10		25	200	to .5		to .1		110	2	X		B		T				1.2	.75	.5
	750	X	X			C	5		25	100	to .5		to .1		110	1.5	X		B		T				1.2	.75	.4
Vogue Instrument Corp. 129-11 18th Ave. College Point, N. Y.	106S	X	X			C	1-20	L	1/2	6	5	N	.01	50		2	X		S		T		X		1.5	1	
	181S	X	X			C	1-40	L	2	30	5	N	.005	50		6	X		S		T		X		1.7	1.5	
	331S	X	X			C	1-40	L	4	50	5	N	.002	50		9	X		S		T		X		2	3.3	
	20S	X	X			C	1	L	2	100	5	N	.02	50		.5	X		S		T		X		1.2	2	
	E10	X	X			C	10		500	75	5		.15			3.7	X		SC						2	1.8	
	E3	X	X			C	3		500	75	5		.15						SC						1.3	1.8	
	E1	X	X			C	1		50	40	5		.75						B								
Waters Mfg. Co. Boston Post Rd. Wayland, Mass.	WPM	X			F	C	1		1K	1K	10	N	3		150	2	X		B		T	S			.6-1.3	1/2	
	JP/2	X	X			C	1		10	20	5		3	140	150	2	X		B		T				.25	.5	
	PT-3/4	X	X			C	1		10	20	5		3		105	1.5	X	X	B		T				.4	.75	
	RT	X	X			C	1		10	250	5		3	140	125	3	X	X	B		T				.4	1	
	AP1-1 16	X	X			C	1		25	300	5		2	140	125	4	X	X	B		T				.5	1	
	AP1-5 8	X	X			C	1		25	500	5		2	140	125	5	X		B		T				.5	1.7	
	AP2	X	X			C	1		100	500	5		.5	140	125	6	X		B		T				.9	2	
	WP-1/2	X	X			C	1		10	100	5		1	100	125	2	X	X	S		T	S			.5	.5	
	WP-7/8	X	X			C	1		10	250	5		1	100	125	3	X	X	S		T				.6	1	
	WP1-1/16	X	X			C	1		25	300	5		1	100	125	4	X		S		T				.6	1	
	WPSC1-1/8	X	X			C	1	NL		20	5			100	125	4	X		S		T				.7	1.1	
	WP1-5/8	X	X			C	1		25	500	5		.5	100	125	5	X		S		T				1	1.7	
	WP2	X	X			C	1		100	500	5		.5	100	125	6	X		S		T				1.3	2	
Weston Instruments, Inc. Archbald, Penna. 18403	349-62	X	X			C	10		1K	1K	5	to .004	.25	100	105	3	X		B		T				1.4	.85	
	341	X	X			C	10		1K	200		to .008	.5	100	140	2.5	X		S/B		T		X		1	.5	10 gm



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Regulation: (Line and load combined) ±0.05%
Ripple: 1 mv RMS max.
Response time: 25 microseconds
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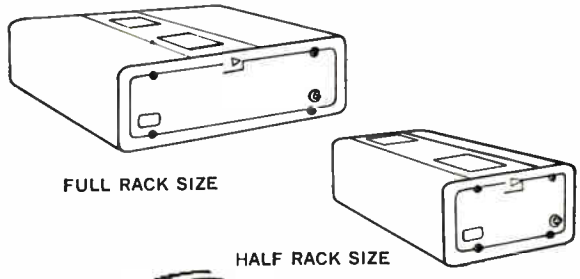

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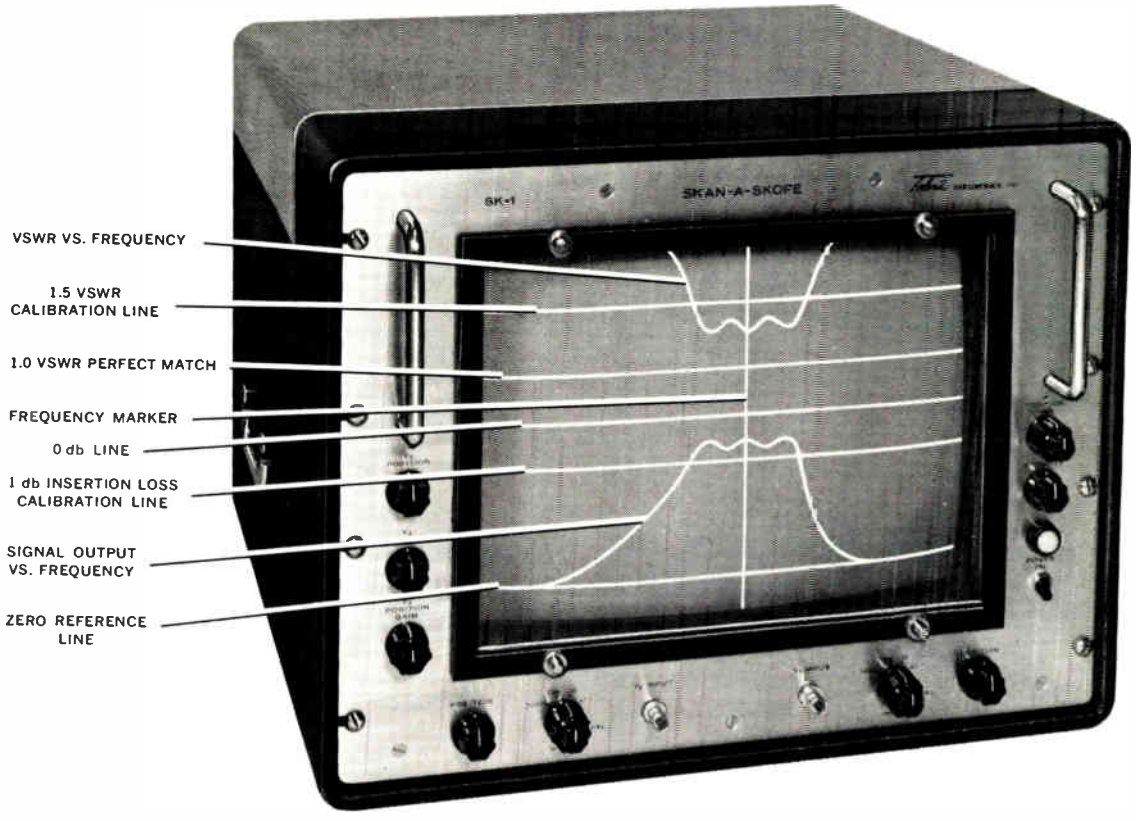

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SKAN-A-SKOPE accepts three Y inputs, one X input and one marker input.

SPECIFICATIONS

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Deflection Factor (Y_1 & Y_2) Inputs	.1 mv/cm, 10 mv/cm, 100 v/cm, 1 v/cm Switch selected 10:1 cont. adj.
Bandwidth	DC to 10 kc (3 db point)
Deflection Factor Y_3	.25 mv/cm
Bandwidth	DC to 10 kc
Reference Line Y_4 & Y_5	May be positioned at any vertical position to identify signal levels.
X Input	Medium gain DC coupled
Deflection factor	100 mv peak-to-peak/cm
Marker Input	Used with pulse or birdy type markers
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CRT	17" Rect.
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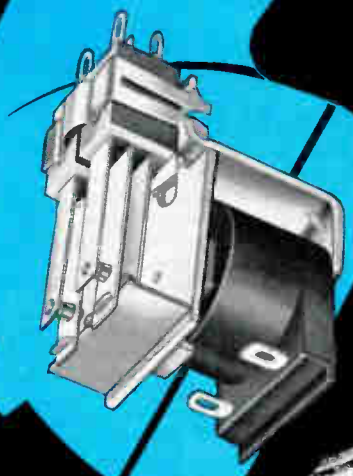

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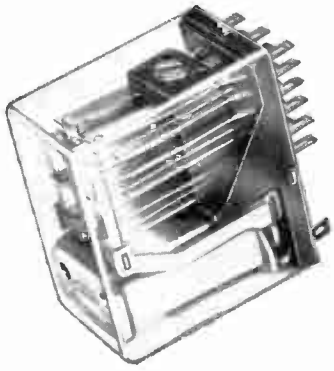

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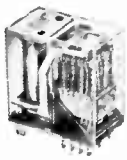

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Where transistors required 8 to 12 tests, integrated circuits require 25 to 50, and the trend is toward even more. At the same time, it is becoming increasingly important to determine operation of IC's under dynamic conditions.

By **EVERETT HANLON** Apparatus Division, Texas Instruments Incorporated, 3609 Buffalo Speedway, Houston, Tex.

The Broad Aspects of Testing

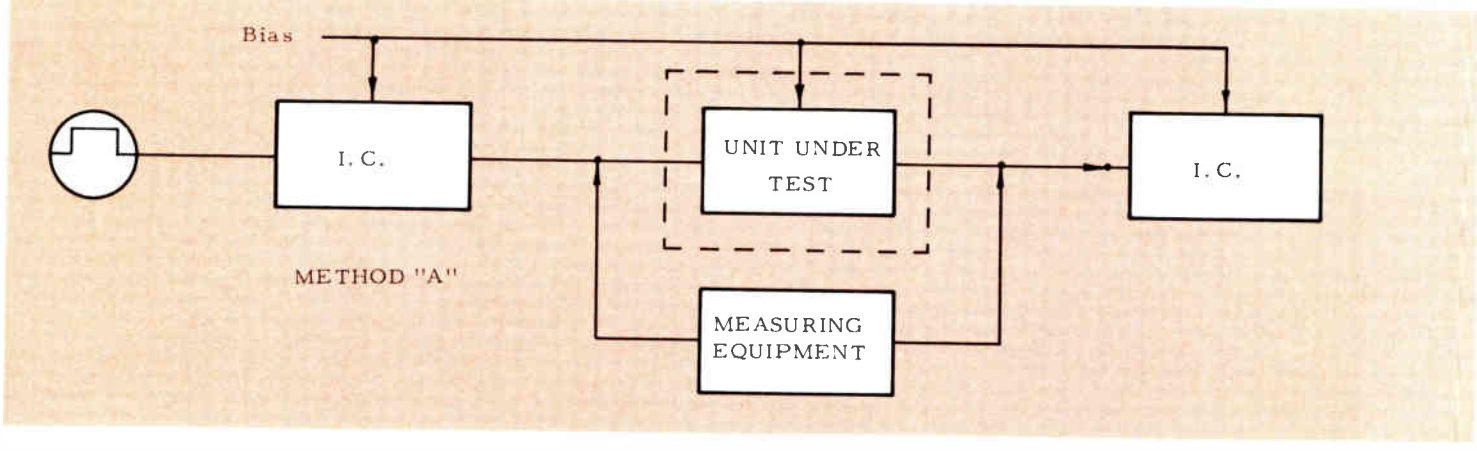
THE UPSURGE OF INTEREST in integrated circuits has brought into focus certain testing problems which were bypassed or ignored by suppliers and consumers of discrete components. With discrete components, the main interest is in parameter tests which defined basic characteristics of the device. This is true because the device type may have many end uses, and mathematical relationships must be used to design the component into its end use circuit. This circuit, in turn, is then functionally tested under its own operating conditions.

With integrated circuits (ICs) testing must be done on the completed circuit. Even if parameter information were obtainable, it would be of little value, since the information needed must now be functional.

All tests performed on semiconductor devices can be broken down into two broad groups. The first, static testing, involves the application of stimuli and measurement of responses which are dc in nature. This means, for example, that a 100 KC rated device should be tested with one to 10 msec. duration stimuli to be truly a static test. Dynamic characteristics, again in the most broad sense, are those which are measured with stimuli and responses which periodically or continuously vary with a period closely approximating the rated operating characteristics of the device. For example: propagation delays of ICs specified for 10 MC use should be measured at a 10 MC repetition rate.

Dynamic testing, therefore, may be generally defined as testing methods which closely simulate the operating conditions. Two methods often used in dynamic testing are shown in Fig. 1. Method "A" provides test results which are related to the operation of the unit under test in a typical system. This requires that the device under test be supplied with a dynamic stimuli (or driving source) which may be an actual IC. In this fashion the source impedances, driving levels, etc. will be those found in actual operation in the end system. Similarly, the output of the device under test supplies a response which is used to drive another IC, which supplies the proper load impedances, fanouts, etc.

Method "B" provides measurements under specific conditions of loading and driving source impedances, levels, etc. Measurements taken this way are more akin to the parameter tests made on transistors. To fully characterize a device under test, both methods must be used. While static testing can produce much data regarding the characteristics of the transistor or IC under test, attempts to correlate this static or dc information with dynamic characteristics (such as switching time) are doomed to failure. Consider the 3 input



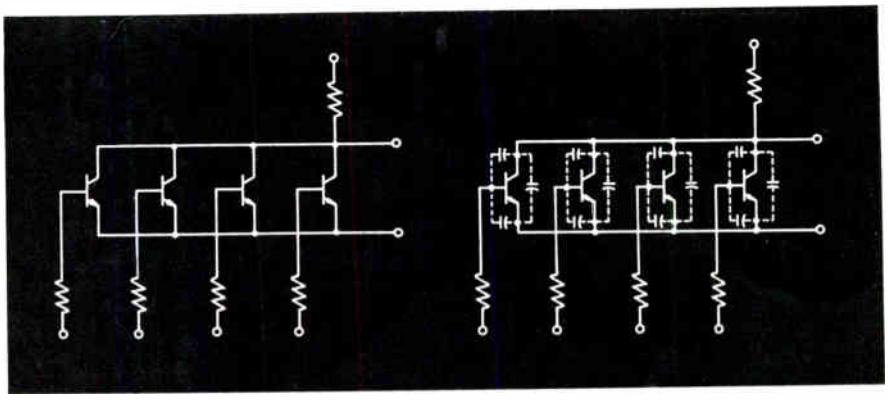


Fig. 2: In this 3 input Nand/Nor device the solid lines for internal structure may be considered for dc and static conditions. Broken lines must be considered for any type of switching or transitional measurements.

Integrated Circuits

NAND/NOR in Fig. 2. While the basic circuit shown with solid lines describes the internal component structure of this IC for dc and static logic considerations, the capacitance (shown with dash lines) must be considered for any type of switching or transitional measurement.

One of the most important characteristics of an IC is noise immunity. This must be spelled out by the device maker for each logic type and continuously monitored by quality assurance so that the user may correctly design his equipment, and have confidence in parts interchangeability. In a flip flop, for example, noise immunity can be considered as the maximum signal which can be applied to the input without causing the device to change states. Noise immunity can follow a curve similar to the approximately exponential one shown in Fig. 3. Increased immunity results from decreasing the smaller applied pulse widths, under constant amplitude conditions. Immunity is at a minimum under applied dc conditions. We see this from the fact that the IC requires a certain minimum amount of energy to trigger, and therefore the internal stray capacitances must be charged before triggering can take place. If only the static noise immunity were considered, the impact would be over-design for transient input noise considerations and reduction of fan-in and fan-out capabilities.

Another example of the dangers of trying to correlate static measurements with dynamic characteristics is in noise feed-through. As shown in Fig. 5, this may be considered the amount of "leakage" through an AND gate when one of its inputs is held at the "off" condition and an "on" signal is applied to the other input. Since the IC contains reactive as well as resistive elements, the output will contain the positive and negative spikes shown in Fig. 4B, rather than the simple dc response shown in Fig. 4A. These noise spikes can potentially be large enough and contain enough energy to trigger the following stages. Therefore, the ability to test for these dynamic characteristics is vital to both supplier and consumer.

Dynamic Measurements

The importance of familiar switching time measurements of delay, rise, storage, and fall time are well established in transistor measurements, and methods and equipment for making these are well known. While much of this technology can be carried over into IC dynamic measurements, there are many areas which are new. For example, the decision points for measuring rise time are specified in terms of percentage as in Fig. 5A. Occasionally, though much more rarely, the decision points may be specified in terms of absolute voltage rather than percent, as in Fig. 5B. This last could be considered as a functional test, since the

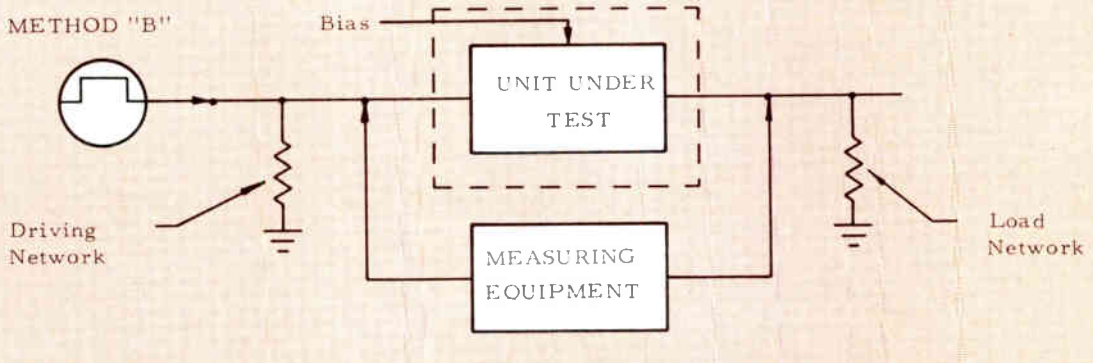


Fig. 1: Two methods used in dynamic testing ICs. "A" (left) gives results for operation under typical use. "B" (right) is for specific operating conditions.

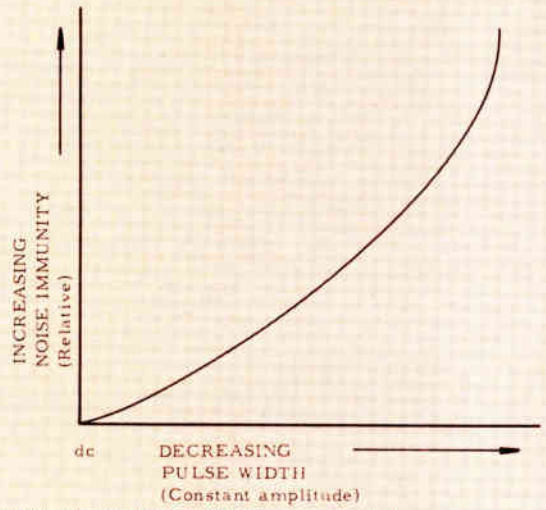


Fig. 3: Noise immunity can follow an exponential curve.

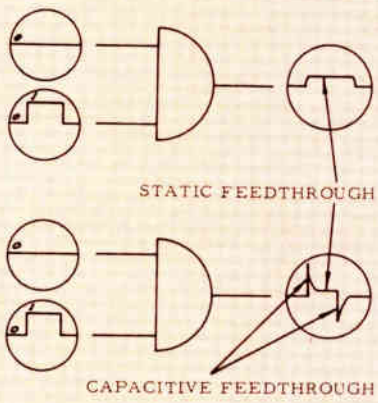


Fig. 4: ICs will have noise spikes instead of pure dc.

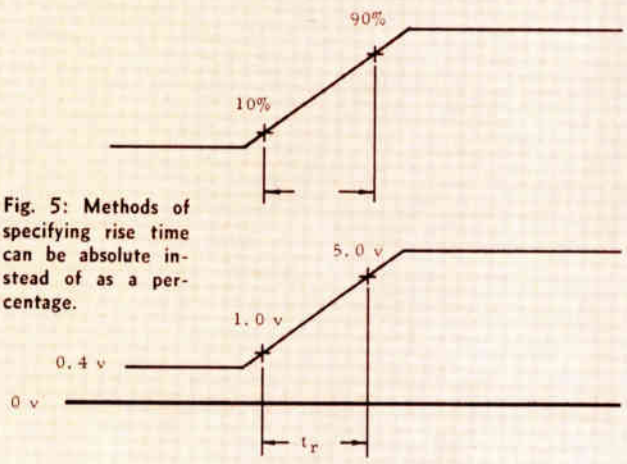


Fig. 5: Methods of specifying rise time can be absolute instead of as a percentage.

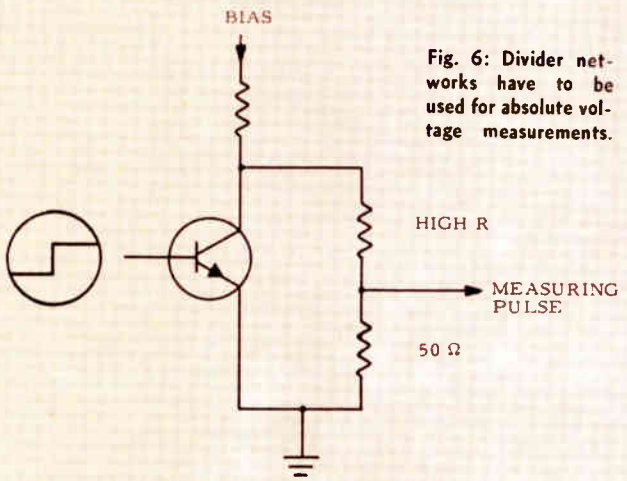


Fig. 6: Divider networks have to be used for absolute voltage measurements.

TESTING ICs (Continued)

interest is in how well the transistor will operate at a voltage level in a particular circuit, not in what its relative operation will be for general purposes.

Measurement in terms of absolute voltage rather than percentage is much more difficult to make with any degree of accuracy, because dc stabilized measuring equipment must be used. DC stabilization can be achieved if low input impedance measuring equipment is used. However, this requires the use of divider networks as shown in Fig. 6. For ICs a low input impedance can provide an intolerable loading condition on the integrated circuit, and the use of a divider string to provide the needed high impedance will so seriously attenuate the output signal, that what little signal is available to the measuring equipment is obscured by noise. It is therefore very important in the measurement of switching characteristics of ICs that high input impedance measuring equipment with effective dc stabilization be used.

Some ICs pose further complication to the time measuring problem, as in Fig. 7. In this case the measurement t_r is referenced to both percentage and voltage. This requires equipment capable of starting the measurement of time at a percentage point, and ending the measurement at an absolute voltage point.

There are two basic types of dynamic tests which must be done to fully characterize an IC. These are shown in Fig. 1. Where medium to large volumes of circuits are involved, either by a manufacturer or by a user, there are severe restrictions imposed on the test equipment. The dynamic performance components on the input and the output of the device under test must be changed automatically from one set of measurements to the next. To achieve this with automatic sequential test systems, switching methods must be used as shown in Fig. 8. Anything which is added to the input and output of the device under test will also add more stray capacitance to the unit under test. Not only will this tend to introduce errors in any dynamic measurements, but also, where T^2L or emitter-coupled logic is being tested, the device may well fall into self-oscillation when dc power is applied. Such oscillations make both static and dynamic measurements unusable. It is therefore extremely important that great care be taken in the design of the switching station with regard to stray capacitance. At the same time, we must maintain the flexibility to switch in the dynamic performance components at the proper time.

In addition to performing straight forward dynamic measurements it is also vital that compound dynamic and static measurements be made. For example, to design and produce any type of computer equipment the amplitude, duration, and nature of any transients introduced into the dc power supply lines by a logic element must be known. As shown in Fig. 9 this means that the testing facility be capable of performing dynamic measurements under dc conditions as in A, and

also be able to measure dc or static conditions (i.e., current drain) with pulse stimuli applied to the input (as shown in B).

Economics

More tests are needed to characterize a device than for transistors. Where from 8 to 12 tests did the job for the transistor, ICs appear to average between 25 and 50, and the trend is upward. Due to the capital equipment requirements for the handling of even a modest volume, the single manual test-set approach, adequate for transistor testing, is prohibitive. Assuming a minimum number of tests, 50% of which were dynamic, an investment of $100,000 would be a practical minimum. Sequential automatic test systems with a dynamic testing capability are therefore essential.

Another aspect is that for the user who requires special testing and/or requires data on test results, indications are that the IC manufacturer is forced to charge an extra $.25 to $3.00 per device. On this basis, alone, even a modest volume will very quickly justify automatic dynamic test equipment.

On the other hand, the manufacturer who wishes to be more competitive can very quickly reduce his own internal testing cost in both the final test and the quality assurance areas, as well as improving accuracies and yields by the reduction in guard bands. Manufacturing time is reduced, therefore reducing inventory, and drastically reducing handling problems involved with multiple test equipments.

Simply analyzing present trends in the IC field show directions where future dynamic test systems must develop capabilities: testing linear functions, with constantly increasing frequency requirements; environmental testing; increasing numbers of active leads; automatic handling and sorting; and increasing complexity of testing routines. In fact, it is not beyond comprehension that the industry may see dynamic test systems capable of not only component test, but complete system checks. It is interesting to speculate on the possibility of a centralized system capable of coordinating and directing incoming tests, quality assurance tests, and final system checkout, all in one facility, using one centralized data processing system.

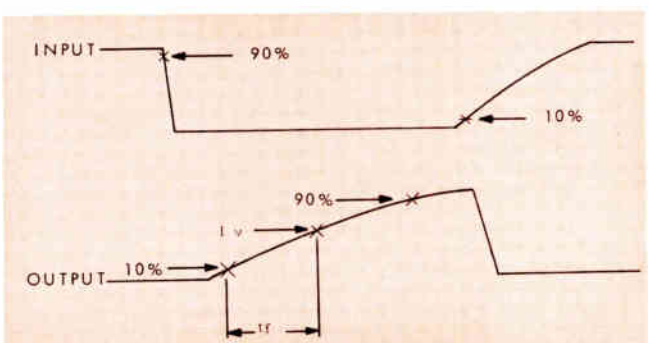


Fig. 7 (above): Some ICs pose complications to time measuring.

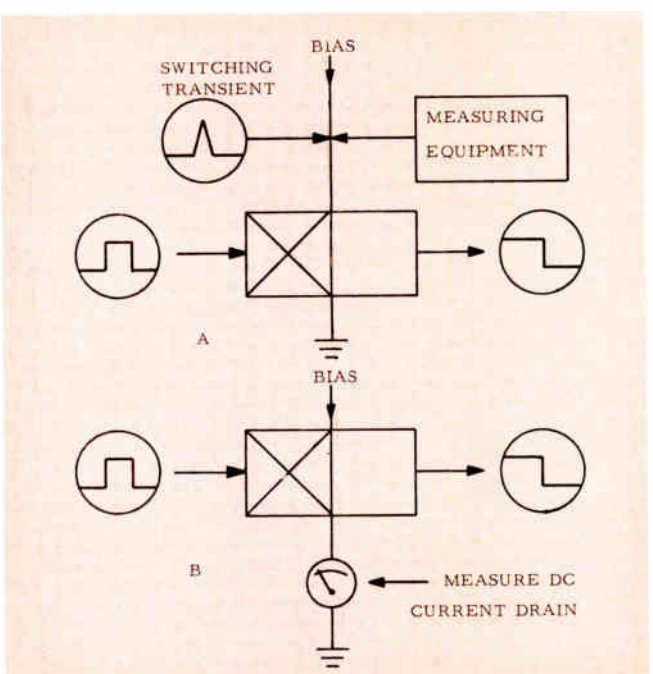
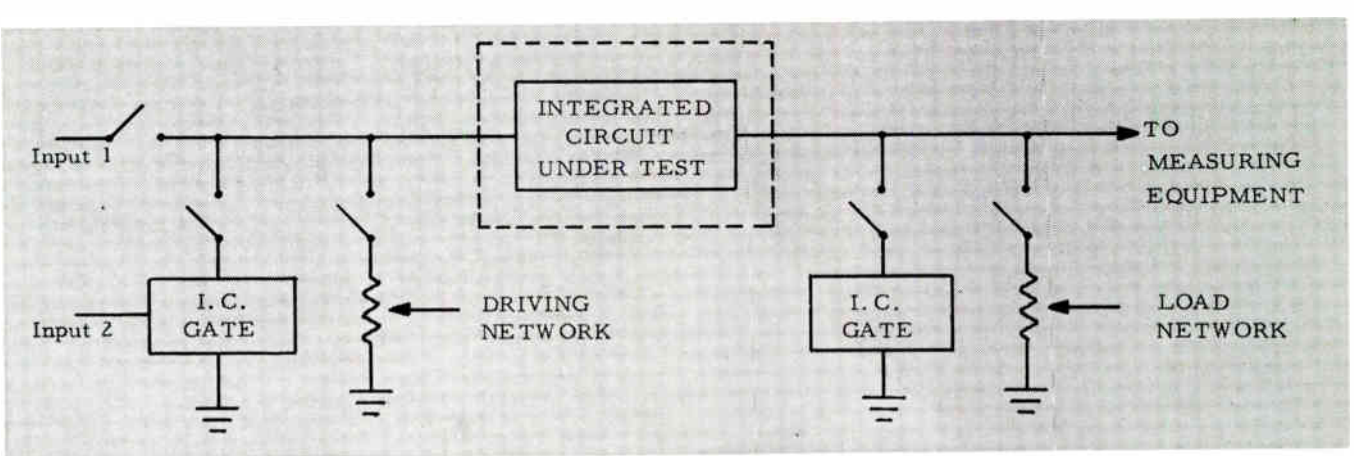


Fig. 9 (right): It is vital that compound dynamic and static measurements be made. Tester must be able to do both.

Fig. 8 (below): For dynamic testing, the tester must be changed automatically from one set of measurements to another.



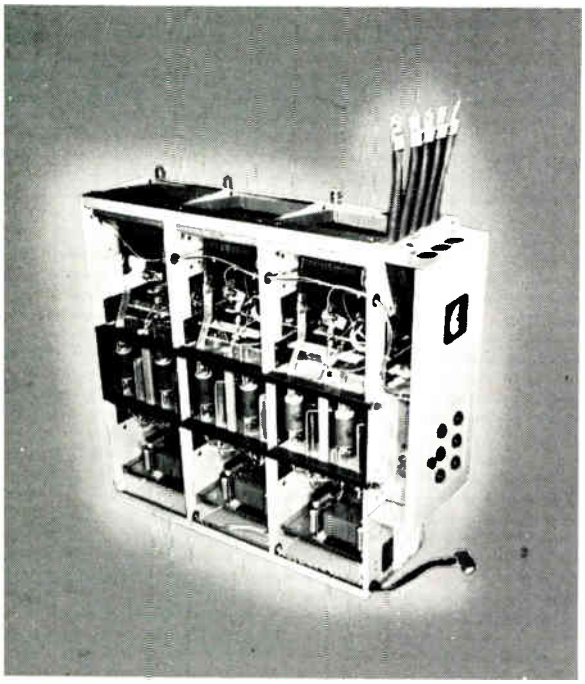


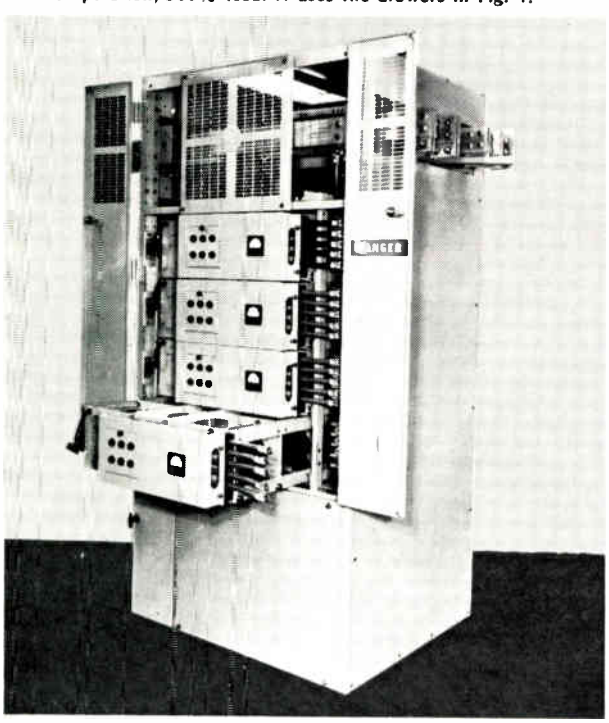
Fig. 1: Modular drawer style case is used for SCR dc drive.

USING SCR's IN POWER CONTROL SYSTEMS

The use of silicon semiconductors in industrial power control has been expanding rapidly. They offer reliability, reduced installation costs, low maintenance, and competitive initial costs. Here we describe methods of using SCR's and some pitfalls to avoid.

THE BASIC BUILDING BLOCK of most power control systems is the silicon rectifier, available in single junction devices through 275 a and voltages at 2,000 v. Control elements in these systems are generally either thyristor controlled rectifiers (SCR's), available through 400 a and 1,200 v, or silicon power transistors, with ratings approaching 100 amps and 300 volts. For the purposes of this article, we will limit the discussion to SCR's.

Fig. 2: This modular case group can supply 100 hp screwdown motor for forward and reverse operation, double operation, 300% load. It uses the drawers in Fig. 1.



Perhaps the most far-reaching use of thyristors is for motor speed controls. The need for variable speed operation, is a long-established one.

The thyristor power supply for large systems is of the modular concept. The basic building block of this module is a unidirectional bridge type converter in a six-phase double-way circuit. Each bridge contains three sections with two diametrically opposite bridge legs per section. In each bridge leg there are two thyristor cells, with protective components, including current limiting fuse, transient and steady state voltage balancing circuits, and voltage limiting devices, plus a balancing reactor and gate pulse distribution transformer circuits. The basic bridge is built into a draw-out case (Fig. 1). Several of these are assembled into a common power unit (Fig. 2). These may be assembled into structures containing the regulating and control cubicle and thyristor circuit breaker cubicle. These are then paralleled to provide the required horsepower rating. For reversing a dual converter approach is used (Fig. 3).

Device Protection

Great care is given to providing protection for the SCR devices. Voltage capability of each bridge leg is 2.5 to 3 times the RMS input voltage. Selenium voltage suppressors are used for fairly slow rising, high energy transients, as well as R-C suppression for fast rising spikes. Discharge of the R-C network presents the thyristor with a high rate of rise of current. Proper gate drive, coupled, with device selection, eliminated the dangers of this problem. Also, the rate of rise of forward blocking voltage *(dv/dt)* has been limited to established ratings. Limiting is done by adding a small series L. This also helps the *di/dt* by delaying the rise

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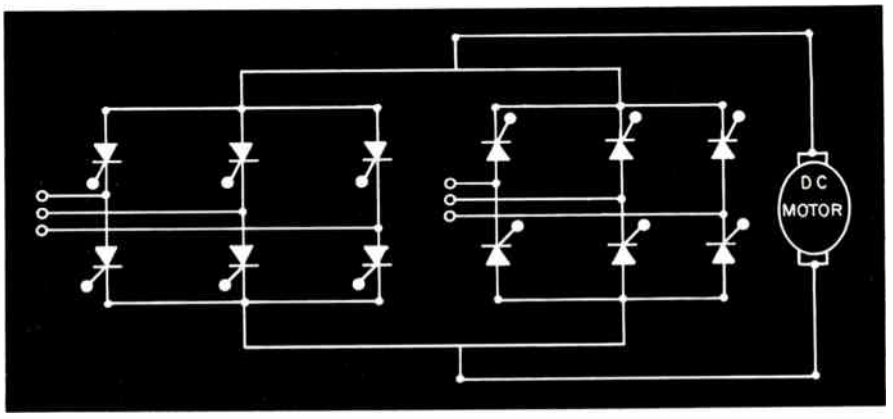


Fig. 3: A basic circuit dual converter for reversing drives.

of anode current. Current limiting is provided in the circuit to protect the thyristors.

Looking for a moment at lower power uses such as the portable tool or universal motor drive, the circuit in Fig. 4 is widely used. Limitations are that the SCR must carry load current during both halves of the cycle, and commutation time is very short. With even a slightly inductive load under phased back conditions, there is a good chance that the device will not recover its forward blocking characteristic.

We have discussed dc motor drives. However, the most promising area lies in the control of ac motors. Variable speed operation of a squirrel cage motor has the advantages over dc motors of almost maintenance-free operation, no brushes or commutator to worry about. Such control can and is being done in several ways.

Inverters

The first of these methods is the variable frequency inverter. The basic circuitry is as shown in Fig. 5. In the parallel inverter, the advantage lies in the small number of devices, but also presents the disadvantage of the off device seeing twice the supply voltage. The parallel inverter applied alternating square waves to the primary of the center tap output transformer. Essentially, the same output is provided by the bridge inverter (Fig. 6). This circuit uses twice the devices, but the blocking voltage per device is less. Either circuit has the disadvantage of possible short circuits across the supply should the commutation time provided not be enough.

The bridge inverter is useful where an output transformer is not required.

Both of these basic circuits have been proven in polyphase circuits. For high efficiency, extensive filtering must be used to eliminate harmonics. One possible disadvantage of the variable frequency inverter system is that when ac is the available source, a dc link must be provided, thus entailing the addition of a power converter to change the input ac to dc.

In most systems, an ac source is available for frequency transformation. Here the cycloconverter approach can be taken for speed control.

This approach involves converting an ac power source to some lower frequency. The practical minimum ratio is about 3:1 in frequency. A typical circuit for one-phase is shown in Fig. 7. By selective firing of the SCR's, the output develops a lower frequency envelope. The logic for this circuit is rather complex and the output has a high ripple content. While this reduces efficiency, particularly as the supply frequency is approached, it will do the job. One example of the envelope developed in changing from 1,200 CPS input to a 400 CPS output is shown in Fig. 9. Frequency transforms from 60 to 20 CPS and below have use in mill auxiliaries.

Device needs are about the same in inverter and cyclo-converter uses with one major exception. Since the cyclo-converter is, in effect, a natural commutation

Fig. 4: Full wave dc output.

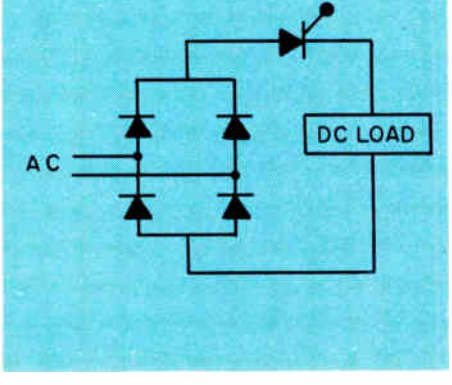


Fig. 5: A basic parallel inverter.

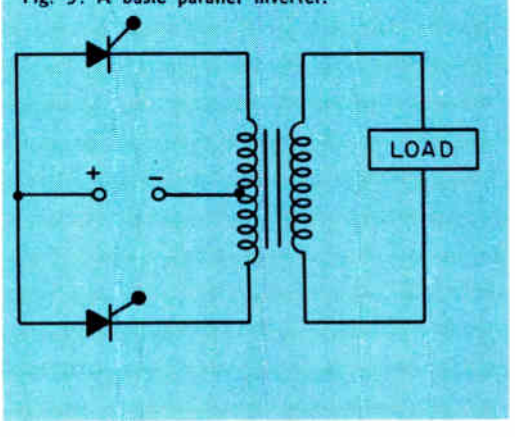
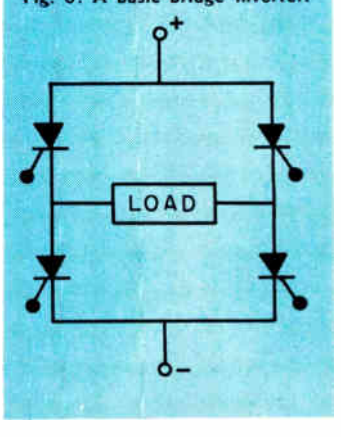


Fig. 6: A basic bridge inverter.



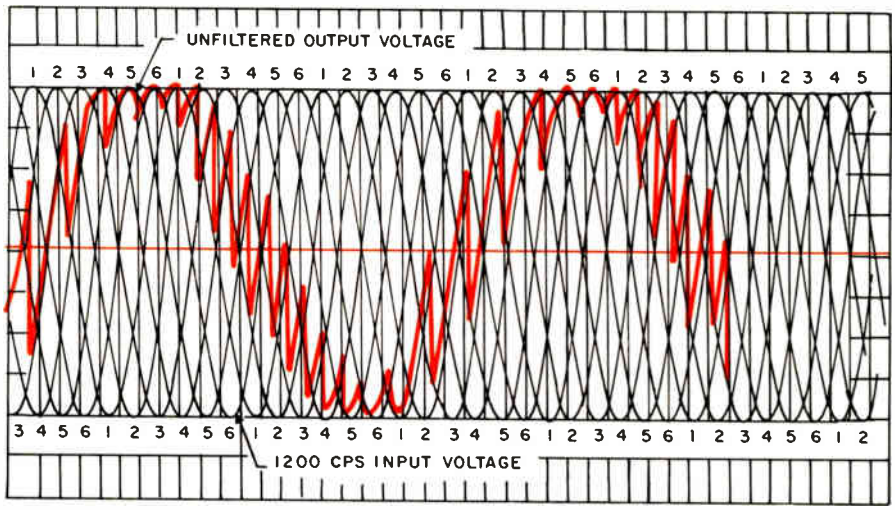


Fig. 8: The theoretical unfiltered output supplied by the circuit shown in Fig. 7.

SCR POWER CONTROL (Continued)

system, turn-off time is not critical. This is not true with inverters. For industrial systems, high voltage, high *dv/dt* ratings, and high *di/dt* ratings are needed for both systems. In making a choice as to which to employ, there is no simple answer. If ac is available, the cyclo-converter may be better. The increased complexity of cyclo-converter logic must be balanced against the addition of a dc link for the inverter. If the source is dc, the inverter approach is the obvious one.

The economy of ac drives vs. dc drives is continually being evaluated. Present feeling is that the complexity of ac control is not justifiable below the several hundred horsepower range. If this is true, dc drives will be with us for some time.

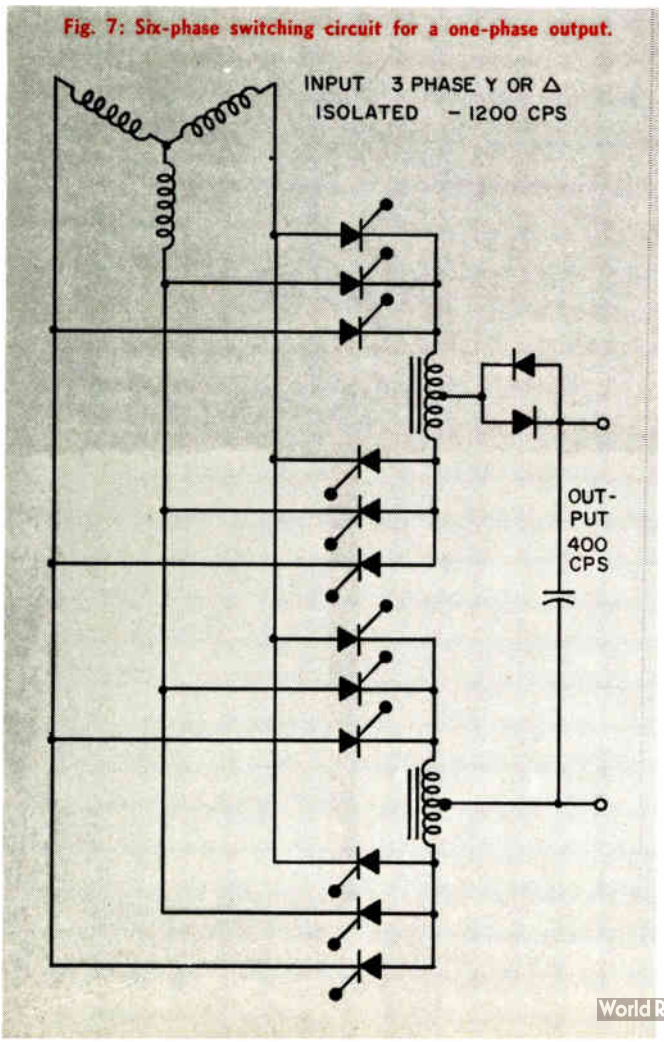


Fig. 7: Six-phase switching circuit for a one-phase output.

Expanding further on ac motor control, the simple inverse parallel connection can be used for low starting torque loads, such as fan and blower motors, and for compressor motors where an unloading clutch is provided. Simple reduction of RMS voltage input to the motor results in a so-called "soft start."

Static Loads

While some of the more dramatic advances being made in power semiconductors are in motor drives, much is also being done with static loads.

For ac loads the most common circuit is that of Fig. 9, the inverse parallel connection. Another useful circuit for ac loads is shown in Fig. 10. This is called the blocked bridge and may in some cases prove cheaper than the inverse parallel circuit. Device limitations are similar to those for the circuit of Fig. 4.

The bulk of the devices applied so far in industry fall into the category of proportional ac control for furnaces and ovens, light dimmers, plating supplies, battery chargers and general purpose dc supplies.

The light dimmer used in studio lighting was one of the first volume applications of thyristors. The first inkling of critical *dv/dt* needs was found here. For economy, elaborate protection schemes were out. Proper device selection solved the problem.

Furnace or oven control by means of thyristors is attractive. The simple inverse parallel setup is normally used. Feedback signals from the oven can be amplified to provide a firing signal for the SCR. Since response time of the SCR is one-half cycle in this natural commutation type of circuit, very close control of temperature may be kept. This control has been applied to in-line process furnaces where several heating zones are maintained. These are also used in the automotive industry for paint curing ovens.

High current plating supplies are now being built with SCR's in the primary, which eliminate the normal saturable reactor. This has been made possible by high voltage, high current SCR's which allow operation from 480 v supplies.

Battery chargers are a good field for thyristors. They are used as power converters on the secondary side of

a transformer, with control feedback for a regulated output. Very high current chargers are used in the telephone industry for central office battery charging. Units have been built with secondary control up to 1600 a. However, the high cost of system construction and a need for conserving space have led to the development of primary controlled battery chargers for the higher current levels.

Recent work in the field of transient operation of thyristors has caused interest in the replacement of ignitron tubes in spot welder controls. Because of the transient thermal traits of the thyristor, short duration pulses of very high amplitude can be tolerated.

With high level transient operation, where thermal excursions are great, the thyristors used must be free from thermal fatigue. This means that the devices should be either hard soldered or compression bond encapsulated.

Device Limitations

Throughout this dicussion, several device characteristics or limitations have been repeatedly mentioned. These include *di/dt*, *dv/dt*, voltage transients, and proper gate firing. It would be useful to enlarge on these.

Somewhat more than 50% of all device failures can be traced to a single phenomenon, *di/dt*. This consists of a downgrading of forward blocking ability or, in extreme cases, a complete short circuit of the device. This characteristic is associated with the turn-on mechanism of the thyristor. When a small gate signal, near the minimum turn-on specification, is used, only a small fraction of the device close to the periphery of the gate is turned on. There is a finite time which must elapse before the balance of the junction turns on. If the load circuit is such that the rate of rise of anode current is very rapid during this turn-on time, all the load current is forced through a small portion of the device area.

If this is high enough an immediate burn-through of the crystal may occur. Another aspect of this problem is that with an applied *di/dt* somewhat less than the destructive rating, some damage can occur to the device and cause a gradual downgrading of voltage blocking capability. A system can operate in a satisfactory mode for several hours, days or even months, and then suddenly, for no apparent reason, fail.

Solutions to this problem are available. Ratings have been set which will allow continuous safe operation of the device. Secondly, methods for protecting the device against excessively high *di/dt* have been developed.

Of these, the single most important method is to apply a proper gate signal to the device. Minimum gate current and voltage to fire, as listed on the manufacturer's sheet, should not be used in designing firing circuits when it is known that high circuit *di/dt*'s are present. This occurs, for example, when firing SCR's in the primary of a transformer. Thyristor makers have firing recommendations available.

Along with proper firing, it has been possible in some cases to introduce some inductance which delays the rise of anode current for a long enough period to allow more of the crystal area to be turned-on. This reduces the current density and peak power dissipation.

The critical rate of rise of forward blocking voltage (*dv/dt*) is important in nearly all high power applications. This parameter measures the ability of the device to withstand forward blocking voltage applied at a specific rate, at some point in time, after the device has stopped conducting forward current. This is associated with the turn-off time of the device, which is very important in forced commutated circuits. The *dv/dt* ratings of 200 v/μsec and higher are available from device manufacturers coupled with turn-off times for low power devices of around 10-12 μsec and in the higher power devices, around 20 μsecs.

The *dv/dt*, per se, does not cause failure, nor does two terminal breakdown. In both cases, *di/dt* is the culprit. Due to junction capacitance, *dv/dt* causes a current to flow in the device, which reaching enough magnitude, can cause device turn-on. If the *dv/dt* is slightly above the critical *dv/dt* of the device, a low level current will flow. This will just barely trigger the device, and cause a situation similar to that found when minimum gate current is supplied. Thus, on circuits where in-rush current is not limited, a very high peak dissipation can be encountered under *dv/dt* triggering. Conversely, an applied *dv/dt* many, many times the critical rating of the device will cause a large amount of current to be generated, which is similar to a very stiff gate signal being supplied to the device. This causes rapid junction turn-on and in all probability the device would not suffer.

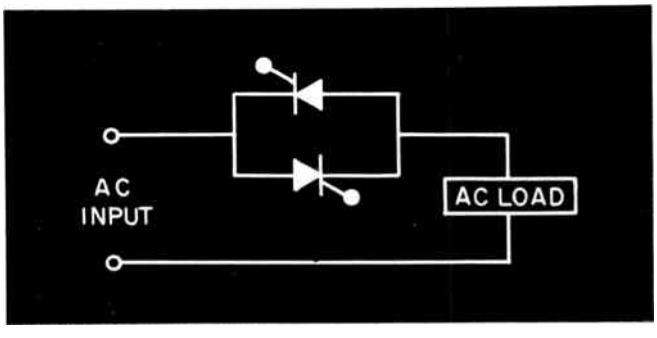
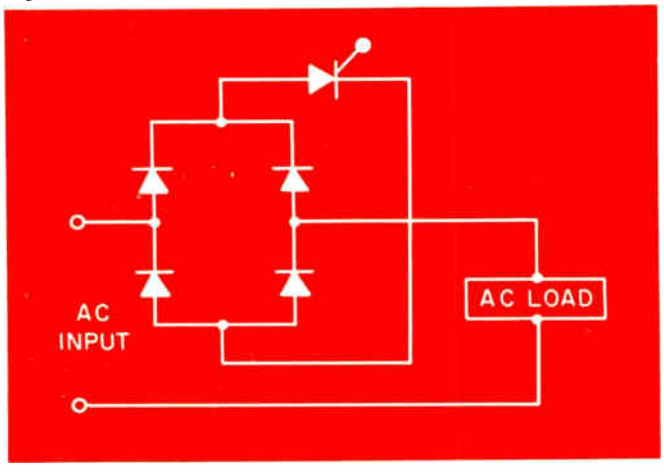


Fig. 9: A basic inverse parallel connection—ac output.

Fig. 10: A basic blocked bridge connection, also ac output.



POTENTIOMETERS (Continued)

(*Continued from page 68*)

applications, noise produces system instability, hunting, fluttering and many other problems. System noise can be caused by factors inherent in the potentiometer (micro-non-linearity apparent even at infinitely slow speed, zero wiper current), and by the interaction of the pot with its use circuit and electromechanical environment (tendency to generate triboelectric, thermoelectric and electrochemical EMF's). Although system noise is the parameter being measured, the *absence of noise* or "output smoothness" describes the smoothness and continuity of a potentiometer's output in system use (Markite*).

New Precision Types

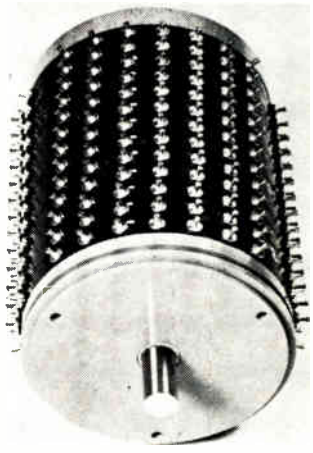
Several manufacturers have recently announced new potentiometer design features and production techniques for improved performance and reliability.

Bonds between terminal and resistance wire are now being made by "Silverweld," a special fusing process designed to prevent bond destruction and thus eliminate one of the major causes of potentiometer failure. Other features include a 20% longer resistance element and double slip-ring contacts (Bourns). A new 50-kilohm, three-turn version of the ten-turn precision "Micropot" results in a housing length of 1-31/64 inches, standard linearity of .5% and power rating of three watts at 40°C (Amphenol). A series of Mil spec single turn pots incorporating a "Vari-Phase" feature designed to permit adjustment of a single cup relative to the shaft of a ganged assembly without affecting the other cups (Clarostat). A ten-turn, ¾-inch dia. by 1½-inch long 2-watt unit with a range of 100-100K ohms and standard linearity of .5% (IRC).

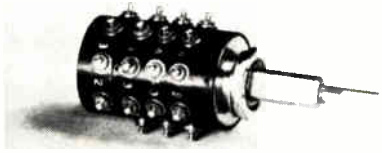
*Output Smoothness is defined and measured in Bulletins TD-110 and TD-111 available from Markite Corporation.

Conductive plastic pot.—Markite Corp.

The 976 (Gen. Radio) has a 2% res. tol.

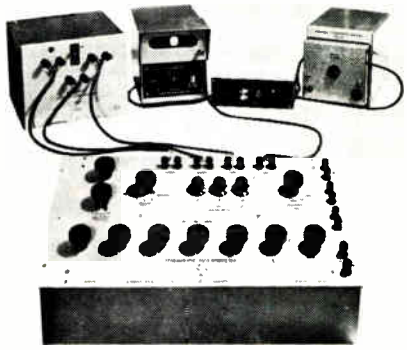


Computer Instruments' 205S has 260 taps.



Ace switch pots join pot. & switching acts.

North Hills' 5545 has a 0.001% accuracy.



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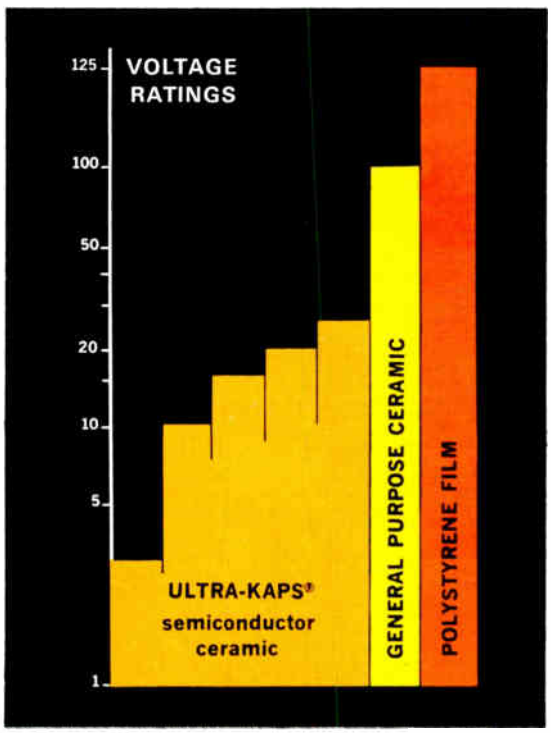

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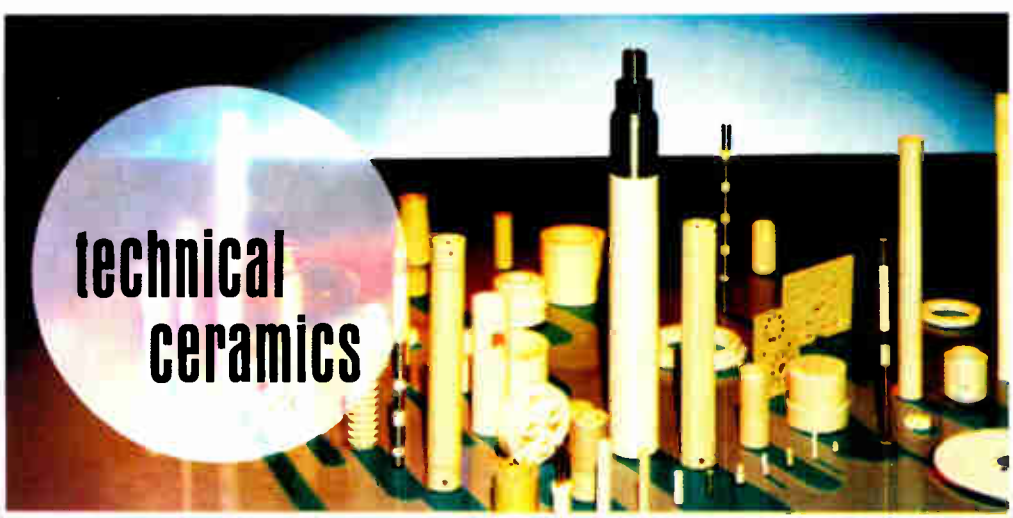

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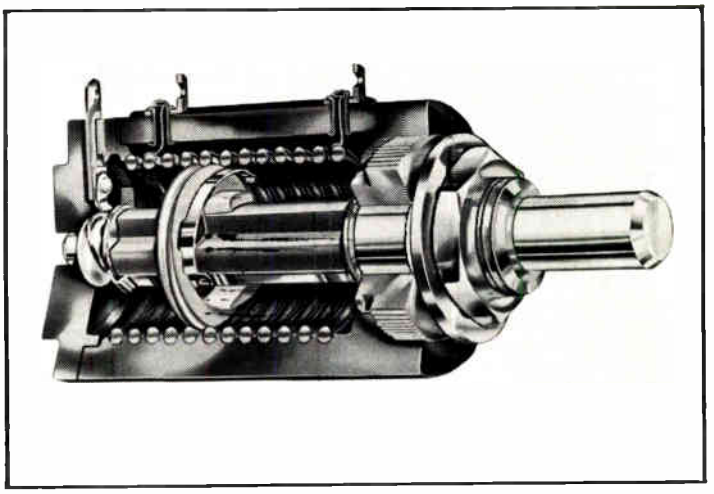
This potentiometer offers ±0.15% zero-based linearity as standard.



In determining whether a precision potentiometer will meet specific electrical needs, the nature of its linearity base must be considered. The type of linearity specified is very significant to the cost.

Potentiometer Linearity Considerations

WHEN SELECTING AND APPLYING precision potentiometers, the type of linearity specified is very significant to the cost. In some instances, equivalent performance can be obtained by more than one method of specification. But, the costs associated with applying the pot can easily make one method the most logical choice.

Linearity is most often defined as a percentage of total applied voltage, e.g., ±0.05%. But, to determine whether a precision pot will meet specific electrical needs, it is also necessary to consider its type of linearity.

The most often specified types of linearity are absolute and independent. Of the two, independent linearity is most often specified. Absolute linearity provides many more technical advantages, thus costs are higher than for independent linearity pots. The absolute linearity definition is very restrictive in that it requires a specific function over a specific length of travel through index points at specific locations. Its main advantage is that all pots made to a given specification will provide identical results in the circuit without further adjustment or trimming of end resistances.

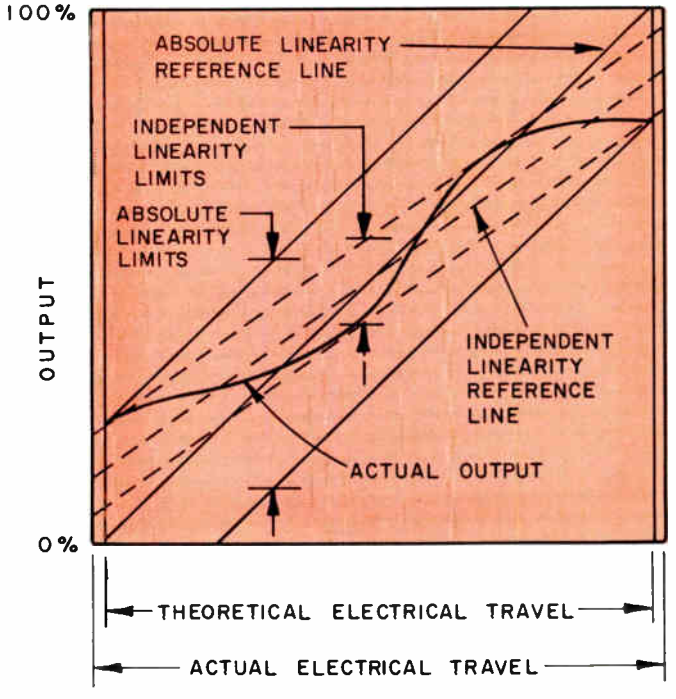
The definition of independent linearity allows tighter tolerances than if the same pot were defined on an absolute linearity basis. It does this by permitting adjustment of the slope of the reference line to minimize actual output errors. But, maximum and minimum output voltages are normally loosely specified, if at all, on independent linearity.

By ROBERT W. KORDATZKY,
Development Engineering Manager,
Amphenol Controls Division,
Amphenol-Borg Electronics Corp.,
120 S. Main St.,
Janesville, Wisc. 53546

These end voltage values must be trimmed in the circuit to achieve conformity with an absolute linearity definition. But, adding two trimming pots to the circuit can add much to the cost of equipment. Also, extra time must be spent in setting the pot and its associated trimmers. Using compensating fixed resistors can be equally involved if not more costly than the trimmer method.

A comparison of both types of linearity applied to the same pot is shown in Fig. 1. The absolute linearity reference line on the chart is specified as zero percent

Fig. 1: Comparison between absolute and independent linearity.



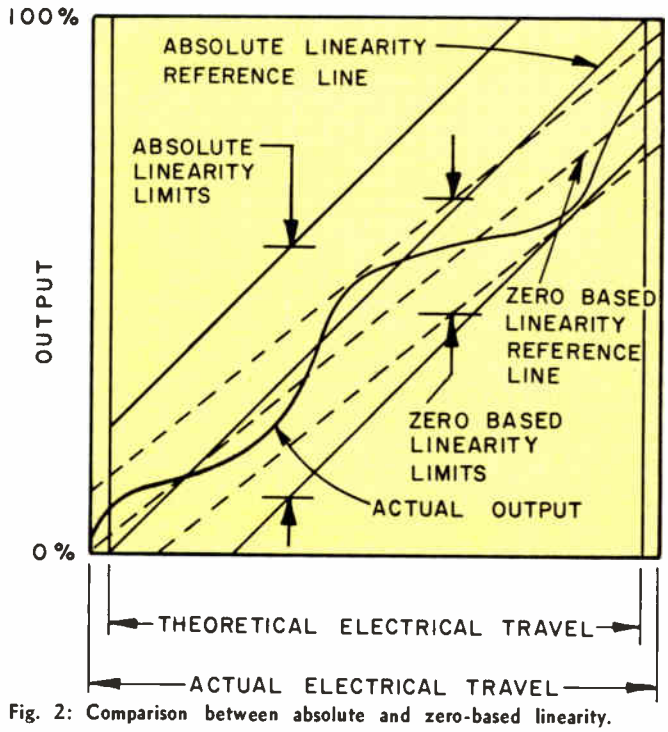


Fig. 2: Comparison between absolute and zero-based linearity.

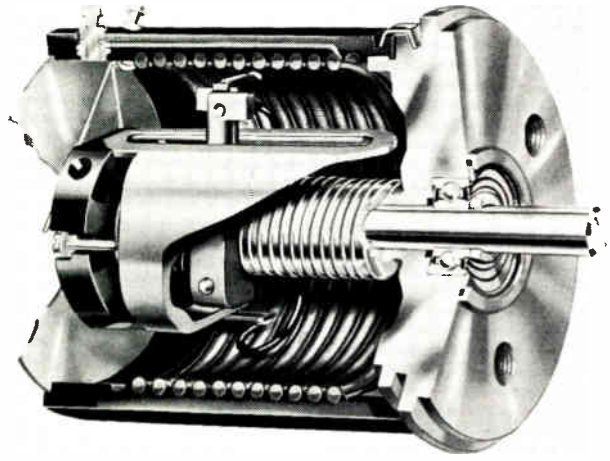
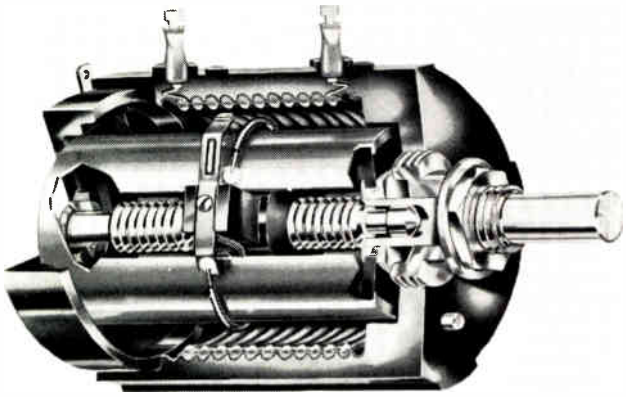


Fig. 3: This precision pot gives ±0.1% absolute linearity as standard. A 3-turn model is available at ±0.25% absolute linearity.

Fig. 4: This pot offers ±0.1% zero-based linearity as standard. A 3-turn version is also available at ±0.5% zero-based linearity.



and 100% outputs at the end points of the specified theoretical travel. Actual output deviates from the reference line by the maximum amount permitted by the limit lines. Slope of the reference line for independent linearity has been chosen to minimize these errors. This results in much tighter limits than the absolute linearity tolerances. But, for equivalent tolerances a pot with absolute linearity is necessarily more precise and thus more expensive than an independent linearity type.

Zero-Based Linearity Solves Problem

An alternative to some of the tedious and expensive trimming procedures on independent linearity pots is the use of a zero-based linearity pot. The zero based definition of linearity is a restricted version of independent linearity in which the minimum output is specified as zero. Actual output must conform with the specified minimum within the linearity tolerances. The maximum output end of the reference line, for the zero-based pot, can be easily trimmed into conformance. A pot with a mechanical stop which coincides with the origin of the zero-based function can be easily installed in a circuit with a minimum of calibration and adjustment. The pot can be installed with the contact engaged with the stop (zero output) and the associated components phased into this setting.

In Fig. 2 the effects of zero-based and absolute linearity are compared. It can be noted that the zero-based definition permits greatly reduced linearity limits as compared to the absolute linearity limits. A large portion of the increased limits is required by the fact that absolute linearity is measured over the theoretical rather than the actual electrical travel which is used in all other linearity types. This requires that any tolerance in the actual electrical angle of the pot contributes to the linearity error. Some pots are designed to permit internal adjustment of the actual electrical travel to coincide with the theoretical. Thus the need for the increased linearity limits is eliminated.

Which Linearity Requirement?

Requirements of each individual application should determine which linearity is the most effective and most economical.

If proportional output is the only requirement, then the choice must be independent linearity. But, if outputs at maximum and minimum end points must be trimmed, the extra cost of parts and labor involved in the trimming operation may well offset the added cost of an absolute linearity pot. Where variable output should represent the total applied voltage, an absolute linearity pot must be used.

Advancements in manufacturing methods and design have made combined zero-base linearity with coincident mechanical stop a relatively economical feature. Zero-based linearity pots which eliminate the need for trimming the minimum output (often necessary with independent linearity pots) frequently are the most economical pots to select for a wide variety of uses.

ELECTRONIC INDUSTRIES

INTEGRATED CIRCUITS COMMERCIALLY AVAILABLE

The tabulation of integrated circuits shown on the following pages is intended as a quick reference guide for selecting IC's for circuit uses. It should be invaluable in the initial stages of circuit design because the operating characteristics shown have been limited to the essential data needed for selection or rejection. After selection, the designer can obtain complete operating data and other information from the manufacturers. The names and addresses of the major manufacturers are listed on this page.

The tabulation is divided into two categories: digital and linear circuits. Within these categories the circuits are listed according to function (AND GATE, OR GATE, etc.), type of logic (DTL, TTL, etc.) and manufacturer. By listing circuits together, the reader can easily compare one company's products against another.

In addition to the off-the-shelf circuits listed, most of the manufacturers offer custom facilities. There are, however, some companies who offer *only* custom facilities. These companies are also listed for your convenience.

MANUFACTURERS

Amelco, Inc., P.O. Box 1030, Mountain View, Calif.
Fairchild Semiconductor Div., 313 Fairchild Drive, Mountain View, Calif.
General Instrument, Inc., 600 W. John St., Hicksville, N. Y.
Hoffman Electronics, Semiconductor Div., 4501 Arden, El Monte, Calif.
Intellux, Inc., 26 Coromar Dr., Goleta, Calif.
Motorola Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz. 85001
National Semiconductor, Sugar Hollow Rd. & Thorpe St., Danbury, Conn.
Philco Semiconductor Div., Lansdale, Pa.
Radiation, Inc., Box 37, Melbourne, Fla.
Raytheon Co., 350 Ellis St., Mountain View, Calif.
Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif.
Siliconix, Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.
Sprague Electric Co., 233 Marshall St., No. Adams, Mass.
Stewart-Warner Electronic Div., 730 E. Evelyn, Sunnyvale, Calif.
Sylvania Electric Products, Inc., Semiconductor Div., Woburn, Mass.
Texas Instruments Incorporated, Box 5012, Dallas 22, Tex.
Transitron Electronic Corp., Wakefield, Mass.
Varo Mfg. Co., 2201 Walnut St., Garland, Tex. 75041
Westinghouse Electronic Corp., Churchill Rd., Pittsburgh, Pa.

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Manufacturers		Mono-lithic	Thin-Films	Multi Chip
Alpha Microelectronics	10501 Rhode Island Ave., Beltsville, Md. 20705		●	
Amphenol Connector	1830 S. 54th Ave., Chicago, Ill. 60650		●	
Bendix Semiconductor	Holmdel, N. J.	●		
Burroughs Corp.	P. O. Box 1226, Plainfield, N. J.		●	
Centralab, Div. of Globe Union	962 E. Keefe Ave., Milwaukee, Wis. 53201		●	
Corning Glass Works	3900 Electronics Dr., Raleigh, N. C.		●	
Electra Mfg. Co.	800 No. 21st St., Independence, Kans.		●	
Erie Technical Prod.	644 W. 12th St., Erie, Pa.		●	●
Fairchild Semiconductor Products	313 Fairchild Dr., Mountain View, Calif.	●	●	●
General Electric Semiconductor Div.	Bldg. 7, Electronics Park, Syracuse, N. Y.	●	●	●
General Instrument, Inc.	600 W. John St., Hicksville, N. Y.	●		●
General Micro-electronics	2930 San Ysidro Way, Santa Clara, Calif.	●		
General Precision Aerospace, Inc.,	1150 McBride Ave., Little Falls, N. J.	●	●	
Halex Inc.	P. O. Box 546, 310 E. Imperial Ave., El Segundo, Calif.		●	
Hamilton Standard Electronic Prod.	Main St., Broad Brook, Conn.		●	
Hoffman Electronics Semiconductor Div.	4501 Arden, El Monte, Calif.	●		
Hughes Semiconductor	Bldg. 114—MS-12 Box 90515, Los Angeles, Calif. 90009	●	●	●
Intellux, Inc.	26 Coromar Dr., Goleta, Calif.		●	
Lear Siegler/Astronics	2820 Washtenaw, Ann Arbor, Mich.		●	
Lockheed Missile & Space Co.	6201 E. Randolph, Los Angeles, Calif.		●	
Mallory-Zerox Corp.	9 Third Ave., Burlington, Mass.		●	
Melpar, Inc.	3000 Arlington Blvd., Falls Church, Va.		●	
Mepco, Inc.	35 Abbett Ave., Morristown, N. J.		●	
Motorola Semiconductor Prod.	5005 E. McDowell, Phoenix, Ariz. 85001	●	●	●
National Resistronics	56 Walter St., Pearl River, N. Y.		●	●
National Semiconductor	Sugar Hollow Rd. & Thorpe St., Danbury, Conn.	●	●	
Norden Div., United Aircraft	Helen St., Norwalk, Conn.	●	●	
Philco Semiconductor Div.	Lansdale, Pa.	●	●	
Radiation, Inc.	Box 37, Melbourne, Fla.	●	●	●
Raytheon Co.	350 Ellis St., Mountain View, Calif.	●	●	●
Republic Aviation	223 Jericho Tpk., Mineola, N. Y.		●	
Signetics Corp.	811 E. Arques Ave., Sunnyvale, Calif.	●	●	
Siliconix, Inc.	1140 W. Evelyn Ave., Sunnyvale, Calif.	●	●	
Sprague Electric Prod.	233 Marshall St., North Adams, Mass.	●	●	●
Stewart-Warner Electronic Div.	730 E. Evelyn, Sunnyvale, Calif.	●	●	

DIGITAL CIRCUITS

Manufacturer	Model	Function	Propagation Delay(nsec)	Fan-In (max)	Fan-Out (max)	Noise Margin (mv)	Temp. Range (°C)*	Package Type
			AND GATE (DTL)					
Motorola	MC 111	3-4 diode	15	–	–	–	–	TO-5
	MC 1112	2-2-2 diode	15	–	–	–	–	TO-5
	MC 1113	1-1-1 diode	15	–	–	–	–	TO-5
	MC 1114	8 diode AND	15	–	–	–	–	TO-5
	MC 203	Diode-AND	4	–	–	500	–	TO-5 & flat pack
	MC 215	Dual AND	–	3.3	–	–	–	TO-5 & flat pack
Varo	8207	–	10	–	10	–	–	–
	8208	–	10	–	10	–	–	–
	8209	–	10	–	10	–	–	–
	8210	–	10	–	10	–	–	–
Signetics	SE 105	–	25	6	1	–	–	–
	SU 305K	6 input	25	6	10	–	−20 + 85	–
	SU 306K	Dual 3 input	25	3	10	–	−20 + 85	–
	LU 305	Dual AND	15	6	10	–	10 to 55	TO-5
	LU 306	Dual AND	15	3.3	10	–	−20 to 85	TO-5 & flat pack
	CS 705	Dual AND	–	3	1	–	–	–
			AND/OR (DTL)					
Texas Instruments	SN 532	5-input	5	–	–	200	–	Flat pack
	SN 534	Dual AND	5	–	8	200	–	Flat pack
Westinghouse	WS 810	AND/OR/NAND	50	2	10	250	0–100	Flat pack
	WS 812	–	50	3	10	250	0–100	Flat pack
	WS 814	–	50	2	10	250	0–100	Flat pack
			AND/NAND					
Westinghouse	WS 813	–	50	2	10	250	0–125	Flat pack
			NAND (DTL)					
General Instrument	NC 16	–	8	4	5	–	–	TO-5
	PC 11	–	8	6	5	–	–	Flat pack
	PC 15	Dual	8	3+3	5	–	–	Flat pack
Stewart-Warner	SWA 01	Dual	18	4	15	900	–	TO-5
	SWA 02	Dual	18	4	15	900	–	TO-5
	SWA 05	Dual	12	4	10	900	–	TO-5
	SW 101	–	20	–	7	500	–	TO-5 & flat pack
	SW 102	–	20	–	7	500	–	TO-5 & flat pack
	SW 115	Dual	20	2	7	500	–	TO-5 & flat pack
	SW 201	Dual	20	3	11	550	–	TO-5 & flat pack
	SW 204	–	20	–	11	550	–	TO-5
	SW 211	Dual	20	4	11	550	–	TO-5 & flat pack
	SW 221	Dual	20	–	11	550	–	TO-5 & flat pack
	SW 224	–	20	–	11	550	–	TO-5
	SW 231	Dual	20	–	11	550	–	Flat pack
	SW 708	Dual	15	10	15	1000	–	TO-5
	SW 930	Dual 4-input	20	–	9	700	–	TO-5 & flat pack
	SW 946	Quad 2-input	20	–	5	–	–	TO-5 & flat pack
Westinghouse	WC 201	Dual	23	–	–	–	–	TO-5 & flat pack
	WC 211	Dual	23	–	–	–	–	TO-5 & flat pack
	WC 221	Dual	23	–	–	–	–	TO-5 & flat pack
	WC 231	Dual	23	–	–	–	–	TO-5 & flat pack
	WC 241	Dual	23	–	–	–	–	TO-5 & flat pack
	WC 261	Dual	23	–	–	–	–	TO-5 & flat pack
	WM 206	Triple	23	3	11	550	–	Flat pack
	WM 211	Dual	23	–	4	550	–	TO-5 & flat pack
	WM 216	Triple	23	3	11	550	–	Flat pack
	WM 226	Triple	23	3	11	550	–	Flat pack
	WM 236	Triple	23	3	11	550	–	Flat pack
	WM 231	Dual	23	4	11	550	–	Flat pack
	WM 246	Quad	19	2	11	550	–	Flat pack
	WM 266	Quad	23	2	11	550	–	Flat pack
	WM 214	–	28	6	11	550	–	Flat pack
	WM 224	–	23	–	–	–	–	TO-5 & flat pack
	WM 234	–	23	–	–	–	–	TO-5 & flat pack
	WM 205	Shift bit	200	–	–	–	–	Flat pack
	WM 286	Hex	23	–	–	–	–	Flat pack
	WM 296	Hex	23	–	–	–	–	Flat pack
	WS 811	Dual	50	3	10	250	0–125	Flat pack
	WC 246	Quad	23	–	–	–	0–75	Flat pack
	WC 266	Quad	23	–	–	–	0–75	Flat pack
	WC 286	Hex	23	–	–	–	0–75	Flat pack
	WC 296	Hex	23	–	–	–	0–75	Flat pack
Varo	8214	Dual	10	15	4	–	–	–
Philco	PL 930	Dual 4-input	20	4	8	500	–	Flat pack
	PL 946	Quad 2-input	20	2	8	500	–	Flat pack
	PL 962	Triple 3-input	25	–	8	–	–	Flat pack
Sprague	UC 1001B	–	15	15	4	500	–	–
Raytheon	RM 223	–	25	4	6	500	–	–
	RM 224	Dual	25	2,3	2,6	500	–	–
	RM 243	–	25	4	6	500	–	–
	RM 201 T,Q,G	Dual 3-input	30	–	11	550	–	TO-5
	RM 211 T,G	Dual 4-input	30	–	11	550	–	TO-5 & flat pack
	RM 211 T,G	Dual 3-input	30	–	11	550	–	TO-5 & flat pack
	RM 231 G	Dual 4-input	30	–	11	550	–	Flat pack
	RM 206 G	Triple	32	–	11	550	–	Flat pack
	RM 216 G	3-input	32	–	11	550	–	Flat pack
	RM 204 T,Q,G	4-input	35	–	11	550	–	Flat pack
	RM 214 T,Q,G	6-input	35	–	11	550	–	Flat pack
	RM 224 T,G	8-input	35	–	11	550	–	Flat pack
Texas Instruments	SN 472	Dual 3-input	40	–	5/gate	1000	0–125	Flat pack
	SN 473	–	80	–	5	1000	0–125	Flat pack
	SN 344A	Triple	120	–	12,12	500	0–65	Flat pack
	SN 341A	7-input	140	–	6	500	0–65	Flat pack
	SN 347A	Dual	140	–	6,6	500	0–65	Flat pack
	SN 359A	Dual	140	–	6,6	600	0–65	Flat pack
			NAND/NOR (DTL)					
Silicanix	A 05	Dual	12	4	10	900	–	TO-5 & flat pack
	A 10	–	12	4	10	900	–	–

* -55° to + 125°C unless otherwise noted.

DIGITAL CIRCUITS - Continued

Manufacturer	Model	Function	Propagation Delay(nsec)	Fan-In (max)	Fan-Out (max)	Noise Margin (mv)	Temp. Range (°C)*	Package Type
NAND/NOR (DTL) (Continued)								
Siliconix (Cont'd)	A 12	Dual	12	4	5	900	–	–
	A 13	–	12	4	5	900	–	–
	AO1,2	Dual	18	4	15	900	–	TO-5 & flat pack
	AO6,7	Dual	18	4	5	900	–	TO-5 & flat pack
Signetics	CS 700	Dual	25	3,2	5	–	–	TO-5 & flat pack
	CS 701	Dual	25	3,2	4	–	–	TO-5 & flat pack
	CS 716	Dual	19	2,2	15	–	–	TO-5
	CS 720	Quad	17	2,2,2,2	5	–	–	Flat pack
	CS 721	Triple	17	3,3,3	5	–	–	Flat pack
	CS 727	Triple	19	2,2,2	5	–	–	Flat pack
	CS 730	Dual	19	5,5	5	–	–	Flat pack
	SE 170	Triple 3-input	17	2,2,2	5	800	–	Flat pack
	SE 180	Quad 2-input	17	2,2	5	800	–	Flat pack
	SE 111	Dual 4-input	20	4,4	15	800	–	Flat pack
	SE 112	Dual 3-input	20	3,3	15	800	–	Flat pack
	SE 113	Dual 3-input	20	3,3	15	800	–	Flat pack
	SE 101	–	4	5	–	800	–	–
	SE 115	Dual	25	2,2	–	800	–	–
Texas Instruments	SN 7310	5-input	30	–	10	–	0 to 70	Flat pack
	SN 7311	Dual 5-input	25	–	10	–	0 to 70	Flat pack
	SN 7330	Dual 3-input	25	–	10	–	0 to 70	Flat pack
	SN 7331	Triple 3-input	25	–	10	–	0 to 70	Flat pack
	SN 7360	Quad 2-input	25	–	10	–	0 to 70	Flat pack
	SN 531	5-input	25	–	10,4	200	–	Flat pack
	SN 533	Dual 3-input	25	–	10,10,10	200	–	Flat pack
	SN 5311	Dual 5-input	25	–	10/gate	200	–	Flat pack
	SN 5331	Triple 3-input	25	–	10/gate	200	–	Flat pack
	SN 5360	Quad 2-input	25	–	10/gate	200	–	Flat pack
Radiation	RD 200	Dual	10	4	12	1000	–	TO-5 & flat pack
	RD 201	–	10	4	12	1000	–	TO-5 & flat pack
Motorola	MC 201,2,6	–	30	–	5	500	–	TO-5 & flat pack
	MC 251,2	–	30	–	–	–	0 to 75	TO-5 & flat pack
	MC 256	Dual	30	–	–	–	0 to 75	TO-5 & flat pack
	MC 207	3,2 dual	30	3	5	–	–	TO-5 & flat pack
	MC 257	3,2 dual	30	3	5	–	0 to 75	TO-5 & flat pack
	MC 208	3,2 dual	30	3	4	–	–	TO-5 & flat pack
	MC 258	3,2 dual	30	3	4	–	0 to 75	TO-5 & flat pack
	MC 212	3,3 dual	30	3	5	–	0 to 75	TO-5 & flat pack
	MC 262	3,3 dual	30	3	5	–	0 to 75	TO-5 & flat pack
	MC 213	3,3 dual	30	3	4	–	0 to 75	TO-5 & flat pack
	MC 263	3,3 dual	30	3	4	–	0 to 75	TO-5 & flat pack
	MC 281G	Dual	18	–	–	500	–	TO-5
	MC 284G	4-input	18	–	–	550	–	–
Fairchild	DTμL 930	Dual 4-input	25	4	8	750	–	TO-5 & flat pack
	μL 927	Quad inverter	10	4	12	1000	–	TO-5 & flat pack
	DTμL 946	Quad	25	2	8	750	–	TO-5 & flat pack
	DTμL 962	Triple	25	3	8	750	–	TO-5 & flat pack
	FμL 93029	Dual 4-input	25	–	–	–	0 to 75	TO-5 & flat pack
Vara	8204	10–15	9	4	–	–	–	–
Sprague	UC 1001B	–	12	15	4	500	–	–
	UC 1003B	–	14	15	15	–	–	Flat pack
Hoffman	HMC 1001	–	35	4	5	600	0–80	TO-5
NOR (DTL)								
General Instrument	NC 10	–	8	4	5	–	–	TO-5
	PC 10	–	8	6	15	–	–	Flat pack
	PC 14	Dual	8	3+3	5	–	–	Flat pack
Signetics	SL 314K	Dual 7-input	30	7	17	800	–20+85	–
EXCLUSIVE – OR (DTL)								
Texas Instruments	SN 5370	Dual	90	–	10/gate	200	–	Flat pack
Intellux	PG 15	–	8–30	20	20	500	–	Flat pack
Signetics	SE 110	–	35	3	20	800	–	–
Motorola	MC 204	–	40	–	20	500	–	TO-5 & flat pack
Fairchild	DTμL 944	Dual 4-input	40	4	27	750	–	TO-5 & flat pack
GATE EXPANDERS (DTL)								
Raythean	RC 226	–	2	6	–	–	–	–
	RC 246	–	2	6	–	–	–	–
Sprague	UC 1005B	–	–	–	–	–	–	–
	UC 1006B	–	–	–	–	–	–	–
Westinghouse	WM 217	Dual	–	7	–	–	–	TO-5 & flat pack
	WM 227	Triple	–	11	–	–	–	Flat pack
Stewart-Warner	SWA 04	–	4	6	–	–	–	–
	SW 933	Dual 4-input	–	4	–	–	–	TO-5 & flat pack
Signetics	CS 709	Dual	–	3,3	1	–	–	TO-5 & flat pack
Fairchild	DTμL 933	Dual 4-input	–	4	–	–	–	TO-5 & flat pack
Philco	PL 933	Dual 4-input	–	–	–	500	–	Flat pack
Radiation	RD 202	Dual	–	5	–	–	–	TO-5 & flat pack
BINARY ELEMENTS (DTL)								
General Instrument	NC/PC 8	–	8	–	5	–	–	TO-5 & flat pack
	NC/PC 12	–	8	1	22	–	–	TO-5 & flat pack
	PC-18	One shot	8	–	5	–	–	Flat pack
	PC-13	–	8	–	5	–	–	Flat pack
	NC/PC 19	–	–	–	5	–	–	TO-5 & flat pack
Fairchild	DTμL 950	R–S, F–F	20	2	12	600	–	TO-5 & flat pack
	DTμL 948	R–S, J–K	40	2	12	600	0 to 75	TO-5 & flat pack
	DTμL 931	Clocked J–K, R–S	50	2	7	5	–	TO-5 & flat pack
	DTμL 945	R–S, J–K	50	2	9	600	–	TO-5 & flat pack
Raythean	RC 202 T,Q,G	R–S 3–set & reset inputs	32	–	–	550	–	TO-5 & flat pack
	RC 212 T,G	R–S 3–set & reset inputs	32	–	–	550	–	TO-5 & flat pack
	RC 203 T,Q	–	–	–	–	550	–	TO-5 & flat pack
	RC 215 T,Q,G	J–K	–	–	–	550	–	TO-5 & flat pack
	RC 213 T,Q,G	Pulse	–	–	–	–	–	TO-5 & flat pack
Vara	8200	F–F	10	–	–	–	–	–
Sprague	UC 1002B	Counter	14	–	5	500	–	–

* -55° to + 125°C unless otherwise noted.

DIGITAL CIRCUITS - Continued

Manufacturer	Model	Function	Propagation Delay(nsec)	Fan-In (max)	Fan-Out (max)	Noise Margin (mv)	Temp. Range (°C)*	Package Type
BINARY ELEMENTS (DTL) (Continued)								
Motorola	MC 282G	F–F	18	–	–	500	–	TO-5
	MC 209	–	50	–	8	500	–	TO-5 & flat pack
Radiation	RD 204	R–S	20	–	10	1000	–	TO-5 & flat pack
Stewart-Warner	SW 212	R–S	20	–	10	550	–	TO-5 & flat pack
	SW 201	R–S	20	–	10	550	–	TO-5 & flat pack
	SW 931	R–S/J–K	40	–	10	1000	–	TO-5
	SW 945/948	R–S/J–K	–	–	–	700	–	TO-5
National	ND 1003	–	20	2	4	750	–	–
Westinghouse	WM 202	–	23	3	10	550	–	TO-5 & flat pack
	WM 212	–	23	3	10	550	–	TO-5 & flat pack
	WM 203	Counter	–	–	4	550	–	TO-5 & flat pack
	WM 215	J–K	–	–	9	550	0–125	TO-5 & flat pack
	WM 213	–	–	–	9	550	–	TO-5 & flat pack
	WM 503	J–K	–	–	–	500	–	Flat pack
Siliconix	A 09	Shift Reg.	32	–	5	900	–	TO-5 & flat pack
	A 03	Shift Reg.	40	–	5	900	–	TO-5 & flat pack
Texas Instruments	SN 530	Single phase J–K	45	–	10	200	–	Flat pack
	SN 337A	–	250	–	12	500	0 to 65	Flat pack
	SN 5111	R–S	300	–	4/20	500	–	Flat pack
Intellux	HD 914	–	50	–	–	600	–	–
Signetics	CS 704	–	60	–	8	800	–	–
	SE 124	–	60	–	8	800	–	–
	SU 320	J–K	–	–	17	800	–20+85	–
Philco	PL 931	J–K	50	–	7	500	–	Flat pack
Hoffman	HMC 1003	–	–	–	8	600	0–80	TO-5
DRIVER BUFFERS (DTL)								
Signetics	SE 155	Dual 4-input	20	4–4	15	800	–	Flat pack
	SE 156	Dual 4-input	20	4–4	15	800	–	Flat pack
	SE 157	Dual 3-input	20	3–3	15	800	–	TO-5 & flat pack
	SE 150	Clock	35	2	20	800	–	–
Texas Instruments	SN 535	Quad Inverter/Driver	25	–	10/gate	200	–	Flat pack
	SN 343A	Dual input	500	–	13	500	0–65	Flat pack
	SN 346A	Dual output	850	–	11	500	0–65	Flat pack
Siliconix	A 20	Dual	–	4	–	–	–	TO-5 or flat pack
	A 11	Dual	35	–	5	900	–	TO-5 or flat pack
Westinghouse	WM 510	Dual	15	5	–	500	–	Flat pack
	WM 210	Dual	37	3	22	550	–	TO-5 & flat pack
	WS 817	Dual	50	3	–	250	0–125	Flat pack
	WS 816	Dual	80	3	2	250	0–125	Flat pack
Raytheon	RC 210 T,Q,G	Dual	32	–	–	550	–	TO-5 & flat pack
National	ND 1002	–	35	2	–	750	–	–
Fairchild	DTμL 932	Dual 4-input	20	4	25	750	–	TO-5 & flat pack
Philco	PL 932	Dual 4-input	20	–	–	500	–	Flat pack
Sprague	UC 1003B	3-input	14	15	15	500	–	Flat pack
Varo	8213	–	15	–	10	–	–	–
Radiation	RD 203	–	20	4	20	1000	–	TO-5 & flat pack
Hoffman	HMC 1002	–	–	3	20	600	0 to 80	TO-5
Sprague	UC 1004B	–	40	–	5	500	–	–
MULTIVIBRATORS (DTL)								
General Instrument	NC/PC 16	One shot	8	–	–	–	–	TO-5 & flat pack
Fairchild	DTμL 951	2-input	25	–	10	950	–	TO-5 & flat pack
Varo	8203	One shot	30	–	4	–	–	–
Siliconix	A 08	One shot	30	1	5	900	–	–
Texas Instruments	SN 1005	–	100	–	10	200	–	Flat pack
Signetics	SE 160	One shot	–	–	4	800	–	–
NAND/NOR GATES (DCL)								
Fairchild	FμL 90329	3-input	10	3	16	300	15 to 55	TO-5 & flat pack
	FμL 91429	2-input	10	3	16	300	15 to 55	TO-5 & flat pack
	FμL 91529	Dual 3-input	10	3	16	300	15 to 55	TO-5 & flat pack
	μL 903	3-input	12	3	5	250	–	TO-5 & flat pack
	μL 914	Dual	12	2	5	250	–	TO-5 & flat pack
	μL 915	Dual 3-input	12	3	5	250	–	TO-5 & flat pack
	FμL 91029	Dual 2-input	25	2	4	300	15 to 55	TO-5 & flat pack
	FμL 91129	4-input	25	4	4	300	15 to 55	TO-5 & flat pack
	MWμL 910	Dual 2-input	45	2	4	350	–	TO-5 & flat pack
	MWμL 911	4-input	20	4	4	350	–	–
NOR (DCL)								
Raytheon	RC 324	Dual	25	–	–	300	–	–
	RC 342	Dual	25	–	–	300	–	–
	RC 344	Dual	25	–	–	300	–	–
	RC 1031	–	25	–	–	300	0 to 65	–
	RC 1032	–	25	–	–	200	0 to 65	–
	RC 1231	–	25	–	–	300	0 to 65	–
	RC 1232	–	25	–	–	200	0 to 65	–
National	NB 1003	3-input	11	3	–	300	–	–
	NB 1007	4-input	11	4	–	300	–	–
	NB 1014	Dual 2-input	11	2,2	–	300	–	–
	NB 1015	Dual 3-input	11	3,3	–	300	–	–
Texas Instruments	SN 731	Dual 2-input	35	–	4/gate	–	–	TO-5
	SN 731A	Dual 2-input	35	–	4/gate	–	–	Flat pack
	SN 733	4-input	35/70	–	4	–	–	TO-5
	SN 733A	4-input	35/70	–	4	–	–	Flat pack
Fairchild	μL 907	4-input	12	4	5	250	–	TO-5 & flat pack
Westinghouse	WS 277	–	25	3	6	275	–	–
GATE EXPANDERS (DCL)								
Amelco	E 11001	Dual 3-input	12	–	–	–	125	TO-5
	E 11004	Dual 3-input	12	–	–	–	70	TO-5
Texas Instruments	SN 732	Dual 2-input	35	–	–	–	–	TO-5
	SN 732A	Dual 2-input	35	–	–	–	–	Flat pack
Fairchild	MWμL 921	Dual 2-input	40	2	–	350	–	TO-5 & flat pack
	FμL 92129	Dual 2-input	–	2	–	300	15 to 55	TO-5 & flat pack
Philco	PL 921	–	40	–	3	–	–	–
NAND/NOR GATES (DCL)								
Amelco	G 11001	5-input	12	–	–	–	–	Flat pack
	G 11004	5-input	12	–	–	–	–	Flat pack
	J 11001	4-input	12	–	–	–	–	Flat pack

* -55° to + 125°C unless otherwise noted.

DIGITAL CIRCUITS - Continued

Manufacturer	Model	Function	Propagation Delay (nsec)	Fan-In (max)	Fan-Out (max)	Noise Margin (mv)	Temp. Range (°C)*	Package Type
NAND/NOR GATES (DCL) (Continued)								
Amelco (Cont'd)	J 11004	4-input	12	–	–	–	–	Flat pack
	K 11001	3-input	12	–	–	–	–	Flat pack
	K 11004	3-input	12	–	–	–	–	Flat pack
	L 11001	Dual 2-input	12	–	–	–	–	Flat pack
	L 11004	Dual 2-input	12	–	–	–	–	Flat pack
	M 11001	Dual 3-input	12	–	–	–	–	TO-5
	M 11004	Dual 3-input	12	–	–	–	–	TO-5
Philco	PL 903	3-input	12	–	5	–	–	–
	PL 907	4-input	12	–	5	–	–	–
	PL 915	Dual 3-input	12	–	5	–	–	–
	PL 910	Dual 2-input	40	–	4	–	–	–
	PL 911	4-input	40	–	4	–	–	–
NOR (DCL)								
Raytheon	RC 323	Dual	18	–	–	300	–	TO-5 & flat pack
	RC 103	–	20	–	–	300	–	–
	RC 123	–	20	–	–	300	–	–
	RC 124	Dual	20	–	–	300	–	–
	RC 144	Dual	20	–	–	300	–	–
	RC 1033	–	20	–	–	300	–	–
	RC 1233	–	20	–	–	300	–	–
	RC 1443	Dual	20	–	–	300	–	–
	RC 401	–	23.5	–	–	300	–	–
	RC 322	Dual	25	–	–	300	–	–
BINARY ELEMENTS (DCL)								
Fairchild	μL 902	–	14	1	4	250	–	TO-5 & flat pack
	μL 916	–	40	2	3	250	–	TO-5 & flat pack
	FμL 92329	–	40	3	10	300	15 to 55	TO-5 & flat pack
	MWμL 913	–	100	1	3	350	–	TO-5 & flat pack
Philco	PL 902	–	14	–	4	–	–	–
	PL 916	–	20	–	3	–	–	–
National	NB 1002	–	22	1	–	–	–	–
Amelco	R 12001	J–K	150	–	–	–	125	TO-5
SHIFT REGISTERS (DCL)								
Amelco	P 11001	Full 2-phase	35	–	–	–	125	TO-5
	R 11001	J–K	35	–	–	–	125	TO 5
	R 11004	J–K	35	–	–	–	70	TO 5
	P 11004	Full 2-phase	35	–	–	–	70	TO-5
	S 11001	Half	22	–	–	–	125	TO-47
	S 11004	Half	22	–	–	–	70	TO-47
Philco	PL 913	Full	80	–	3	–	–	–
	PL 905	Half	15	–	4	–	–	–
	PL 906	Half	22	–	4	–	–	–
Fairchild	μL 905	Half	18	3	5	250	–	TO-5 & flat pack
	FμL 90529	Half	18	3	5	300	15 to 55	TO-5 & flat pack
	μL 906	W/O inverter	22	3	4	250	–	TO-5 & flat pack
Raytheon	RC 301	Full	60	–	–	300	–	TO-5 & flat pack
National	NB 1005	Half	11	1	–	300	–	–
COUNTER ADAPTERS (DCL)								
Amelco	C 11004	–	28	–	–	–	70	TO-47
	C 11001	–	28	–	–	–	125	TO-47
National	NB 1001	–	21	1	–	300	–	–
Philco	PL 901	–	22	–	25	–	–	–
ADDERS (DCL)								
Fairchild	μL 904	Full	16	2	5	250	–	TO-5 & flat pack
	MWμL 908	Full	90	2	4	200	–	TO-5 & flat pack
	MWμL 912	Half	90	2	4	200	–	TO-5 & flat pack
Philco	PL 908	Full	80	–	4	–	–	–
	PL 904	Half	14	–	5	–	–	–
	PL 912	Half	80	–	4	–	–	–
Amelco	H 11001	Half	22	–	–	–	125	TO-47
	H 11004	Half	22	–	–	–	70	TO-47
National	NB 1004	Half	17	2,2	–	300	–	–
Intellux	HA 15	Half	60	–	–	700	–	–
BUFFERS (DCL)								
Fairchild	μL 900	–	16	2	25	250	–	TO-5 & flat pack
	FμL 90029	–	16	6	80	300	15 to 55	TO-5 & flat pack
	MWμL 909	–	80	4	30	350	–	TO-5 & flat pack
Amelco	BC 11001	–	15	–	–	–	125	TO-47
	BC 11004	–	–	–	–	–	70	TO-47
Philco	PL 900	–	15	–	25	–	–	–
	PL 909	–	80	–	30	–	–	–
National	NB 1000	–	8	1	–	300	–	–
Intellux	GB 15	–	–	3	–	–	–	–
MULTIVIBRATORS (DCL)								
Amelco	T35–002	Single shot	100	–	–	–	125	TO-5
Intellux	CD 15	Current Driver	–	3	–	–	–	–
AND/OR/NOT GATE (TTL)								
Stewart-Warner	SWG 5A	Dual	12	3	15	1000	–	TO-5
	SWG 5B	Dual	12	4	15	1000	–	TO-5
	SWG 21	Dual	15	–	–	1000	–	TO-5
NAND GATE (TTL)								
Stewart-Warner	SW 103	Dual	10	4	15	1000	–	TO-5
	SW 104	–	10	8	15	1000	–	TO-5
	SWG 4A	Dual	11	3	15	1000	–	TO-5
	SWG 4B	Dual	11	4	15	1000	–	TO-5
	SWG 14	Dual	11	4	7	1000	–	TO-5
	SWG 16	–	15	8	–	1000	–	TO-5
	SW 402	Dual	100	3	5	300	–	TO-5
	SWG 40	Dual 4-input	10	–	15	–	–	TO-5 & flat pack
	SWG 60	8-input	12	–	15	–	–	TO-5 & flat pack
	SWG 120	6-input	18	–	15	–	–	TO-5 & flat pack

* -55° to + 125°C unless otherwise noted.

DIGITAL CIRCUITS - Continued

Manufacturer	Model	Function	Propagation Delay(nsec)	Fan-In (max)	Fan-Out (max)	Noise Margin (mv)	Temp. Range (°C)*	Package Type
NAND GATE (TTL) (Continued)								
Texas Instruments	SN 5400	Quad 2-input	13	–	10 gate	1000	–	Flat pack
	SN 5410	Triple 3-input	13	–	10 gate	1000	–	Flat pack
	SN 5420	Dual 4-input	13	–	10 gate	1000	–	Flat pack
	SN 5430	8-input	15	–	10 gate	1000	–	Flat pack
	SN 5440	Dual 4-input	17.5	–	30	1000	–	Flat pack
NAND/NOR GATE (TTL)								
Transition	TNG 3141	Dual	10	4	20	1000	–	TO-5 & flat pack
	TNG 3041	–	10	8	20	1000	–	TO-5 & flat pack
	TNG 3047	–	10	6	7	1000	–	TO-5 & flat pack
	TNG 3043	–	10	8	7	1000	–	TO-5 & flat pack
	TNG 3045	–	10	6	20	1000	–	TO-5 & flat pack
	TNG 3143	Dual–4	10	4	7	1000	–	TO-5 & flat pack
	TNG 3145	Dual–3	10	3	20	1000	–	TO-5 & flat pack
	TNG 3147	Dual–3	10	3	7	1000	–	TO-5 & flat pack
	TNG 3011	–	15	8	20	1000	–	TO-5 & flat pack
	TNG 3013	–	15	8	7	1000	–	TO-5 & flat pack
	TNG 3015	–	15	6	20	1000	–	TO-5 & flat pack
	TNG 3031	–	15	4	7	1000	+10 to 60	TO-5
	TNG 3111	Dual	15	4	20	1000	–	TO-5 & flat pack
	TNG 3113	Dual	15	4	7	1000	–	TO-5 & flat pack
	TNG 3117	Dual	15	3	7	1000	–	TO-5 & flat pack
	TNG 3115	Dual	15	3	20	1000	–	TO-5 & flat pack
	TNG 3131	Dual	15	2	7	1000	+10 to 60	TO-5
	TNG 3231	Dual	15	2	7	1000	+10 to 60	TO-5
	TNG 3017	–	15	6	7	1000	–	TO-5 & flat pack
Sylvania	SG 140,141,142, 143	Quad 2-input	12	–	–	–	–	TO-5 & flat pack
	SG 40,41,42,43	Dual 4-input	12	–	20	1000	–	–
	SG 60,61,62,63	Single 8-input	12	–	20	1000	–	–
	SG 120,121,122, 123	Expandable	12	–	20	1000	–	–
Siliconix	BO 1	–	10	8	15	1000	–55 to 165	TO-5 & flat pack
	BO 2	Dual	10	4	15	1000	–55 to 165	TO-5 & flat pack
Fairchild	TTμL 103	Dual 4-input	25	4	15	750	–	TO-5 & flat pack
	TTμL 104	8-input	30	8	15	750	–	TO-5 & flat pack
Westinghouse	WM 701	Dual	45	4	–	550	–	Flat pack
	WM 704	–	45	8	–	500	–	Flat pack
NAND/OR (TTL)								
Transitron	TNG 3211	Dual	15	4	20	1000	–	TO-5 & flat pack
	TNG 3213	Dual	15	4	7	1000	–	TO-5 & flat pack
	TNG 3215	Dual	15	3	20	1000	–	–
	TNG 3217	Dual	15	3	7	1000	–	TO-5 & flat pack
	TNG 3241	Dual 4-input	10	4	20	1000	–	TO-5 & flat pack
	TNG 3243	Dual	10	4	7	1000	–	TO-5 & flat pack
	TNG 3245	Dual	10	3	20	1000	–	TO-5 & flat pack
	TNG 3247	Dual	10	3	7	1000	–	TO-5 & flat pack
EXCLUSIVE OR (TTL)								
Sylvania	SG 50,51,52,53	Quad 2-input	12	–	20	1000	–	–
	SG 110,111,112, 113	Dual 4-input	12	–	20	1000	–	–
	SG 100,101,102, 103	Triple 3-input	12	–	20	1000	–	–
Texas Instruments	SN 5450	Dual	15	–	10/gate	1000	–	Flat pack
GATE EXPANDER (TTL)								
Sylvania	SG 170–173	Dual 4 OR	–	–	–	1000	–	–
	SG 180–183	Dual 4 AND	–	–	–	1000	–	–
Texas Instruments	SN 5460	Dual 4-input	–	–	4	1000	–	Flat pack
Transition	TNG 3051	–	–	8	–	1000	–	TO-5 & flat pack
	TNG 3251	–	–	4	–	1000	–	TO-5 & flat pack
BINARY ELEMENTS (TTL)								
Sylvania	SF 10–13	R–S	12	–	20	1000	–	–
	SF 20–23	Clacked	12	–	20	1000	–	–
	SF 30–33	Single-phase	12	–	20	1000	–	–
Transition	TFF 3011	Dual	18	3	20	1000	–	TO-5 & flat pack
	TFF 3013	Dual	18	3	7	1000	–	TO-5 & flat pack
	TFF 3015	Dual	18	2	20	1000	–	TO-5 & flat pack
	TFF 3017	Dual	18	2	7	1000	–	TO-5 & flat pack
Texas Instruments	SN 5470	J–K	40	–	10	1000	–	Flat pack
ADDER (TTL)								
Sylvania	SG 90–93	Half	12	–	20	1000	–	–
GATES (ECL)								
Motorola	MC 309–311	Dual 2-input NOR	6	–	26	–	–	TO-5 & flat pack
	MC 359–361	Dual 2-input NOR-NAND	6	–	26	–	0 to 75	TO-5 & flat pack
Stewart-Warner	SW 309–311	Dual	6	–	26	–	–	TO-5 & flat pack
Westinghouse	WS 371	Dual	10	4	–	250	0 to 75	Flat pack
Motorola	MC 301	5-input	6	25	26	–	–	TO-5 & flat pack
	MC 306–307	3-input	6	25	26	–	–	TO-5 & flat pack
	MC 351	5-input	6	5	26	–	0 to 75	TO-5 & flat pack
	MC 356–357	3-input	6	25	26	–	0 to 75	TO-5 & flat pack
Stewart-Warner	SW 301	–	6	5	26	–	–	TO-5 & flat pack
	SW 306–307	–	6	25	26	–	–	TO-5 & flat pack
GATE EXPANDERS (ECL)								
Motorola	MC 305	–	6	–	–	–	–	TO-5 & flat pack
	MC 355	–	6	–	–	–	0 to 75	TO-5 & flat pack
Stewart-Warner	SW 305	–	6	–	–	–	–	TO-5 & flat pack
ADDERS (ECL)								
Motorola	MC 303	Half	6	–	25	–	–	TO-5 & flat pack
	MC 353	Half	6	–	25	–	0 to 75	TO-5 & flat pack

* -55° to + 125°C unless otherwise noted.

DIGITAL CIRCUITS - Continued

Manufacturer	Model	Function	Propagation Delay (nsec)	Fan-In (max)	Fan-Out (max)	Noise Margin (mv)	Temp. Range (°C)*	Package Type
GATE EXPANDER (TTL)								
Motorola	MC 304	–	–	–	25	–	–	TO-5 & flat pack
	MC 354	–	–	–	25	–	–	TO-5 & flat pack
Stewart-Warner	SW 304	–	–	–	25	–	–	TO-5 & flat pack
BINARY ELEMENTS (ECL)								
Motorola	MC 302	Set–Reset	10	–	25	–	–	TO-5 & flat pack
	MC 308	J–K	10	–	–	–	–	TO-5 & flat pack
	MC 352	Set–Reset	10	–	25	–	0 to 75	TO-5 & flat pack
	MC 358	J–K	10	–	–	–	0 to 75	TO-5 & flat pack
Stewart-Warner	SW 308	J–K	10	–	25	–	–	TO-5 & flat pack
LEVEL TRANSLATORS (ECL)								
Motorola	MC 1511	DTL to CML	–	1	25	0.4v	–	TO-5
	MC 1512	CML to DTL	–	25	–	–	–	TO-5
NAND/NOR GATES (RCTL)								
Texas Instruments	SN 5161	Triple 2-input	65	–	5/gate	200	–	Flat pack
	SN 5162	Triple 2-input	65	–	5/25	200	–	Flat pack
NOR (RCTL)								
Intellux	GG 33	–	4	3	–	500	–	–
Raytheon	RC 1243	Dual	20	–	–	300	–	–
NOR/NAND (RCTL)								
Texas Instruments	SN 512A	6-input	65	–	5	200	–	Flat pack
	SN 513A	6-input	65	–	5/25	200	–	Flat pack
	SN 514A	Dual 3-input Dual 2-input	65	–	5/gate	200	–	Flat pack
	SN 516A	Inverter/buffer	65	–	5,25	200	–	Flat pack
	SN 515A	Exclusive OR pulse	100	–	5	200	–	Flat pack
	SN 5191	Exclusive OR	–	–	5	200	–	Flat pack
NOR/NAND (RCTL)								
Sprague	USO 102A	–	100	6	25	–	–	–
	USO 103A	–	100	6	25	–	–	–
BINARY ELEMENTS (RCTL)								
Texas Instruments	SN 510A	R–S FF/Counter	300	–	4	200	–	Flat pack
	SN 511A	R–S FF w/fallower	300	–	4	200	–	Flat pack
	SN 5101	R–S	300	–	4	200	–	Flat pack
	SN 5112	Ripple Counter	300	–	2/4/16	200	–	Flat pack
Intellux	FF 33	–	8	1	–	500	–	Flat pack
Sprague	USO 100A	–	–	–	4	–	–	–
	USO 101A	–	–	–	20	–	–	–
MULTIVIBRATOR (RCTL)								
Texas Instruments	SN 518A	One shot	–	–	5	200	–	Flat pack
CLOCK DRIVER (RCTL)								
Texas Instruments	SN 517A	–	–	–	20	200	–	Flat pack
GATES (UTILOGIC)								
Signetics	LU 305	6-input AND	15	6	10	–	+ 10 to 55	TO-5
	LU 306	Dual 3-input AND	15	3,3	10,10	–	+ 10 to 55	TO-5
	LU 316	Dual 2-input NOR	20	2,2	17,17	800	+ 10 to 55	TO-5
	SU 316	Dual 2-input NOR	20	2,2	17,17	800	– 20 + 85	TO-5 & flat pack
	LU 315	Dual 3-input NOR	20	3,3	17,17	800	+ 10 to 55	TO-5
	LU 314	7-input NOR	20	7	17	800	+ 10 to 55	TO-5
GATE EXPANDER (UTILOGIC)								
Signetics	SU 300	–	5	33	–	–	– 20 + 85	TO-5 & flat pack
	LU 300	–	5	33	–	–	+ 10 to 55	TO-5
BINARY ELEMENTS (UTILOGIC)								
Signetics	LU 320	J–K	65	–	17	800	+ 10 to 55	TO-5
GATES (CTL)								
Fairchild	CTμL 953	2,2,3-input AND	3	8	12	400	15 to 55	Flat pack
	CTμL 954	Dual 4-input AND	3	8	12	400	15 to 55	Flat pack
	CTμL 955	Single 8-input AND	3	8	12	400	15 to 55	Flat pack
	CTμL 952	NOR	9	–	10	400	15 to 55	Flat pack
BINARY ELEMENT (CTL)								
Fairchild	CTμL 957	Dual Rank	15–20	–	15	400	15 to 55	Flat pack
BUFFER (CTL)								
Fairchild	CTμL 956	–	12	–	25	400	15 to 55	Flat pack

* -55° to + 125°C unless otherwise noted.

LINEAR CIRCUITS

Manufacturer	Model	Freq. Range (KC)	Input (Volts)	Input Z (ohms)	Output Z (ohms)	Package
VOLTAGE REGULATORS						
General Instrument	PC 501	100	+ 16 to + 24	–	0.2	Flat pack
	PC 502	100	– 16 to – 24	–	0.2	Flat pack
	PC 503	100	+ 28 to + 36	–	0.4	Flat pack
	PC 504	100	– 28 to – 36	–	0.4	Flat pack
	NC/PC 511	100	+ 15 to + 24	–	0.1	TO-5 & flat pack
	PC 512	100	+ 27 to + 36	–	0.2	Flat pack
	NC/PC 513	100	– 15 to – 34	–	0.1	TO-5 & flat pack
	PC 514	100	– 27 to – 36	–	0.2	Flat pack
ANALOG SWITCH						
General Electric	45P912	100 MC	0.0006	–	–	TO-5
	4JP913	100 MC	0.0006	–	–	TO-5
General Instrument	PC 401	200	3	10K/3.9K	–	Flat pack
DEMODULATOR CHOPPER						
Texas Instruments	SN 354A	5	26	–	–	Flat pack
D–A SWITCH						
General Electric	4JP3800	250 MC	–	–	20	TO-5
DRIVER SWITCH						
Texas Instruments	SN 355A	50	± 20	11 K	–	Flat pack
MIXER OSCILLATOR						
Westinghouse	WM 1102	30 MC	–	100	200	Flat pack

LINEAR CIRCUIT—A circuit whose output is an amplified version of its input, or, whose output is a pre-determined variation of its input.

MONOBRID—A method of manufacturing integrated circuits by using more than one monolithic chip within the same package.

"NOT"—A Boolean logic operator indicating negation. A variable designated "not" will be the opposite of its "and" or "or" function. A switching function for only one variable.

"OR"—A Boolean operator analogous to addition. (Except that two truths will only add up to one truth.) Of two variables, only one need be true for the output to be true.

PARALLEL OPERATION—Pertaining to the manipulation of information within computer circuitry in which the digits of a word are transmitted simultaneously on separate lines. Faster than serial operation, but requires more equipment.

PASSIVE ELEMENTS—Those components in a circuit which have no gain characteristics, capacitors, resistors, inductors.

POSITIVE LOGIC—The more positive voltage (or current level) represents the l-state; the less positive level represents the 0-state.

PROPAGATION DELAY—A measure of the time required for a change in logic level to propagate through a chain of circuit elements.

RCTL: RESISTOR-CAPACITOR-TRANSISTOR-LOGIC—Same as RTL except that capacitors are used to enhance switching speed.

REGISTER—A device used to store a certain number of digits within the computer circuitry, often one word. Certain registers may also include provisions for shifting, circulating, or other operations.

RTL: RESISTOR-TRANSISTOR-LOGIC — Logic is performed by resistors. The transistor produces an inverted output from any positive input.

SERIAL OPERATION — Pertaining to the manipulation of information within computer circuitry, in which the digits of a word are transmitted one at a time along a single line. Though slower than parallel operation its circuitry is considerably less complex.

SKEWING—Refers to time delay or offset between any two signals.

SKEWING RATE—Refers to rate at which output can be driven from limit to limit over the dynamic range.

SYNCHRONOUS—Operation of a switching network by a clock pulse generator. Slower and more critical than asynchronous timing but requires less and simpler circuitry.

THIN FILM—A method of manufacturing integrated circuits by depositing thin layers of materials to perform electrical functions; usually only passive elements are made this way.

TTL: TRANSISTOR-TRANSISTOR-LOGIC—A modification of DTL which replaces the diode cluster with a multiple-emitter transistor.

WORD—The term "word" denotes an assemblage of bits considered as an entity in a computer.

NEW TECH DATA

Instruments and Controls

This 58-page catalog covers pressure transducers, accelerometers, gyros, instrument recorders, angle of attack vanes, temp. probes, potentiometers and stepping motors. Complete specs., diagrams and photographs are included. The publication contains tables of standard atmospheric data, second-order linear system curves, and data on transient response as a function of damping ratio in second-order systems. Giannini Controls Corp., 1600 S. Mountain Ave., Duarte, Calif.

Circle 325 on Inquiry Card

Transducer Report

"Optimization of Potentiometric Type Pressure Transducers" discusses potentiometric transducer state-of-the-art with emphasis on new design principles and optimization possibilities. It can be obtained from Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle 326 on Inquiry Card

PC Connectors

Catalog Form PC600-765 Rev., 48 pages, is a PC connector catalog covering printed-card and tape-cable uses. Line includes microminiature, miniature, and standard size connectors. Designated Series 600, these receptacle-type units are made in a variety of single and dual read-outs with sizes from 6 to 210 contacts. They are capable of accommodating board thicknesses of 1/32, 3/64, 1/16, 3/32, and ⅛ in. These connectors meet or exceed applicable Mil-C-19833 specs. Continental Connector Corp., Woodside 77, N. Y.

Circle 327 on Inquiry Card

Receptacles Catalog

Catalog DHX-02 contains full description and spec. data on the DH02 series hermetic receptacles. The series meets all applicable specs. of Mil-C-5015 and all sealing specs. of Mil-S-8484. The receptacles mate with all MS (AN) plugs and use pin arrangements of the MS (AN) type. It is available in shell sizes 10SL through size 32 MS (AN) to mate with MS and MS-E plugs; either round or sq.-flange types may be ordered. Uses include direction finders, tachometers, relays, position indicators, transducers, etc. Deutsch-Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 328 on Inquiry Card

Conductive Adhesive

This high-thermal conductivity adhesive can be used for bonding semiconductor to chassis heat sinks; for fabricating heat sinks or thermal links; or for permanent bonding of all materials with highly thermal conductive interface. Called Delta Bond 152, the 100% solid adhesive is effective on porous and non-porous surfaces such as metals, glass, ceramics and most plastics. It produces a rigid high strength bond to most materials when cured. Complete details available from Wakefield Engineering, Inc., 139 Foundry St., Wakefield, Conn. 01881.

Circle 329 on Inquiry Card

Brushless Motors

Bulletin 7002 describes a line of brushless motors for high-speed uses. The literature explains how the units achieve high performance levels by substituting solid-state electronics for conventional brushes and commutators. It also tells how the motors, ranging in size from 1/100 hp to ½ hp, can be adapted to meet exacting uses by modification of circuitry and / or components. Different sections discuss freq. and speed characteristics; component selection; ac and dc packaging; performance evaluation; and application potential. Lamb Electric, Kent, Ohio.

Circle 330 on Inquiry Card

Mylar Capacitors

Bulletin Data-Log C-103C describes a greatly expanded line of metallized Mylar capacitors. They include expansions in round and flat wrap-and-fill and hermetically-sealed tubulars and a new line of bathtub hermetics. Featured is a 100vdc series. This line of miniature capacitors has been designed for complex circuits which require max. space economy and high performance. Hopkins Engineering Co., P. O. Box 191, San Fernando, Calif. 91341.

Circle 331 on Inquiry Card

Monitor/Controllers

Bulletin PS-14 presents comprehensive data on a new and versatile line of ult-Relay monitor/controllers. The 12-page, 2-color bulletin supplies general application background data, lists standard and optional features, thoroughly describes principles of operation, and provides many illustrations and drawings. Airborne Accessories Corp., Electronic Products Div., 1414 Chestnut Ave., Hillside, N. J. 07205.

Circle 332 on Inquiry Card

Test/Patch Panels

This data describes a new concept in design and construction of test panels. Metal panels of desired size or shape are drilled or stamped to spec., providing 0.250 in. dia. mounting holes. Then closed-entry test jacks for 0.080 in. dia. probes are pressed in for fast installation. The flexibility of design permits an infinite combination of layouts, with up to 10 different colors of jacks for coding. Electronic Molding Corp., 36 Church St., Pawtucket, R. I. 02860.

Circle 333 on Inquiry Card

Rectifier Catalog

A catalog entitled "Slater Assemblies" describes high-voltage rectifiers, bridges, miniature assemblies and other specially designed encapsulated units. It contains typical circuit uses, electrical specs. of high-voltage rectifiers, subminiature high-voltage silicon cartridge rectifiers and full wave bridge rectifiers. One such rectifier produces 200 to 1000v PIV/leg and 5a. average. The package measures 1 x 1 x 7/16 in. and requires no heat sink. Slater Electric Inc., Semiconductors Div., Glen Cove, N. Y.

Circle 334 on Inquiry Card

NEW TECH DATA

Measurement Note

Application Note #69, 40 pages, is a practical text on dc voltage measurement. Entitled "Which DC Voltmeter?," it begins with a lucid explanation of the available types and the reasons for their existence. It goes on to show how a dc voltmeter should be specified so as to serve the purpose exactly, while avoiding under-specifying and unnecessary cost from over-specifying. One chapter tells how to minimize the effect of unwanted signals in any type of dc measuring instrument, removing all the mystery from "floating" and "guarding." Hewlett-Packard, P. O. Box 301, Loveland, Colo. 80537.

Circle 291 on Inquiry Card

In-House Microcircuits

Small companies can now produce hybrid microcircuits within their own facilities for $110 a month. The equipment includes: a master reduction camera, a layout board, an oven, and a resist spinner. All parts offer the greatest flexibility to users in producing a substantial number of high value, stable and close tolerance resistors. Also available are consulting and advisory services covering the design, production and application of hybrid microcircuits. Complete details available from Electronic Films, Inc., a sub. of Xerox, Burlington, Mass.

Circle 292 on Inquiry Card

Nomographs

Two nomographs for determining Q from capacitance or inductance measurements are provided in a new technical publication. This folder also includes a convenient table of capacitance loss formulas for relating such quantities as D, Q, conductance, parallel resistance, and series resistance. Boonton Electronics Corp., Parsippany, N. J.

Circle 293 on Inquiry Card

Designers' Manual

This 16-page photocell manual should be invaluable to designers. Included is a bulletin describing 5H material, a photoconductive substance combining cadmium sulfide and cadmium selenide to realize the best features of each. The bulletin describes a series of photocells with speeds of between 1 and 2msec., and memory characteristics 15 times lower than those of CdSe photocells. Clairex Corp., 8 W. 30th St., New York 1, N. Y.

Circle 294 on Inquiry Card

Telephone-Type Relays

Data sheet No. 552 describes miniature telephone-type relays. Types LB and LBP relays, which provide high switching capability and versatility for their size, are described in detail. Coil, contact, and other electrical characteristics, as well as important environmental, mechanical, and dimensional data of the relays are included. C. P. Clare & Co., 3101 Pratt Blvd., Chicago, Ill. 60645.

Circle 295 on Inquiry Card

NEW TECH DATA

Relay Handbook

This relay handbook contains principles and contact characteristics necessary for proper use of the Drireed switching concept. The 56-page book contains graphs, drawings, and definitions for reed relays. The curves and data are planned as a guide to avoid misapplication of these relays. Hathaway Instruments, Inc., 5800 E. Jewell, Denver, Colo. 80222.

Circle 296 on Inquiry Card

Microdiodes

Bulletin 129 describes a microdiode production and reliability processing capability. The devices can be packaged into computer assemblies. Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif.

Circle 297 on Inquiry Card

Electroplating Process

Brochure E-70 describes a bright gold electroplating process. A graph indicating the effect of plating temp. and current density on Knoop hardness is included. By proper choice of conditions, deposits between 110 and 260 on the Knoop scale may be obtained. Technical Service Dept., Engelhard Industries, Inc., 75 Austin St., Newark, N. J. 07114.

Circle 298 on Inquiry Card

Resistor Catalog

This catalog on fixed-carbon composition resistors includes tables of sizes and physical dimensions. Ratings are provided in watts as well as the Mil type and standard resistance values and tolerances. Additional data on the Mil numbering system, color code, max. continuous working voltage, and dc resistance test voltages are also contained. Speer Resistor Div., Speer Carbon Co., P. O. Box 547, Bradford, Pa. 16701.

Circle 299 on Inquiry Card

Wire Bulletin

Bulletin #R-150 covers a new wire which meets Mil-W-81044 spec. for mid-temp., high-performance hook-up wire. Data contains mechanical performance, size, temp., rating, weight, charts, and other pertinent characteristics. Rachem Corp., Oakside at Northside, Redwood City, Calif.

Circle 300 on Inquiry Card

Oscillograph

Bulletin 5-124 contains data on a low-cost, portable recording oscillograph for aerospace, industrial, and medical uses. Type 5-124 can be operated by personnel with no training and features a new line of accessories. Channel capacity of the 40 lb. oscillograph is 6, 12, or 18, and static and dynamic data from dc to 13,000 cps can be recorded. Records are produced by the direct print process, which means no chemical processing is required. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 301 on Inquiry Card

Measurement Bulletin

The thermometer, resistance, and applied thermocouple methods that motor manufacturers use to measure temp. rise are fully detailed in "Bodine Motorgram" Vol. 45, No. 4. Pointers on applying motors in amb. over the temp. rise rating are also discussed. Bodine Electric Co., 2500 W. Bradley Place, Chicago, Ill. 60618.

Circle 302 on Inquiry Card

Relay & Contactor Catalog

This 19-page catalog features general and special-purpose relays and contactors. Pictures, dimension drawings, and specs. are included for 15 basic models. Units described are the R and FE relays, the B contactor (with models rated from 25a. through 75a.), the type BR reverser, and the fused contactor. The Rowan Controller Co., Eatontown, N. J. 07724.

Circle 303 on Inquiry Card

Encapsulants Guide

Selection Guide to RTV Encapsulants, a 2-color brochure, gives comparative physical, chemical, and electrical properties of 6 room-temp.-vulcanizing silicone-rubber encapsulants for electronic packaging. The brochure, 08-156, also gives how-to-use suggestions for the 6 materials, including data on pot life with different catalyst concentrations and data on how viscosity can be adjusted to suit particular processing needs. Dow Corning, Midland, Mich.

Circle 304 on Inquiry Card

NEW TECH DATA

Allied Catalog

Catalog 660, 544 pages, lists over 60,000 electronic components, communication gear, sound and allied equipment. Engineering data and prices of the new Knight relays, panel meters, variable and fixed transformers, wire and cable, and compact solid-state oscilloscopes are shown. Listed are: a complete section on integrated circuits; IC breadboarding equipment and connectors; precision thermistors; circuit modules; optical fibers; etc. Allied Electronics Corp., 100 N. Western Ave., Chicago 80, Ill.

Circle 305 on Inquiry Card

Core Memory

A new core memory system with 1μsec. speed and large memory capacity is described in bulletin 6534. The Series MFA1, with 400nsec. access time, is available in word capacities up to 32,000 in any bit length. Construction is all-silicon semiconductor PC modules. The brochure includes data for specifying any of 4 cycle operations, 6 access modes and 9 combinations of address and data registers, power supply and self-test circuitry. Physical, electrical and environmental data, and a timing chart are included. Fabri-Tek Inc., Amery, Wis.

Circle 306 on Inquiry Card

Thin-Film Materials

This data gives pertinent facts concerning the properties of various materials used in thin-film vacuum deposition. The brochure, called Chart A, alphabetically lists the material, its chemical symbol, melting point, density and minimum vaporization temp. at 10^{-8}, 10^{-6}, 10^{-4} Torr. It also includes brief notes concerning sources and deposition methods. Sloan Instruments Corp., P.O. Box 4206, Santa Barbara, Calif.

Circle 307 on Inquiry Card

Flat Pack

This data sheet describes the Mico Lead Design flat pack. The monolithic base of the MLD is alumina or beryllia for high mechanical strength. The 14 leads are either Kovar or nickel. Chip attachment can be made by wire bonding, flip-chip, or cantilever chip attachment techniques. Coors Porcelain Co., Golden, Colo.

Circle 308 on Inquiry Card

Memory Cores

Preliminary specifications on a new wide temperature, two-aperture Ferramic® core for nondestructive memory uses are described and illustrated in bulletin 2MAC-503. The bulletin contains dimensional drawings and typical oscilloscope photographs which show responses between −10°C and 70°C. Indiana General Corp, Electronics Division/Memory Products, Keasbey, N. J.

Circle 309 on Inquiry Card

Motors Brochure

GEA-7374 provides mechanical and electrical data on the 59 frame shaded-pole Unitized™ fractional hp motors. These 3.4 in. dia., all-angle type KSM motors are for use in forced-draft space heaters, portable fans, ventilators, portable evaporative coolers, tape recorders, humidifiers, etc. Publication includes a motor selection guide, mounting dimensions, and connection diagrams. General Electric Co., Specialty Motor Dept. 1635 Broadway, Ft. Wayne, Ind. 46804.

Circle 310 on Inquiry Card

Volt-Ratio Meter

Bulletin No. 92, 8 pages, describes the P9000B series digital instruments with a 3-year unconditional warranty. The bulletin also includes the B series plug-ins and digital data acquisition system accessories. Cimron Corp., 1152 Morena Blvd., San Diego, Calif.

Circle 311 on Inquiry Card

Protective Coating

Data is available on a new silver conductive coating for use on ceramics or plastics. Called HumiSeal Type CO-616, it is a low temp. cure, thermosetting material applicable to 500°F. It can be easily applied by pen, brush, or spray, and is recommended for shielding instruments or components electrostatically or electromagnetically. Columbia Technical Corp., Woodside, N. Y.

Circle 312 on Inquiry Card

NEW TECH DATA

Seal Catalog

A complete line of single pin glass-to-metal seals is described in Catalog 701. Called "Single Pin Terminals" the catalog contains detailed specs. of the dimensions and terminal configurations for over 150 seals, and provides a chart giving the max. test voltage and current rating of each seal as per Mil-C-8384B. Graphs to spacing of the terminals are provided. Aerospace Components Div., Atlas Chemical Industries, Inc., Valley Forge, Pa.

Circle 313 on Inquiry Card

Multipurpose Relay

Series 44 DC is a compact, versatile 4-pole double-throw relay. Typical load-life capability of 400K cycles at 5a. and a 50-pulse/sec. response rate make it ideal for use in telephone and communications equipment, computers, and various types of data processing and process control equipment. Detailed specs. cover both relay and socket assembly and include all essential electrical, environmental, and mechanical data. Sigma Instruments Inc., 170 Pearl St., Braintree, Mass. 02185.

Circle 314 on Inquiry Card

Instrument Knobs

A data sheet is available which describes a line of instrument knobs designed on the basis of human-engineering studies. Single knobs are offered in 6 models, including round, pointer and bar styles. Three models of concentric bases include pointer and round styles. A number of combinations are possible. All styles and sizes conform to requirements of equipment built to Mil-T-21200, Mil-E-16400, etc. North Atlantic Industries, Inc., 200 Terminal Dr., Plainview, N. Y. 11803.

Circle 315 on Inquiry Card

Resistor Catalog

This 16-page catalog describes a complete line of precision wirewound resistors. It gives detailed descriptions of the four major classes of resistors most commonly used in the electronics field: composition carbon, deposited carbon, metal film and precision wirewound resistors. The maximum capabilities are shown in comprehensive charts, and the advantages in specific uses for each of these classes are described. Daven, Div. of Thomas A. Edison Industries, Livingston, N. J.

Circle 316 on Inquiry Card

Semiconductor Package

This data describes the Versa-Pak, a relatively inexpensive line of semiconductor packages using Al_2O_3 ceramic. The basic design is quite versatile. Without additional tooling, it can be varied to accommodate diode arrays, matched pair transistors, or 1 or more discrete or monolithic dice. In all cases, the dice area is recessed to permit ohmic bonding upward, away from the device; or if a flip-chip is used, it can also be oriented in most cases to accommodate this approach, presenting a flip-chip within a flip package. CFI, 320 Long Island Expressway So., Melville, N. Y. 11749.

Circle 317 on Inquiry Card

HIGH VOLTAGE SILICON TRANSISTORS

Low cost
Fast switching speeds
400 volt Vceo ratings
Good current gain
High power dissipation
Operation directly from rectified line voltage
TO-3 package

Television horizontal and vertical deflection output stages
Single-ended high voltage audio output
Inverters and converters
Low frequency R.F. amplifiers
Fluorescent light inverters
High voltage regulators

HIGH POWER GERMANIUM NU-BASE TRANSISTORS

Very good high voltage-high current sustaining characteristics
High power dissipation
High beta
Vcex ratings to 325V
Low thermal resistance
Very rugged
TO-3 package

Automobile ignition systems
Television horizontal & vertical deflection systems
High efficiency inverters and converters
Fluorescent light inverters
Voltage and current regulators
High current control circuits

HIGH CURRENT GERMANIUM TRANSISTORS

25, 35, 50 amperes
Minimum beta of 12 at 50 amperes collector current
Vceo ratings to 60V
Low saturation resistance
Low thermal resistance
High power dissipation
TO-36 package

High power DC to DC converters
Power conversion from a low voltage source
Pulse width motor speed control
High current control circuits
General purpose switching circuits

MEDIUM POWER GERMANIUM ALLOY TRANSISTORS

Low cost
Linear transconductance
Proven reliability
Very high beta
Low thermal resistance
TO-3 package

High Fidelity audio amplifiers
Automobile radio audio output
Voltage regulators
Medium power inverters and converters
Television vertical deflection
Medium current control circuits

HIGH POWER GERMANIUM ALLOY TRANSISTORS

15 ampere switching capability
High power dissipation
Extremely reliable
Many voltage and beta ratings
Low saturation resistance
Collector diode voltages to 100V
TO-36 package

High efficiency inverters and DC to DC converters
Voltage and current regulators
Single-ended audio output
Control circuits
Switching circuits
High power communications modulators

MEDIUM POWER GERMANIUM NU-BASE TRANSISTORS

Small size
High current capability
Fast switching speed
Low cost
Good beta to 7 amperes collector current
High voltage ratings
TO-37 package

Print-out hammer driver
DC to DC Conversion at high efficiency
Portable fluorescent lights
Audio drivers and output stages
Regulator circuits
Light flashers

RECTIFIERS

Extremely reliable
Low cost
Press-fit package for inexpensive mounting
High average current rating
300 ampere ½ cycle surge current
Available in negative or positive case

Automobile a.c. generators
Battery chargers
High current bench supplies
General purpose high current rectifier
Polarity protection applications

These are our basic semiconductor families. They contain devices ideal in cost, quality and electrical capability for each of the applications listed.

One of them may help you crack a pesky circuit problem, or even suggest a better solution. Call us for data and applications assistance.

DELCO RADIO
Division of General Motors, Kokomo, Indiana
Phone (317) 457-8461

UNION, NEW JERSEY*
Box 1018 Chestnut Station
(201) 687-3770

SYRACUSE, NEW YORK
1054 James Street
(315) 472-2668

DETROIT, MICHIGAN
57 Harper Avenue
(313) 873-6560

CHICAGO, ILLINOIS*
5151 N. Harlem Avenue
(312) 775-5411

SANTA MONICA, CALIFORNIA*
726 Santa Monica Blvd.
(213) 870-8807

General Sales Office:
700 E. Firmin, Kokomo, Ind.
(317) 452-8211—Ext. 500

*Office includes field lab and resident engineer for applications assistance.

NEW TECH DATA

Cabinet Catalog

"Practical Cabinetry Designed with Alcoa Aluminum for the Electronics Industry" is a guide on how to design and fabricate electronic housings. It details the advantages of coated, vinyl-clad, and patterned aluminum sheet, patterned aluminum extrusions, and aluminum fasteners in both functional and appearance design for relay and cabinet racks, panels and brackets, decks, foundations, chassis bottom plates, and meter and speaker cases. Alcoa, 682 Alcoa Bldg., Pittsburgh, Pa. 15219.

Circle 318 on Inquiry Card

Toggle Switches

Publication LE-104 describes the "Designer Line" toggle switches. They come in a choice of 7 standard colors, 8 lever styles, 5 circuit arrangements, 3 terminal configurations, and 3 different ampere ratings for ac or dc. The full-color, illustrated publication lists design features, electrical ratings, circuit and terminal configurations, lever style and switch base dimensions on the complete line. Cutler-Hammer Inc., 4201 N. 27th St., Milwaukee, Wis. 53216.

Circle 319 on Inquiry Card

Slotted Lines

Bulletin SL-1 describes slotted lines which measure impedance of large size coaxial devices in their own dia. The bulletin offers data on freq. range, impedance, residual VSWR and connector configuration for 3 standard models in 1⅝, 3⅛ and 6⅛ in. dia. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 320 on Inquiry Card

Amplifiers Brochure

This brochure contains specs. and applications for a line of single-ended and differential amplifiers. The single-ended models use FET choppers and are short-circuit proof. The differential units are small encapsulated models which use either regular transistors or FETs. In addition to the products, company facilities are included. Zeltex, Inc., 2350 Willow Pass Rd., Concord, Calif.

Circle 321 on Inquiry Card

Random Access Memory

Product Data 1-103 describes a dual-cartridge random access memory system, the RAM® Model TLM-4550. It uses a drive system which allows high-density magnetic tape loops as the storage medium. These loops give the RAM simplicity of design and flexibility. The memory provides 50.2 million bits of on-line capacity equally divided between the 2 cartridges. Data is recorded serially at a data density of 1000 bits/in., and any data may be written or read at random by transmitting address information to the unit with an appropriate command signal. Average access time is less than 90msec. Potter Instrument Co., 151 Sunnyside Blvd., Plainview, N. Y. 11803.

Circle 322 on Inquiry Card

LEAK DETECTOR

If you ever tried to locate a microscopic vacuum leak you know it can take up to several days. This time is reduced to minutes by using a simple tool called an Ultraprobe. Made by Eitel-McCullough, San Carlos, Calif., it pinpoints leaks to within 0.010 in. when used with a mass spectrometer leak detector.

Rocket motor static level and high-frequency instability measurements from near dc to above 10kc are made with a high-precision transducer which uses "helium bleed" techniques. In the Model 615A, a product of Kistler Instrument, Clarence, N.Y., a very small, helium gas-filled passage is used to transmit both static and dynamic pressures to a protected, miniature quartz element. Using helium instead of air nearly triples the frequency response of the passage. The constant flow of gas also maintains the transducer in an environment conducive to precision measurement, and eliminates the need for water-cooling connections.

A report is available that answers many questions relative to flexible bonding configurations and their effectiveness at high r-f frequencies. Called "Theoretical Analysis, Measurements, and Practical Applications of Flexible Radio-Frequency Bonding Configurations," it is the result of tests conducted to compare the Z of various flexible bonding configurations, and gain a better insight concerning r-f bonding characteristics. Write to McDonnell Aircraft Corp., Lambert-St. Louis Airport, Box 516, St. Louis, Mo. Attention: R. M. Soldanels.

Engineers at the TRW Space Technology Labs. have found a way to stop the earth—at least as far as measurement purposes are concerned. Scientists trying to guide a missile to a target have the problem of compensating for the earth's movement. This problem is compounded by the instability of launch pads or structures. A new measurement technique, developed by TRW, combines optical and inertial sensing instruments to accurately measure the stability of launch structures. By determining the exact launch point, the boosters guidance system will have a reliable reference point on which to base its targeting.

How transfer standards are useful to compare standard cells against working standards to an accuracy of 2 ppm during a working day in a normal laboratory environment is explained in application note #70. This should be especially useful to facilities which must maintain accuracy in the calibration of dc standards, data acquisition systems, and dc digital voltmeters. Write to Hewlett-Packard Co., P.O. Box 301, Loveland, Colo.

The Radio Standards Laboratory of the NBS Institute for Basic Standards at Boulder, Colo., has announced three changes in the microwave calibration services it offers: (1) Calibration of noise sources has been extended to WR62 waveguides. (2) Calibration of coaxial attenuators and couplers has been pushed beyond the former ceiling of 12 GH$_z$ up to 18 GH$_z$. (3) Measurements of reflection coefficient magnitude is now also available for WR137 waveguides.

Non-contact measurement of displacement, vibration, dimension, reflectivity, speed, quantity, etc., can be easily made with a versatile fibre-optics cartridge/probe device. Made by Mechanical Technology Inc., Latham, N.Y., it has a displacement range of 0.002 in. to 0.500 in.; freq. range is dc 2MC; and resolution is from 0.000001 in. in static instrument to 0.000010/25 in. in dynamic version.

Extremely high analytical sensitivity in the order of 1 part/billion, and electronic recording of mass spectrometric data are features of the Ion Microprobe Solids Analytical Mass Spectrometer now being offered by GCA Corp., Bedford, Mass. The instrument can be used to obtain a recorded analysis of the surface and bulk of solid materials, rapidly and without sample preparation.

NOT QUITE

Almost perfect sphere isn't perfect enough at ACF Industries' Albuquerque Div. standards laboratory. Technician Anthony Hofman demonstrates on chart how slighest deviation is shown in roundness of 3½ in. reference ball that will be used in test equipment. Device rotates and charts ball to 3-millionths of an inch.

By H. HELLER Senior Staff Engineer, Bird Electronic Corp., Cleveland, Ohio.

A discussion of directional R-F wattmeters, why they work and how to use them.

Applying Directional RF Wattmeters

DIRECTIONAL R-F WATTMETERS ARE AVAILABLE to measure power of either the forward or the reflected wave in 50-ohm coaxial r-f transmission lines. How is this done?

Whether for use with r-f cable connectors or for rigid lines to 9 in. dia., the wattmeters consist of an accurately constructed section of known characteristic impedance Z_o (50.0 ohms), precision-machined sockets for the insertion of the various plug-in elements which determine power and frequency range of the instrument, and one or two D'Arsonval meters. The sensing circuit, which is completely contained in each element, is basically a resistor R in series with a loop coupled to the center conductor by mutual inductance M. Since the elements can be rotated in their sockets by 180°, M is either positive (when the arrow points toward the load), Fig. 1 (a), or negative (with the arrow in the opposite direction), Fig. 1 (b).

The bottom of the resistor and the portion of the loop parallel to the axis form a third component, capacity C, with the center conductor. The complete basic sensing circuit with associated voltages is shown in Fig. 2. This is the circuit of a "lumped constant" directional coupler, if the physical dimensions of the loop are kept to a small fraction of a wavelength.

How does this circuit discriminate between the forward and reflected waves, i.e., what makes it directional?

The output voltage, e, is the sum of two samples: e_R from the division of E by R and C,

$$e_R = \frac{RE}{X_c} = RE\ [j\omega C \text{ (if } R \ll X_c)], \text{ and}$$

e_M by induction.

$$e_M = I\ [j\omega\ (\pm M)].$$

The sum, $e_R + e_M = j\omega\ (CRE \pm MI) = e$.

Besides selecting R very much smaller than X_c, the components of the circuit are chosen so that $CR = M/Z_o$.

The output voltage is now:

$$e = j\omega\ (EM/Z_o \pm MI) = j\omega M\ (E/Z_o \pm I).$$

At any one point on a transmission line, the voltage, E, is the sum of the forward and reflected voltages $E_f + E_r$ (Fig. 4); and the current, I, is $E_f/Z_o - E_r/Z_o$. (Since the reflected wave travels in the opposite direction $I_r = -E_r/Z_o$).

When the element is pointing toward the load, the output voltage is:

$$e = j\omega M\ (E/Z_o + I) =$$

$$j\omega M \left(\frac{E_f + E_r}{Z_o} + \frac{E_f - E_r}{Z_o}\right) = \frac{j\omega M}{Z_o}\ (2E_f);$$

and turning the element toward the source, it becomes:

$$e = j\omega M\ (E/Z_o - I) =$$

$$j\omega M \left(\frac{E_f + E_r}{Z_o} - \frac{E_f - E_r}{Z_o}\right) = \frac{j\omega M}{Z_o}\ (2E_r)$$

Fig. 1: Schematic of sensing circuit. At (a), mutual coupling is positive; at (b) negative.

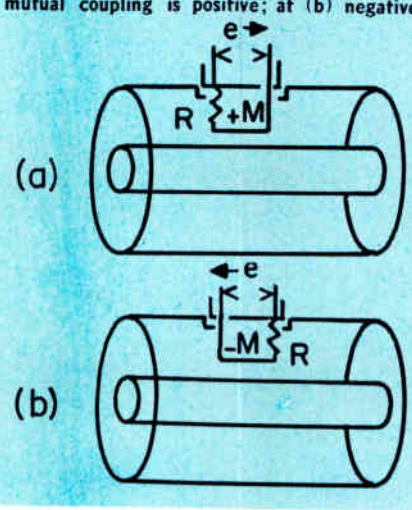
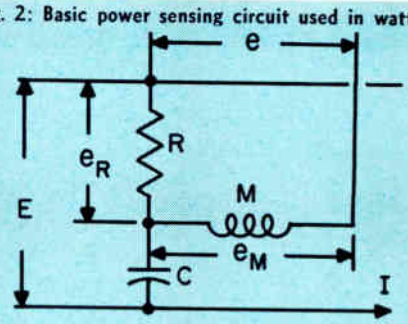


Fig. 2: Basic power sensing circuit used in wattmeter.



C & R = voltage dividing network
M = mutual inductance between loop and center conductor
E = voltage between outer and center conductor
I = current in line

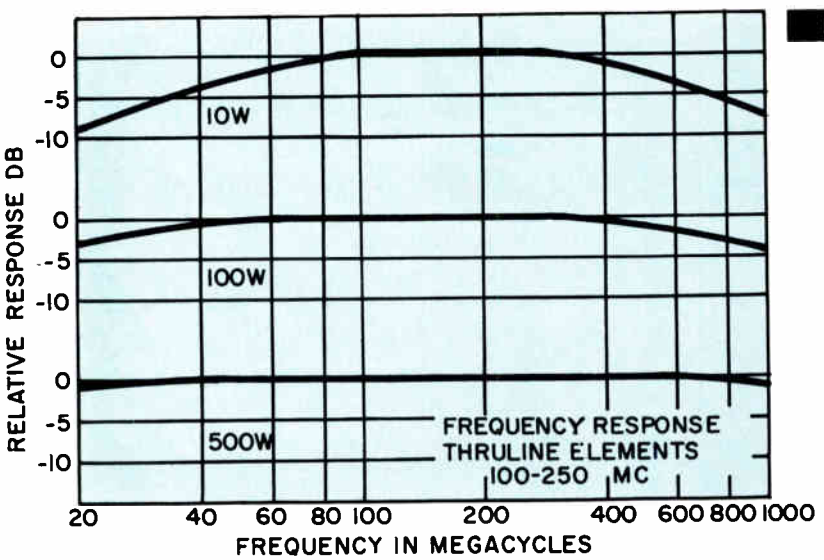


Fig. 3: Typical sensitivity response curves for r-f wattmeters.

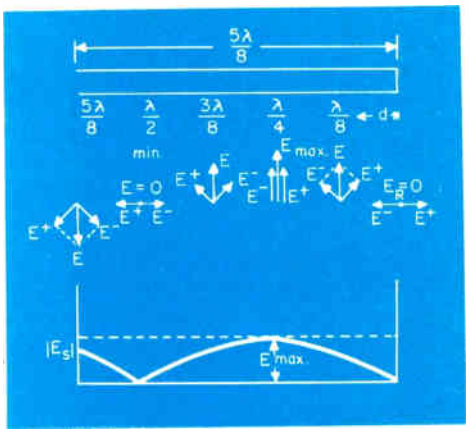


Fig. 4: Standing-wave diagram for voltage on a transmission line.

This proves that the r-f output voltage from the sensing element is directional and proportional to the voltage in the line due to either the forward or the reflected wave. It is also directly proportional to ω, that is to frequency ($\omega = 2\pi f$). To make it frequency independent, e can be terminated in a capacitive reactance which is inversely proportional to ω. The voltage across this capacitor is rectified, filtered and displayed on a meter calibrated in r-f watts.

How frequency-independent are the plug-in elements and what happens beyond their stated limits? The "frequency range," i.e., the band of frequencies for which 5% measurement accuracy is listed, varies from narrow to 15/1. The most common top-to-bottom frequency ratio is presently 2.5/1 as shown in Fig. 3. Designed for operation between 100 and 250 MC, the 500 w element is flat far beyond these limits, while the 10 w unit drops off on either side of the limits.

The explanation for this is simple. Since the same indicating meter is used for all power ranges, the output voltage, e, for full scale deflection must be the same. The sensing element must be coupled tighter to the line for low power levels than for higher powers, i.e., the C and the M must be larger. The larger C eventually violates the design condition that R be much smaller than X_c, and larger mutual inductances M are no longer purely reactive.

Furthermore, the ability of the circuit to discriminate between the forward and reflected wave components, i.e., its directivity, depends upon the relationship $CR = M/Z_o$. While the C and the Z_o are easy to maintain, keeping undesirable reactance and resistance factors out of R and M requires state-of-the-art skill and components.

What is the effect of load impedance on the accuracy? The design formulas show that the only impedance influencing the output voltage is Z_o, the characteristic impedance of the line at the point of measurement. Since each commercial wattmeter is supplied with a section of 50-ohm line, this Z_o is accurately known.

Where should the wattmeter be inserted? Again referring to the formulas, it can be seen that the elements extract a voltage proportional to *either* E_f *or* E_r. While the total voltage, E, varies along an improperly terminated 50-ohm line, the component voltages do not. This is simply another way of saying that the energy contained in the forward wave remains the same from the source to the load, where some or all of it is reflected (unless the load is 50 ohms) and that reflected energy remains constant from the load back to the source. The directional power meters can, therefore, be placed anywhere between the source and the load.

There are some logical exceptions. For instance, if the transmission line is long and lossy, some energy will be dissipated in it. A power meter at the transmitter will measure power at that point and, when transferred to the antenna, will measure how much of it arrived. Incidentally, the difference between the net power levels represents the line or cable losses. Similarly, a power meter inserted between a transmitter and a low-pass filter indicates the sum of the fundamental and harmonic frequencies power in the forward direction, and all of the harmonic frequencies power plus whatever fraction of the fundamental is reflected in the reverse direction (the sensitivity of elements to harmonics depends on their frequency response as shown in Fig. 3). If the meter is now transferred to the other side of the filter, it will only indicate fundamental power in either direction.

Wattmeters, designated "Thruline" by Bird Electronic Corp., are available from 1 w to 250 kw, from 0.45 to 2200 MC, and for all sizes of 50-ohm rigid line or cables. Model 43 for cables, and details of rigid line and peak-reading models, are shown in general catalog GC-65, available on request from Bird Electronic Corp. direct.

WHAT'S NEW

HIGH-RESOLUTION PICKUP TUBE

UP TO 3000 TV LINES/IN. ARE EASILY ATTAINED by a new 3-in. image dissector pickup camera tube. Called the WL-23111, it has excellent black and white contrast as well as a short rise and decay time. The tube is ideal for microfilm readout, TV film scanning, and high-speed flying-spot scanning.

Its manufacturer, Westinghouse Electric, Elmira, N. Y., says the new tube is inherently more rugged and longer lived because it has no target or hot cathode to deteriorate. Circuitry is simpler since there is no beam-forming gun, and standard image orthicon components can be used when scan rates permit. A zoom effect can be attained electronically by magnification through scan reduction. By decreasing the deflection amplitude and underscanning the image, a magnification of several hundred times is possible. Resolution is the same as that for the original area imaged on the photocathode. No change in light level is necessary during the underscan operation.

In operation, an electronic picture corresponding to the optical image focused on the faceplate is emitted from the photocathode. The picture is then scanned across an aperture, and at any instant in time only the electrons passing through the aperture enter the electron multiplier. The quantity varies with the light intensity on the portion of the image being scanned. Further amplification is accomplished by secondary emission in the 12-stage multiplier section. The resulting output from the multiplier collector represents the dissection of the original image into an orderly sequence of electronic segments which are then fed into a video amplifier.

Image dissector pickup camera tube has no target or cathode.

MICROELECTRONIC DEVELOPMENTS . . .

General Micro-electronics has introduced a family of monolithic integrated MOS sub-system functions. The MOS sub-system functions are a continuation of GMe's PICOLOGIC family. The series contains counters, gates and registers, useful for many functions covering general logic design, digital computation, and analog signal multiplexing.

Electronic Films Inc., subsidiary of Xerox Corp. has announced an "unusual entry" into the equipment leasing business. For a monthly rental the firm will provide a complete set of equipment enabling users to custom-produce their own designs in hybrid microcircuits within their own facilities.

Sperry Semiconductor announced that it has available for delivery five monolithic RTL circuits in flat packages and in low profile TO-5 cans. The circuits are under the Sperry name "MICRONETS," but they are produced under processing methods patented by Fairchild Camera and Instrument Corp.; they are completely interchangeable with Fairchild units.

Microtek Electronic Inc. announces new thick-film capacitor networks from 1,000 to 500,000 pf/in² with low temperature coefficients, low dissipation factors and low voltage coefficients which cover circuit applications ranging from bypassing to high-Q 500 MC tuning. Voltage is rated to 50 volts.

Complete process systems for washing and rinsing semiconductor substrates and other micro-electronic devices are offered by Interlab Inc. Standard designs incorporating up to six stages offer choice of overflow tanks, multi-stage cascades, automatic or manually adjustable heating systems and ultrasonic equipment specifically designed for processing the most fragile components.

Electroglas Model 131 Motorized/Manual Wafer Die-Sort combines a number of advances for improved microcircuit and transistor wafer testing, according to Electroglas Inc. "Versatility of Model 131 probe head and vacuum stage adjustments—plus motorized, footswitch-operated probe ring —make it the fastest operating, non-automatic die-sort in the industry."

COMPUTER APPREHENDS OFFENDERS

A NEW APPLICATION FOR A COMPUTER SYSTEM is being tested out by the New York City police department with startling results so far.

The police have been faced with a serious problem of apprehending over 100,000 scofflaw offenders a year who break traffic laws but fail to answer court summonses or pay the prescribed fines, and with solving some 30,000 cases of stolen cars and 10,000 stolen license plates. By working in cooperation with engineers at Sperry Rand Univac Division, a system was devised to aid in the solution of these crimes.

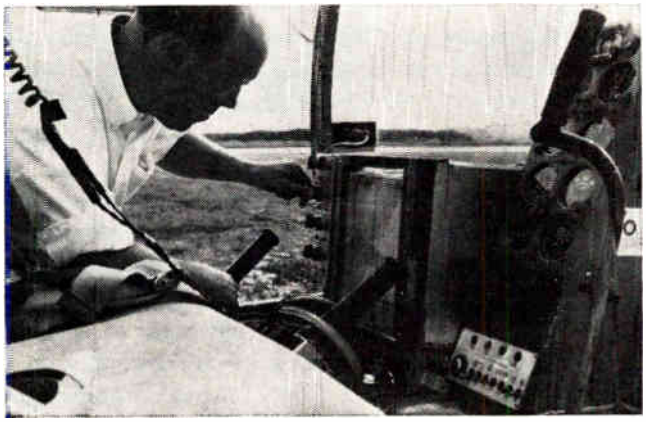
Called "Operation Corral" (Computer Oriented Retrieval of Auto Larcenists), the system operates as shown in Fig. 1. First, the license plate numbers of offending motorists are fed to the memory drums of a Univac 490 Real-Time Fastrand Mass Storage Subsystem located in the U.S. Pavilion at the New York World's Fair. Two police cars are strategically placed on a densely packed roadway. The rear police (observer) car obtains license numbers from passing cars and radios these numbers consecutively to police headquarters. A communicator at headquarters teletypes these numbers to the Univac 490 computer where the offending numbers are stored. If the number transmitted is in storage, a signal is given which is relayed to the forward police (apprehending) car which makes the arrest. Time for completion of the check is only 5 to 7 seconds from the time the car license number is first observed.

In demonstration before the press, a car was apprehended whose driver had passed through a red light early in 1964 but had failed to answer a summons or pay the customary fine for such offense. A warrant had previously been issued for her arrest but could not be served because she had moved without leaving a forwarding address. The warrant was in the apprehending police car and was served on the spot. The offender was driven to court and required to stand trial!

In use since May on a very limited basis, this electronic system has resulted in the apprehension of about 2,000 scofflaws. For instance, on May 27th, a 20 year old man was apprehended for a stolen license plate in the Bronx. When arrested, he was also charged for grand larceny, a forged drivers license, forgery of motor vehicle registration and a stolen car. On July 3rd, a man was apprehended in Manhattan for a stolen license plate. When arrested it was learned that he was wanted in Camden, N. J., for assault and robbery. On July 13th in Brooklyn, a young man was apprehended for a stolen license plate. Police discovered and charged him with illegal possession of narcotics.

Whether the electronic system will be continued beyond a trial period that will end with the closing of the World's Fair will depend upon the economics of it. This is yet to be evaluated. But, it looks good and could prove to be just one more mass application for computers.

BLH RECORDER MEASURES AIR POLLUTION



Four-channel recorder, highly portable, easily installed in aircraft, used to record air pollution over metropolitan New York. The recorder, made by Baldwin-Lima-Hamilton Electronics, is adjusted by Alex Proudfit, head of Sign-X Labs., firm making air sample tests.

DOD STANDARDIZATION FLAW—Somewhat red-faced Pentagon brass, prodded by the General Accounting Office, are setting up a system to review new items and make sure that items dropped by the procurement standardization program stay dropped. GAO discovered that while one Defense group was busy cataloging and standardizing general supply items, other branches were blithely buying items that had been dropped. Apparently the problem arose where new items were not analyzed by persons with technical ability to decide whether a standard item would serve as well.

EDITOR'S NOTEBOOK

NOISE-CANCELLING dynamic microphone with built-in transistor amplifier for telephone-type handsets where a uniform frequency response, low noise and low distortion are required, has been introduced by Altec Lansing. Typical uses includes high quality sound systems where telephone transmitters are dialed into sound systems for paging.

AUTOMATED air conditioning and other functions is one of the newest uses for computers. The new International Monetary Fund building in Washington, D.C., is being fitted for a Westinghouse Prodac® 50, with a 12,000-word memory, expandable with modules to 16,000 words at will. The system will handle the air, heat, ventilation, lights, power and fuel usage and other functions important to the operation of a large office building.

COMRADE SOLONS for Soviet legislative drafting agencies are thinking about using computers to prepare legislation, as reported by Radio Liberty in West Germany. The law agencies are showing great interest in the possibility of using computers in the law office. A Soviet source hints that the first electronic law clerk will be employed "in the near future," although research is slow.

SOLID-STATE electronic control of large capacity trucks (up to 40,000 lbs.) opens up "exciting vistas in the use of electric trucks for material handling," according to Elwell-Parker Electric Co. Control circuitry employs silicon controlled-rectifiers instead of mechanical switches or power transistors to modulate traction motor power. SCR control delivers full motor torque, without jerks or wheel spinning, at any truck speed.

COMPUTERS have landed and the U.S. Marines have them well in hand. The Corps has started a computerized logistic system—for almost instantaneous response to a world-wide military commitment. The system includes five IBM System/360s at three USMC locations. Hub of the system, and inventory control point, is at Philadelphia, Pa. The system will control some 380,000 supply items for the Fleet Marine Forces, ranging from transistors to huge tanks.

GIRL FRIDAY — electronic style — breezed through its first test of public opinion with all semiconductors flying. Fascinated customers at three South Florida banks gave the automated machine (Lectro-Teller by Milgo Electronic Corp., Miami) their strong approval after watching it unfailingly accept deposits, issue receipts and reject counterfeits.

ELECTRONIC REVENOOERS are closing in. The IRS has added five more Honeywell 200 computers to its nationwide system. There are now 15 systems being used to process individual and business income tax returns. IRS believes the systems are improving mathematical verification of returns, increasing ability to detect improper refund claims.

ICE CONDITION detector designated I C E D (Ice condition Electronic Detector) developed by Holley Carburetor Co., Warren, Mich. "I C E D can anticipate conditions that form ice before ice can form, and then actuate a predetermined mechanism to start an anti-ice action." System includes moisture and temperature sensing elements, power supply and logic circuit.

BOOKS

Physical Networks

By Richard S. Sanford. Published 1965 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 07632. Price $17.25. 576 pages.

Several areas of engineering are linked to present a unified treatment of linear lumped-parameter systems. Electrical, mechanical, hydraulic, acoustical, and thermal systems are examined side by side in this investigation. Subject matter ranges from classical techniques to modern developments that have exerted an influence on systems analysis methods.

Probability and its Engineering Uses, 2nd Ed.

By Thornton C. Fry. Published 1965 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. Price $15.00. 462 pages.

First published in 1928, much of the material has been completely rewritten, and new material on Random Walks, Markov Processes, and the Foundations of Statistics has been added.

Book contains many examples and presents a well-graduated introduction to the mathematical theory of probability. This is followed by a treatment in greater depth of topics of special interest to physical and social scientists. It presupposes a knowledge of mathematics through the calculus.

Rectifier Circuits: Theory and Design

By Johannes Schaefer. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $13.50. 347 pages.

Gives a clear, up-to-date account of rectifier connections of practical value for small power supplies and large rectifier installations. Both performance and design characteristics are included. The connections are briefly introduced, explained, and commented upon regarding practical applications. Following this, the relations between the electrical quantities are investigated for the a-c side, considering the rectifier connection as a load to the a-c supply system. Finally, the relations between the d-c quantities are examined, conceiving the rectifier as a source of d-c power.

Electronic Ceramics

By Dr. John H. Koenig. Published 1965 by American Society for Testing and Materials, 1916 Race St., Phila., Pa. 19103. Price $1.25; to ASTM members: $0.90. 26 pages, paperback.

Book is a printed version of a lecture given by Dr. Koenig during ASTM's 67th Annual Meeting, held in Chicago on June 24, 1964. This lecture, entitled the "1964 Edgar Marburg Lecture," is a memorial to the first secretary of ASTM.

Dr. Koenig discusses some of the present electronic ceramics and the effect our basic knowledge of these materials and new methods of fabrication will have on future developments.

The Nature of Induction Machines

By Philip L. Alger. Published 1965 by Gordon and Breach, Science Publishers, 150 Fifth Ave., New York 11, N. Y. Price $25.00. 516 pages.

The author provides an understanding of the nature, design, and uses of both single-phase and polyphase induction motors. He extends in scope and updates his earlier book "The Nature of Polyphase Induction Machines."

Books Received

Electrodynamics

By L. Page and N. I. Adams, Jr. Published 1965 by Dover Publications, Inc., 180 Varick St., New York 14, N.Y. Price $2.50. 505 pages, paperback.

This Dover edition is an unabridged and unaltered republication of the second (1945) printing of the work first published in 1940 by D. Van Nostrand Co., Inc.

Micropower Logic Circuits

By John C. Sturman. Published 1965 by NASA. Copies of this report may be obtained from Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151. Price $0.75. 15 pages.

Electromechanical Control Systems and Devices

By Eugene B. Canfield. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $13.50. 328 pages.

Technical Writer's & Editor's Stylebook

By Rufus P. Turner. Published 1964 by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis 6, Ind. Price $3.95. 208 pages, paperback.

INTERNATIONAL NEWS

London—Plessey Company Ltd. is undergoing a major realignment aimed at a larger share of world markets. UK operations will be divided into automation, components, dynamics, electronics, and telecommunications, all under Plessey name.

Chelmsford, Essex — A cryogenic strip-line circulator has been developed by Marconi Co. to operate as low as —260°C, an essential component in certain types of low noise amplifier for satellite communications.

Hayes, Middlesex—A new portable professional tape-recorder, less than 11 pounds in weight including batteries, was announced by EMI Electronics Ltd. It can take a fourth magnetic head for sound sync. and can mix two mike inputs.

Farnborough—New dynamic analysis equipment developed by Solartron is to be introduced to U.S. markets. Agreement has been reached between Solartron and the Boonshaft and Fuchs Division of Weston Instruments.

Glasgow—Complete automatic equipment for analyzing effect of rocket motor flame on radar signals has been developed by James Scott Ltd., Carntyne, Glasgow, for the Ministry of Aviation.

Carnarvon — CTS Corp., Elkhart, Ind., announced that a license agreement is being negotiated with A. B. Metal Products Ltd., Wales, for the manufacture of microelectronic components and circuits.

Belfast—An electronic components manufacturing operation is being established in Northern Ireland by Globe-Union, Inc., Milwaukee, and Simms Motors and Electronics Corporations, Ltd., London.

Toronto—Smiths Aviation Division announced that 15 Hawker Siddeley Trident 2 aircraft recently ordered by British European Airways will be fitted with Smiths' Series 5 Flight Control System.

Mar del Plata — Principal seaside resort and one of the largest cities in Argentina, will soon have one of the most modern Marconi television broadcasting stations in the country.

Mainz—IBM Germany announced plans to build a new computer manufacturing facility of 200,000 square feet. Plans call for start of manufacture of System/360 computers in the new plant by mid-1966.

Stuttgart—A Telefunken high-capacity computer TR4 has been acquired by Stuttgart Technical University for the solution of problems in solid-state physics and nuclear energy.

Munich—"electronica 66" International Trade Exhibition of Electronic Components and Related Measuring and Production Equipment will be held at Munich October 20, through 26, 1966.

The Hague—Dutch P.T.T. has ordered a radio link network from Telefunken. The system (FM 600-TV/7400) is transistorized except for one klystron in the transmitter stage. System can handle 600 telephone channels.

Emmen—Oak Electro/Netics Corp. has established a European R&D center in the Netherlands. With 30 scientists and engineers, it will occupy the facility of N.V. Messa Electronics, continental branch of Oak.

Copenhagen—The International Fair for Electronics, Automation, and Gauges, will take place in Copenhagen February 25 through March 6, 1966.

Sevres — Alpha Microelectronic Co. Inc. (AME), Beltsville, Md., and Airtronics of Sevres, France, have a licensing agreement in thin film microelectronics. Airtronics' initial needs will be satisfied by Alpha Microelectronics directly.

Rome—Italian avionics firm—Construzioni Aeronautiche Giovanni Agusta—has purchased a light-weight LFE Doppler Radar Navigator for use in an Italian Navy anti-submarine warfare helicopter.

Milan—The 43,000-ton flagship of the Italian merchant fleet, S.S. Michelangelo, is equipped with a radio-telephone station designed and manufactured by IT&T FACE Standard.

Fukaya—Toshiba has opened another plant in Japan to meet the growing demand for color TV. Production is expected to begin in October, with the initial rate of 5,000 sets per month.

New Ghana—The Ghana television service installed by Marconi Co., "the most modern television system in Africa," has been officially declared open by President Dwame Nkrumah.

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PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

TI PERSONNEL GROWTH MAY BECOME INDUSTRY TREND

Texas Instruments' President Patrick E. Haggerty commented recently on the rising need for highly-trained people to keep pace with the complexity of electronic technology. He said employees with master's or doctor's degrees in his firm had increased from a few in 1950 to more than 700 at the end of 1964.

From 1960 through 1964, Mr. Haggerty said, the growth rate of such degrees needed by TI had been nearly constant. He said the rate may accelerate over the next ten years. He projected that TI would require nearly 12,000 college-trained personnel of all degrees by 1974.

He also expects that over the next ten years TI will have hired more than 4,000 persons with master's degrees and about 10,000 with bachelor's degrees.

HIRING PACE QUICKENS

Hughes Aircraft Company wants to hire about 600 scientists and engineers by the end of this year. The firm is recruiting men with all degrees for work on Early Bird-type communications satellites, Surveyor soft-landing moon vehicle, Phoenix air-to-air missile system, TOW missile, tactical avionics systems, an air-to-surface missile system, lasers, infrared, radar and signal processing and display systems.

Hallicrafters Co. says it plans to hire 300 scientists, engineers and technicians by the end of 1965 for work on several programs involving advanced technologies in electronic countermeasures. The programs are in support of the new strategic and tactical requirements of the Department of Defense.

COURSES FOR ENGINEERS

In a further development of its special programs in science and engineering, Newark (N. J.) College of engineering has announced a new Division of Continuing Engineering Studies to provide very advanced noncredit courses for practicing engineers in various phases of technology.

SCIENCE AND MATH PROBLEMS A 'CINCH' NOW

Stephen Downing (right) checks 900-line-per-minute printer of GE 215 computer system at Altoona (Pa.) Senior High School. The $250,000 system has become an important tool for 1,000 out of 3,300 students. Kenneth Long prepares to feed problems to the system.

SURVEY SHOWS ENGINEERING SECOND; MEDICINE IS FIRST

A Gallup survey has shown that engineering is topped only by medicine in terms of public esteem, reports the National Society of Professional Engineers.

In a report on the recent nationwide survey, Joseph L. Gillman, P.E., chairman of the NSPE Public Relations Committee, and consulting engineer, pointed out that while engineers in general ranked second, there was widespread lack of understanding as to what engineers actually do.

Respondents were handed a card listing nine professions, and asked: "Suppose a young man asked your opinion about a profession. Assuming he was qualified, which would you first recommend?" A total of 33% said doctor of medicine, 18% said engineer, and 11% said scientist.

Next in order was lawyer, 7%; clergyman, 7%; dentist, 5%; professor, 4%; government administrator, 3%; and banker, 2%. About 23% of men chose engineering, while only 13% of women did so.

Survey findings were based on interviews with 1,633 adults selected as a close approximation to the U. S. adult population. Mr. Gillman said interviewees chose engineering because of: best future, diversity of opportunity (40%); good income (29%); and engineers are needed (18%).

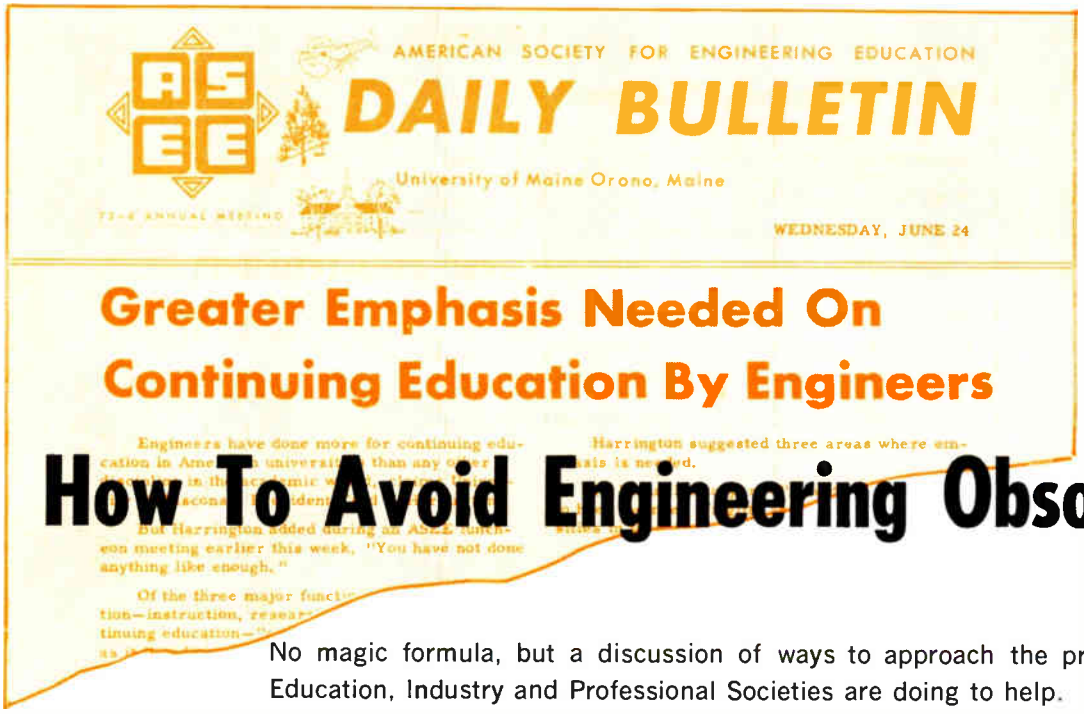
About 60% defined a scientist as one who invents, discovers, or researches. Some 29% think an engineer works with the practical application of known facts or of scientific discoveries. Some thought of an engineer as a builder (17%), while 8% said he plans, drafts or designs plans, 20% didn't know what an engineer does, and 21% didn't know what a scientist does. About 3% said there is no difference.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 134.

DEMAND INDEX RECORDS 5-YEAR HIGH FOR MID-1965

Heavy recruiting continues to characterize 1965 as the Deutsch & Shea Engineer/Scientist Demand Index registered 128.7, the highest July demand in the five-year history of the Index.

Although down more than nine points from the previous month's 1965 high, this decline can be attributed to traditional seasonal factors. The July figure is the second highest thus far in 1965 and is 60 points above July, 1964, an increase of 87%. All indications point to a continuing strong demand for technical people for the rest of the year.


AMERICAN SOCIETY FOR ENGINEERING EDUCATION

DAILY BULLETIN

University of Maine Orono, Maine

WEDNESDAY, JUNE 24

Greater Emphasis Needed On Continuing Education By Engineers

Engineers have done more for continuing education in Ame... than any ... in the ... economic ... But Harrington added during an ASEE luncheon meeting earlier this week, "You have not done anything like enough."

Harrington suggested three areas where emphasis is needed.

Of the three major functions—instruction, research, continuing education—...

How To Avoid Engineering Obsolescence

By ELMER T. EBERSOL
Editor-at-Large
ELECTRONIC INDUSTRIES

No magic formula, but a discussion of ways to approach the problem and what Education, Industry and Professional Societies are doing to help.

ELECTRONIC ENGINEERING, as it is today, could not have been studied 20 years ago.

A 1933 engineering graduate who has kept up with the times said: "Our technological world is changing so rapidly that its forward thrust, like that of the huge rocket that catapulted Gemini 5 into space, is overwhelming." He went on to say that 30 years ago, "it was inconceivable that the length of a conductor and the time required for a pulse to travel its distance could ever present a problem. Today, one of the limiting factors in computer design is the length of the conductors even on the small circuit boards of approximately 2 x 4 in."

The transition from what might be called "handbook engineering" to engineering based upon new scientific fundamentals was stimulated by the exigencies of World War II. The following years of uncertain peace have, in turn, continued the demand for creative scientific engineering and an engineering educational system capable of supporting it. The stimulation of competition, the increased tempo of engineering development, the demand for new materials, systems and processes has not diminished and, in fact, will not diminish. As a consequence, the changes in engineering curricula have been so rapid, that it is not now uncommon for a senior to graduate with a different program than he anticipated as an entering freshman. Alumni returning a few years after graduation would find a different vocabulary and would generate a feeling that they might best start all over again. It is in this context and for these reasons that continuing education for practicing engineers is assuming the proportions of a major challenge to the professional societies and universities alike.

If one reflects upon the educational needs of experienced engineers and the attendant responsibilities of our professional societies and of engineering schools, he must recognize that new approaches to teaching and learning are needed which may differ widely from accepted academic practice in degree programs. The domain of continuing education must develop characteristics germane to the problems and must find solutions which assure acceptance and engender the respect of the engineering community.—Dr. Ernst Weber, President, Polytechnic Institute of Brooklyn.

Keeping Up

Much has been said and written recently about engineering obsolescence and an engineering half-life of 10 years. If the charge is true, engineers who graduated a decade or more ago could well fit into this category. This could be true whether his degree is B.S., M.S., or Ph.D. But, obsolescence is hard to define. So is "continuing education"—the suggested cure for obsolescence. Although a relatively new term, "continuing education" (CE) programs are currently offered at almost every major college and university. Trouble is, there is no standard definition for CE. Some schools offer adult education courses under this label; others call their graduate degree-granting programs "continuing education." Those courses of principal interest to practicing engineers some years out of college are those whose contents are specifically designed to meet their immediate or future needs without primary concern for credit toward advanced degrees.

That what constitutes CE may often seem confusing is not surprising when one understands that this term was virtually unheard of three years ago. If you don't know where to start on a program of continuing education, yourself, you are also in good company. How can a man know what to study when he doesn't know what he will be expected to do in his company six months hence? It is an indictment of American Industry that advanced planning for personnel only exists in a very few enlightened companies.

You may not get much help from your supervisor, but there are guidelines by which you can get started. During and immediately subsequent to World War II, most engineering courses were of a "how-to-do-it"

nature. The trend in recent years has been away from "hardware" oriented college courses and toward a broad scientific background of fundamentals. If you will get an up-to-date copy of your engineering school's catalog, you will undoubtedly see many course offerings unfamiliar to you—courses that weren't offered when you were in school. Undoubtedly, you will need these new courses if you are to compete with current graduates. If you can learn the contents of the new courses, you will continue as a valuable employee and be better able to supervise new engineering graduates who may report to you.

The Interface Problem

Unfortunately, educators often don't know what industry needs, and industry frequently can't accurately define the educational requirements for current or future jobs. Thus, this seems to point to the fact that there must be a high sensitivity on the part of each professional engineer to sense his own educational needs. He must become aware of his own inadequacies for an assigned job or job potential and initiate appropriate action to become "prepared."

Many large companies have personnel to assist the individual engineer or an engineering department to keep up with evolving technological developments. Such companies often pay all or part of the cost of formal courses pursued by the engineer in areas related to his work. The training director will post notices of technical short courses, adult educational programs, continuing educational studies, seminars, extension courses, technical meetings and the like. Many training directors arrange with colleges and universities for certain specific courses to be given for their engineers. Such courses are frequently open to engineers from other companies that wish to participate. Some of the biggest problems for any training director are to ascertain who needs what knowledge that he doesn't possess, when he needs it, who can provide it and practical means for providing it.

"Continuing education is that education which is needed by the professionally employed engineer, as perceived by him or his employer, to enhance his total job competence." . . . A.C.I.[1]

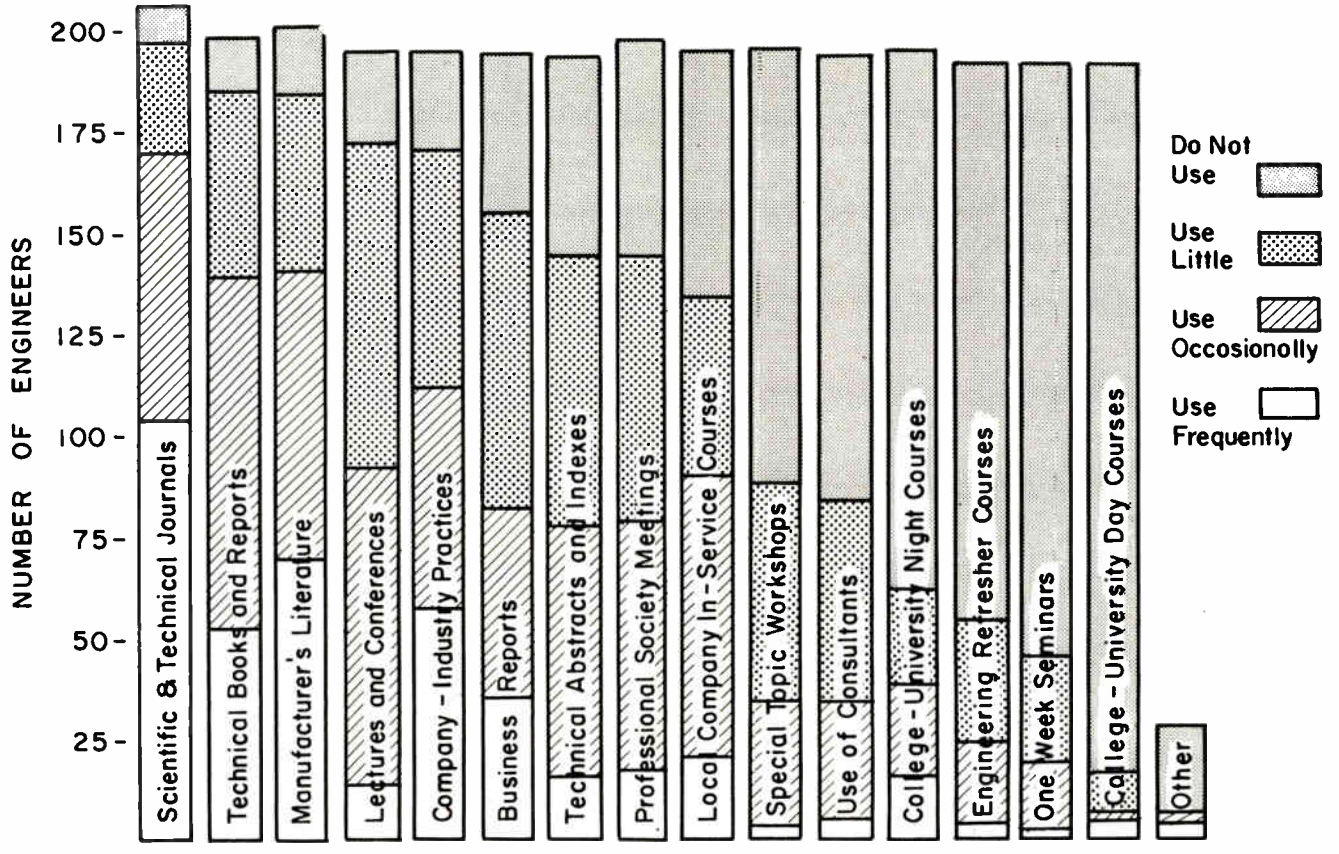
Both credit and noncredit studies are included in this definition. However, the Goals Committee of ASEE under Dr. Eric A. Walker of Penn State has considered it appropriate to differentiate between credit and noncredit programs. Graduate education is seen to perform an upgrading function, while continuing education better equips a person for his work through updating, diversifying or maturing.

Continuing Education and the Colleges

Colleges and universities have traditionally been degree-granting institutions. As long as one satisfactorily pursues a standard program of studies, he receives a "sheep skin" that, in effect, says that he is "qualified"

[1] From a report by A. C. Ingersoll of the Univ. of So. Calif. to the 1964 annual meeting of the American Society for Engineering Education.

Fig. 1: Where engineers obtain their "continuing education." (Based on a survey by Pennsylvania State University).



ELECTRONIC INDUSTRIES Professional Profile

Please type or print

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

to perform engineering work. Faculty people gain "status" by teaching "standard" graduate programs and writing articles and books that can be used in degree-granting courses. It hasn't become popular, yet, to teach working engineers what they need to know (usually without formal academic credit) rather than what old-fashioned tradition dictates they should study. College teachers have always been able to assume that students taking a given course have completed established prerequisites in advance. Experienced engineers who return to school for refresher or retread courses may not have such prerequisites. The use of regular college teachers in such courses often proves disastrous because they can't explain the subject in simple terms or at the achievement level of the student body.

MODERN MATHEMATICS AND ENGINEERING APPLICATIONS	
(60 hours, 2 semesters)	(60 hours, 2 semesters)
Differential equations	Linear systems analysis
Modern Algebra	Feedback systems
Numerical analysis	Digital systems
Probability	Communication and Control systems
Statistics	Reliability
MODERN PHYSICS AND ENGINEERING APPLICATIONS	
(60 hours, 2 semesters)	(60 hours, 2 semesters)
Introductory Physical Electronics	Transistor circuit design
Atomic Models	Magnetic devices and nonlinear magnetics
Introductory Wave Mechanics	
Introductory Solid State Theory	Transistor and device models and fabrication
	Masers and microwave devices
ENGINEERING SCIENCE AND ENGINEERING APPLICATIONS	
(60 hours, 2 semesters)	(60 hours, 2 semesters)
Thermodynamics	Energy conversion devices
Classical mechanics	Gyrodynamics and guidance
Optics	Optical systems
Electromagnetic Theory	Electromagnetic characteristics of plasmas

TABLE: COURSES OFFERED AT THE POLYTECHNIC INSTITUTE OF BROOKLYN IN THEIR CONTINUING EDUCATION PROGRAM.

Technical versus Non-technical Courses

The professional engineer today cannot afford to limit his knowledge and understanding to strictly technological developments. More corporate executives are engineers by training and experience than ever before. But, such engineers must be trained in the humanities, in business, in economics and in cultural areas. They must take a keen interest in community and national affairs and in the world and the universe. In other words, they cannot be specialists only; they must have a broad outlook and knowledge to support it as well as up-to-date know-how of electronic technology.

Today's Engineering Curricula

It is hardly a secret anymore that the days of the "cook book" engineer are numbered. The valuable engineer of the future will be the one who is able to solve new engineering problems not yet conceived. The so-called "cook-book" engineering will undoubtedly be left to the engineering technician as it should be. These technicians will be the practitioners, while engineers will be the innovators.

What Course to Take?

The $64 question for most practicing engineers is: "What course should I take first?" First step is to decide at the outset that obtaining academic credit must be secondary to obtaining specific knowledge that will help you do your job. Dr. Ernst Weber, who heads a Joint Advisory Committee on Continuing Engineering Studies for several professional societies, has stated: *"The professional man has the obligation to keep abreast of the advances in science and engineering by every available means."*

One cannot give a specific list of subjects for courses needed by every electronic engineer. What courses to pursue will depend on when he received his formal engineering education and what he has learned since, plus a knowledge of what is expected of him on the job, both now and in the foreseeable future. Table I gives a list of basic courses offered by the Polytechnic Institute of Brooklyn, none of which would have been offered to the graduate of 15 to 20 years ago! You may want to take some highly specialized courses or general background courses, depending on your immediate needs and past background. In any event, try to ascertain in advance of enrolling in a course just what topics will be covered, the teacher's background and reputation and the prerequisites required or assumed.

Types of Educational Programs

There are many ways one can keep updated on technical developments. See Fig. 1. In its interim report, the Professional Societies Task Force to the Joint Advisory Committee on Continuing Engineering Studies (CES) listed some of these. They are: 1. Through reading of publications for general information, for new technical studies or developments in your field and by reading miscellaneous manuals and reports; 2. Through attendance at society meetings—national, regional and local; 3. Through technical committee activities on a national or local level; 4. Through pursuit of new

TABLE 2: TYPICAL COURSES OFFERED AT NORTHEASTERN UNIVERSITY CENTER FOR CONTINUING EDUCATION.

Cryogenic Engineering	Matrix Analysis
Direct Energy Conversion	Ordinary Differential Equations
Dynamic Analysis of Linear Systems	Mathematic Probability—Applications to Engineering
Heat Transfer in Electronics	Principles of Quantum Systems
Fundamentals of Digital Logic	Statistical Communication Theory
Electromagnetic Scattering and Diffraction	Geometrical Optics
Microwave Theory and Techniques	Introductory Mathematics to Advanced Optics
Antenna Theory and Techniques	State Space Techniques in Systems Analysis
Introduction to Optical Masers	Random Processes in Electrical Engineering
Semiconductor Electronics	Infrared Systems Engineering
Computer Programming of Engineering Problems	Space Sciences
Vector Analysis	

ENGINEERING OBSOLESCENCE (Continued)

academic courses of study, attendance at local seminars, and specialty conferences for new technical or state-of-the art information; 5. Through pursuit of programmed instruction courses and correspondence courses in certain limited areas.

Motivation

One of the most difficult problems facing the practicing engineer in a rapidly changing technology is motivation for "keeping up." Married men with growing families find full-time educational programs out of the question financially. Part-time evening and Saturday classes are difficult to pursue for older engineers who have community and home responsibilities in addition to demanding jobs. Released time from work for the purpose of pursuing "continuing education" courses, even if granted, often places the engineer at a disadvantage with his supervisor who reluctantly spares him for the purpose.

Some larger companies sponsor seminars and courses of instruction either partially or fully on company time. Some companies pay the expenses for key engineers to study special courses at universities and colleges for periods up to a semester or two and with full pay and allowances. This, however, is more the exception than the rule.

Schools frequently take the initiative such as at Northeastern University in Boston. Such schools survey industry needs for knowledge in the geographical area served by the school.

Continuing Education Programs

Within the last year, many so-called "continuing education" departments have been set up around the country at colleges and universities. Unfortunately, the types of programs these departments offer vary not only in subjects offered but in their objectives. Some are departments of adult education with a new name; some are correspondence schools; some offer only courses toward advanced degrees but at times most convenient to employed students. Only a few offer courses designed strictly for the mature engineer with specific needs for becoming updated or retreaded. To list all schools that claim to offer courses in "continuing education" would, we feel, serve no useful purpose. As time resolves the controversy on what constitutes continuing education, and as schools agree on some form of standards for courses for mature practicing engineers, a list of schools and courses each offer may be possible. Until then, we can only suggest that the engineer seriously interested in up-dating himself check with schools in his area for courses being offered and under what conditions — prerequisites, content, credit, type and background of instructors, costs, etc.

Where We Go From Here

According to President Fred H. Harrington of the University of Wisconsin, there are three areas where emphasis on continuing education is needed: Financial support, course organization and broadened curriculum.

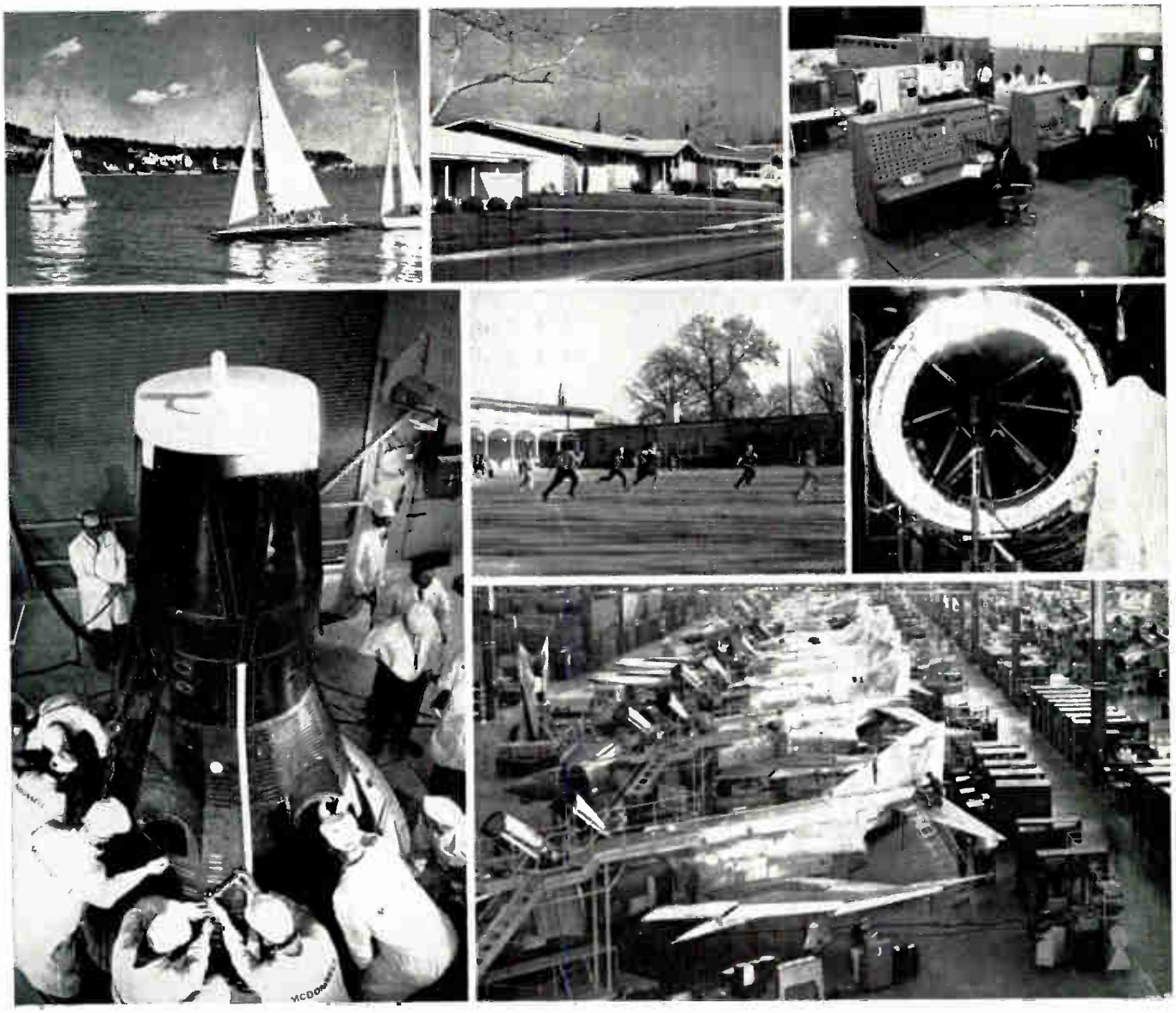
"Industry would do well to heed the need for gifts and grants to universities in the area of continuing education.

"The shot-gun approach of a wide variety of courses without any pattern or progression must be replaced with organized continuing education that will head toward a goal and, by progressive steps, get there.

"While the primary need is for professional and vocational learning, and continuing education must first meet this need, its offerings ultimately must include liberal educational opportunities.

"Engineers may take on more roles in administration and management in the future, and continuing education must equip engineers to play a key part in the world of tomorrow."

Enough serious effort is being put into solving the obsolescence problem by industry leaders, educators and professional societies to move the continuing engineering studies programs forward rapidly. The Government is also vitally concerned and will put on the pressure. You can do your part, too, by seeking and asking for educational programs that meet your immediate and future needs. You should make your needs known to your company and to educational institutions located in your area. You should also expect the engineering societies, such as I.E.E.E., to take a direct interest in programs designed to keep you up-to-date.



MEET "MAC"

If you think growing room is at a premium, look to McDonnell where there's no ceiling on professional growth. McDonnell's many more active programs in-house—in *spacecraft, aircraft, missiles, electronics, precise time reference systems,* and *automation* have kicked the lid off. ■ The McDonnell Team enjoys group insurance (McDonnell pays 90%); retirement income (McDonnell pays ⅔); patent compensation; 8 paid holidays; educational assistance (up to full sponsorship and reduced work weeks); professional recognition; beautiful communities and natural vacationlands. ■ To arrange an interview appointment in your area of interest, please send your résumé with the completed coupon. *We will answer every inquiry.*

MCDONNELL

A Plans for Progress Company and
An Equal Opportunity Employer

Long-term positions are immediately available for the following specializations:

- Aircraft Structural Design Engineers
- Electronic Systems Engineers
- Structural Test Engineers
- Propulsion, Aerodynamics Engineers
- Operations Analysis Engineers
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- Industrial Engineers
- Stress Analysts
- Loads, Weights Engineers
- Plant Design Engineers
- Facilities Engineers
- Specifications Engineers
- Engineering Psychologists
- Flight Test Engineers
- Aerospace Ground Equipment Designers
- Chemical Engineers
- Systems Analysts
- Scientific Programmers
- Electronic Equipment Engineers

MCDONNELL, P.O. Box 516, St. Louis, Missouri 63166
Att: W. R. Warcle, Engineering Employment Office, Dept. AZ-10

Name_____

Home Address_____

City & State_____

Phone_____

Present Position_____

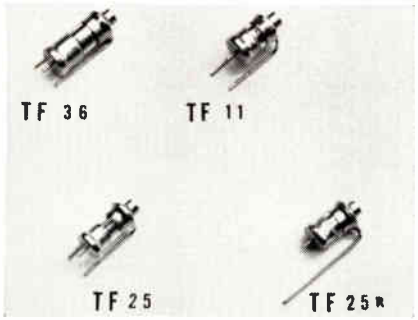
Degree_____

NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

TRIMMER CAPACITOR

Vertically-mounted for PC boards. Can be adjusted from the top.

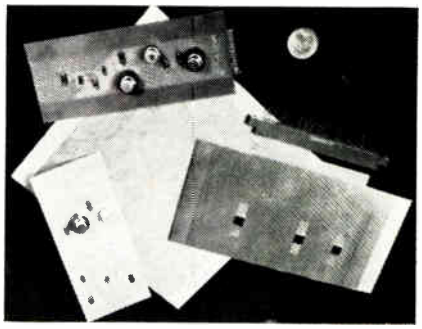


The TF series is sealed and features a non-rotating piston construction. The "O" ring seal provides protection during user assembly, soldering, cleaning, encapsulation and in the field. The unique design offers long life, low inductance, low resistance, high "Q" and no self-resonance below 1200MC. Operating working voltage is 750 and 1000dc; min. "Q" is 700 to 11100 @ 1MC and 500 to 1000 @ 20MC. Linearity is ±1% with no capacitance reversals. Voltronics Corp., 296 Route 10, Hanover, N. J.

Circle 236 on Inquiry Card

TUNING FORK OSCILLATOR

Freq. stability accurate to 0.1% over a temp. range of —20°C to 70°C.

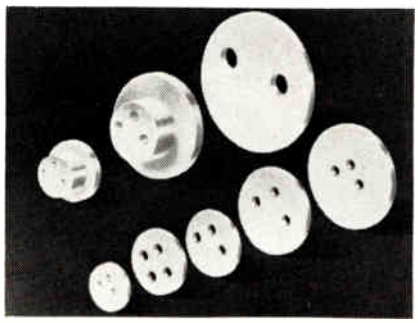


The model 6226 tuning-fork is small, measuring only 2¼ x 3¼ x 1 in. It has accuracy sufficient to perform in telemetry, gyroscope power standards, computers, precision motor drives, and musical standards. An internal coupling capacitor isolates the dc from the output connection. The case is floating and may be grounded to either the plus or the minus side of the power source. Starting time is approx. 5 sec., and the output wave-shape is essentially square. Varo, Inc., Box 1500, Santa Barbara, Calif.

Circle 238 on Inquiry Card

HEAT SINKS

High resistivity and low dielectric loss with optimum thermal conductivity.

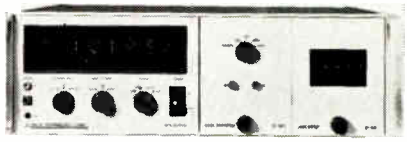


This line of 23 transistor beryllium oxide heat sinks combine both dielectric insulation and high heat transfer from the device to the chassis. The heat sinks are available in JEDEC-TO numbers: 3, 5, 8, 9, 11, 12, 16, 18, 33, 38, 39, etc. They come in a standard thickness of ¼ in., but are also available in 1/32 in. thickness. Beryllium oxide heat sinks increase transistor life and output, have freedom from outgassing, are extremely resistant to shock, vibration and moisture, and have infinite shelf life. Birnbach Radio Co., 435 Hudson St., New York, N. Y.

Circle 237 on Inquiry Card

DIGITAL VOLTMETER

Accuracy: ±0.005% of F.S.; linearity: ±0.001% of reading ±1 digit.



The DVX-315 Integrating Digital Voltmeter is used for dc voltage measurements. Numerous plug-in units extend its capability so that ac voltage, resistance, and voltage ratios can be measured. Other plug-in units correct for zero offset of transducers, translate the reading into true engineering units of pressure, temp., etc., and make GO-NO GO comparisons. It has greater than 1000 megohms constant input impedance, and 6-digit display is up to 10μv resolution. Data Technology Corp., P. O. Box 10935, Palo Alto, Calif. 94303.

Circle 239 on Inquiry Card

PLUG-IN CONTROL

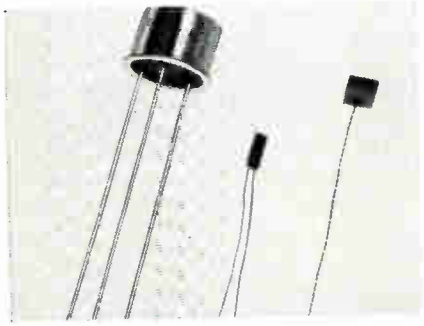
Translates numerical data into precise linear or rotary motion.

The unique feature of this point-to-point positioning system is the use of a fixed program plug-in module to generate all directional and operational signals. The plug-ins, designed as a replacement for paper tape and punched cards, make it possible to have a low-cost library of stored fixed data programs. This modular approach allows the user to select specific sequences he wants instead of interrupting a tape program of fixed sequences. Pace Controls Corp., subs. of Warner Electric Brake & Clutch Co., Beloit, Wis.

Circle 240 on Inquiry Card

MAGNETORESISTORS

Display resistance increase of 8 to 20 times zero-field value at 10 kilogauss.



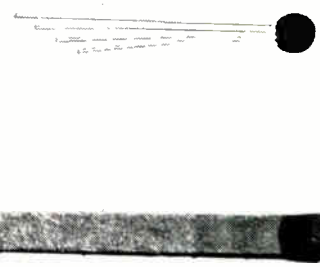
The low cost Series M magnetoresistor is ideally suited to magnetic sensing and contactless switching, in many cases supplementing photoconductors and magnetic reed switches. It fits easily into switching circuits. Disc-shaped sensors can be made with a resistance change factor of up to 30 at 10 kilogauss. Resistance at zero field is generally between 1 and 4Ω. Other configurations, such as rectangular slabs of solid material, have a zero field resistance between 1Ω and several thousand ohms. Instrument Systems Corp., 770 Park Ave., Huntington, N. Y.

Circle 241 on Inquiry Card

NEW PRODUCTS

RECTIFIER BRIDGE

Miniature design permits a sharp reduction in space requirements.

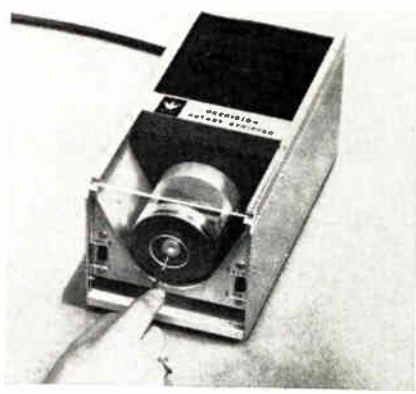


Series P miniature silicon rectifier circuits are available in full wave, half wave, doubler, center tap and open bridge types. Currents are from 50 to 600ma and voltage ratings from 50 to 800 PIV. Special types are also available. Edal Industries, Inc., 4 Short Beach Road, East Haven 12, Conn.

Circle 242 on Inquiry Card

WIRE STRIPPER

For solid or stranded conductors with single layer insulation from AWG #16-#26.



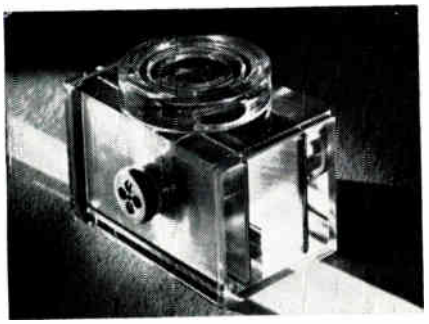
The Precision Rotary Wire Stripper gives consistent nick-free wire stripping on a production basis. It will precision-strip slick insulation such as Teflon or PVC with thicknesses up to 1/32 in. and overall wire dia. up to ¼ in. The unit weighs 11¼ lbs. The stripping head contains a removable anodized aluminum wire guide which is available in 23 sizes from 0.040 in. through 0.250 in. Behind the wire guide is the stripping blade assembly. It consists of a blade guide and leaf spring to which a reversible, double-edged carbide blade is attached. The blade's stripping depth is adjusted with a calibrated tool. Each revolution of this tool moves the blade 0.006 in. giving the operator precise control over the adjustment. Ideal Industries, Inc., Sycamore, Ill.

Circle 243 on Inquiry Card

NEW PRODUCTS

KERR CELL

Controls ½ to 1 in. ruby rods in giant pulse laser uses.

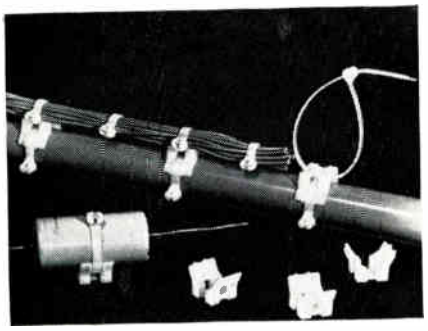


In this Kerr cell the windows are flat to a quarter wavelength and are low-reflection coated for 6943Å. The device is hermetically sealed and filled with hyper pure nitrobenzene. This eliminates space charge effects, produces an extremely uniform electric field, and creates a uniform and complete closure. Electrode separation or aperture width is 0.8 in. and aperture height is 1.5 in. Kappa Scientific Corp., 5785 Thornwood Ave., Goleta, Calif.

Circle 244 on Inquiry Card

SADDLE CLAMP

Fastens components to circuit boards or holds wire bundles to cylindrical objects.



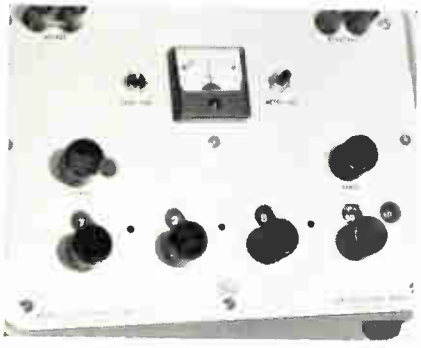
The saddle part of this clamp accommodates a range of dia. from ¼ to 1 in. The flat portion is limited only by the capacity of the Ty-Rap cable tie, which is adjustable from 1/16 to 4 in. if the larger TY-8 is used. For vertical, horizontal, overhead or base type mounting, the clamp accommodates 2 Ty-Rap cable ties—one for the saddle side to hold a cylindrical component or to hold the clamp against a cylindrical support, and the other to hold a wire bundle intact and space the bundle away from the metal conduit. A screw is used to secure the clamp to a flat surface. The clamps are premountable and reusable. Loads up to 50 lbs. in any direction can be accommodated with the new mounting base. The Thomas & Betts Co., 36 Butler St., Elizabeth 1, N. J.

Circle 245 on Inquiry Card

NEW PRODUCTS

WHEATSTONE BRIDGE

Measures the absolute value of resistors over a wide range.

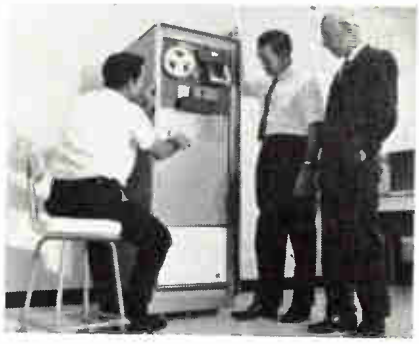


Model 308-A provides in 1 compact, portable instrument a complete resistance measuring facility featuring both high accuracy and operating convenience. The balance controls are direct-reading with automatic placement of the decimal position at the time of bridge balance, thus completely eliminating the need for applying multiplication or ratio factors. Measuring range is 0 to 11 megohms; accuracy of resistance measurement is 0.05% or better. Brown Electro-Measurement Corp., 827 7th Ave., Kirkland, Wash.

Circle 246 on Inquiry Card

GENERAL PURPOSE COMPUTER

Medium capacity unit has an add time of 4μsec. and multiply time of 12μsec.



SCS 670-2 is a $35,000 unit. The price includes hardware, input-output channels, a direct register control console and index register. It is solid-state, binary, single address with indexing, indirect addressing and a complete instruction repertoire. Core memories have 4,096-word capacity, expandable to 32,000 words of 24 bits. Software includes a symbolic assembler, utility and mathematic routines, a Fortran compiler, diagnostic routines. Scientific Control Systems, Inc., 14008 Distribution Way, Dallas, Tex.

Circle 247 on Inquiry Card

CIRCULATOR AND DRIVER

A 5-port device, it has a freq. range of 5.25 to 5.75GC.

The CMC-1342S and QSP-17 are switchable 5-port circulators and driver devices. The circulator is used with parametric amplifier to provide automatic amplifier protection and test signal injection. The device is pulse switched and latched and returns to a predetermined switch position upon power failure. A holding current is not necessary to maintain the switch in either position. VSWR (Ports 1, 2, 4) is 1.2 max.; at Port 3 it is 1.1 max. Western Microwave Labs., Inc., 1045 DiGiulio Ave., Santa Clara, Calif.

Circle 248 on Inquiry Card

Circle 105 on Inquiry Card

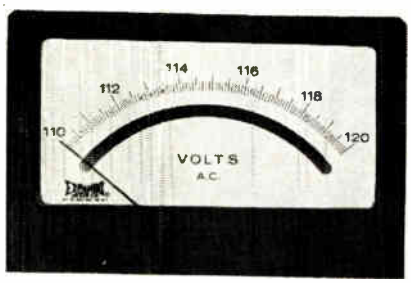
Circle 67 on Inquiry Card

Circle 68 on Inquiry Card

NEW PRODUCTS

PANEL VOLTMETER

Replace thermal transfer standards, lab. potentiometers and standarding supplies.



Featuring knife edge pointers and mirror scales, these meters maintain a ±0.1% accuracy in any position, and may be used with magnetic or non-magnetic panels. They are available in either pivot and jewel or taut-band construction. Standard ranges are 115 (±5vac), 26 (±1vac), 28 (±1vdc). AC freq. range is 50 to 500 cycles; sensitivity is 300Ω/v. Standard sizes are 3½ and 4½ in. sq. and rectangular, 4 x 6 in. and 7 in. sq. The meters are self-contained and self-powered requiring no external power source. A & M Instrument, div. of Loral Corp., Community Dr., Great Neck, N. Y. 11022.

Circle 263 on Inquiry Card

PROBE POINT

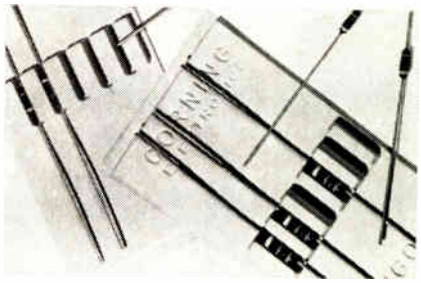
Ensures level points in multipoint wafer-probe machines. Fits most machines.

The probe-point Planerizer is used with multipoint wafer-probe machines. Available in 12- and 18-point models, it connects a high-input impedance FET in series with each probe point. The FETs turn on individually numbered lights as each probe point is brought into contact with the conducting plate of the wafer-probe machine. Use of the FET as a switch prevents point erosion and damage during the planning procedure by reducing current flow and arcing. With this accessory, probe points can be leveled to within 0.0005 in. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif. 94086.

Circle 264 on Inquiry Card

TIN OXIDE RESISTORS

Used for general purpose, semi-precision and precision applications.



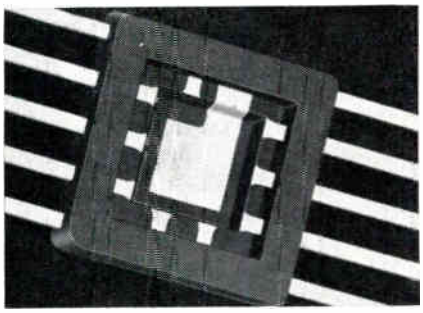
The C-4 and C-5 resistors surpass the requirements of Mil-R-22684B and Mil-R-10509E, characteristic D. They are rated in 3 ways: by selecting various combinations of purchase tolerances, wattages, and load life requirements. This rating versatility means that 1 resistor can be stocked where several are now needed in an inventory. Initial tolerances are 1, 2, or 5%. Temp. coefficient of resistance is ±100ppm/°C between −55 and +175°C. Change in resistance under load life conditions is either 0.5 or 1%, depending on rating. Corning Glass Works, Corning, N. Y.

Circle 265 on Inquiry Card

NEW PRODUCTS

FLAT PACKAGES

For integrated circuits. Unique recessed pad package solves assembly problems.

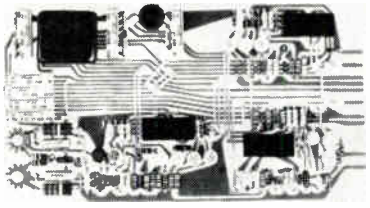


These hermetically-sealed flat packs come in 10 and 14 lead flush pad designs, and a new recessed pad 10-lead design. The recessed 10-lead series FK22NAT-10-2 avoids bonding problems when silicon chips are assembled to the pad area. FK22NAT10-1, 10 leads, is a ¼ in. sq. package of hard glass fused to match nickel-iron cobalt alloy. The 14-lead FK 23NAT14-1 is made with hard glass and gold-plated, expansion-matching, nickel-iron cobalt. Glass-Tite Mfg., div. of G.T.I. Corp., Branch Ave., Providence, R. I.

Circle 266 on Inquiry Card

ANALOG MULTIPLIER

Output voltage is proportional to instantaneous product of 2 input voltages.

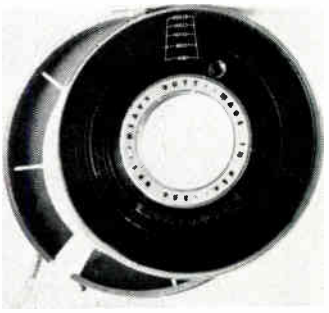


Hallefex® Model 1700-153 analog multiplier is a self-contained solid-state device. This unit consists of 2 input amplifiers, a multiplier utilizing 2 thin-film Hall-effect voltage generators, and an out amplifier. True algebraic products are obtained through 4-quadrant multiplication, and the output voltage has a true mathematical sign. Output voltage is 0.1 times the 2 inputs within the range of −10 to +10vdc @ 1ma. Helipot Div. of Beckman Instruments, Inc., Harbor Blvd., Fullerton, Calif. 92634.

Circle 268 on Inquiry Card

TAPE PROTECTORS

Fits all standard 10½ in. solid-flange, computer tape reels.



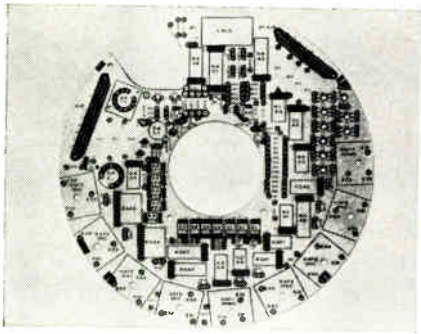
Protect-A-Tape™ is a quick and simple "snap-on, snap-off" 1-piece computer tape reel package. It offers: a built-in environmental seal which provides total protection against dust and other contamination; stacking-ring which guarantees positive reel stacking without slip or tilt; built-in positioning grooves which perfectly position the reel in the package so there is no pinching of reel or tape; and a positive-action, snap-lock which is color-coded for instant identification. Computron Inc., 122 Calvary St., Waltham, Mass. 02154.

Circle 267 on Inquiry Card

NEW PRODUCTS

COPPER-CLAD LAMINATES

For multilayer etched circuits. Furnished with sheets of prepreg materials.

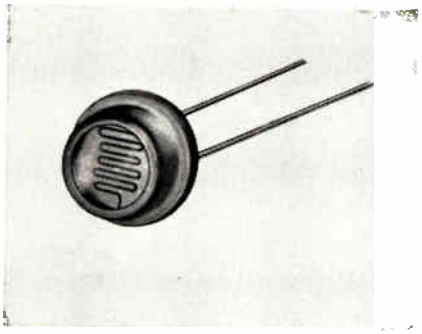


Two grades of ultrathin copper-clad laminated plastics are available for multilayer etched circuits. GEC-500 E, with base material, meets the specs. for NEMA grade G-10 laminate; and Fireban 600 E, a flame-retardant grade with base material, meets the specs. for NEMA grades G-10 and FR-4. Prepreg (B-stage) insulating sheets of the corresponding base laminates can be furnished. Taylor Corp., Valley Forge, Pa. 19481.

Circle 269 on Inquiry Card

PHOTOCONDUCTIVE CELLS

Especially designated to operate in low-voltage photoelectric choppers.



Type NSL-364C cadmium selenide photoconductive cells have chopping freqs. up to 2KC. Very low applied voltage operation is possible since the photocells have a linear voltage-current characteristic. Illuminated by a neon lamp, typical photocell resistance is 5KΩ, and dark resistance is 50 megohms minimum. Higher resistance types are also available. National Semiconductors Ltd., 2150 Ward St., Montreal 9, Canada.

Circle 270 on Inquiry Card

ENTRY PRINTER

Prints data at the same rate at which data is received.

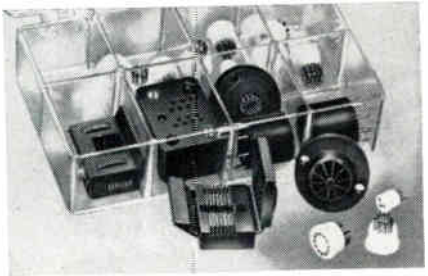
Model 750 is a high-speed, alpha-numeric data printer. It combines the speed and reliability of a line printer with the ease of operation, flexibility and low cost of a serial entry printer. Printing speed is 75 char./sec. Uses include on- or off-line operation with tab card, punched tape, and magnetic tape devices. It accommodates roll paper as wide as 50 in. and all standard sizes of fan-fold paper. The Bristol Co., Waterbury, Conn. 06720.

Circle 271 on Inquiry Card

NEW PRODUCTS

I. C. SOCKETS

Contains a variety of the most commonly used sockets for circuit breadboarding.

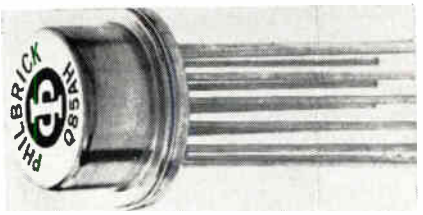


This new kit, Q-401, provides the semiconductor engineer with a greatly-increased working flexibility, especially when he has to secure single quantities of sockets for designing or specifying. The versatile and easy-to-use kit provides virtually every type of socket necessary for breadboarding, testing, and aging applications involving standard configurations. All sockets have a life of 50,000 insertions or better and each uses wiping-type contacts plated with nickel over a gold. Barnes Development Co., Lansdowne, Pa. 19050.

Circle 272 on Inquiry Card

IC AMPLIFIERS

Operates from standard ±15v. supply; full output of ±11v. @ 2.2ma into 5k load.

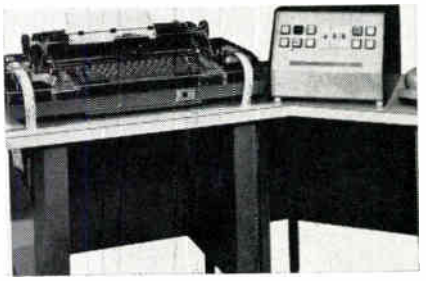


Integrated-circuit operational amplifiers, Models Q25AH and Q85AH, have dc gain of 20K at full rated load. Gain-bandwidth is 50 MHz, and full output is 100 kHz as a unity-gain follower. Common-mode input range is ±10v. Model Q85AH has common-mode rejection exceeding 20,000:1, and offset vs. temp. typically 5μv/°C. They are hermetically packaged in the special low-profile cylindrical TO-8 package having max. dimensions 0.6 in. D x 0.185 in. H. Philbrick Researches, Allied Dr. at Route 128, Dedham, Mass. 02026.

Circle 273 on Inquiry Card

DATA TERMINAL

Used with real-time computers, time-sharing systems, and inter-office networks.



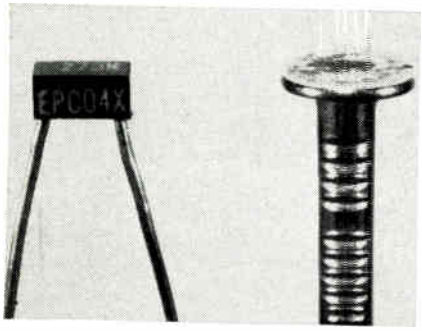
The Data Terminal unit is compatible with all major computer systems which read and punch paper tape and edge-punch cards, while simultaneously producing a printed document and data. It also accommodates many types of systems. Speeds up to 175 words/min. are possible on-line or off-line. The system goes on-line via Data Phone or comparable equipment. Each machine is bi-directional and can serve as either a transmitter or receiver. Dura Business Machines, sub. of Dura Corp., 32200 Stephenson Hwy., Madison Heights, Mich.

Circle 274 on Inquiry Card

NEW PRODUCTS

CERAMIC CAPACITORS

Provides capacitance range from 10pf through 0.027μf in a 0.2 x 0.1 x 0.1 in. case.



The Nailhead™ is part of the Neolythic™ capacitor series. They are designed for miniature and subminiature electronic packaging in filters, coupling, phase shifting, and most commercial, industrial, and military general-purpose digital circuitry. The capacitors are available in radial-lead epoxy-encased rectangulars, as well as axial-lead round tubular configurations. Electron Products, div. of Marshall Industries, 1960 Walker Ave, Monrovia, Calif.

Circle 275 on Inquiry Card

SYMBOL TUBE

Generates a complete font of upper and lower case letters, numerals, etc.

The CK1414 Symbol Ray Tube provides the alpha-numeric inputs for computer read-out devices. Its 3 in. face can be scanned electronically by a computer to select the letters, numerals and symbols in the proper sequence to form the visible readout on a display tube. Raytheon Co., Components Div., Lexington, Mass. 02173.

Circle 276 on Inquiry Card

POWER TRANSISTORS

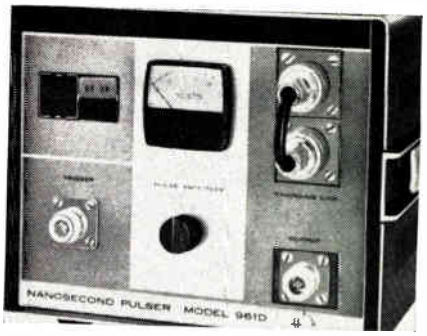
For power amplifier and oscillator uses in HF / VHF transmitters.

The B-3465 and B-3466 are 3a. r-f silicon planar-epitaxial NPN power transistors. High output power and high efficiency are characteristic. The B-3465 is contained in the solid TO-5 package and the B-3466 in the stud nut heat sink MT-27 package. Gain bandwidth product is 200MC minimum. Bendix Semiconductor Div., The Bendix Corp., Holmdel, N. J.

Circle 277 on Inquiry Card

PULSE GENERATOR

Output pulses are variable from 2 to 20nsec. with 0.5sec. rise and fall.

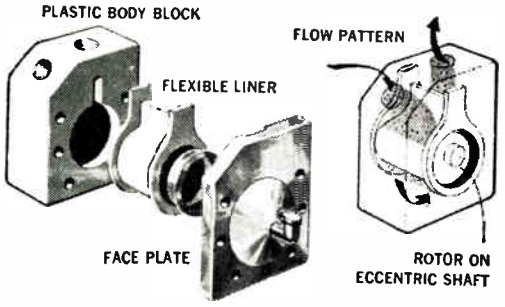


Model 961 provides high-voltage nsec. pulses for R&D, engineering and calibration uses. Amplitudes are adjustable from 0 to 3kv. Repetition rate is at 1 CPS, line freq., or pushbutton actuated. The primary use is for simulation of scintillations from nuclear events by driving nsec. light sources. Other uses include photosynthesis timing, impedance measurements, multiplier phototube testing. Huggins Laboratories, 999 E. Arques Ave., Sunnyvale, Calif.

Circle 278 on Inquiry Card

PLASTIC SEALLESS PUMP

Standard capacities are from ⅓ to 40 gpm



A rotor, mounted on an eccentric shaft in this plastic pump, rotates within a liner to create a progressive squeezing action on fluid trapped between the liner and the body block. All metal parts and mechanical action takes place inside the liner where fluid never reaches. This completely eliminates the need for stuffing boxes or shaft seals, guaranteeing no leakage.

The pump is self-priming, operates wet or dry and is suitable for extremely corrosive fluids, abrasive slurries or viscous materials. Applications include pumping of acids, alkalies, distilled water, diatomaceous earth slurries, electroplating solutions, ceramic tile glaze as well as shear sensitive emulsions.

Standard capacities are from ⅓ to 40 gpm with discharge pressure up to 50 psi. Materials of construction include Teflon, PVC, linear polyethylene, Buna-N, Bakelite or stainless steel for body blocks and Viton-A, Kel-F elastomer, Hypalon, Neoprene and Buna-N for the liner. These are the only parts in contact with the fluid.

For additional information, write Vanton Pump & Equipment Corporation, Hillside, New Jersey or telephone Area Code 201 Murdock 8-4120.

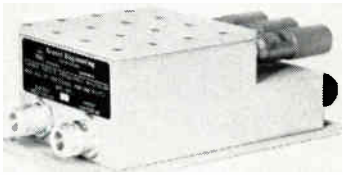
On display at the Chem-Show Booth #1229

Circle 76 on Inquiry Card

NEW PRODUCTS

FREQUENCY MULTIPLIER

Multiplication is adjusted by micrometer tuning. Input and output Z is 50Ω nom.



The Model 90600 tunable solid-state freq. multiplier is useful in L-Band and S-Band. The passive unit accepts input signals from 150 to 300MC and delivers typically ½ to 1w. output power between 900MC and 2.4GC. A multiplier diode type of unit, it is compact and weighs less than 3 lbs. Output filtering holds undesired harmonics and spurious freq. oscillations down more than 30db, typically 50db or more. Resdel Engineering Corp., 990 S. Fair Oaks Ave., Pasadena, Calif.

Circle 279 on Inquiry Card

TIME DELAY RELAY

Capable of delaying dc voltages powering loads to 3a. Life is 2 million cycles.

Model RST-2 is low-cost static time-delay relay. This subminiature device measures 1 15/16 x 15/16 x 17/32 in. and weighs approx. 1 oz. The delay time is continuously adjustable from 1.0 to 120 sec. by adding an external ½ w. resistor. Operate over temp. range is −20°C to +71°C. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 280 on Inquiry Card

HIGH-VOLTAGE CAPACITOR

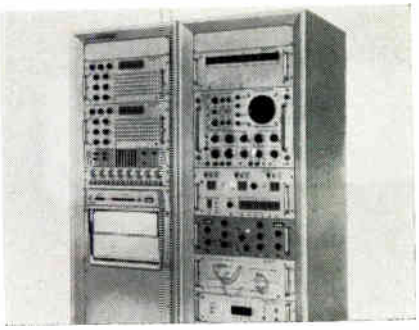
Uses a combination of Mylar and paper dielectric impregnated with oil.

The B161Y and B161YT are high-voltage tubular capacitors (3K to 3Kv) for bypass, filter, or coupling uses. They feature an unusually high humidity resistance. Other features of these new capacitors include: no derating required up to 85°C; power factor will not exceed 1%; high insulation resistance; case will not crack or chip. Aerovox Corp., New Bedford, Mass. 02741.

Circle 281 on Inquiry Card

PCM GROUND STATION

Compact unit accommodates all presently used IRIG code formats.



Model TRC-138 PCM ground station decommutates, synchronizes and reconstructs signals in the presence of noise, freq. drift and signal fadeout. It provides max. versatility for accommodation of both present and future requirements with performance within 1db of the theoretical optimum and bit synchronization to −10db. Decommutated channels may be prime, subcommutated or supercommutated data. The Roback Corp., Dept. 1526, Huntingdon Valley, Pa.

Circle 282 on Inquiry Card

NEW PRODUCTS

COUNTER

Counting interval of 0.01, 0.1, 1, or 10 sec. is extendible.

The Type 1144-A 100MC digital frequency meter combines a 10MC counter with a decade scaler. It features 100mv sensitivity, full input controls, display and counting time selection, and a self-check mode. Display time for the 5-digit incandescent in-line readout can be set at any one of 7 values from 0.16 to 10.24 sec., or to infinity. Counting interval is extendible by a multiplier switch or set manually. The 2 component instruments can be easily separated and used individually. General Radio Co., West Concord, Mass. 01781.

Circle 283 on Inquiry Card

DIAMOND TOOLS

For drilling glazed alumina ceramic substrates for thin-film circuits.

Series-167 diamond tools include solid diamond drills and scribers for processing thin-film substrates and semiconductor materials. They can be used for scribing fragile single crystals of silicon and germanium for semiconductor devices. Aremco Products, Inc., P. O. Box 145, Briarcliff Manor, N. Y. 10510.

Circle 284 on Inquiry Card

NPN TRANSISTOR

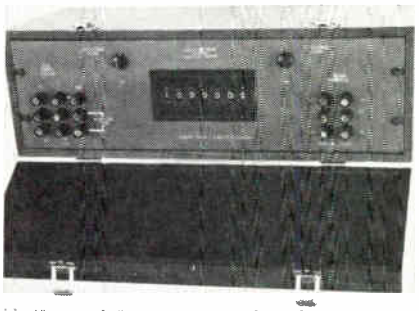
Combines thin-film and planar-epitaxial techniques. Handles 30 watts.

FT7207 uses nichrome thin-film emitter resistance elements to equalize current flow through the multiple geometry of this monolithic unit. This equalization prevents thermal runaway, and enables the device to operate at high power, voltage, and temperature levels with a gain-bandwidth product of 70MC minimum. It is packaged in an isolated 7/16-in. hexagonal case. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif.

Circle 285 on Inquiry Card

VOLT/RATIO DIVIDER

Combines a lead resistance compensator and 7 dial v./ratio divider.



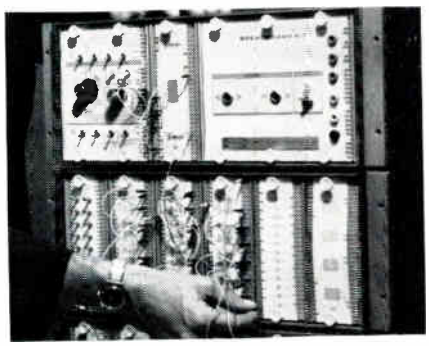
Model DV 4007 compensated v./ratio divider eliminates errors normally associated with IR drops occurring in the interconnection of precision voltage dividers. The resistive, drift-compensated Kelvin-Varley divider operates over an amb. temp. range of 0°C to 50°C. Long term stability is better than ±5ppm/yr. Accuracy is 4 parts/million. The voltage divider may be used as a ratiometer or master voltage divider in precision ratio, voltage, resistance or current measurements. General Resistance, Inc., 430 Southern Blvd., New York, N. Y. 10455.

Circle 286 on Inquiry Card

NEW PRODUCTS

BREADBOARD KIT

Developing, checking out and testing digital circuits, sub-systems and systems.



The MBK2 silicon module breadboard kit provides a simple and convenient method of developing and testing circuits. A basic kit can accommodate up to 10 modules. The kit contains a power supply, a 1 pps to 1MC signal generator for static or dynamic circuit analysis, and an indicator panel with lights for visual observation of circuit operation. Circuit wiring is then done with external patchcords. Raytheon Computer, 2700 So. Fairview St., Santa Ana, Calif. 92704.

Circle 287 on Inquiry Card

CROSSBAR SWITCH

Rapid circuit selection while eliminating wires, clips, pins and soldering.

This crossbar-type selector switch fits in a space 4 x 4 x 2 in. It consists of rhodium-plated printed-circuit base of parallel conductors, transverse to which are 10 cross rails carrying sliding contacts. The 10 x 11 arrangement provides 100 switching positions plus an off position for each circuit. Cherry Electrical Products, Box 439, Highland Park, Ill.

Circle 288 on Inquiry Card

VOLTMETER-AMMETER

Measures to 5mv and 5 picoamps full scale; has high input resistance.

As a voltmeter and null detector Model 153 has 34 full-scale ranges from 5mv to 1kv, and a ± 1% accuracy on 3mv and higher ranges. Input resistance on 100/microvolt and higher ranges is 200 megohm; zero drift is ± 2mv/24 hours. As an ammeter it has 42 full-scale ranges from 5 x 10^{-12} to 10^{-1} ampere, and ± 2% accuracy on 3 x 10^{-9} ampere and higher ranges. Keithley Instruments, 12415 Euclid Avenue, Cleveland 6, Ohio.

Circle 289 on Inquiry Card

ULTRASONIC SWITCH

Senses objects passing through or from a highly directional ultrasonic beam.

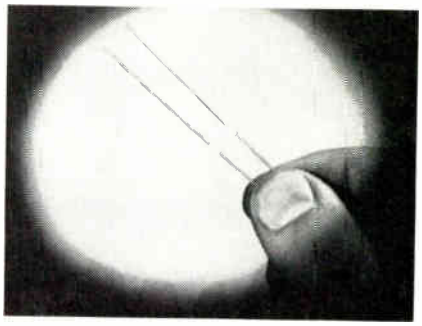
Model S-82 consists of a transmitter, receiver and control unit. The transmitter contains an 82KC piezoelectric transducer. Transmitter power is supplied by the control unit or by battery if separation of the 2 units is desired. The control unit converts 60 CPS, 110v. to low voltages for the transistorized transmitter, receiver, relay driver and switching circuits. Electronic Components Div., Genisco Technology Corp., 6320 W. Arizona Circle, Los Angeles, Calif.

Circle 290 on Inquiry Card

NEW PRODUCTS

METAL FILM RESISTOR

The 1/10 watt miniaturized resistor features capped construction.

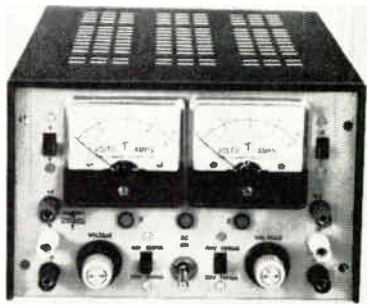


The MF35C conformally coated units are rated at 1/10 watt at 125°C, derating to 0 at 175°C. They have a resistance range from 30.1 ohms to 100K, and a tolerance of 1%. Tested in accordance with MIL-R-10509E, they feature a standard temperature coefficient of ± 100 PPM/°C, with TC of ± 50 PPM/°C and ± 25 PPM/°C also available. Body length is only 0.220 in. The diameter is 0.074 in. Electra Manufacturing Co., Independence, Kansas.

Circle 249 on Inquiry Card

SILICON POWER SUPPLY

Features 2 independent power outputs with dual ranges on each output.



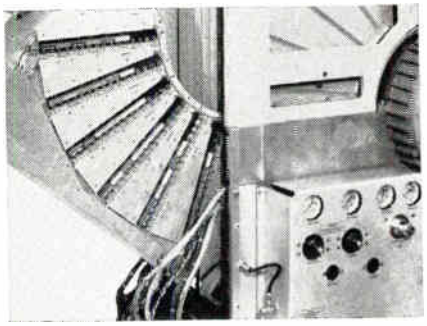
Model DL40-700 Silicon Dual Lab power supply is designed for general laboratory uses. Independent range switches permit selection of either 40v. @ 350ma, or 20v. @ 700ma outputs, from each section, with automatic voltmeter range switching. The individual sections can also be paralleled or put in series for greater versatility. One power supply provides the following outputs: two 0-20v. outputs @ 0.7a. each; two 0-40v. outputs @ 0.35a. each; one 0-20v. (0.7a.) and one 0-40v. (0.35a.); one 0-20v. @ 1.4a. (parallel operation); one 0-40v. @ 0.7a. (series or parallel operation); and one 0-80v. @ 0.35a. (series operation). Trygon Electronics, Inc., 111 Pleasant Ave., Roosevelt, L. I., N. Y. 11575.

Circle 250 on Inquiry Card

NEW PRODUCTS

DISC MEMORIES

Storage capacity is 6.4 billion bits. Average access time is 35msec.

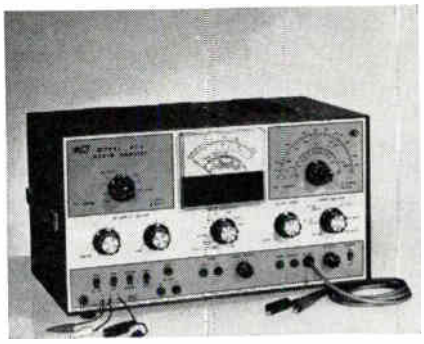


The Librafile 4800 mass memories are available in a basic 6-disc configuration. Storage capacity is 400 million bits, and data transfer rate is up to 150 million bits/sec. By combining 16 files on a single trunk line, an on-line storage capacity of 6.4 billion bits can be achieved. The memories have a fixed-head/track, two methods of search and retrieval, and retractable head plates. Retractable mounting plates permit easy maintenance. General Precision, Inc., Librascope Group, Glenside, Calif.

Circle 323 on Inquiry Card

TRANSISTOR TESTER

In-circuit testing of almost any analog, ac, or dc coupled transistor circuits.



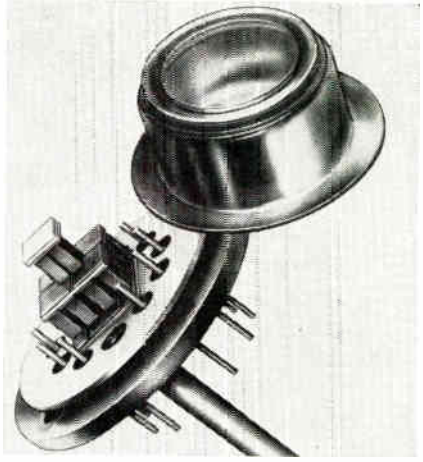
With the Model 970 Transistor Analyst, no alteration in printed circuits or removal of soldered-in transistors is normally necessary to make the test. The 970 uses an analysis technique of dc signal injection into the transistor stage to be checked. The unit meters the total power supply current in a sensitive, easily balanced bridge circuit. Go, no-go indication of the transistor stage operation is shown on the meter. Power transistors may be accurately tested out of circuit with current up to 1a. The analyst also generates an AM or FM modulated, or unmodulated carrier freq. from 240KC to 2000KC, 10 to 11.4MC and 88 to 108MC. B&K Mfg. Co., div. of Dynascan Corp., 1801 W. Belle Plaine Ave., Chicago, Ill. 60613.

Circle 324 on Inquiry Card

NEW PRODUCTS

COMPONENT COOLER

Cools critical components presenting a light heat load.

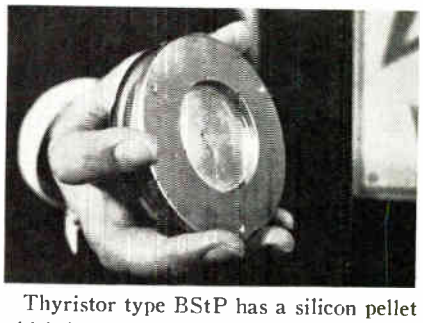


Model 094447 is a 2-stage cascade thermoelectric unit. It is capable of achieving a zero load temp. differential of 85°C. Carrying a 15mw heat load, this cooler will maintain the cold plate junction at −58°C in a vacuum of 10^{-6} Torr with a +27°C heat sink temp. Cooler performance including vacuum level is guaranteed for 1 year. A 4w. heat sink is required, while input power is 3.5a. @ 1.1-vdc. Borg-Warner Thermoelectrics, Wolf & Algonquin Rds., Des Plaines, Ill. 60018.

Circle 251 on Inquiry Card

THYRISTOR

Unique cooling method allows for lower junction temperature.



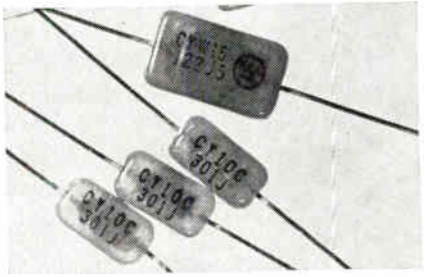
Thyristor type BStP has a silicon pellet which is more than 30mm. Instead of the usual stud-mounted encapsulation, this large pellet is encapsulated in a disc cell. In this way the heat is conducted from the pellet to both sides. Therefore, it is possible to keep the junction temp. comparatively low and thus increase the surge load capacity. The continuous load capacity can also be increased without exceeding the max. permissible junction temp. of about 110°C. With air cooling this thyristor has a current rating of about 500a. (mean dc current). Siemens America Inc., Components Div., 230 Ferris Ave., White Plains, N. Y.

Circle 252 on Inquiry Card

NEW PRODUCTS

GLASS CAPACITORS

For circuits needing high stability and low drift or losses.

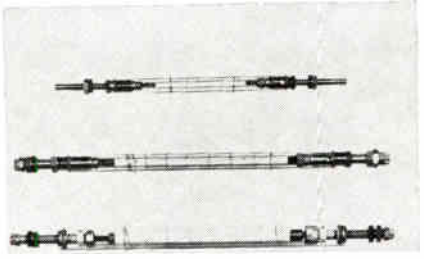


These glass-dielectric capacitors come in military and industrial types. The military glass capacitors, type CY, cover the capacitance range of 0.5 through 300pf with voltage ratings of 300 and 500v. @ 125°C. The industrial glass capacitors, type CYW, cover the range of 0.5 through 1200pf with voltage ratings of 100 and 500v. @ 125°C. Both meet or exceed the requirements of Mil-C-11272. The electrical characteristics are so stable that 2000 hrs. of operation at 150% rated volts and 125°C will change the capacitance no more than 0.5%. Westinghouse Electronic Capacitor Dept., Box 130, Irwin, Pa.

Circle 253 on Inquiry Card

FLASHTUBES

Watercooled to provide more efficient operations. Excess of 300,000 flashes.



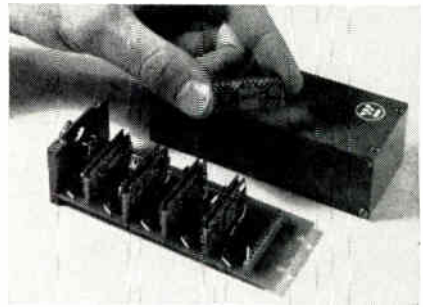
The FX-62B, FX-65B, FX-67B, FX-74B and FX-75B flashtubes economically replace main discharge tube with standard off-the-shelf replacement tubes. The FX-74B has a max. average power input of 0.5kw with a max. energy/pulse of 100 joules at 200μsec. pulse duration. The FX-75B has a max. average power input of 1kw with a max. energy/pulse of 400 joules at 200μsec. The FX-62B has a max. average power input of 4kw with a max. energy/pulse of 600 joules at 1200μsec. The FX-65B has a max. average power input of 8kw with a max. energy/pulse of 2000 joules at 340μsec. The FX-67B has a max. average power input of 10kw with a max. energy/pulse of 4000 joules at 340μsec. EG&G, Inc., Products Div., 160 Brookline Ave., Boston, Mass. 02215.

Circle 254 on Inquiry Card

NEW PRODUCTS

TELEMETRY OSCILLATORS

For use as freq.-modulated subcarrier oscillators for aerospace telemetry.

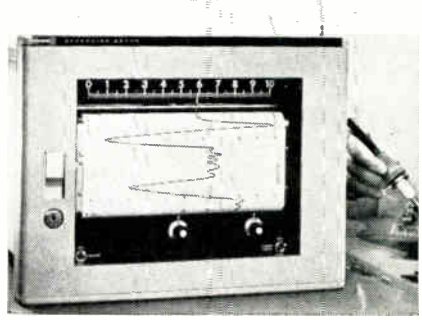


These high-reliability units operate over the standard IRIG freq. bands and 6 additional h-f bands in the range of 95KC to 165KC. The oscillators use a new drift-field delay element. This element, coupled with a feedback amplifier to form an oscillator, provides a linear relationship between the freq. of oscillation and the applied input voltage. The delay time, which sets the freq., depends upon the velocity of carriers injected into the semiconductor. The velocity is in turn directly related to the voltage applied across the drift-field element. Westinghouse Electric Corp., Box 2278, Pittsburgh, Pa. 15230.

Circle 255 on Inquiry Card

SERVO RECORDER

Records with 2/10 sec. full scale response over the full 10 in. span.



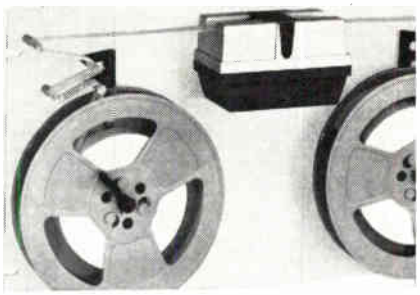
The Wide Chart Speed Servo features a unique shuttle servo motor with only 1 moving part. It has no drive cords or gears. In the inking system an inertial ink pump provides skip-free writing even when pen speed is 100 in./sec. Yet, the inking system will not bleed even when the recorder is stopped. An automatic chart drive enables users to instantly dial any one of 15 chart speeds including ½, 1, 2, 4 and 8 in./sec., min. or hr. Single speed, 2 speed and 10 speed drives can also be ordered. None of the drives requires gear change, motor or screw driver adjustments. Esterline Angus Instrument Co., Inc., P. O. Box 24000, Indianapolis, Ind. 46224.

Circle 256 on Inquiry Card

NEW PRODUCTS

HIGH-SPEED READER

Reads from bottom of tape at 150 cps asynchronously and bidirectionally.



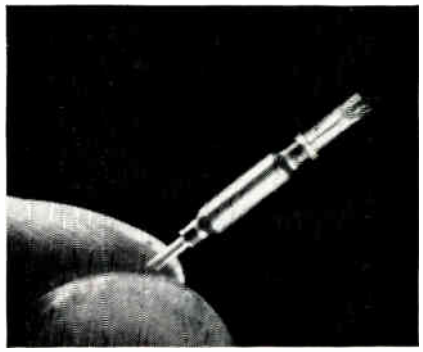
The R-150 reads 5, 6, 7, or 8 level tape without adjustment or modification. Any tape, such as paper, mylar, or foil, in widths of ⅞ in., 11/16 in., or 1 in. can be used without regard to color, thickness or opacity. The new reader is available in either table top console without reeling, or standard panel mount with or without integral reel tape handling. It operates on the non-return to zero principle and uses the starwheel method of reading which causes very little wear on tapes. Form "C" switching provides positive hole/no-hole identification. Tally Corp., 1310 Mercer St., Seattle, Wash. 98109.

Circle 257 on Inquiry Card

NEW PRODUCTS

LOW-PASS FILTERS

For use in cable connectors. Provides max. RFI reduction in a min. of space.

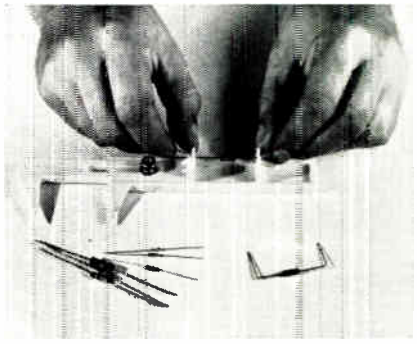


The subminiature FO type filters provide attenuation of greater than 50db over the freq. range from 100MC to 10GC. Unique design allows unusually close spacing so they can be introduced into cable connectors with no reduction in the number of terminals. Further, they provide the possibility of individual replacement of filters if desired. When mounted through a ground plane in the connector, there is complete shielding to prevent any possibility of r-f coupling between input and output. Allen-Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis. 53204.

Circle 258 on Inquiry Card

LEAD FORMER

Makes precision bends in lead wires for mounting in PC boards.



This plastic tool resembles a caliper having a sliding section within a fixed mounting. Right-angle trammel points on the end of each section are positioned to coincide with the hole spacing desired. To use the tool, the operator adjusts the spacing of the trammel points to coincide with the desired hole spacing in the PC board. This spacing is precisely duplicated by V slots located one in the sliding section and one in the fixed section of the device. Once spacing is established, the component is placed midway between the V slots with a lead in each slot. A push of the fingers forms the bend. Davey Products, Box 567, Fairfield, Conn.

Circle 259 on Inquiry Card

NEW PRODUCTS

ATTENUATOR

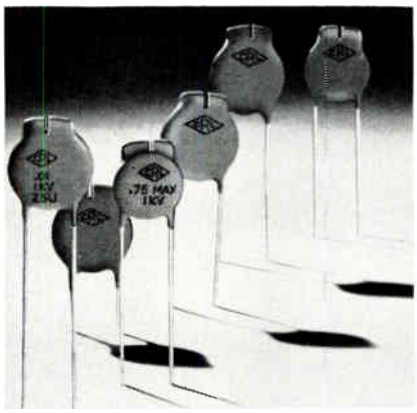
Features low bias current and improved bias-current impedance.

Model X430 Switch/Modulator/Voltage-Controlled Attenuator has its switching diodes connected in series, instead of the usual parallel. This allows a choice of either polarity grounded biasing or straight through bias drive in an ungrounded system. Min. attenuation of 3db or less is realized from 8.5 to 9.5gc with a total diode current of 150ma. Modulation freq. are dc to 500Mc. Modulation is 99% from 8.2 to 10.5gc. Somerset Radiation Laboratory, Inc., Box 201, Edison, Pa. 18919.

Circle 260 on Inquiry Card

CAPACITOR PROTECTOR

Protects the CRT *control grid in color* TV *sets from arc-overs.*



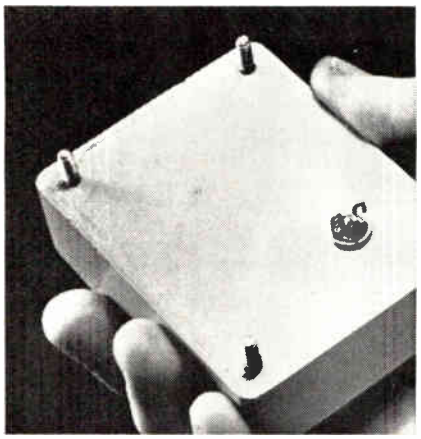
The Gap-Cap® spark gap and capacitor protective device consists of a ceramic disc capacitor with a built-in spark gap which has a well defined arcing voltage. Units now in production are for voltages of 1.5kv and 2.5kv and are available in several capacitance values. The Gap-Cap is used as a protective device in color TV sets to protect control grid circuitry from arc-overs in the color gun, and for protecting other high-voltage circuits. The cost of the device is said to be less than 7¢ in production quantities. Centralab, Electronics Div. of Globe-Union Inc., P.O. Box 591, Milwaukee, Wis. 53201.

Circle 261 on Inquiry Card

NEW PRODUCTS

MICROCIRCUIT BOARD

The 1/32 in. thick board is for integrated circuit uses.



The phenolic Veroboard has a series of parallel copper strips each pierced with a matrix of holes spaced at 0.050 in. This spacing corresponds to 0.050 in. spacing of flat packs. It is available as a single-sided or double-sided board. Copper strips on the reverse side run at 90° to the front of the board. Vero Electronics Inc., 48 Allen Blvd., Farmingdale, N. Y.

Circle 262 on Inquiry Card

ELECTRONIC INDUSTRIES

Advertisers—October 1965

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*Regional Advertising

11TH DEVICES MEET TO COVER MICROWAVE GENERATORS

New microwave generators which have attracted widespread attention in the industry will be discussed by four leaders in the field at the opening session of the 1965 International Electron Devices Meeting (IEDM) October 20-22.

The IEEE conference, which will be held at the Sheraton-Park Hotel in Washington, D. C., takes on a broader look in program this year as it goes international for the first time.

The broadened scope—in program topics and conference sessions plus extension of a formal invitation to engineers throughout the world to take part —was disclosed by Dr. Clare G. Thornton of Philco Corporation's Lansdale (Pa.) Division. Dr. Thornton is general chairman of the 11th annual convention.

The overall Program Committee has been increased in size and scope so as to provide additional emphasis on new areas that include microelectronics, power sources, and quantum electronics, he added; more flexibility has been written into the program format.

The meeting will cover research, development, design and manufacture of electron devices in five major areas, each with its own program subcommittee.

Dr. James B. Gunn, of the IBM Research Center, Yorktown Heights, N. Y., will chair the general keynote session on "Two-Terminal Semiconductor Devices," Wednesday, October 20.

He will introduce the discussion and then present Dr. A. L. McWhorter, MIT-Lincoln Laboratory, Lexington, Mass.; Dr. Bernard C. DeLoach, Bell Telephone Laboratories, Murray Hill, N. J., and Dr. C. Hilsum, England's Ministry of Aviation, Royal Radar Establishment.

William C. Hittinger, of Bell Labs.. program chairman for the conference, said, "These are new and very important devices and we feel most fortunate in having these four gentlemen on the program; they are the technical leaders in the field."

The program chairman said that considerable interest has been generated overseas in the 1965 meeting, both in university and industrial laboratories.

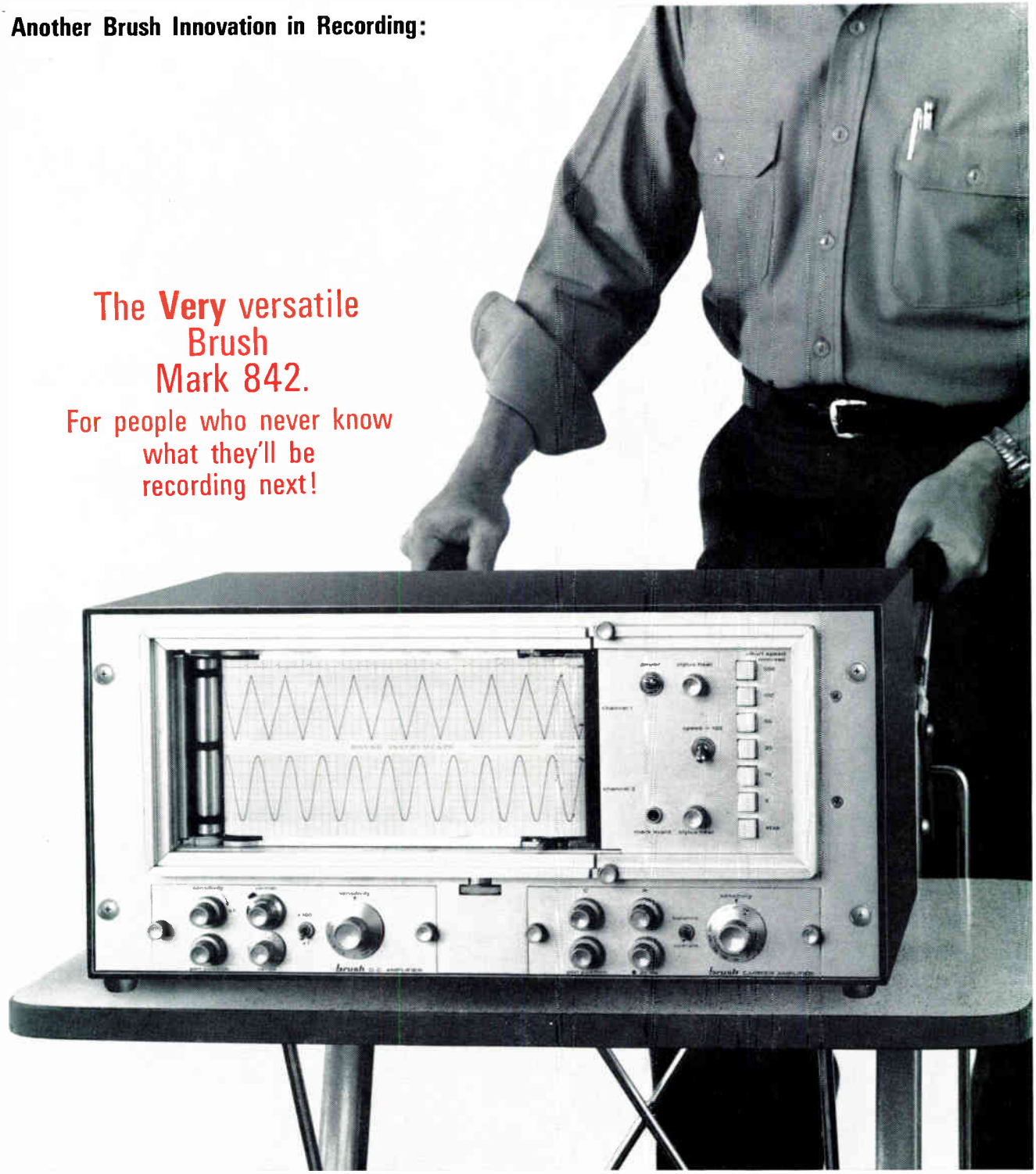
The conference will cover the areas of energy conversion, electron tubes, integrated circuits, solid state devices, and quantum electronic devices.

CLASSIFIED

Another Brush Innovation in Recording:

The **Very** versatile Brush Mark 842.

For people who never know what they'll be recording next!



You know what we mean.

Recording requirements change. So it makes sense to buy a recorder you can change with them. Like the Brush Mark 842. See the two pre-amplifiers right below the display and controls? They're the interchangeable plug-in type. Brush gives you a choice of nine. Plus a pick of seven conversion couplers. And *any* mounting arrangement you can think of. Lets you match the new Mark 842 to whatever recording job comes along. Great performance, too. Highest usable frequency response of *any* direct writing recorder . . . 75 cps full scale; flat to 150 cps at reduced amplitude. 1/2% Linearity. All solid state electronics. High torque penmotors. Rugged, crisp-writing styli to assure razor-sharp traces of unmatched reproducibility. Pushbutton choice of 12 writing speeds. All yours in the clean, neat, easy-to-operate Mark 842. Built by Brush to meet your recording needs for years to come. Ask your local Brush Sales Engineer for a demonstration. A new brochure is yours for the asking. Brush Instruments Division, Clevite Corporation, 37th & Perkins, Cleveland, Ohio 44114.

CLEVITE

brush INSTRUMENTS DIVISION

Circle 103 on Inquiry Card

RCA announces a new high-speed miniature core-driver...RCA-40283... specially designed for ultra-compact computers

Now—commercially available, this tiny new RCA-40283 N-P-N silicon core-and-line driver packs substantially all the performance of TO-5 core drivers into a tiny TO-46 case.

✓ Check these features:

☐ **HIGH POWER-HANDLING CAPABILITY:** 2 watts max at $T_C = 25°$ C

☐ **HIGH OUTPUT VOLTAGE:**
$V_{CEO} = 30$ volts max.

☐ **HIGH GAIN-BANDWIDTH PRODUCT:** $f_T = 375$ Mc (typical)

☐ **FAST SWITCHING:**
Turn-on time: 16 nsec typ at $I_C = 150$ ma, $I_{B_1} = I_{B_2} = 15$ ma
Turn-off time: 27 nsec typ at $I_C = 150$ ma, $I_{B_1} = I_{B_2} = 15$ ma
Storage time: 17 nsec typ at $I_C = 150$ ma, $I_{B_1} = 15$ ma

☐ **WIDE TEMPERATURE RANGE:**
$-65°$ to $+200°$ C, storage and operation

☐ **EXCELLENT HEAT DISSIPATION:**
At case temperatures up to 25° C: 2 watts max.
At free-air temperatures up to 25° C: 0.4 watt max.

☐ **VERY LOW COLLECTOR SATURATION VOLTAGES:**
V_{CE} (sat) = 0.28 v. at $I_C = 150$ ma, $I_B = 7.5$ ma
V_{CE} (sat) = 0.45 v. at $I_C = 500$ ma, $I_B = 50$ ma

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