True rms of any waveform measured with this new broadband (10 cps-7 mc) vtvm ... p 68
SPECIAL PULSE TRANSFORMERS TO YOUR REQUIREMENTS

The pulse units illustrated below show a few of the thousands of special types designed and produced by UTC to customers’ requirements. Range covered on special pulse units is from a few microwatts to 10 megawatts. Rectangular pulse shapes are deliberately shown exaggerated to clarify parameters.

25 KC pulse transformer, DD-T or Di-T configuration. Pulse width 60 µSec. Rise time less than 0.5 µSec. Secondary C.T. balance each side to within 1% to ground. MIL-T-27A, GR 8. Size: DD-T, 1/4 dia. x 1/4, wt. 1.10 oz.; Di-T, 3/8 dia. x 1/4, wt. 1.20 oz.

Special precision miniature pulse transformers, designed in our standard stock mold to your specs. Check and precisely adjusted in your tube or transistor blocking oscillator circuit. Sizes: 1/8 dia. x 1/4, 1 gram; 1/4 dia. x 1/4, 4 grams; 3/8 dia. x 1/4, 6 grams.

Ferrite core blocking oscillator transformers, 0.1 µsec, -10%, 100 KC, 25 µm, 5% 2 windings. Rise time 10 µsec. MIL-T-27A, 1/4 dia. x 1/4, 1 oz.

600 µsec, coupling transformer for printed circuit application. 1 winding, 1% w/ flat copper case for extreme shielding. 20 K, 10 henrys, 1% w/ flat copper case for extreme shielding. 10 henrys, 1% w/ flat copper case. Standard UTC, MIL case. 3/4 dia. x 3/4, 1 oz.

The pulse units illustrated below show a few of the thousands of special types designed and produced by UTC to customers’ requirements. Range covered on special pulse units is from a few microwatts to 10 megawatts. Rectangular pulse shapes are deliberately shown exaggerated to clarify parameters.

Almost thirty years of pioneering in the design and production of transformers plus exhaustive life testing programs and rigid quality control measures guarantee components of highest reliability in the industry. You can take YOUR reputation on UTC products.

COVER: Arrows contain waveforms equal in peak amplitude and varying in frequency. The true rms meter correctly indicates the difference in reading, which a peak reading meter could not do. The circle at the junction of the arrows represents meter input.

Sidelights of This Issue

Reaching for the Moon

The world is indebted to the Russians and their photos of the far side of the moon for demolishing for all time an unscientific theory. While abundant holes exist on the hidden lunar surface, the photos showed, there is no noticeable evidence of cheese.

Another popular belief—that only the guileless would purchase a piece of real estate on the moon—may soon topple, too. Lockheed Aircraft of Marietta, Ga., is proposing a satellite that could map the planet block by block. See p 8.

The Voters’ Choice

Electronic Design’s fifth Most Valuable Idea of Issue Award of $50 goes to H. W. McCord, engineer in the Electronic Tube Div. of the Radio Corp. of America, Harrison, N. J. His design idea—’Ungrounded Shield Reduces Effective Cable Capacity’—(April 26 issue)—won a plurality of your votes.

Why not join the voters and see if you can back a winner? It takes but a few minutes, and it doesn’t cost a cent. Turn to the Ideas for Design section, starting on p 158, then cast your ballot on the Reader-Service Card.

< CIRCLE 1 ON READER-SERVICE CARD
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**ELECTRONIC DESIGN - ONE DAY SERVICE**

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ELECTRONIC DESIGN
ONE DAY READERS INQUIRY SERVICE
830 Third Avenue
New York 22, New York
Easier reading continuous display
Higher sampling rate
Multi-period average
Wide temperature range
Low-frequency accuracy
Versatile new modular design
Measurement flexibility, moderate cost

IN 4 NEW hp SOLID STATE COUNTERS!

Turn the page to learn about new measuring convenience, dependability from hp.
CIRCLE 2 ON READER-SERVICE CARD
Call your engineering representative today for data demonstration of these time-saving, precision, advanced instruments.

Your representative is your headquarters for sales, service and parts on the industry's most complete-coverage instrument array. (*) indicates factory-level field repair stations.

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a pleasure to measure with these...

4 NEW SOLID STATE COUNTERS

Measure frequency, period, ratio, quick scanning, and continuous display, no "blinking"...0.1%...Unique low frequency accuracy...Other features:

All the advantages of solid-state design are now yours in these new solid state counters—offered at prices comparable to those of today's vacuum tube counters. And you get the plus advantages of greater readability, faster measurements, easier routine maintenance, rack-and-stack convenience of the new universal module instrument cabinets.

Offered in four models, these new counters have maximum counting rates of 300 KC or 1.2 MC, with a choice of Nixie or columnar readouts. The high-intensity, neon readouts are stacked in compact columns for faster, easier reading. On the in-line readouts, pioneered standard incorporation of the new long-life, wide-viewing Nixies gives you many extra hours of lamp life and heretofore unknown readability even at extreme angles. Polarized screen provides maximum readout brilliance with freedom from reflections.

A unique display storage feature of these new counters produces a continuous visual readout of the most recent measurement, even while the instrument is making a new measurement. Only if the new count differs from the previous count will the display change, in which case it will shift directly to the new reading. The fatigue and error possibility of a "blinking" display is eliminated. The storage feature may be disabled with a rear panel switch.

The counter's "inactive time" (when not making a new measurement) is independent of gate time and adjustable from 0.2 to 5.0 seconds, thus permitting a higher sampling rate.
quickly, accurately ...Compact, easy-to-use instruments provide
...0.1 volt sensitivity ...Solid-state dependability...Higher sampling rate
...Operation —20° to +65° C...Prices comparable to vacuum tube counters!

<table>
<thead>
<tr>
<th>Period</th>
<th>Measurement</th>
<th>Frequency Measurement</th>
<th>Ratio</th>
<th>Measurement</th>
<th>Accuracy</th>
<th>Price</th>
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<td>Accuracy</td>
<td>Reads in</td>
<td>Periods Averaged</td>
<td>Range</td>
<td>Accuracy</td>
<td>Reads In</td>
</tr>
<tr>
<td>2 cps to 10 KC in single period; up to 300 KC in multiple period average</td>
<td>± 10 ± 2 time base accuracy ± trigger error</td>
<td>Milliseconds with positioned decimal</td>
<td>2 cps to 300 KC</td>
<td>± 1 count ± time base accuracy</td>
<td>KC with positioned decimal</td>
<td>10, 1, 0.1, 0.01 sec.</td>
</tr>
<tr>
<td>2 cps to 10 KC in single period; up to 1 MC in multiple period average</td>
<td>± 1 ± 2 time base accuracy ± trigger error</td>
<td>Milliseconds or microseconds with positioned decimal</td>
<td>2 cps to 1.2 MC</td>
<td>± 1 count ± time base accuracy</td>
<td>KC with positioned decimal</td>
<td>10, 1, 0.1, 0.01 sec.</td>
</tr>
</tbody>
</table>

Solid state design and construction gives you the advantages of low heat dissipation with minor heating effect on adjacent equipment, fast warm-up, low power consumption and new standards of reliability.

The new counters include a four-line BCD code output. This output, with assigned weights of 1-2-4, is available for systems use or to operate devices such as the 562A Digital Recorder. Front panel controls include Input Attenuation, Display, Reset and Function.

Call or write your representative or call us today for information and a demonstration!

Data subject to change without notice. Prices f.o.b. factory.

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Geneva, Switzerland
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The physical arrangement of

...Solid state photoconductors...Compact...Easy-to-use...An example of new design and reliability.
THESE "WIRE-WOUNDS" ARE CIRCUIT SHRINKERS...... newly expanded line lets AXIOHM® power resistors go into smaller circuits!

Ward Leonard AXIOHM power resistors are now available in seven sizes—down to 2 watts, up to 12.5.

They're ideal for miniaturization in printed-circuits, industrial instrumentation and automation circuitry. But they're recommended for any electrical or electronic application where the highest stability and maximum overload capacity are required.

The seven AXIOHM sizes come in a complete range of resistance values (see table) from 0.1 to as high as 75,000 ohms. Naturally, they feature the qualities Ward Leonard has made famous in power resistors:

Vitrohm vitreous enamel; Ward Leonard's specially made ceramic core; specially selected and matched resistance wire; and strong, permanent, low-resistance, spot-welded, lead-to-end-cap junctions.

<table>
<thead>
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<th>Resistances (ohms)</th>
<th>Dimensions (inches)</th>
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<td>0.1</td>
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<tr>
<td>12.5</td>
<td>12.5X</td>
<td>0.1</td>
<td>75,000</td>
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*Less leads.

Get complete details in Supplement C to Catalog 15. Write for your copy and a list of stocking distributors today. Ward Leonard Electric Co., 77 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)
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For the first time one instrument provides 1 per cent midband accuracy.
7-mc bandwidth and 100-pv sensitivity to measure the true rms value of
virtually all waveforms

Permanently Tuned, Ceramic, IF Transformer Is Temperature Stable .... 70
New device may change appearance of broadcast receivers
New Products
Outstanding items among the new products of direct interest to designers are 1-kv silicon rectifiers, a low-noise GaSb tunnel diode, high-temperature ceramic diodes, a variable transducer, and a servo galvanometer which is accurate to 0.25%.

Ideas for Design
Circuit Squares DC Input Voltage
Inverted Exclusive-OR Circuit Compares Binary Lits
Voltage Changes Transmitted As Shifts in Frequency
One-Shot Multi Fixes Turn-On State of "Bistable" Unit
Modified Circuit for Constant-Width Pulses
Two-Transistor Circuit Increases Null-Detector Sensitivity
High Power AND Gate Uses Discharging Capacitor
Simplified Gate Driver Reduces Delay Between Outputs
Diodes Checked Out On Single 60-Cycle Tester
Ideas-for-Design Entry Blank

Design Decisions
Steel Ribbon Converts to Angular Motion
Liquid Lock Makes Loose Fit Press Fit
Hi-Fi Die Obviates Milling in St-Erie-o Cartridge Element
Noisy Multivibrator Helps Locate Distress Light

The Art of Tacking
How to solder your career—R. W. Johnson

Production Products
New Literature
Books
Letters
Careers
Advertisers' Index

Coming Next Issue
New design interest in surface-wave transmission lines is reported in the MicroWaves section of the August 2nd issue of ELECTRONIC DESIGN. This well-known, but little-used transmission method may be coming into its own for antenna lines and long-haul communications. Articles on design of magnetic radar modulators and selection of Doppler modulation systems are also featured. The latter article should be of particular importance to designers interested in the fast-growing Doppler field.
A revolutionary new, highly versatile, general purpose, portable pulse generator for field and laboratory use. Featuring a self-contained rechargeable battery pack which allows independent operation "in-the-field" as well as from standard line voltages.

**SPECIFICATIONS:**

- **Main Pulse**—plus or minus, 18 volts into 50 ohm amp.
- **Repetition Rate** from 20 CPS to 2 MCS in 5 ranges.
- **Pulse Delay** from 0.0 to 10,000 USEC in 5 ranges.
- **Pulse Width** from 0.05 USEC to 10,000 USEC in 5 ranges.
- **Overshoot and Undershoot**—5% or less.
- **Duty Factor**—60% max. at any rep. rate.
- **Sync. Pulse Out**—positive, 8 volts min., open circuit amplitude.
- **Size:** 8" wide x 8¼" high x 12" deep.
- Also available as rack mounted unit.

THE COMPLETE LINE OF RUTHERFORD PULSE GENERATORS AND SYSTEMS WILL BE ON DISPLAY—WESCON SHOW—BOOTH NOS. 1501 & 1502

Write for complete catalog to Dept. ED7-19

Rutherford ELECTRONICS CO.
8944 Lindblade Street • Culver City, California • TWK-CVR-CY-4133

pulse generators / pulse systems / accurate time delay generators

CIRCLE 5 ON READER-SERVICE CARD
Advances Spur Thin-Film Computer Hopes

Hughes Testing Complete DDA Using Films;
RCA Claims Field-Effect Deposited Transistor

SEVERAL recent developments indicate that designers are advancing in their drive to miniaturize computers via thin-films.

- At Hughes Aircraft Co., Culver City, Calif., tests are proceeding on a complete airborne computer in which thin-film capacitors and resistors operate in conjunction with conventional semiconductors of the smallest available type.
- Researchers at Radio Corp. of America, Princeton, N. J., claim development of a thin-film cadmium-sulfide transistor operating on field-effect principles but differently from other field-effect devices.
- General Electric's Light Military Electronics Dept., Utica, N. Y., has built thin-film logic circuits which it is proposing to the military services as replacements for conventional logic modules.

RCA reports it has deposited thin films of cadmium sulfide in strips so thin that electrodes can be spaced only 5 microns apart. The films are 1 micron thick. By using a source, drain, and gate configuration (corresponding to the emitter, collector and base nomenclature of conventional devices), RCA researchers have been able to make the combined cadmium-sulfide-insulation and metal-electrode structure act like a transistor.

To do this however, they have had to bias the gate positively so that the gate material, starting as an insulator, has electrons drawn into it, enhancing its conductivity. Enhancement current rather than depletion current is said to be the dominant factor in the device's operation. In field-effect devices such as the Shockley unipolar transistor the gate is biased negatively so that current passing through the device may be modulated by varying the amount picked off.

Because of the extremely narrow electrode spacing, reports RCA, the insulation-like cadmium sulfide can be made to operate at high frequencies, overcoming the low carrier drift mobilities of the material. In laboratory transistors made so far, gain-bandwidth-products of about 5,000 have been measured, the company says. A transconductance of 5,000 was achieved at 10 mA and 10 V.

RCA says the device and the techniques it has developed appear very suitable for mass deposition of computer circuitry. However, its speed is limited to 1 mc at present. Because only a few milliwatts are required for operation, component densities of 10,000 per sq in. are expected.

Experimental Hughes Thin-Film Computer Has 8,000 Components, Draws 30 W

To demonstrate feasibility of thin-film circuitry for logical processing in an airborne computer, Hughes has built a digital differential analyzer based on the circuitry of the
Thin-film field-effect transistors deposited on substrate are made of cadmium sulfide. Electrodes for individual transistors in development at RCA have been spaced as little as 5 microns apart to overcome some of the effects of using an insulator-like material for an active device. Substrate holds three transistors.

Mark II Polaris guidance computer. The unit is said to have more than 8,000 components. It weighs 1 lb, occupies 20 cu in, and requires 30 w of power. It has a core memory and logical circuitry made of thin-film capacitors and resistors deposited on top of one another and micro-transistors and diodes.

Resistors are formed by depositing a 250-A thick layer of Nichrome on a 40-mil Fotoceram wafer and covering this layer with an insulation of silicon monoxide. A layer of copper to form a capacitor plate is deposited on the silicon monoxide.

Either silicon monoxide or anodized aluminum is used as dielectric. Another layer of copper and insulation makes a capacitor.

Interconnections are formed by etching a network of horizontal and vertical conductors separated by a flexible insulator. In one 1-by-1-in. rectangle on the wafer, Hughes says, 44 horizontal wires cross 64 vertical wires with interconnections at each intersection. Reliability is said to be very great. In the circuit mentioned, more than a million on-off cycles have handled 1.4-amp with no failures, according to Hughes.

The computer is divided into 25 wafers, of which 17 logic wafers are nearly identical. For the 25 wafers only nine basic layouts are required, Hughes says. The wafers become unique when interconnections are selectively etched and when the semiconductors are added. These are inserted into holes ultrasonically drilled in the wafer. The wafers are hinged for accessibility so that the entire computer opens like a book.

Hughes estimates that if the computer were to be produced in a production run, the semiconductors would make up about 70 per cent of the cost of the end product. Labor and materials would be 30 per cent. ■ ■

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NEWS

Sensing Network Is Planned in Gulf

Feasibility of Undersea Program To Undergo U.S.-Private Tests

Thomas E. Mount
West Coast Editor

The feasibility phase of a wide-ranging oceanography project in the Gulf of Mexico is expected to be operational by mid-October. An underwater data-sensing system, linked to off-shore towers, will be used to tie together the instrumentation systems used in the project, according to Roy Gaul, program coordinator for the Dept. of Oceanography and Meteorology at Texas A & M.

The towers belong to the Navy’s Mine Defense Laboratory in Panama City, Fla.; however, the project will be a joint effort of the Government, industry and educational institutions. Although the first phase of the Air-Sea Environmental Interaction Research program is directed only at showing feasibility, subsequent financing of the program should permit instrumentation of the entire Gulf.

While the sensing equipment to be established in the Gulf consists only of militarily innocuous oceanographic equipment, industry sources speculate that, after systems have been installed, ASW and sonar equipment may be attached.

Transducers used measure current speed, current direction, water temperature at three subsurface points. At one surface location, wind velocity and direction, air temperature and wave motion will be measured. The underwater sensors are all manufactured by Hytech Corp., Inglewood, Calif. Savonius rotors are used for measuring current velocity, while standard meteorological gear, such as anemometers, vanes, and barometric pressure devices are used for air measurements.

There is a need for better barometric pressure devices, Mr. Schlagel said. “The trouble with strain gages calibrated from 5 to 15 psia is that we are working at the high end of the scale and the sensitivity is not great enough.”

Thermistors, housed in 0.006 in. OD tubing, are used to measure temperature. Hytech is said to be building instruments with an error no greater than 0.05 C for all temperature measurements including air. Response of the thermistor device is only 1/2-sec but
the slow-changing nature of the measurements makes this response adequate. In the Gulf instrumentation set-up, buoys, used to house power supplies, conversion and transmitting equipment, would be linked to multiple underwater sensing stations. These would transmit data over webs to the buoy and the buoy would retransmit the data to equipment on an oil derrick or Texas Tower in the vicinity. In turn the information would be transmitted to shore site data reduction facilities by microwave link.

The power supply in the buoy would consist of standard wet cell batteries and a small diesel engine. When the batteries' charges reach a preset low the engine would turn on automatically to recharge them.

Telemetering equipment for the program is supplied by Telemetering Corp. of America, a subsidiary of Pacific Mercury Electronics, Sepulveda, Calif. A straightforward fm-fm telemetering system will be used, according to TCA's Vernon A. Dorrell, chief systems engineer. Frequencies used will be in the neighborhood of 135 mc in the vicinity of the Gulf missile range. In other areas of the Gulf, transmission frequencies used should be in the 225-260 mc band.

The program, thus far a patchwork of loosely-knit organizations, was sparked by Texas A & M's Roy Gaul. Mr. Gaul recently made a presentation to 30 or 40 different government organizations, including Office of Naval Research and National Science Foundation, who have expressed interest in the program.

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**Only a Bird In a Gilded Cage**

As succeeding generations of missiles penetrate the curtain of space that separates Earth from other planets, the importance of electronic guidance, control and airborne telemetry systems becomes obvious. For, without new engineering design techniques to provide reliable communication and control, the most advanced missile is but a bird in a gilded and very expensive cage.

As typical examples of what can be accomplished to insure maximum performance in missile telemetering, communication, data processing and other applications, Burnell & Co. has developed two new filters—a miniature 3 ke crystal filter and, employing modern synthesis techniques, a miniature 500 kc LC toroidal filter possessing low transient distortion characteristics.
Satellite System Would Map Moon With Erasable Tape

Lockheed Design Calls for Electrostatic-Thermoplastic Recording
Of Lunar Surface and High-Speed Transmission of Data to Earth

Peter de Blanc
News Editor

ELECTROSTATIC-thermoplastic tape recording, high-speed data transmission and an accurate earth-controlled guidance system are basic concepts of a lunar-mapping satellite design described at the AIEE Aerospace and Transportation Committee Technical Conference in Philadelphia.

The design was drawn up by the Lockheed Aircraft Corp., Marietta, Ga., prime contractor for the Samos (Satellite And Missile Observation System) vehicle. Company engineers said that the design considerations for the lunar satellite were similar to those for Project Samos. Thus far, however, Lockheed has no contract to develop its moon-mapping system.

The recording technique combined with the guidance system is said to make possible a final map of the moon with altitudes exact to 50 ft and linear-distance measurements exact to 158 ft.

The Lockheed method would utilize a computer on earth for guidance and positioning of the satellite's attitude in flight, as opposed to a pre-programed computer in the satellite proper.

The time history of the satellite's altitude would be telemetered back to earth for computation of orbital parameters. Then thrust initiate and magnitude signals would be sent to the vehicle. Thrust direction information would probably not be necessary, as the inertial guidance system would position the vehicle properly. This system is said to permit a guidance accuracy of 50 miles inclination from the desired polar orbit.

The mapping camera to be used would employ electrostatic-thermoplastic film and have a focal length/ format ratio of 1/3. Each frame would be a 30-by-30 mile segment of the moon's surface.

On exposure, static charges are arranged on a plastic tape corresponding to various levels of light. Images are recorded in 16 shades of gray, with a resolution inaccuracy of 158 ft in a 30-by-30 mile area at a distance of 30,000 ft. The tape can be read out directly. Readout is destructive, returning the tape to its original neutral electrical state. It may then be re-used.

Photographs of a 30-by-30-mile area with an overlap of 60 per cent will be taken every 10 sec for 1 hr during each 2 hr orbit. This requires a total of 360 frames. A film capacity of 1,000 frames will provide an adequate reserve.

Data Link Would Transmit One Frame Every 12 Sec

Under the proposed system, data would be transmitted at a rate of $3 \times 10^6$ bits per sec at a bandwidth of 750 kc. This speed would enable all of the information collected during the period of one orbit to be transmitted in a relatively short time. Picture elements themselves are resolved into 16 shades of gray, or 4 binary bits. The speed allows the transmission of one frame of data every 12 sec, a timing interval said to be an excellent compromise between readability and speed.

The star background over an area of the moon would be photographed concurrently with that area. The method devised for this would use an integrated technique of electrostatic-thermoplastic recording. The star background would be recorded on the mapping format itself and included on each frame, thereby eliminating the need of a separate recording system.

Scientists would be able to use the photo of the star background over a mapped area, along with accurate time measurements, to determine the nadir point location of each frame. Then instruments such as the Kelsh Plotter, automatic mosaicker and others, would be used to put together the final map.

The navigation and control subsystem of the satellite would be composed of a programmer, including core storage, scalers and

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Sample picture frame as it would appear when received from proposed satellite shows portion of the moon's surface with star background directly above it.

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Figures were obtained in tests with available high-accuracy airborne mapping systems.

Graphical relationship of ground resolution to altitude of a mapping satellite.
**Film for Moon: A Compromise**

Electrostatic-thermoplastic tape recording—a merger of television and photography—was selected as the recording media for Lockheed's proposed moon-mapping satellite after careful consideration. The methods considered included:

**Radar:** Due to the low altitude of the proposed mapping vehicle and the lack of any attenuating or refracting atmosphere, a ppi-type radar originally exhibited considerable merit as a mapping technique. However, upon further examination, difficulties in the resolution of many successively overlapping ppi presentations and in the vertical and azimuth stabilization of a satellite carrying a rotating antenna ruled out this system.

**Television:** Resolution and linearity obtainable with present vidicon-type tubes would give only relatively coarse terrain data, hardly comparable with photographic capabilities. While being satisfactory for navigation use, the image obtained would not do for map makers.

**Infrared:** Basically similar to television, in that the image resolution obtained is not accurate enough for map-making.

**Conventional Photography:** A camera is figuratively the best choice for data-recording with the highest precision. But film in the quantities necessary to map the moon would weigh over a ton. Even if a suitable transport vehicle were devised, the film would have to be returned to earth for processing. And the sensitive film necessary for the job would undoubtedly be fogged by high-level cosmic radiation.

A timing clock with an accuracy of 1 part in 10⁴. Also in this package would be an inertial guidance system, radar altimeter and earth sensor.

Data transmission equipment would include the tape scanner and digitizers, a set of command receivers and transmitters, and the parabolic antenna.

Power would be supplied by solar cells and nickel-cadmium batteries.

The satellite itself would be cylindrically shaped. Around its perimeter four solar cell paddles would be spaced. At one end of the satellite would be a 5 ft parabolic antenna on a shaft, and at the other the main mapping camera. By means of an earth sensor, the antenna would be kept pointing continually toward the earth. Stabilization jets placed around the midsection of the vehicle would be used for control of unit orientation. Alongside the mapping camera, would be a sensor, used to maintain stabilization.

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NEWS

2.25-Gc Transmitter Is All Solid State

Tubeless 2-W RF Source Is Built Into S-Band Telemetry Equipment

A N ALL-SOLID-STATE rf source said to be capable of supplying 2 w of power at 2.25 Gc has been incorporated in an S-band telemetry transmitter, according to Sylvania Electric Products, Inc., Buffalo, N. Y.

The source is an exciter — consisting of a 93.75-mc oscillator with high-gain buffer, varactor-doubler, driver and power-amplifier stages — driving a harmonic multiplier string. According to Sylvania, the use of solid state components gives the complete transmitter an estimated mean-time-to-failure of 14,000 hours. An engineering model built for Wright Air Development Div. occupies 41 cu in. and weighs 3 lb, including a 1-lb copper heat sink.

The transmitter is single-sideband, suppressed-carrier modulated at a high level by phase discrimination. The modulator converts standard am or fm input to a sideband power of 320 mw. In the all-solid-state exciter of the transmitter, a fifth-overtone series crystal operating at 93.75 mc is used. This frequency is multiplied in a varactor...
doubler that uses a PC-119-10 Varicap as the active element in a shunt-type circuit. Operation is an environment of -20 to +80 was required by WADD. This called for a careful heat-sinking of the power amplifier. A nickel-plated beryllium-oxide disk is used in the sink for each of two TA2084 transistors employed.

The harmonic generator consists of a cascaded tripler and two doublers. It uses varactor diodes with breakdown voltages in the -100-range. This high voltage is said to keep peak currents low and provide reasonable varactor conversion efficiency. Total conversion efficiency is said to be 7 db in converting 10 w at 187.5 mc to 2 w at 2,025 mc.

The configuration of the varactor was not conducive to high power dissipation. This required compensation in the microwave structure, where a bead-supported coaxial transmission line was used. Tuning stubs that match varactors individually and ease replacement are used as direct thermal paths. They are shorted half-wave transmission lines that provide metal-to-metal contact.

In the modulator, individual modulators each suppress the carrier frequency while generating both upper and lower sidebands. These are then directly combined to give only one sideband. This occurs when one of the balanced modulators shifts the phase of one of the sidebands 180 deg while maintaining the other at the reference, or input, phase. The balanced modulators, the phase shifter and the microwave sum network are strip transmission line 3-db directional couplers. This portion of the transmitter was built in a three-dimensional coordinate system.

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Satellite Triplets Send Back Key Data

Transit IV-A and 2 Smaller Vehicles Are Proving Worth of Multiple Launchings Despite Difficulties

THE FEASIBILITY of multiple satellite launches has been established despite some difficulties in the recent triple-launching of Transit IV-A and two smaller orbiting vehicles, according to space officials.

The three satellites, riding a Thor-Able-Star from Cape Canaveral, were designed to be separated by a spring mechanism so that all would follow separate orbits. The two smaller vehicles, Greb III and Injun, failed to separate. Much of the data hoped for from these satellites is being obtained despite the separation failure, according to a Navy spokesman.

The multiple launching approach appears to be an ideal method of accomplishing several distinct space missions without the excessive costs of several individual launches.

The three satellites now in orbit are expected to accomplish the following:

- Transit IV-A, a navigational satellite, will signal from space on the energy provided by a small atomic battery atop the drum-shaped craft.

- Injun will investigate the radiation in the Van Allen belts and its relationship to the Northern Lights.

- Greb III will study X-ray radiation from the sun and its effects in causing ionospheric disturbances and radio blackouts on earth.

According to a Navy spokesman, Greb III is not rotating as rapidly as planned and is receiving only one-half of the data anticipated. A photometer installed in Injun, is blocked by Greb III, therefore preventing the instrument from making air glow observations. However, Transit IV-A is working successfully, according to the Navy spokesman.

This was the first time a triple-decker payload launch had been attempted. Two previous successful Transit satellites have
The Transit IV-A satellite is one of a series of Snap (System for Nuclear Auxiliary Power) devices being developed by the Atomic Energy Commission for applications in space and on earth.

Inside the grapefruit-sized Snap device is a small amount of plutonium-238. As the radioactive material decays, it gives off heat. This heat is converted by thermocouples directly into electricity powering instrumentation and two of the four transmitters aboard the Transit satellite. The half life of the plutonium-238 isotope used is 89.6 yr. In addition to the 4.7-lb Snap generator, developed by the Martin Co., Baltimore, the satellite is powered by solar cells and carries two nickel-cadmium batteries.

Transit IV-A has an improved memory system (including an absolute time system) which will periodically receive orbital data from a ground injection station. The satellite will transmit these orbital data continuously until new data are received from the ground to replace the old. A single orbital passage of the satellite, will enable a properly equipped ground station to compute its own position from the orbital data and Doppler shift measurement.

The Injun satellite was designed and built by Dr. James Van Allen of the State University of Iowa as part of a program of research directed by him under contract with the Office of Naval Research.

carried single piggy-back satellites with them into orbit.

The tiny atomic power generator in the Transit IV-A satellite is one of a series of Snap (System for Nuclear Auxiliary Power) devices being developed by the Atomic Energy Commission for applications in space and on earth.

The Snap generator is fastened to the base of Transit IV-A satellite by Martin Co. researchers. Fueled with plutonium-238, it is designed to provide continuous electrical energy for two of the four satellite transmitters. Additional power source is supplied by solar cells and two nickel-cadmium batteries.
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KIN TEL's Model 121A/A non-inverting DC amplifier has fixed gains of 0, +1, +10, +20, +30, +50, +100, +200, +300, +500, and +1000. A variable gain control adjusts any fixed gain from x1 to x2.2. A gain calibration control gives ±2.5% adjustment for each gain other than +1.

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NEWS

Single Radar to Aid All Ships in Harbor

Scan-Converted Display Is Sent To VHF Receivers on Vessels

THE COAST GUARD is about to test a navigation aid based on the broadcast of converted data from harbor surveillance radars to shipboard television receivers. In the tests, scheduled to begin shortly in New York Harbor, scan-converted data from a powerful radar will be transmitted omnidirectionally to adapted vhf receivers.

The system is designed to give large and small ships the ability to move about in a crowded harbor during low-visibility conditions without requiring a harbor surveillance radar aboard each craft. According to the Coast Guard, the only shipboard equipment required is an antenna and an ordinary TV set adapted for an additional channel.

The Coast Guard's plans were described by Capt. L. E. Brunner at the 17th annual meeting of the Institute of Navigation held in Williamsburg, Va.

Captain Brunner reported that the data to be broadcast would be unedited by monitors and that no means of identifying in-

Proposed as a space-navigation aid, optical maser in receiver configuration would differ from transmitter unit mainly in use of slightly transparent mirrors. In the transmitter maser one mirror would be highly reflecting, and a powerful pumping light would be used. In the receiver, the pumping light would be bright enough to keep energy stored in atoms of an activ medium but not so bright that noticeable transmitter maser action would begin. Received light from a companion transmitter would trigger the release of stored energy, which would emerge from a second mirror greatly amplified.
Coast-Guard conception of integrated display of navigation instruments on ship's bridge is being implemented in stages. In panel shown, which would permit one man to handle a sizable ship, the only equipments still undeveloped are a memory device, for display of navigational and other tables, and a video system to display ppi data broadcast from harbor surveillance radar. Scan-conversion video system is to be tested soon in New York Harbor.

Individual blips would be included in the system. In Europe, he said, similar systems are in use in which selected and otherwise processed data are broadcast.

It was learned at the meeting that General Precision, Inc., of Tarrytown, N. Y., has proposed a method of blip identification for use with the system but that the proposal has not been accepted. This technique would allow each ship to identify its own pip on the over-all harbor display. Called PLAN (Positive Locator Aid to Navigation), it would use a narrow rotating beam broadcast from an antenna mounted on the surveillance system transmitter. Each time this beam would be received by a ship in the harbor, the blip representing that ship on the harbor display would appear brighter than other blips.

Captain Brunner reported that development of the navigation aid was part of a continuing effort to develop a ship's bridge display of integrated instruments that would permit one man to navigate a sizable vessel.

Optical Maser Proposed as Aid To Space Ship Navigation

At the meeting, C. B. Ellis and I. A. Greenwood, GPL Div., General Precision, Inc., Pleasantville, N. Y., said that an optical maser appeared suitable as a space navigation aid, especially to determine distance. They reported on company studies indicating that a pulsed optical maser, operating at about 66 w average beam power, would permit measurement of the distance from one space ship to another at 160,000 km with an accuracy of one part in 100,000.

Such a maser might have 10 per cent power stabilization of different optical media.
LITTON DIGITAL COMPUTER COMPONENTS

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Direct inquiries to Special Products Marketing Department, Litton Systems, Inc., Guidance and Control Systems Division, 5500 Canoga Avenue, Woodland Hills, California.

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NEWS

Test of Pay Television to Be Delayed Another Year by FCC

The Federal Communications Commission has set back the test date of a pay-TV test in Hartford, Conn., to July 1, 1962. The tests were originally scheduled to begin on August 23 of this year (ED, March 15, p.4).

The FCC said the delay was requested by RKO Phonevision, Hartford, Conn., sponsor of the tests. RKO Phonevision is a joint venture of RKO General, a unit of General Tire and Rubber Co., and Zenith Radio Corp. RKO Phonevision said the delay was necessary because more time was needed for production and delivery of equipment to be used.

A suit brought by a Connecticut group against the tests is said not to be responsible for the request.
Flarescan-ILS System Allows Blind Landings

Blind aircraft landings have been accomplished with a new system combining an added scanning beam and present Instrument Landing System (ILS) equipment.

The Flarescan-ILS system, under development by Airborne Instruments Laboratory, division of Cutler-Hammer, Inc., Deer Park, N. Y., will soon be evaluated by the Federal Aviation Agency at its Atlantic City experimental facility.

The present ILS system, using equipment installed at hundreds of airports and in thousands of aircraft, allows a pilot to approach a runway on a 3-deg glide slope by following indications of instruments in the cockpit. Since this is too steep an angle for landing, the pilot must take over control before reaching 200 ft altitude, and flare the aircraft out for touchdown. The added Flarescan equipment will allow the pilot to make the complete landing, including flareout, by following glide slope indicators.

ILS provides both lateral and vertical guidance to an aircraft by means of transmitted beams picked up by an airborne receiver. Error signals generated when the plane is not in the center of the beams position indicators which show the pilot the proper direction to bring the aircraft back onto the glide slope.

An added microwave transmitter used in the Flarescan-ILS system is located some distance (2,500 ft in the experimental system) behind the ILS transmitter along the runway. This generates a fan-shaped microwave beam, about 20 deg wide and 1/2 deg high, which is mechanically scanned from the ground up to about 20 deg vertically 8 to 10 times a sec. Pulse coding of this beam at various angles allows a receiving system in the aircraft to determine its angular distance above the transmitter. The difference between this angle and the 3-deg ILS angle, along with the known baseline between the two transmitters, permits a geometric solution for aircraft altitude and horizontal distance from the transmitters.

The solution obtained allows the indicators in the aircraft to make his approach shallower at the proper time, decreasing to about 1/2 deg at touchdown. At 3,000 ft from the transmitters the system provides an accuracy within 5 ft in altitude and 200 ft in range, according to an AIL spokesman.
A MAJOR BREAKTHROUGH – ALL-GLASS MICROMINATURE COMPUTER DIODES FOR NANOSECOND SWITCHING.

HIGHEST RELIABILITY • LOWEST LEAKAGE • HERMETIC SEAL

micro glass silicon mesa computer diodes provide optimum miniaturization and highest reliability. Direct fusion of hard-glass to junction, and use of bonded contacts produces mechanically rugged diodes with exceptionally stable electrical characteristics. Excellent reverse current characteristics are combined with switching speeds of typically 2 nanoseconds. Higher allowable junction temperature of 200°C — true hermetic seal (kovar to hard-glass) — and solid mass-of-glass construction, recommend these diodes for all military-severe applications.

“Available also in .090” with slightly less power dissipation.

| MICROWAVE ASSOCIATES, INC. |

CIRCLE 18 ON READER-SERVICE CARD

NEWS

New MM Waveguide Uses Plastic Lenses

Signals Beamed in Concrete Pipe Could Supplant Circular Guide

A BEAM waveguide said to achieve extremely low-loss transmission of millimeter waves is in development at the Army Signal Corps Laboratories, Fort Monmouth, N. J. The new guide consists of phase-correcting plastic lenses spaced at intervals within a large concrete or plastic pipe.

Signals are transmitted along the guide by free-space propagation and are guided by resetting the cross-sectional phase distributions at periodic intervals by means of the lenses.

Laboratory tests at 35 Gc have shown propagation losses of only 1.75 db per km, according to Dr. Georg Goubau, inventor of the guide. Construction of a 1-km-long guide for field tests is under way at Fort Monmouth.

The dimensions of the guide are frequency-dependent, with the concept becoming increasingly practical at higher frequencies. A 50-Gc guide would consist of a pipe between 1 and 2 ft in diameter in which dielectric lenses would be spaced at about 150-ft intervals. Transmission characteristics improve at high frequencies, so the pipe can be made progressively smaller and the phase-correcting lenses can be spaced farther apart.

Calculations indicate that a 1-ft-diam pipe with lenses 47 m apart would have a propagation loss of only 5 db per mile at 100 Gc.

Alignment of the lenses is reportedly not critical, and the signal can be readily transmitted around corners by dielectric wedges. Furthermore the beam guide does not introduce any delay distortions when transmitting a broad spectrum of microwave energy. Signals of different polarizations can be transmitted simultaneously in opposite directions through the guide.

Beam Principle Avoids Use Of PCM Transmission

Proponents of the beam guide believe that these properties will make it an economical alternative to the circular metallic waveguide.

“We can run our guide around corners
without difficulty, and the absence of delay distortions means that we can avoid using penn transmission," Dr. Theodore Hafner, president of Beam Guidance, Inc., New York, licensees for the guide, told ELECTRONIC DESIGN. "Concrete pipe, while expensive, doesn't begin to approach the cost of precision-machined metal guides."

It was also pointed out that while rain would tend to degrade performance, open guides, consisting only of appropriately spaced lenses could prove feasible in certain less demanding applications.

The beam guide is being further developed by refinement of the phase-correcting elements. Multiple-layer dielectric lenses to reduce reflection are being tested. Doublet lenses, metal lenses and combination metal-plastic are among the devices under study.

The results reported by Dr. Goubau were of tests on a model guide in which long path distances were achieved by successive reflections over a 30-m path, as in an interferometer setup. Several lenses of 20-cm diameter were interposed at about 1-m intervals between the reflectors.

Test signals consisting of 70-μsec, 35-GeV pulses were transmitted in this manner along a total path of 4.5 km. Radial field measurements revealed that the beam was almost completely contained within a cylindrical space of the diameter of the lenses and was not affected by metallic or nonmetallic obstacles outside this space. • •

Unstable tape can cup or ruffle—cause read/write errors because the tape loses contact with the recording and playback heads. Dimensionally stable "Mylar" polyester film base prevents tape cupping or ruffling. It does not shrink from dryness or swell from excess humidity, but maintains the original width and flatness of the tape.

"Mylar" is strong... has an ultimate break strength over 20,000 psi! Tapes of "Mylar" can resist edge nicks, stretching or breaking from sudden stops and starts. And since it contains no plasticizer to dry out, tapes of "Mylar" can be stored indefinitely without becoming brittle.

A stable tape assures accurate data acquisition—helps prevent costly read/write errors and loss of valuable test data. Tapes of "Mylar" have this stability. To be sure you'll get the best performance, insist on a base of "Mylar" on your next order for magnetic tape. Write for the free booklet on comparative test data. Du Pont Company, Film Dept., Wilmington 98, Delaware.

"Mylar" is Du Pont's registered trademark for its brand of polyester film. Only Du Pont makes "Mylar".

R. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room 121, Wilmington 98, Delaware
Please send free, 12-page booklet of comparative test data to help me evaluate magnetic-tape reliability.

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Company _________________________
Address __________________________
City __________________________ Zone ______ State ______

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Crystal Filters do Wonderful Things

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Perhaps you don't need a 10 cycle wide crystal filter. But could you use the ingenuity that built one? Could Itek technical leadership help you?

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CIRCLE 20 ON READER-SERVICE CARD
DOD SPURS ACTIVITY IN QUANTUM ELECTRONICS

The Dept. of Defense will attempt to exploit as rapidly as possible the promising results of the last year's intensive R&D activity in optical and infrared masers.

A committee of DOD consultants and representatives of each military service will be formed shortly to review all Government and private R&D programs in maser technology. It will evaluate potential applications for extending the range of frequencies for radar and communications and also study prospects for use of coherent light in generation of power.

Prime purpose of the survey is to determine whether the scope of current R&D is adequate for military requirements and to pinpoint facets that may require more emphasis and increased Government financial support. The committee's findings also are expected to provide a time scale by which equipment and systems designers can anticipate the availability of practical devices.

By its effort to spur early development of practical quantum electronic devices, the Office of Defense Research and Engineering points up a policy matter of growing concern. This relates to the contention, particularly among officials responsible for development of advanced components, that applied research and component development in promising new areas of technology have lacked adequate support when not specifically designated for use in projected weapon system programs. These officials have advocated that such activities be managed and financed independent of weapon system projects.

TOWARD SHIPBOARD AUTOMATION

The Maritime Administration has launched R&D programs that may lead eventually to the integration of all shipboard operating functions under automatic control systems. Its objectives are to improve safety at sea and to make U.S. shipping more competitive by saving manpower.

Sperry-Rand is under contract to develop a prototype bridge control system console that will centralize the outputs by which a watch officer performs his present functions. The unit will be composed of five sub-consoles relating to navigation, plotting, steering, radar and communications, and the ship's condition.

The console will incorporate such familiar elements as a weather facsimile recorder, an automatic direction finder, an adaptation of an X-Y recorder for plotting, the gyro-pilot and radar readouts. New elements will be a radar data computer and a ship-stability computer.

The Radar Data Computer, under development by Goodyear Aircraft, is an anti-collision device capable of tracking 10 targets with analog computing circuits and of sounding an alarm on the bridge.
when a target crosses a track. It will be possible for the watch officer to put a trial correction of the course in the computer and then change to this course if it clears the alarm.

The ship-stability computer will be an adaptation of existing equipment under the Sperry contract. A combination analog-digital computer, it will automatically make computations to determine the stability of the ship, provide readouts on the vertical acceleration of the bow, and perform watertight door and smoke and fire control functions.

More Advanced Control Techniques on the bridge, including engine-room monitoring and control, are planned for the next R&D stage. Already in the works is a course computer, for which Norden Division of United Aircraft is making an engineering study. This will compute an optimum course to a destination with automatic feeding of correction data.

Since no previous attempt has been made to integrate control of a ship's steam power plant, the Maritime Administration has two parallel efforts underway to develop a system for controlling the whole operation from a console. Envisioned is a solid-state electronic servo system with hydraulic and pneumatic boosters. The console probably would contain automatic logging and computer programming. A similar effort will soon be launched for control of gas-turbine plants.

A BOOST FOR HIGHWAY CONTROL SYSTEMS

Commerce Secretary Luther M. Hodges is considering recommendations by his department's transportation policy group that would enable the Federal Government to provide a much-needed incentive for further development of electronic highway control systems.

Under one proposal the Bureau of Public Roads would provide a large-scale feasibility test of a system for automatic control of car steering, braking and acceleration on a limited access highway. A test strip of up to 100 miles is proposed.

The roads agency would name a prime contractor to serve as systems manager for the project. The contractor would assist the bureau in evaluating several proposed systems and handle the sub-contracting and over-all supervision.

RCA, Bendix, Thompson-Ramo-Wooldridge and Battelle Memorial Institute are considered the leaders in this field, and all have been consulted by the bureau in preliminary planning.

The Urban Traffic Problem will receive attention under another proposed Bureau of Public Roads program to foster development of electronic systems that would anticipate snarls and automatically indicate corrective action.

Preliminary planning for this experimental project envisions use of imbedded inductive pick-up or transducer devices. The devices would measure traffic speed and density continuously for computer inputs. The computer would actuate control signals. Its readouts also would be used to relay instructions to motorists via radio or variable signs.

Such a system is considered particularly applicable to increasing the efficiency and capacity of urban expressways.

ELECTRONIC DESIGN • July 19, 1961
Service with a smile

As more and more G-E germanium tunnel diodes are being designed into low level switching circuits, it becomes increasingly apparent that many design engineers prefer to determine their own electrical specifications. Your wish is our command, and a section of our manufacturing line is now exclusively utilized to "tailor make" your tunnel diodes. Example: you can choose your own specs for peak current from 25 to 250 ma. and one other important parameter, such as capacitance or peak voltage.

While you're ordering your tunnel diodes, you might be interested in another little G-E gem of reliability data, compiled on our computer-general purpose line. Twelve units were subjected to 10,000 hours of life testing... with virtually no degradation of characteristics. One more example from over 3 million tunnel diode hours of life testing, with truly remarkable results.

Incidentally, you can also order "A" versions of these germanium tunnel diodes, specifically designed for your fastest switching applications. You'll get speed so fast that it pushes the capability of present sampling scopes. You also get extremely tight control of the three primary characteristics for switching tunnel diodes: peak point, temperature stability and switching speed.

Applications are bustin' out all over

A great deal has been written in recent months on tunnel diode usage, particularly in the UHF and microwave areas. Now that practical tunnel diode devices are available, the circuit designer has a real need for a comprehensive and authoritative survey of this information, along with a concentrated bibliography. If you'll pardon a modest bow of the head and downcast eyes, the job has been done.

Erich Gottlieb, one of G-E's top tunnel diode application engineers, has covered the field of articles and papers published over the last year on tunnel diode usage at UHF and microwave frequencies. Over 90 pages of authoritative information, this survey is divided into four main sections: Amplifiers, Oscillators, Converters and General Information. Particular attention has been paid to noise figure and gain bandwidth, and how they relate to stability.

If you have a "need to know," drop us a line to Section 23G101 for your free copy.

More proof positive...

...that our 2N497A-498A and 2N656A-657A medium power silicon mesa transistors are indeed the industry's most thoroughly characterized and tested! You have probably seen our published 1,000 hour life tests. May we modestly bow our head again while you look over the following 6,000 hour chart, and note the long term stability and reliability that can mean so much in your circuit designs?

Footnote to the above: the "A" versions are exclusive from General Electric, have higher power with cooler operation (cool transistors are reliable transistors), low input impedance (200 ohms vs. the usual 500 means more signal gets into the transistor and more current flows out), and lower saturation resistance (10 ohms vs. the usual 25 means less power loss when you turn the unit on). How can you go wrong?

MIL types?

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Semiconductor Products Department, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: International General Electric, 150 E. 42nd St., N.Y. 17, N.Y.
Resistor Line Fully Automatic

A completely automatic computer-controlled production line for manufacturing deposited carbon resistors has been demonstrated at the Western Electric Co.'s North Carolina Works near Winston-Salem. The computer controlling the line can be programed to schedule a month's output. It will then issue suitable instructions to fabricating machines, capable of a continuous production of 1,200 finished resistors per hour. The final products are specified accurate to a tolerance of 1/2 of 1 per cent.

End of the line for the deposited carbon resistor is the packing machine, above. Here resistors are imbedded in styrofoam blocks, and loaded into a magazine. The magazines are then removed by an operator, who will prepare the blocks for shipment.

Bell jar held by Western Electric engineer has a gold cathode, used to deposit a layer of gold on the ends of carbon-coated resistor cores passing through the line. The gold termination forms a contact on each end of the resistors, to which the next machine attaches wire leads and caps.

The automatic production line for making deposited carbon resistors is made up of eleven stations. The control computer, an LGP-30, runs the process completely, from raw materials to finished resistor. Until loading for shipment, the resistors are not handled by operators.

Automatic inspection and testing station of automatic line plots test record of every unit on a graph, and rejects defective resistors. The station also provides feedback control to the computer, resulting in line self-correction, if necessary to maintain standards.
NEW PRODUCT

High Density Miniature HYFEN with center jackscrew

Now available from the Burndy Corporation, Omation Division is a new miniature HYFEN connector with a center jackscrew which provides alignment and engaging force. This connector is presently designed in two configurations: 1) 104 contacts; and 2) six miniature coax contacts combined with 48 standard contacts. Contacts are crimp-type which snap-lock into and out of the connector body. Both inner and outer portions of the miniature coax contact are crimp-type. This connector may be designed to accommodate other combinations of coax, miniature coax, and standard contacts for particular applications.

Crimp-type contacts are installed by tools which are full-cycling, thereby guaranteeing a complete installation every time. These installation tools—hand, pneumatic or semi-automatic—provide a measurable crimp, facilitating quality control.

Connector bodies are molded of high heat-resistant, flame-proof diallyl phthalate with molded-in ferrules for contact retention. Jackscrews and guide pins and sockets are stainless steel. The connector can be easily polarized by varied placement of guide pins and sockets.

All contacts are gold plated with nickel plated beryllium copper locking springs. Quality materials throughout provide maximum reliable performance of this connector. This miniature HYFEN connector performs to the applicable sections of MIL-C-8384 and MIL-T-7928. Further information is available from

Burndy Corporation, Norwalk, Connect.
CIRCLE 22 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
**Industry First...** RN55 Precision Film Resistors in RC07 Size

Replace Fixed Composition Resistors

Every critical circuit forced to attain smallness through use of RC07 style composition resistors can now be upgraded. To make this possible, IRC offers both metal film and deposited carbon precision resistors in a new subminiature size.

1. the first time a molded RN55 resistor is available completely interchangeable in physical size with the RC07
2. meets or exceeds performance of precision films (MIL-R-10509), which means lower noise, better TC, superior all-around stability than fixed composition RC07’s (MIL-R-11)
3. surpass RC07’s even when run at the MIL-R-11 rating of 1/4 watt @ 70° C
4. uniform, molded bodies just right for automated assembly ... immune to damage by normal transit and handling

For top resistor performance without any space penalty, specify new IRC Type EM or DM units for every miniature circuit. Full details in a new 12-page bulletin. International Resistance Company, 401 North Broad St., Philadelphia 8, Pennsylvania.

**CAPSULE SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Metal Film</th>
<th>Deposited Carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wattage</td>
<td>1/10 watt @ 125 C</td>
<td>1/10 watt @ 125 C</td>
</tr>
<tr>
<td></td>
<td>derated = Zero</td>
<td>derated = Zero</td>
</tr>
<tr>
<td></td>
<td>load = 175 C</td>
<td>load = 175 C</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>± 75 PPM (“E” Char.)</td>
<td>± 75 PPM (“E” Char.)</td>
</tr>
<tr>
<td></td>
<td>± 50 PPM (“C” Char.)</td>
<td>± 100 PPM</td>
</tr>
<tr>
<td></td>
<td>± 150 PPM</td>
<td>± 150 PPM</td>
</tr>
<tr>
<td>Resistance</td>
<td>5 ohms min.</td>
<td>10 ohms min.</td>
</tr>
<tr>
<td></td>
<td>100K ohms max.</td>
<td>301K ohms max.</td>
</tr>
<tr>
<td>Standard Tolerance</td>
<td>± 1%</td>
<td>± 1%</td>
</tr>
<tr>
<td>MIL-R-10509</td>
<td>RN5 Characteristic E and C</td>
<td>RN55 Characteristic D</td>
</tr>
<tr>
<td>Size</td>
<td>025” x 031” x 093”</td>
<td>025” x 031” x 093”</td>
</tr>
<tr>
<td>IRC designation</td>
<td>EM</td>
<td>DM</td>
</tr>
</tbody>
</table>

**Digital Communication Modules Developed**

Prototypes Can Be Combined to Form Systems or Used to Adapt Data Units

PROTOTYPE modules that can be combined to form complete digital communication systems have been constructed.

The modules can also be used to adapt data communication equipment for special needs. In use they adapt teletypewriter, data transceivers, facsimile machines, tape equipment and other devices for compatible operation.

The prototype series is made up of input-output multiplex equipment, modulator-demodulator units (modems) and special devices, such as parallel-to-serial and serial-to-parallel converters.

This concept of modularization at the functional level is a development of ACF Electronics Div., Riverdale, Md., under its ACF Building Block Communications Devices program (ABCD). Wherever possible, according to the company, standard solid-state circuits on plug-in cards are used throughout the series of functional blocks. This is said to permit the equipment to be sold at relatively low prices. Many of the cards are interchangeable, as are the modules within each type.

Modem to Process 4,800 Bits Per Sec Is Among the Blocks Built So Far

The following have been built so far: a modulator said to be capable of operation at 4,800 bits per sec for use with either radio or telephone links; a demodulator with an unusual equalizer; a stable clock with phase corrector; five multiplexer blocks for such equipment as facsimile systems and IBM transceivers; five demultiplexer blocks; serial-to-parallel and parallel-to-serial converters, and an encryption control.

The multiplexer equipment operates at up to 4,800 bits per sec, a limit imposed by telephone-system channels. ACF says the circuits in the time-division system are capable of rates as high as 50 kc. From two to 16 channels can be multiplexed and demultiplexed. These may be either from asynchronous equipment, like teletypewriters;
Communications system consisting of modular functional blocks is designed for flexibility in handling digital data from a variety of sources. The block being examined provides a multiplex input channel for teletype equipment.

quasi synchronous equipment, such as facsimile; or synchronous systems, such as an IBM card reader.

Logic levels in the multiplexing building-block circuits are 0 and -12 v nominal, and supply voltages, -12 and +12 v. All circuits operate at the nominal maximum frequency of 50 kc. The levels of terminal devices are changed to ABCD voltage levels by buffer circuitry when necessary.

Terminal Devices of Varying Bit Rate Reduce Effective Transmission Time

In the multiplex system, terminal devices with more than eight information bits per character must be accommodated by two or more channels of the multiplex cycle, because each channel is limited to eight bits. Another disadvantage, ACF admits, is that when terminal devices of greatly different bit rates are used, the multiplexer transmits no information for much of the time.

The modem blocks use four-level am, suppressed-carrier, vestigial-sideband transmission. Am was chosen, the company says, because of cost, size and complexity benefits. Four-level, suppressed-carrier techniques are said to give the same signal-to-noise ratio at 4,800 bits per sec as two-level unsup-

Hughes TWT capability offers you

New solutions for tube and systems problems

A continuing program of applied research by Hughes has resulted in the development of outstanding operating features such as those illustrated in the accompanying cutaway of a high-powered TWT.

When you have a requirement for an advanced microwave tube—CW or pulsed—consider TWT's, and Hughes. Perhaps the solution to your problem is already in development, or production, at Hughes.

For a more complete rundown on what Hughes can offer you, contact your nearest District Office today, or write for your copy of the Hughes short form catalogue.

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13 Lloyd Avenue, West Long Branch, N. J. CAPital 2-1111
WESTERN 11105 South La Cienega Blvd., Los Angeles 45, Calif. SPRing 6-1515

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BIG JOBS
2400 epa
CLOCK

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TYPE

310 A
Modem processes up to 4,800 bits per sec using four-

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level am, suppressed-carrier, vestigial-sideband tech­
niques. Binary data at 4,800 bits are transmitted as
four-level, 2,400-bit data. An intersymbol interference
corrector in the receiver compensates simultaneously
for delay and amplitude distortion.

TO ALL TUBES AND COMPONENTS

Measuring deviations to quantity parts-per-million in
similar units under test.
Instrumentation includes a Tektronlx Type 310 A Oscil­
loscope and the new Electro Scientific Industries precision­
measurement console—which measures resistance, ca­
pacitance, and voltage ratio over wide ranges with direct
traceability of accuracy to three reference standards cer­
tifiable by the National Bureau of Standards.

Need a precision-measurement tool in the dc-to-4 mc range?
A small-size, light-weight, semi-ruggedized instrument that operates
almost anywhere from 50-to-800 cycles line frequency?
One that combines stability in performance, simplicity of operation,
accessibility for maintenance?
Then consider a Tektronix Type 310A Oscilloscope.
For size, convenience, presentation of trace display—a Type 310A
ideally suits precision-measurement applications at point-of-use ...
such as quality-control checks in production testing ... or mainte­
nance and calibration of complex electronic equipment in the labo­
ratory or in the field.

Frequency Response—de to 4 mc: 100 mv/div to 125 v/div; 2 cycles to
3.5 mc: 10 mv/div to 100 mv/div. Risetime— less than 90 nanoseconds.
Sweep Range—0.5 ^sec/div to 0.2 sec/div in 18 calibrated steps, con­
tinuously variable between steps and to 0.6 sec/div uncalibrated.
5X Magnifier—extends calibrated sweep range to 0.1 /»sec/div. Trig­
gering—amplitude-level selection with manual or preset stability
control, and automatic facility. Horizontal Input. Amplitude Calibrator.

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Encino • West Los Angeles) • Minneapolis. Minn • Montreal, Quebec, Canada • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N j.) • Orlando, Fia • Philadelphia. Pa. • Phoenix (Scottsdale) Ar./
Poughkeepsie, N.Y. • San Diego, Caltf- • San Francisco, CaM. Area (Lafayette. Palo Alto) • St. Petersburg. Fla. • Syracuse, N.Y • Toronto (Willowdale) Ont . Canada • Washington, D C-(Annandale. Va ).


CIRCLE

26 ON READER-SERVICE CARD

pressed carrier systems operating at 2,400
bits per sec. Vestigial-sideband modulation
permits double the information rate of a
double-sideband system. For communication
at 4,800 bits per sec the data stream is
changed to a four-level stream of 2,400 bits
per sec by converters, which are switched
out for rates of 2,000 bits or less.
An unusual type of distortion compensa­
tion is used in the modem. It is said to cor­
rect simultaneously both amplitude and delay
distortion. The compensator is reported use­
ful as an equalizer of digital or analog trans­
mission systems, a highly adjustable filter,
or an instrument for obtaining any amplitude-vs-frequency curve or differential-delayvs-frequency curve.
The compensator consists of a string of
time-delay stages, an adjustable adder net­
work and inverters. Data pass serially
through the delays, the outputs of which
are continually summed. When the adder
network is properly adjusted—after an
oscilloscope “eye” pattern of received data
is observed—the output of the network is
compensated for the distortion. The delay
stages are designed to introduce a minimum
of distortion of their own, ACF says. ■ ■
CIRCLE 910 ON CAREER

INQUIRY FORM, PAGE

177

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There is a continuing need to know more about the nature of space and its complex environment. Only through fundamental research and scientific inquiry can this need be met.

At Convair Astronautics Electronics Research Laboratories, our task is to meet this need: to explore the space sciences; to advance the state of the space technology arts. Here, company-funded research in space electronics and space physics is in progress, motivated by the need to develop instruments and electronic techniques vital to the progress of space flight and exploration.

The men selected to staff these laboratories must be of high academic caliber. They must possess the sort of professional background which demonstrates interest and achievement in solving the broad spectrum of problems associated with space technology.

Senior and staff positions are available now for electronic scientists and physicists with advanced degrees. Specific areas of research are detailed on the back of this page. If they meet your interest, we invite your investigation. A convenient inquiry card is attached which you may mail in complete confidence. It will be promptly reviewed by a member of the Electronics Research Laboratories staff.

If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Mail Zone 130-90, Convair Astronautics, 5676 Kearny Villa Road, San Diego 12, California.

(If you live in the New York area, please contact Mr. T. Cozine, manager of our New York placement office, Circle 5-5034.)

CONVAIR/ASTRONAUTICS
DIVISION OF GENERAL DYNAMICS

SENIOR SCIENTISTS AND ENGINEERS: ANNOUNCING STAFF OPENINGS AT ELECTRONICS RESEARCH LABORATORIES
Engineers and Scientists for
ELECTRONICS RESEARCH LABORATORIES

The Electronics Research Laboratories at Convair Astronautics offer fine facilities and a professional atmosphere, plus a distinguished staff of associates, to scientists and engineers with an interest in fundamental research.

A free exchange of ideas is actively pursued through attendance at scientific meetings, and since a great deal of the research conducted here is unclassified, publishing of papers is also encouraged. An added advantage is the location of the Laboratories. San Diego, California, boasts an ideal climate, fine living conditions, excellent schools, vigorous cultural attractions, and constantly expanding facilities for advanced education.

SENIOR AND STAFF POSITIONS ARE AVAILABLE NOW TO ELECTRONIC SCIENTISTS AND PHYSICISTS TO CONDUCT RESEARCH IN THE FOLLOWING AREAS:

Solid State and Thin Film Research for application to micro-electronics using sputtering, vacuum evaporation-deposition, decomposition-sublimation, and advanced electron beam graphics.

Surface physics studies of film kinetics and structures by electron microscopy including the study of epitaxy and nucleation from the vapor phase "in situ."

Materials research and synthesis of inorganic semiconductors for active components in molecular electronics and solar energy conversion applications.

Theoretical and experimental studies of thin magnetic films for computer applications. The mechanism of orientation, domain nucleation and wall motion, and the mechanisms of nanosecond flux reversal.

Study of geo-astrophysical phenomena including the development of instrumentation to study weather-indicating phenomena, cosmic radiations, magnetic and gravity field measurements of planetary bodies, by means of space probes.

Space Electronics Research for application to tracking, communication and data processing systems and special purpose devices and instruments, for use in satellite payloads.

Statistical Communication Theory studies of narrow banding, correlation and rate controlled sampling and quantization techniques for threshold improvement of long range tracking, communication and real-time digital control and data processing systems.

Special purpose instrumentation for sensing and controlling attitude and velocity of space vehicles, with heretofore unattainable sensitivities and precision including microgram thrust rockets, gravity field differential torquing, and radiation pressure sensing.

If you desire more information, may we urge your prompt inquiry on the attached card. If it has been removed, or if you wish to furnish more details about your background, please write to Mr. R. M. Smith, Industrial Relations Administrator-Engineering, Mail Zone 130-90, Convair Astronautics, 5676 Kearny Villa Road, San Diego, California. (Men living in the New York area are invited to contact Mr. T. Cozine, manager of our New York placement office. Circle 5-3034.)

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR, OR NATIONAL ORIGIN.
Electronic Manufacturer Contracts For Servicing of Its Computers

Clary Corp. of San Gabriel, Calif., has contracted with Federal Electric Corp. to provide nationwide service for its computers.

This is a departure from traditional servicing methods, but it will enable the company to sell in areas previously beyond its servicing capabilities.

Federal Electric, service associate of International Telephone & Telegraph Corp., with headquarters in Paramus, N. J., said it will supply the full range of service normally received from a factory service arm, including maintenance.

Information-Hunting Computer Has a 8,192-Word Memory

A mechanized information-retrieval system with an 8,192-word, magnetic-core memory of 20-bit words is in operation at Western Reserve University for the American Society of Metals.

The system, developed over the last four years by the university, is built around a GE 225 computer, programmed for literature searches. The memory is said to enable the computer to search through 100,000 indexed abstracts, patent reports, technical articles and the like in an hour. Western Reserve indexing and tape language are compatible with most existing data processing installations.

Able to utilize either magnetic-tape or punched-card input, the General Electric computer features a 15,000-character-per-second transfer rate.

Control console of GE 225 information searching computer, installed at Western Reserve University for the American Society of Metals.

Crystal tungsten opens up a new era for the metal in electronics

A new method of consolidating tungsten powder into tungsten ingots has been created by LINDE's Crystal Products Department. This new material—crystal form—changes the whole approach to use of tungsten in electronic applications.

Compared to metallurgically prepared (PM) tungsten, crystal tungsten offers 5 to 15 per cent higher electrical conductivity. Thermal conductivity is about 20 per cent higher at 500°F, resulting in improved heat dissipation. These properties can be advantageous in electronic design.

Useful in vacuum devices

The high purity and zero porosity of the crystal tungsten also suggest its use not only in electrical contact points, but also in vacuum switches, electrical leads in vacuum tubes, and applications where outgassing or leakage is a problem. Their purity and lack of grain boundaries provide more even electron emission, making them valuable in several high pressure vacuum or open air switches. Other uses include: flexible sheet in electronic tubes; x-ray anti-cathode targets.

LINDE crystal tungsten is considerably more ductile than undoped PM tungsten. It can be drawn into wire as fine as 1 mil, giving greater yield of finished products from the starting ingot. Although undoped crystal tungsten has a lower recrystallization temperature, it does have a yield point at about 150°F.

Material easily worked

Significant is the fact that it can be easily worked and at temperatures 800°F lower than working temperature for powder metallurgy or vacuum-arc cast tungsten—making it useful for a wide range of non-electronic applications. Present shapes include swaged rods from 1/10 to 3/8-inch diameter, as grown ingots up to 3/4-inch diameter in production, and even larger diameters in development.

For more details on this new material, check the coupon below.

Typical electronic shapes fabricated from crystal tungsten (l. to r.): target emitter; zero-porosity tungsten anode for high-powered electron tubes with fluid cooling; high-power vacuum switch contact of zero-porosity tungsten mounted to copper.

Super-hot process metal-coats and fabricates intricate parts

Dense, high-purity metal coatings for certain base materials, and the fabrication of odd shapes, are accomplished with "Plasmplate," a super-hot plasma stream process developed by LINDE's Flame-Plating Department.

In operation, a high-current torch uses temperatures up to 30,000°F to produce a supersonic stream of ionized gas—melt and accelerate to high velocity particles of any inorganic material that melts without decomposition.

High-purity coating materials—such as tungsten or other refractory metals—are thus permanently fused to the surfaces of materials such as graphite, brass, copper, steel, molybdenum, titanium, aluminum and others.

Parts of intricate configuration can be fabricated by depositing the coating material on a mandrel machined to the desired internal shape of the finished part. After the desired thickness is obtained, the mandrel is dissolved out by chemical means.

Tungsten grid cage—one of many complex shapes made by LINDE'S "Plasmplate" Process.

Thin coatings of tungsten carbide and other hard materials can also be applied to base metals by the LINDE oxyacetylene Flame-Plating "gun" process, to increase surface wear as many as 40 times.

For details on either of these LINDE processes, check the coupon below.

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NEWS

Solderless Wirewraps Have Low Failure Rate

Solderless wirewrap connection techniques now gaining wide use in industry are averaging only 1 failure per 200,000 connections according to production engineers.

Speaking at the recent IRE Production Engineering Conference in Philadelphia, A. H. Wenner of IBM's Federal Systems Div., Kingston, N. Y., said that IBM is now making solderless wirewrap connections at the rate of 100 million per year with the 1 in 200,000 failure rate. Following the presentation of the paper a representative from West-
ern Electric Co. said that his firm was experiencing a similar failure rate on wirewrap connections made at the rate of 6 million per year.

The failure rate figures apply to the number of substandard wraps discovered during inspection. Very few failures ever occur beyond this point, the production engineers indicated. Mr. Wenner said that operator variations were the main cause of poor connections. He and others at the meeting agreed that new numerically controlled automatic wirewrapping machines being produced by Gardner Denver Co. should increase the yield of good connections.

Cost of the conventional manual connections using a hand wirewrap tool is about half that of conventional solder joints, according to Mr. Wenner.

Wirewrap techniques have also proved surprisingly good for low production and even breadboarding. Isaac Auerbach of Auerbach Electronics Corp., Philadelphia, said that when his firm was forced to use the technique for a prototype item because of customer specifications, the technicians discovered it was both easier to use the first time and easier to modify.

Automatic Data Reduction System To Assist Oceanographic Studies

An automatic data-reduction system will be used by Woods Hole Oceanographic Institution, Woods Hole, Mass., to convert analog data gathered for ocean wave studies.

Called the Addressor System, by its developers Tele-Dynamics, a division of American Bosch Arma Corp., Philadelphia, the system can also be used for:
- Investigations of thermal microstructure in a thermocline.
- Studies of transfer of momentum, heat, and water vapor across the ocean-atmosphere interface.
- Studies of bottom friction of oceanic and tidal currents.

The Addressor comprises a two- or four-track tape playback system, 12-fm demultiplexers, and an analog-to-digital converter. It includes such features as tape error compensation using any channel as reference, reference detection for computer control, and a specially designed flexible patchboard. The outputs permit on-line entry of data to existing high speed digital computers. Direct analog outputs will also be available.

Immediate Minuteman and Dyna-Soar openings for Electronic and Electrical Engineers

Electronics is one of the fastest growing areas of engineering at Boeing. Electronic and electrical engineers interested in the advancement of space-age technologies will find challenging and deeply rewarding opportunities in advanced Boeing programs, including the Dyna-Soar manned space glider and the solid-fuel Minuteman ICBM. Assignments exist in your particular area of interest and at the level you require for career satisfaction and advancement. For your convenience, a professional application form appears at the right, and continues on the following page.

ELECTRONIC DESIGN • July 19, 1961
**NEWS**

**Single-Channel, 3-D TV Speeds Atomic Assembly**

Three-dimensional television now available as an industrial aid uses only a single vidicon and one channel instead of the two vidicons and two channels needed with former stereoscopic techniques.

The new closed-circuit sets are being used to monitor the manipulation of component parts and the assembly of radioactive isotope power sources at Atomics International Corp., Div. of North American Aviation, Inc., Los Angeles.

In the past, single-plane TV techniques for nuclear assembly proved lengthy and arduous. To simplify the job, atomic developers painted the radiation chambers and “hot” cells with easily spotted reference lines of different colors.

**3-D Television Kits Being Used For Nuclear Power Source Program**

Atomics International purchased the unusual 3-D television kits to speed work for the SNAP program (Systems for Nuclear Auxiliary Power).

Made by Stereotronics Corp., 1717 N. Highland St., Los Angeles, the television system works as follows:

A mirror system, screwed onto a standard 16-mm industrial TV camera lens, doubles the image. The pair of half-size images is then transmitted to the TV monitor, where they are presented side by side on the viewing screen.

By replacing the standard safety screen with polarized filters and then viewing the...
screen through converging polarized lenses, one sees a 3-D image.

Instead of glasses, a viewing hood may be used. No electronic modifications are necessary to adapt a closed-circuit TV system to three dimensions. The cost is on the order of $900.

**Many Other Military, Industrial Uses For Stereo-Viewing Kit**

Other uses for the Stereotronics 3-D TV kit include viewing screens for tanks, underwater manipulation, stereo microscopes and commercial TV, according to the company president, James F. Butterfield.

Stereotronics Corp. is preparing the kit for commercial TV. Temporary stereo glasses would be wrapped in colored cellophane. The unwrapped cellophane would fit over the TV screen and serve as the polarizing medium. Instead of field polarization, color polarization—with suitably colored convergence lenses in the glasses—would be used.

**Automated Storage System to Use Digital and Analog Techniques**

An automated storage system, combining digital and analog techniques, will automatically stack and store heavy aircraft engine parts.

The storage system, to be developed by Electro Nuclear Systems Corp., Minneapolis, Minn., will be installed at Alameda Naval Air Station, Calif.

**Loads of Up to 500 Lb Automatically Placed in Compartments**

The storage system will move pallets holding loads of up to 500 lb and deposit them in any one of more than a thousand storage compartments. By using automatic controls the stackers will be able to move in both vertical and horizontal directions simultaneously, thus reducing time and increasing the efficiency of the operations. The system will also be able to withdraw the loads, which measure more than one yard in each dimension, from the compartments and return them to a central conveying point.

According to specifications, the stacking system will accomplish about 185 stacking operations per hour or about three per min. In operation, the automatic stacker removes a loaded pallet from a conventional conveyor. The operator at a control console directs the load to its destination by depressing keys on the addresser.

**NEW SOLID-STATE DIGITAL VOLTMETER AT WORK!**

As reliable as they are quiet, the EAI Series 5000 Transistorized Digital Voltmeters combine a unique “Full-Time” high input impedance circuit with outstandingly accurate, high speed performance.

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Versatile as well as economical, these voltimeters provide decimal and binary-coded decimal electrical outputs for driving a full range of accessory equipment. Brilliant, easy-to-read projection displays eliminate “glow-through” ambiguity while providing wide angle reading—even under adverse ambient lighting conditions.

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NEWS

'Dunking Duck' Is Invented With Transistor Oscillator

An all-electronic version of the toy "dunking duck" has been invented by Dr. H. E. Stockman, Professor of Electrical Engineering at Lowell (Mass.) Technological Institute.

The usual version of the toy consists of a model duck so mounted on a pivot that once set in operation the head dips repeatedly, without any immediately apparent mechanical stimulus. The electronic unit, made in the shape of a duck or a bee, depends for its operation on a transistor oscillator.

A tapped inductor forms a cavity. A small Alnico magnet, attached to the duck's head, dips into the cavity. The 3,000-to-5,000-turn inductor is connected to the transistor in a common-emitter configuration. The bottom winding is connected to the base, and the top winding is connected through a 1.5-v battery to the collector.

Ultrasonic or High Audio Frequency Oscillation Results From High Mutual Inductance

Because of the high value of mutual inductance, the system oscillates at a high audio or ultrasonic frequency. This results in a dc collector current of several milliamperes. However, because this oscillation is damped by a resistor connected between the base and ground, if mechanical oscillations are not allowed to take place, the electrical oscillations vanish also.

Once the unit has been started, and mechanical oscillations have begun, mutual inductance in the circuit increases during each down-dip, so that the oscillation limit $\beta A = 1$ is exceeded. With a short rise time, the device then works itself into a "spike" of ultrasonic oscillations of high-average current value and short duration, causing the down motion of the magnet to become forcefully enhanced.

Duck's Head Begins to Rise As Collector-Current Pulse Dies

Associated with the increase in mutual inductance is a secondary electromotive force. This biases the base of the transistor until a point of diminishing return is reached, whereupon the driving collector-current pulse vanishes, and the duck begins to raise its head again.

Mechanical oscillations are determined by
Schematic of the toy shows that it is a simple transistor oscillator with a movable magnetic core. E2 is a secondary electromotive force generated by mechanical motion of the magnet.

The natural frequency of the oscillation—in this case on the order of 1 cps.

Because the magnet serves as a quenching agent and the ultrasonic oscillation pertains to system resonance, the phenomenon resembles super-regeneration; on an oscilloscope the ensuing wave-train looks very much like that obtained from a transistor super-regenerative device.

The unit is said to consume so little power that the battery used should last for several months.

Produced by Sine-Serco of Waltham, Mass., it sells for $11.

Tiny Ferrite Cores Form Memory

Miniature ferrite cores, above, form the memory of a data-processing system that will be used in the first Orbiting Astronomical Observatory of the National Aeronautics and Space Administration (ED, Jan. 4, p 12).

The advanced memory system, developed by International Business Machine's Federal Systems Div., Rockville, Md., uses quadruple-component and tripe-modular redundancy. Asynchronous operation simplifies tie-in to external equipment. Nondestructive readout permits multiple readout of the entire memory while the satellite is in range of a receiving station. The memory's storage capacity is 102,400 bits, redundant, and 204,000 bits, nonredundant.

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TO THE ENGINEER

who needs the magic of mercury

If you're stymied by switching problems in data processing, automatic control or high-speed keying, then consider the unusual attributes of AE's Series V51 mercury-wetted contact relay.

This fleet switcher can be driven at speeds up to 100 operations per second, completely free from contact bounce. It requires no maintenance within its life of over a billion transfers. The contacts can switch dry circuits or handle loads up to 250 volt-ampere. Operate and release time is approximately 3 milliseconds.

Contact and armature assemblies of the V51 are hermetically sealed in a glass capsule with a high-pressure hydrogen atmosphere. Mercury wetting continuously renews the contacts, eliminates wear, erosion, welding and sticking. Operating sensitivity is 250 milliwatts, minimum.

AE engineers will be glad to aid in applying the V51 to your designs. Ask for Circular 1988 covering full specs on the V51. Write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

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NEWS

Digital Computers To Be Used For Process Control Computation

Four digital computers will be used for process control computation in an ethylene and ethylene co-products plant currently under construction.

The computers and other electronic instrumentation are being furnished by Minneapolis-Honeywell Regulator Co.'s Special Systems Div. of Pottstown, Pa., for the Monsanto Chemical Co., Chocolate Bayou, Tex.

The plant will operate initially on an open loop with the computers continually monitoring process conditions, making calculations, and furnishing printed instructions to operating personnel who will make necessary process changes.

Cost of the computer control system was not disclosed.

Ballistic Camera Sync System Times Shutters Within 0.1 Msec

A ballistic three-camera synchronization system, which can keep the timing of rotating shutters within 0.1 msec of each other at distances up to 200 miles away, has been accepted by the Army Ordnance Ballistic Research Laboratories.

Developed and manufactured by the Electronic Engineering Co. of Santa Ana, Calif., the system will be used for tracking space vehicles or capsules.

The entire system is housed in three trailer vans. The vans contain one central camera control and two remote-control timing stations. The cameras are interconnected by radio or telephone circuits.

In operation the system provides shutter-synchronizing control from a central point for phototheodolites, used in the tracking of rockets or satellites.

Sine-wave signals sent from the central control station may be phase-shifted to vary the shutter opening time. At the remote station the shutter opening is detected, and a shutter-opening signal is transmitted back to the central camera control station as a precise time mark. These return time marks are compared with other time marks delayed from a real-time reference. Either a 1-pps local range timing signal or a 1-pps time signal from WWV may be used as the real-time reference.
To synchronize the camera shutters, an unusual method of detection is employed to time the incident of maximum shutter opening.

A shutter disk drive incorporates two aluminum wheels with small iron slug inserts, which are geared to the input shafts of the two rotating disk shutters. Reluctance pick-ups are accurately positioned with respect to the aluminum wheel to sense the open position of the disk shutter.

The ballistic camera synchronization system also includes equipment for the measurement of time delays in transmitting shutter-open pulses through the modulation and demodulation circuits, as well as time delays in the communications circuits.

Fiber-Glass Instrument Carrier Built for Underwater Research

A new submarine instrument carrier, called the V-Fin (Vehicle For Instrumentation), has been developed by the Braincon Corp. of Marion, Mass. The molded fiberglass vehicle is useful for such projects as seismic investigation, temperature and pressure studies, echo-sounding and high-speed sampling at constant, predetermined undersea depths.

The V-Fin, because of its precise hydrostatic design, is said to be completely stable at speeds up to 20 mph, remaining at the desired depth regardless of fluctuations in the speed of the towing ship.

The instrument compartment of the V-Fin is 12 in. long, 2-1/2 in. wide and 1-1/8 in. deep. It can be sealed; components placed in it may be individually potted. Information is transmitted to the towing ship over a coaxial towing cable.

A hydrophone and impedance-matching transistorized preamplifier is available for use in the V-Fin, the company reports.

V-Fin underwater instrument carrier for marine researchers and commercial fishermen is said to be stable at speeds up to 20 mph.
New Laboratories Going Up As Research Spending Rises

Total electronic research expenditures have climbed over $2 billion a year, estimates the Commerce Department's Bureau of Defense Services Administration. Military R&D alone in 1960 hit over $1.8 billion—a 10 per cent jump over 1959. To keep pace with these expanded research needs, new laboratories have been springing up throughout the industry. Shown here are examples of some of the projects being carried on in the many new facilities.

Photodetectors for space using semiconductors and liquid electrolytes are under development at International Business Machines Corp.'s Thomas J. Watson Research Center in Yorktown Heights, N. Y. The photodetector above is sensitive enough to detect weak signals from the moon, but rugged enough to withstand intense direct sunlight. It is expected to operate for several years with a 1.36-v battery. In normal solar cells light must pass through a thin silicon layer to reach the junction where energy conversion takes place. In the IBM device the surface layer is a sulphuric acid electrolyte which absorbs very little light. Sensitivity is 740 μA/cm² measured at 0.9 micron at a light level of 24 μA/cm², according to IBM. High sensitivity to ultraviolet is used in ultraviolet detector using similar principle, below.

Developments such as this miniature all-attitude inertial platform (above), weighing less than 20 lb, are being handled by United Aircraft Corp.'s new Norden Div. research laboratory in Norwalk, Conn. This platform will be used in a new navigational system.

Sealed chamber (right) with controlled atmosphere allows Philco Corp. researcher to assemble semiconductor devices under carefully controlled atmosphere. Rubber gloves built into the sealed chamber permit the worker to manipulate minuscule parts without breaking the seal. Philco's new research center is located in Blue Bell, Pa.
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Delco Radio's new silicon digital modules operate on less than 4 mw. of power per logic stage. They are rugged enough to withstand extreme environmental conditions and are small and lightweight. Encapsulated in light foamy epoxy, each module weighs less than 12 grams and occupies less than one-half cubic inch. The basic set of modules includes a bistable multivibrator, a diode NOR gate, a power driver, a monostable multivibrator and an astable multivibrator. From these basic units larger computer subassemblies can be assembled, such as shift registers, adders, binary counters, decimal counters and timing devices. A range of applications—from small scale switching circuits to large computers can be satisfied with these modules. Environmentally proved to:

NEwS

Analog-Digital Recording Systems To Be Developed For the Navy

Two identical high-speed digital data recording systems, to be designed for shipboard installations, will use both digital and analog inputs.

The system, to be developed by Monitor Systems, Inc. of Fort Washington, Pa., will handle up to 25 inputs, 10 in analog voltage form and 15 in digital form. In its normal mode of operation, each system will sample all data channels within 20 msec followed by a quiescent interval for the remainder of the sampling period.

Frame rate will be adjusted by the operator to 0.1, 0.2, 0.5, 1, 2, 4, 8, 16, 32, or 64 seconds as desired. The operator will be able to select any one channel for high-speed sampling at a rate of 800 samples per sec. All data will be recorded on magnetic tape in compatible format for IBM 650 or 704 computer processing.

The systems will be developed under a $250,000 Navy contract.

Optical Sensor Designed to Help Blind 'See' Approaching Objects

An optical range finder is being developed to help blind people sense the distance of approaching objects by means of vibrations applied to their fingers.

The device is essentially a zoom lens operating in conjunction with a photomultiplier, which converts the light variations of an approaching object into mechanical vibrations.

The detector is being incorporated into a briefcase that has a handle with four metal membranes, arranged so they touch the fingers of the holder. The membranes are set for fixed-distance ranges—1 to 3 ft, 3 to 9 ft, 9 to 30 ft, and beyond 30 ft. A blind person would sense approaching objects—an auto, say—through successive activation of the membranes, while using his thumb to change the angle of the lens.

The device is being developed by Dr. Bertil Jacobsen of Karolinska Hospital, Stockholm, Sweden. He is also the inventor of the endoradiofonde, a tiny transistor radio transmitter that can be swallowed by a patient to supply data to a receiver outside his body.
Seconds after countdown, a microscopic pit in a miniature bearing could ground the most carefully planned space shot. To eliminate pits and other imperfections, Fafnir helped pioneer miniature ball bearings of vacuum-melt stainless steel. This “extra-clean” steel is completely free of impurities, and makes for flawless bearing performance. Look to Fafnir for leadership in ball bearings. The Fafnir Bearing Company, New Britain, Connecticut.
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Get the highest available accuracy in this piston type attenuator.
Features: 30 and 60 Mc standard frequencies. Continuously variable over 80 db range above minimum insertion loss. Accuracy ±.006 db per db from 10 to 80 db; ±.06 db from 0-10 db. Price $250 to $295. Circle publication No. 785.

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Many types of precise measurements of R-F circuits are possible with this excellent labora-
tory tool. Calibrate R-F attenuators and couplers. Measure noise figure and selectivity.

Features: Incorporates Type 30 attenuator, 30 and 60 Mc standard frequencies. Noise figure 1.6 db at 30 Mc; 2.4 db at 60 Mc. Prices $1,350 and $1,400. Circle publication No. 788.

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Type 113030 (not illustrated)—Radar Performance Monitor. Transistorized. Measures noise figure, checks mixer crystals; checks transmitted and reflected power. Circle publication No. 790.

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IDEAS FOR DESIGN
Radar Augmenter Enlarges Target On Radars of Tracking Planes

An active radar augmenter has been developed to make small Air Force drone or target aircraft appear as large “enemy” planes on the radars of tracking planes.

The 14-lb augmenter, developed and now being produced by Lockheed Electronics Co. of Plainfield, N. J., electronically simulates the radar-echo characteristics of target vehicles. The typical augmenter gain is about 70 db at 9 Gc. The unit receives a radar-transmitted signal and transmits an amplified signal back to the tracking missile-carrying aircraft.

Simulated Enlarged Target Area Can Be Varied With Attenuator

Assuming the transmitter and receiver line losses are equal to the antenna gains and that the antenna isolation obtainable is greater than 70 db, the simulated target area is 850 sq m. Target areas may be varied by a variable attenuator in the antenna output line.

The C/X-band unit uses a traveling-wave-tube amplifier, transistorized power supplies and matched receiving and transmitting antennas. The frequency range is 5 to 11 Gc. Output power is 1 w minimum, although more than 3 w are transmitted over a major portion of the band. Signal gain over the major portion of the frequency range is greater than 65 db and as high as 72 db. Input and output impedance is 50 ohms nominal. Input power (dc) is 100 w with a voltage rating of 25 to 29 vdc. Regulation is 1 per cent.

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CIRCLE 43 ON READER-SERVICE CARD
EDITORIAL

Getting Obsolete?

Is experience the best teacher? Will you be worth more as an engineer 10 years from now because of your experience?

Dr. Thomas Stetson, Head of the Department of Civil Engineering at Carnegie Institute of Technology expresses some provocative ideas on the value of experience in an article titled “Education for Oblivion” (Carnegie Alumnus, April 1961).

He points out that starting salaries for engineering graduates have risen far more rapidly than those of experienced employees with the same basic training. This situation, he says, is claimed to be caused by a temporary maladjustment caused by an expanding technology combined with a shortage of engineers.

Commenting on this, Dr. Stetson says:

"... There is considerable evidence to indicate that the situation is not temporary, but will continue and may even become more pronounced. Such a trend implies that a new engineering graduate is near the peak of value to his employer and society, and that several years of experience may only add slightly to his professional stature..."

He goes on to view the problem quantitatively.

"... Unless a graduate of 10 years ago has systematically spent about 10 per cent of his time extending his knowledge beyond the level of development achieved in his collegiate training he will not have value in excess of a new graduate. This... assumes that he has retained all of his previous training, which is probably far from realistic.

"If an estimate of decay from neglect or disuse is also 10 per cent per year, an engineer is faced with the task of growing in new knowledge at the rate of about 20 per cent per year to remain of equal value to his employer and society. To increase in value at a significant rate he should probably devote about one-third of his productive hours to self-education and improvement..."

In other words, you have got to keep with your field or become obsolete. How can you keep up? One way is to learn how to read effectively—and use this skill to regularly absorb the carefully compiled, edited, and detailed account of the advances in your field that appears in every issue of technical magazines like ELECTRONIC DESIGN.

Employers would also do well to act on this problem. Technical management should not merely expect engineers to keep up with the advances in their field, it should insist on and require this as part of each man's job. One of the best ways to do this is to encourage and make time available for technical reading—right on the job.

If a man is to spend one-third of his time to grow in his field, surely one hour of his working day, set aside for technical reading, is not asking too much. Certainly he will supplement this one hour with many more on his own, encouraged by the knowledge that management is really interested in his growth.

[Signature]

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ELECTRO-MEASUREMENTS, INC.

CIRCLE 45 ON READER-SERVICE CARD
Transistor and Switching-Circuit Measurements

At present, rise and fall time measurements for switching transistors are taken at the 10 and 90 per cent points of the device excursion. Although this approach is acceptable for an exponential function, the 10 and 90 per cent levels are difficult to determine for transistors having a delayed exponential due to high frequency loading; capacitive feedthrough and ringing also limit the accuracy of locating the 10 and 90 per cent points. Response measurement using 20 to 80 per cent levels, author Charles Askanas argues, is equally valid and avoids the above problems.

The Exponential Related to Switching-Speed Characteristics

Review of Definitions: The dimensionless exponential response of a network is:

\[ \frac{k(t)}{K_0} = e^{-t/T} \]  

(1)

\(K_0\) is the initial current or voltage at time \(t = 0\), \(T\) is the time constant of the system.

A tabulation of \(t/T\) is shown in Fig. 1, together with a plot of the normalized exponential. It can be seen that the exponential will reach a steady state in five time constants.

Relationship between Exponential Rise Time and Frequency Response: Since shunt (distributed and lumped) capacitance determines high-frequency response, consider the rise time of the integrating network (low-pass filter) shown in Fig. 2.

The rise time, defined as the time interval between 10 and 90 per cent of the total excursion is:

\[ t_r = 2.3 \text{ RC} - 0.1 \text{ RC} = 2.2 \text{ RC} \]

The cut-off frequency of the network is:

\[ f_c = \frac{1}{2\pi RC} \]

\[ t_r = \frac{2.2}{2\pi f_c} = 0.22 \]

and \(t/t_c = 0.35\)

If the rise times were defined as the time interval required for voltage output to go from 20 to 80 per cent of its final value

\[ t_r = 1.6 \text{ RC} - 0.22 \text{ RC} = 1.38 \text{ RC} \approx 1.4 \text{ RC} \]

\[ t/r_c = 0.22 \]

Since the exponential becomes asymptotic to its final value in five time constants, the selection of the 10 and 90 per cent points on the waveform is straightforward. However, it can also be seen that selecting the time between 20 and 80 per cent is as valid for indication of the frequency response as the 10 and 90 per cent points—one just deals with a different constant. However, defining switching times between 20 and 80 per cent must still be justified.

Switching Response of A Grounded-Emitter Transistor

The most accepted form of the saturating grounded-emitter transistor response is the exponential:

\[ t = \frac{1}{f_c(m) - f_c(m_o)} \ln f_c \left( \frac{i_{c(e)}}{i_{c(o)}} \right) \]

\(m_o = \) the common-base current gain cut-off radian frequency.

Charles Askanas
Engineering Project Manager
Lumatron Electronics, Inc.
New Hyde Park, N. Y.

Lack of correlation and repeatability in switching speed measurements plague manufacturers and users of fast transistors for computer circuits. Among the many factors which compound this problem is the lack of uniformity in circuit construction and layout resulting in nonrepeatability of the distributed reactances critical at high frequencies.

The lack of correlation is partially due to the persistent use of a definition which was originally intended for use with somewhat classic exponentials. That is, the definition of rise time and fall time between 10 and 90 per cent, and turn-on delay time and storage time between 10 per cent of an input pulse and 10 per cent of an output pulse. The advantage and validity of measuring switching times between 20 and 80 per cent is given.

Fig. 1. Plot of a normalized exponential.

42
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Frequency stability over the entire 5 cps to 500 KC range is better than \( \pm 0.03\%/^\circ C \) from 0\(^\circ\) to 55\(^\circ\). Amplitude stability over rated frequency range and output levels is better than \( \pm 0.1\% \) over 8 hours of operation at constant line voltage and temperature*; better than \( \pm 0.2\% \) for line voltage changes of \( \pm 10\% \); better than \( \pm 0.1\%/^\circ C, 0-55^\circ C \).

Output of the 204B is fully floating, isolated from both power line ground and chassis. Balanced and unbalanced loads, and loads referenced either above or below ground, can be driven by this versatile oscillator. Low impedance circuits drive the 600 ohm output, effectively isolating the oscillator stage.

Designed in the new **hp** instrument module packaging, the 204B is only 6-3/32" high, 5-5/8" wide and 8" deep; weighs just 6 pounds! A new rack mount adapter holds three 204B oscillators or other **hp** instruments of the new modular design.

*On battery operation, stability \( -1\% \) during battery depolarization, less than 30 minutes.

---

\[ a = \text{the common-base current gain} \]
\[ i_c = \text{collector current} \]
\[ i_b = \text{"on" or "off" base current} \]

These equations, valid to determine an approximate response or a direction for design, are accurate within 20 per cent; the following are assumed:

1. The transistor switch input is from an idealized constant-current source. Actually, most of the switching circuits are voltage driven from source impedances between 50 and 100 ohms.

2. The transistor is considered essentially nonloaded, i.e., the load resistance is assumed small enough so that the short-circuit current gain can be used, and the only load capacitance considered is that of the collector capacitance which is nominally in the order of 1.0 to 30 pf.

Analytically, the nonloading assumption is:

\[ R_e C_{c(e)} \ll 1 \]

*Continued on p 44*
Fig. 4. The equivalent transistor output developed from Fig. 3.

Fig. 5. Characteristic curve of a transistor with a load line drawn from "off" (point A) to "on" (point B).

Fig. 6. Common emitter collector saturation characteristics.

To determine the validity of the nonloading assumption, consider a typical high-frequency switching circuit:
The alpha cut-off frequency = 100 mc
\( \alpha_c = 2\pi f = 2\pi \times 10^8 \text{ rad/sec} \)
\( C_e = 10 \text{ pf} \)
\( R_L = 500 \text{ ohms which is fairly small load resistor} \)
\( \alpha_c C_e R_L = 2\pi \times 10^8 \times 10 \times 10^{-12} \times 5 \times 10^2 \)
\( \therefore R_1 C_{e_1} > 1 \)

Thus, the loading effect cannot be ignored. Furthermore, this is neglecting the effect of distributed circuit capacitance due to layout and wiring and the capacitive input of most oscilloscopes or probes used to monitor fast switching times.

Consider the switching circuit output shown in Fig. 3.
\( C_{in} \) and \( R_{in} \) are the input impedance to the monitor oscilloscope (if its input is capacitive, as well as resistive.)
\( C_i \) is the collector capacitance.
\( C_s \) is the distributed circuit capacitance. Consider the transistor as a function generator whose output is the idealized exponential. In the equivalent circuit, \( R_{total} \) includes the transistor output impedance and its shunt load resistance \( R_L \) (which is at ac ground) and \( C_T = C_{in} + C_s + C_e \) as shown in Fig. 4.

As shown, for high-frequency operation:
\( RC_{total} > 1 \) and \( C_T > C_i \)
\( \therefore \alpha_c > \frac{1}{RC} \) and \( RC > > \frac{1}{\alpha_c} \)

As shown, it is RC which determines the response and not \( \alpha_c \).
Rewriting Eq. 1 as:
\[ t = -K \ln g \quad \text{when} \quad g = \frac{f_i(t, i_0)}{f_i(t, i_0, \alpha)} \]
\[ K = \frac{1}{f_i(t, \alpha) - f_i(t, \alpha, \alpha)} \]

\( K \) is a constant for a given transistor.
\( g = e^{-t/K} \)
which is the assumed exponential feeding the integrating network.

Using transform theory:
\[ \mathcal{L}(e^{-t/K}) = \frac{1}{(S + 1/K)} \]
The transfer function of the equivalent low-pass filter is:
\[ \frac{V_o(S)}{V_i(S)} = \frac{1}{R + \frac{1}{CS}} = \frac{1}{1 + CSR} \]
\[ \therefore \frac{V_o(s)}{V_i(s)} = \frac{1}{1 + CSR} \]
\[ = \frac{1}{(s + 1/K)(CSR + 1)} \]
\[ = \frac{1}{CR} \left[ \frac{A_1}{s + 1/K} + \frac{A_2}{s + 1/RC} \right] \]

By residues:
\[ \frac{V_o(S)}{V_i(S)} = \frac{1}{CR} \left[ \frac{A_1}{s + 1/K} + \frac{A_2}{s + 1/RC} \right] \]

\( R \) in the above treatment has been assumed as constant. However, \( R \) includes the output impedance of the transistor which varies by many orders of magnitude as the transistor switches from "on" to "off."

The slope of the \( V_{ce} = I_c \) characteristic curves of the grounded emitter transistor is a good approximation of the transistor output impedance. The characteristic curve of a "typical" transistor is considered in Fig. 5.

Some small change in the transistor output impedance is seen as it switches from point A to point B. A rapid change in impedance is seen as the transistor reaches the saturation point, Q. However, if the voltage axis is increased by a factor of at least 10, a more realistic view of the transistor saturation characteristic is obtained as shown in Fig. 6.

In Fig. 6 the output impedance of the transistor is seen to vary markedly as the transistor is driven further into saturation. The transistor output impedance, which is a function of \( I_c, V_{ce}, \) and \( V_i \), can be approximated by linear increments which are functions of time. Thus in the frequency domain,
PROVEN IN FLIGHT / FAIRCHILD PRECISION POTENTIOMETERS

In our country's defense program, failure cannot be tolerated. The "Reliability Factor" of all elements of defense becomes more and more important as the arsenals of both East and West become more and more sophisticated. In the future, less business will go to the unproven, low priced producer. Management has learned that the lowest initial cost does not always result in the lowest end cost. Fairchild precision potentiometers are proven performers. They are flying with predicted excellence in many important missile, special weapon and space vehicle applications. They have earned a reputation for sustained high accuracy over a wide temperature range, lowest noise level and long life—quality features that can be achieved only with experienced, precision workmanship and painstaking attention to the smallest detail. As a result, "Fairchild Reliability" has become an industry standard.

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There are over 28 standard models available in sizes that range in diameter from \( \frac{1}{4}" \) to \( 5" \). They feature high functional accuracy, high resolution, low noise, wide electrical angle, wide temp. range, one-piece wiper, simplified precious metal slip-ring construction, welded taps and terminals, and precious metal contacts and resistance wires. Bushing or servo mounts, sleeve or ball bearings. Gangeble, with no increase in diameter.

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Fig. 9. Normalized total transistor response.

Thus, the transistor response is the delayed exponential which would be expected when driving an RC network with an exponential. However, the resultant output rise time of the delayed exponential is altered by the shift in $R(t)$, i.e., $R$ changes during the transistor excursion.

The theoretically predicted resultant delayed exponential including the effect of the transistor loading is shown in Fig. 7. In order to verify the appearance of the delayed exponential, the output of the circuit shown in Fig. 8a was monitored.

The transistor has the following specified characteristics:

$$h_{fe} = 20 \text{ at } I_c = 10 \text{ ma, } V_{cc} = 1 \text{ v}$$
$$C = 4.5 \text{ pf}$$
$$h_{fe} = 2 \text{ at } V_{cc} = 15 \text{ v dc, } I_c = 10 \text{ ma, and } f = 100 \text{ mc.}$$

It can be seen that the transistor is being sufficiently overdriven to assure saturation.

The response oscillogram of the circuit appears in Fig. 8b. The delayed exponential characteristic can be observed in Fig. 8b, i.e., the waveform continues to increase in magnitude after the steady state appears to have been reached. If one changes the sweep speed to 50 nsec per cm in order to view the entire characteristic, the delayed response is not as evident. Response characteristic at a sweep speed of 50 nsec/cm is shown in Fig. 8c.

In Fig. 8d one can see an oscilloscope display of the response characteristics on a Tektronix 541A. Again the delayed exponential characteristic can be seen.

Errors in Selecting 10 and 90 Per Cent Points

The high frequency delayed transistor response appears in Fig. 8. The curve shown in Fig. 8 is so nonlinear around the 90 per cent region that a small error in the selection of the 90 per cent point yields a very large error in time. The 80 per cent point is approximately the first easily selected linear portion of the curve and a small error in the selection of the 80 per cent point corresponds to correspondingly small error in time.

As can be seen graphically:

$$\Delta V_1 = \Delta V_2 \quad \text{but } \Delta t_1 >> \Delta t_2$$

Aside from the delayed transistor response the faster switch has anomalies in the response characteristic such as capacitive feed through, reflection due to improperly terminated inputs, and ringing. Each of these may have peaks which are over 10 per cent of the total transistor swing.

It is desirable to have test limits which are easily selected regardless of a change in waveform and are not disturbed by the above described anomalies. But, most of all, it is desired to have test limits which encompass, as completely as necessary, the waveform being observed.

The 20 per cent level can be justified as the lower test limit since it is high enough on the curve to be independent of the reflections and feed through.

The 80 per cent upper test limit is the highest point of the linear portion of the re-
response characteristics which is easily determined. As shown graphically in Fig. 9, a small error in the selection of 80 per cent means a correspondingly small error on the time axis. The exponential delay can be further increased without seriously effecting the 80 per cent limit; however, the error in selecting 90 per cent would increase proportionately with an increase in exponential delay.

However, 20 per cent as the lower limit and 80 per cent as the upper limit are not the only optimum test limits. Specific requirements may result in other limits. The limits are selected as being optimum in order to present the most general case.

**Instrumentation Errors**

**Due to Sweep Speed Choice**

Further justification of the nominal 20 and 80 per cent points as the lower and upper test percentage points can be made from an instrumentation point of view.

If one wants to determine switching times accurately with an oscilloscope, the sweep speed must be such that the waveform may be viewed over a large a time as possible. This increased resolution results in the measuring error illustrated graphically in Fig. 10. If the resolution is decreased in order to see the entire response, it may appear as shown in Fig. 10b. In Fig. 10b, the entire waveform is reduced at levels which are less than 50 per point is reduced, but the entire measurement is correspondingly reduced in accuracy.

The users of transistor switches are rarely concerned with the upper portion of the leading edge of a drive or trigger pulse. Circuit designers are primarily concerned with transfer and delay time between logic elements. Both are functions of the level at which a logic element triggers.

In most designs, logic circuits are triggered at levels which are less than 50 per cent of the input pulse, in order to reduce turn on delay times. Furthermore, delays between successive stages are usually computed from 50 per cent points. Thus, the above 50 per cent nonlinear portion of the delayed exponential rise usually yields no useful information to the logic designer.

**Acknowledgments**

The author expresses appreciation to Philip Emile and Paul Schwartz of Lumatron Electronics for their many helpful comments and enlightening suggestions and to Lawrence May for his drawings.

**Reference**

Precision Potentiometers
Need Better Specifications

One would think that after all these years virtually everyone should know how to specify a precision potentiometer. But it just isn’t so, according to Robert Hennessy. Mr. Hennessy, who’s been designing precision pots for more than nine years points out that even pot manufacturers don’t agree on basic electrical definitions. (This is one of the problems that the new Precision Potentiometer Manufacturers’ Association will try to solve.) In an effort to eliminate the most pressing ambiguities he offers this article.

Robert Hennessy
Carter Manufacturing Corp.
Hudson, Mass.

Electrical specifications for precision potentiometers are too ambiguous. They were developed solely for specifying the shaft-voltage relationship of precision potentiometers. Presently used specifications have, in practice, created situations where the manufacturer is not clear as to the customer’s requirements and the customer often receives a unit that meets the letter of his specifications and then finds his specifications do not reflect his requirements. Since manufacturers often disagree among themselves on the precise meanings of various specifications, it seems that the problem is not merely one of customer education.

Further proof of this lies in the fact that requirements exist that cannot be covered by the existing definitions. Thus, the customer or designer may be expert in the field of precision potentiometers and find he cannot specify the requirements and consequently must buy a unit that is over specified.

Accuracy Definitions
Cause Most Trouble

Accuracy definitions are the most troublesome. There is some disagreement in the industry on the precise meaning of resolution, electrical angle, etc., but these are minor and they do not often cause severe difficulty.

Basically, a precision potentiometer generates a voltage output as its shaft is rotated. This relationship is specified by an equation, a table of output values corresponding to shaft angle, or a graph. In each case, the function to be generated is easily understood but difficulties arise as to tolerances.

Through custom, the accuracy is based on the maximum deviation from a theoretical master function of zero error. In practice, the accuracy of a precision potentiometer (once manufacturing is complete) can be altered in any one of three ways (or a combination of them).

1. By using an angle that varies somewhat from the prescribed 100 per cent rotation angle. (This is done presently under “independent linearity.”)

2. By phasing the potentiometer to the system so that the actual output varies its relationship to the absolute shaft position.

3. By varying the actual voltage across the potentiometer whereby the output range is greater or less than the 100 per cent reference voltage. (This is also done, at present, under “independent linearity” and also “independent conformity.”) External circuitry is generally needed for this adjustment.

Specifications Should Show Which Allowances Are Permitted

Accuracy definitions are needed to indicate whether any of these allowances are permissible and, where they are, the tolerances of the adjustments and of the accuracy with the adjustments.

When the system designer has a precision-potentiometer requirement, he knows the following:

1. The function to be generated by the potentiometer (linear, square law, logarithmic, etc.).

2. The shaft angle over which this function is to be generated.

3. Whether this total shaft angle is absolute or can be varied.

4. Whether external circuitry can be made available or is desirable by means of which the voltage at the low-voltage-end terminal of the potentiometer may be adjusted.

5. Whether the high-voltage end may be similarly adjusted.

6. If it is necessary that the first indication of voltage (or voltage change) must be the beginning of the function.

7. What accuracy is required in the shaft-position-to-voltage-output relationship.

If a table or a check-off list is now made, the potentiometer can be specified completely. For example:

(1) Function \[ E_o = \ldots \]

(2) Reference Angle \[ \ldots \text{deg} \]

(3) Reference Angle Tolerance \[ \pm \ldots \text{deg} \]

(4) Low-Voltage End \[ \square \text{ Independent} \]

(5) High-Voltage End \[ \square \text{ Independent} \]

(6) Index \[ \square \text{ Zero Base} \]

(7) Conformity \[ \pm \ldots \% \text{ of } E_o \]

If the function is defined by a graph or a
### TABLE

| Function | Square Law 330 deg |
| Reference Angle | +0 deg |
| Reference Angle Tolerance | Independent |
| Low-Voltage End | Terminal |
| High-Voltage End | Independent |
| Index | Zero Base 5% at 297 deg* |
| Conformity | ± 0.5% |

*Manufacturer would indicate output per cent of input voltage at the specified rotation angle for the specific potentiometer.

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CIRCLE 49 ON READER-SERVICE CARD
FREQ. STDS.

AND PRECISION FORK UNITS
1 TO 40,000 CYCLES

TYPE 2007-6 FREQUENCY STANDARD
Transistorized, Silicon type
Size, 1½” x 3½” x ½”
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± 0.2% (-50° to +85°C)
2007-6 ± 0.002% (+15° to +35°C)
W2007-6 ± 0.005% (-65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2 FREQUENCY STANDARD
Size, 3¼” x 4½” x 6” H., Wt., 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±0.01% at +20° to +30°C
Output: 5V at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28V
Accessories Modular units are available to divide, multiply, amplify and power this unit.

TYPE K-5A FREQUENCY STANDARD
Size, 3½” x 3” x 1¼”
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: ±0.03%, -55° to +71°C
Input: 28V DC ± 10%
Output: 100 cy. approx. SQ. wave at 115V into 4000 ohm load (approx. 4W)

TYPE 25 PRECISION FORK
Size, ¾” dia. x 2¼”
Weight: 2 ounces
Frequencies: 200 to 1000 cy.
Accuracies:
R: 25T ± 0.02% (15° to 35°C)
25T and 25V ± 0.02% (-65° to 85°C)
For use with tubes or transistors.

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You are invited to submit any problems within the area of our activity for study by our engineering staff.

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CIRCLE 50 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961

The phasing or indexing of the potentiometer should in no way be interpreted as a variable, either independent or dependent. Rather, it is supplementary. It is an added requirement in the case of "zero base" and it only restricts any increase in conformity that could be obtained by phasing the potentiometer to its most desirable conformity condition for this case.

Circuit Designer's Needs Should Dictate Specification
Technically, the proper attack on this problem is to consider exactly what is being
specified by the designer. When he specifies a total function angle and the corresponding output, he is defining the ideal potentiometer (or master) for his application. If the system can tolerate an angular deviation—if he sees that 329 deg as well as 330 deg total angle can be tolerated, he is in effect saying his master or ideal potentiometer can have a total angle of 329 deg and the manufacturer is, therefore, allowed this range for his reference angle.

Theoretically, there is no connection between this angle and the actual total electrical angle as the potentiometer is manufactured. If the manufacturer can meet the conformity requirements with a winding angle of 325 deg, the specifications are met. Indeed, something of this nature is usually done when a potentiometer with a function that includes a zero derivative is being manufactured.

Applying the same attack to the output, the designer, by saying one or both ends are adjustable, specifies that the ideal 100 per cent output voltage can vary from the total potentiometer voltage. The current independent-linearity definition is often described as "the best straight-line fit." This "best straight-line fit" is again a master potentiometer defined as having an input (or total angle) that may vary within a few degrees and an output whose total range also may vary slightly. It is up to the manufacturer to select the best master within these ranges. The proposed table further permits this output to be varied on only one end while the other end is predeterminated.

The table can be further improved by removing all terms that need defining. It would then look like this.

(1) Function  
(2) Total Function Rotation      deg  
(3) Function Rotation Tolerance    deg  
(4) Low-Voltage End         Adjustable  
(5) High-Voltage End         Adjustable  
(6) Index         Nonadjustable  
(7) Conformity         % at deg  

While answering quality control's demand for inherent stability, Dale resistors also meet production's need for easy assembly.

Conveniently packaged Dale resistors are available in a wide variety of sizes and terminations to fit every circuit. Meanwhile, inherent stability is assured through Dale's advanced design and stringently controlled methods of manufacture—methods which are at new levels of achievement as part of Dale's super-high reliability development program.

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Charles A. Harper
Air Arm Div.,
Westinghouse Electric Corp.
Baltimore, Md.

OUR TERMS are used to describe materials capable of reacting with epoxy resin polymers: curing agent, converter, hardener and catalyst.

The first three terms are actually interchangeable and describe materials which react with the resin to become part of the end product. But the last term, catalyst, is only correct when describing a material which causes epoxy resin polymer units to react with one another, with the catalyst not being part of the cured product. This is similar, then, to the curing of polyester resins. (Polyesters were compared with epoxies in the first article of this series in the May 10 issue). Some examples of catalysts for epoxy resins are given in Table 1. The amines included in this table represent a common type of epoxy curing agent. They can usually be identified by their pungent, fishy odor.

Curing Agent-Terminology Helps Reduce Confusion

Sub-terms often used to describe curing agent types are aliphatic and aromatic. Other sub-terms are primary, secondary, or tertiary. The latter group of terms deals with the number and locations of the nitrogen or amine (—NH₂) groups on the molecule in the case of amines (in other chemicals these terms may refer to different groups). The term aromatic identifies any organic chemical built up of a basic chemical building block employing the benzene ring structure (C₆H₆) often structurally shown as:

\[
\begin{array}{c}
\text{Aliphatic} \text{ describes any organic chemical not using the benzene ring in the basic skeleton of the molecule. Generally speaking, aromatic amines are more difficult to process than aliphatic amines, since most aromatic amines are solid, while aliphatic amines are generally liquid. Aromatic amines give considerably better thermal aging properties, though.}

\text{Acid Anhydrides: Good for High Temperatures}

A second class of curing agents often used with epoxy resins is the class known as acid anhydrides. The main advantage of acid anhydride curing agents over amine curing
Table 1. Curing Agents for Epoxy Resins

<table>
<thead>
<tr>
<th>Curing Agent</th>
<th>phr*</th>
<th>Gel Time</th>
<th>Curing Schedule</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epi-Cure 83</td>
<td>15</td>
<td>24 hr</td>
<td>16 hr/165 F</td>
<td>Slow cure, low exotherm. Recommend for large castings.</td>
</tr>
<tr>
<td>Epi-Cure 86</td>
<td>10</td>
<td>6 hr</td>
<td>1 hr/212 F</td>
<td>Good mechanical and electrical properties. Recommend for electrical potting.</td>
</tr>
<tr>
<td>Piperidine</td>
<td>6</td>
<td>8 hr</td>
<td>3 hr/212 F</td>
<td>Used for casting and potting applications.</td>
</tr>
<tr>
<td>Benzyl Dimethylamine</td>
<td>5-10</td>
<td>4-8 hr</td>
<td>2-4 hr/200 F</td>
<td>Used at 0.1-1.0 per cent as an accelerator for anhydride curing agents.</td>
</tr>
<tr>
<td>Diethylamino-propylamine</td>
<td>6-10</td>
<td>3-5 hr</td>
<td>Several days at room temperature.</td>
<td>Has been used in room temperature cure adhesives.</td>
</tr>
<tr>
<td>Dimethylamino/methylphenol (DMP-10)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Used at 0.1-1.0 per cent as an accelerator or at 10 phr with LP-3 polysulfide.</td>
</tr>
<tr>
<td>2,4,6-Tri (dimethylamino-ethyl) phenol (DMP-30)</td>
<td>6-10</td>
<td>1/2-1 hr</td>
<td>1 hr/200 F</td>
<td>Main use is same as DMP-10 except that it is more active.</td>
</tr>
<tr>
<td>BF₃ - Ethylamine complex</td>
<td>2-5</td>
<td>Months</td>
<td>1 hr/200 F</td>
<td>Cured resins are quite brittle. Recommend for B-stage systems.</td>
</tr>
</tbody>
</table>

agents is the superior high temperature properties of the resulting acid anhydride-cured epoxy system.

Until recently, the acid anhydrides used were all solid materials. The more common solid acid anhydrides used are phthalic anhydride, hexahydrophthalic anhydride, pyromellitic dianhydride and chlorendic anhydride. They melt at 128 C, 35 C, 286 C and 239 C respectively, and give heat distortion temperatures ranging from 135 to 260 C. With the exception of hexahydrophthalic anhydride, certain practical difficulties in the use of these materials have been an unfortunate detriment to their wider usage. Not only are their melting points high but it is difficult to get the anhydrides into solution with the epoxies. Even when they are put in solution the pot lifes are relatively short.

The liquid and low melting temperature acid anhydrides commonly used are dodecyl succinic anhydride, hexahydrophthalic anhydride, and Nadic methyl anhydride.
### B — Aliphatic Polyamine Curing Agents for use with Epoxy Resins

<table>
<thead>
<tr>
<th>Curing Agent</th>
<th>phr*</th>
<th>Gel Time **</th>
<th>Curing Schedule</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diethylene triamine (DETA)</td>
<td>10</td>
<td>30 min</td>
<td>Overnight at room temperature. Several days for full cure.</td>
<td>Good general purpose room temperature curing agent, but fairly toxic.</td>
</tr>
<tr>
<td>Triethylene tetramine (TETA)</td>
<td>12</td>
<td>30 min</td>
<td>Overnight at room temperature. Several days for full cure.</td>
<td>Usually preferred over DETA and TEPA.</td>
</tr>
<tr>
<td>Tetraethylene pentamine (TEPA)</td>
<td>13.8</td>
<td>30 min</td>
<td>Overnight at room temperature. Several days for full cure.</td>
<td>Recommended in protective coating applications.</td>
</tr>
<tr>
<td>Iminobispropylamine</td>
<td>13</td>
<td>30 min</td>
<td>Overnight at room temperature. Several days for full cure.</td>
<td>About the same as (TETA) but higher cost.</td>
</tr>
<tr>
<td>Xylylene diamine</td>
<td>18</td>
<td>20 min</td>
<td>Room temperature. Several days for full cure.</td>
<td>Exceptionally good color. Forms carbonates with CO₂ of atmosphere.</td>
</tr>
<tr>
<td>Methane diamine</td>
<td>22</td>
<td>8 hr</td>
<td>1 hr/200 F 3 hr/350 F</td>
<td>Good color. Similar to aromatic amines in curing schedule and properties.</td>
</tr>
<tr>
<td>Armine AL-1</td>
<td>22</td>
<td>15-20 min</td>
<td>1 hr/212 F</td>
<td>Very exothermic but requires heat cure for maximum properties.</td>
</tr>
<tr>
<td>Aminoethyl piperazine (AEP)</td>
<td>22</td>
<td>20 min</td>
<td>1 hr/212 F</td>
<td>Short pot life, high exotherm. Requires heat cure. Cured resin has excellent impact strength and heat distortion temperature of 105-110 C.</td>
</tr>
</tbody>
</table>

### C — Aromatic Polyamine Curing Agents for Epoxy Resins

<table>
<thead>
<tr>
<th>Epi-Cure 841</th>
<th>22.5</th>
<th>8-10 hr</th>
<th>1 hr/200 F 2 hr/400 F</th>
<th>Liquid mixture.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-phenylene diamine (MPDA)</td>
<td>14</td>
<td>6-8 hr</td>
<td>1 hr/200 F 2 hr/400 F</td>
<td>Solid melting at 62 C.</td>
</tr>
<tr>
<td>Methylene-dianiline (MDA)</td>
<td>26</td>
<td>30 min</td>
<td>1 hr/200 F 2 hr/400 F</td>
<td>Solid melting at 90 C.</td>
</tr>
<tr>
<td>Tonox-PL</td>
<td>28</td>
<td>8-10 hr</td>
<td>1 hr/200 F 2 hr/400 F</td>
<td>Waxy solid melting at 80 F. Can be cooled before addition to resin without solidifying.</td>
</tr>
<tr>
<td>Diaminodi-phenyl sulfone (DDS)</td>
<td>32</td>
<td>1 hr at 250 F 1 hr/300 F 3 hr/425 F</td>
<td>Solid melting at 175 C. Forms B-stage resins with excellent stability. Cure may be accelerated with 1 phr of BF₆ ethylamine complex.</td>
<td></td>
</tr>
</tbody>
</table>

*Parts by weight per 100 parts of Epi-Rex 510 (Jones-Dabney) or equivalent.

**For a 1-lb batch at an ambient temperature of 77 F.

(For larger batch size the gel time may be considerably less.)
Also, what has been termed a liquid eutectic anhydride mixture is available as a mixture of hexahydrophthalic anhydride and chlorendic anhydride.

Table 2 shows heat resistant properties of the various commonly used curing agents. The heat distortion temperature referred to in the table is the temperature at which a flat sample under a standard load will deflect a given amount. For rigid resins, high heat distortion compounds are usually better in over-all thermal aging properties. Semi-rigid and flexible resins naturally have lower heat distortion temperatures since they deflect faster under load. Other thermal properties of semi-rigid and flexible resins are governed primarily by the curing agent and the modifiers used.

Still Other Epoxy Resins
For Exotic Uses
In addition to the bisphenol type epoxies which have been discussed thus far, there are several other epoxy molecular modifications which are used. Three of these will be briefly discussed to round out the total epoxy picture: Cycloaliphatic diepoxides, epoxy novolacs, and epoxidized polyolefins.

Cycloaliphatic diepoxide resins represent a class of epoxy materials which do not contain the phenolic rings associated with most of the commercially available epoxy resins. Therefore, these diepoxides are virtually unaffected by ultraviolet light and in addition have excellent resistance to thermal degradation and air oxidation. Some heat distortion point comparisons are shown in Table 3. These materials have been developed by the Union Carbide Chemicals Co. and are identified as Epoxide 201, Epoxide 207 (dicyclopentadiene dioxide) and vinyl cyclohexene dioxide. For comparison with a conventional bisphenol epoxy resin the structural formulas of these diepoxides are shown in Fig. 1. The shorter distance between reactive groups means compounds made from these diepoxides are more highly cross-lined. Thus, higher heat distortion temperatures can be obtained with many of the same hardeners used for bisphenol epoxies.

Epoxy Novolacs
For Highest Temperature Applications
An epoxy resin system known for its superior temperature resistance is epoxy novolac. Epoxy novolac resins contain more of the benzene ring or phenolic resin type structure in the molecule; thus they combine the excellent thermal stability of the phenolic structures with the reactivity of the bisphenol epoxies, see Fig. 2.

Hardeners or curing agents used with conventional bisphenol-A epoxy resins can also be used with epoxy novolacs, since the curing reaction is through the epoxy groups of the molecule. Postcuring is usually necessary to develop the maximum properties of the epoxy novolac resins.

Another group of epoxy resins are the epoxidized polyolefins. These polyfunctional epoxies contain epoxy groups, hydroxyl groups (\(-\text{OH}\)) and double bonds [vinyl type functionality, \((\text{C} = \cdot\)] . It will be
remembered from the discussion of polyesters that this double bond arrangement is typical in a polyester resin. Thus, as with polyester resins, epoxidized polyolefins are capable of reacting with the peroxide catalysts which are conventionally used with polyester resins. Also, since epoxidized polyolefins contain the reaction points common to epoxy resins, these resins can be reacted with amine and acid-curing agents.

The simplified structure of an epoxidized polyolefin is compared to the structural formula for a bisphenol-epichlorohydrin, Fig. 3.

The epoxidized polyolefins are liquids of various viscosities at room temperature. The uncured resin is about 20 per cent lighter than conventional epoxy resins. Electrical properties are comparable to those of conventional epoxies while exotherm curves are flatter. Epoxidized polyolefins offer excellent high-temperature performance.

In this and the previous article in this series on epoxies, we have covered the main degrees of freedom possible for the designer merely by the choice of the particular resin and particular catalyst to be used in the resin-catalyst system. In the final article, the one remaining degree of freedom, the modifier, will be discussed. ■
Selecting a miniature lamp for use in mass-production electronic equipment isn't always a matter of picking up a catalog and ordering the first type that will work. Author Curtis, who has worked with miniature lamps for 25 years, tells what the engineer should worry about.

SELECTING miniature lamps for use in electronic equipment requires more thought than is usually realized. This is especially true when the lamp is to go into mass produced gear where it must function reliably for long periods of time.

To select the best lamp type for his equipment, the engineer should consider not only its electrical performance and the circuit in which it will be used, but also the testing procedures it will undergo on the assembly line. The lamp's physical strength can be just as important as its inherent noise characteristics.

The need for ruggedness was demonstrated by an auto radio manufacturer who checked his sets for loose connections by tapping them with a rubber mallet. As a result of this test-

**Table 1. Low-Voltage Miniature Lamp Types**

| Type  | Design Voltage | Design Current |Rated Avg. Lab. Life —Hr at Design Volts| Inherent Strength | Inherent "Noise"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>2.5 v</td>
<td>0.35amp</td>
<td>3,000 hr</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>47</td>
<td>2.5 v</td>
<td>0.25amp</td>
<td>3,000 hr</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>44</td>
<td>2.5 v</td>
<td>0.25amp</td>
<td>3,000 hr</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>1847</td>
<td>2.5 v</td>
<td>0.25amp</td>
<td>Indef. Long</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>1866</td>
<td>2.5 v</td>
<td>0.25amp</td>
<td>Indef. Long</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Table 2. Common 12.0-v Miniature Lamp Types**

| Type  | Design Voltage | Design Current |Rated Avg. Lab. Life —Hr at Design Volts| Inherent Strength | Inherent "Noise"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1815</td>
<td>14.0 v</td>
<td>0.20amp</td>
<td>3,000 hr</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>1816</td>
<td>14.0 v</td>
<td>0.33amp</td>
<td>1,000 hr</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>1891</td>
<td>14.0 v</td>
<td>0.24amp</td>
<td>500 hr</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>1892</td>
<td>14.0 v</td>
<td>0.24amp</td>
<td>1,000 hr</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>57X</td>
<td>14.0 v</td>
<td>0.24amp</td>
<td>500 hr</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>1895</td>
<td>14.0 v</td>
<td>0.27amp</td>
<td>1,500 hr</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>1893</td>
<td>14.0 v</td>
<td>0.33amp</td>
<td>Indef. Long</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>1898</td>
<td>14.0 v</td>
<td>0.24amp</td>
<td>500 hr</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Table 3. Common 28.0-v Miniature Lamp Types**

| Type  | Design Voltage | Design Current |Rated Avg. Lab. Life —Hr at Design Volts| Inherent Strength | Inherent "Noise"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>313</td>
<td>28.0 v</td>
<td>0.170amp</td>
<td>500 hr</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>327</td>
<td>28.0 v</td>
<td>0.040amp</td>
<td>1,000 hr</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>336</td>
<td>28.0 v</td>
<td>0.040amp</td>
<td>1,000 hr</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

**Table 4. "Baseless" and Wedge Lamp Types**

<table>
<thead>
<tr>
<th>Type</th>
<th>Design Voltage</th>
<th>Design Current</th>
<th>Rated Avg. Lab. Life —Hr at Design Volts</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.5 v</td>
<td>0.50amp</td>
<td>3,000 hr</td>
<td>2-pin</td>
</tr>
<tr>
<td>12</td>
<td>6.3</td>
<td>0.15amp</td>
<td>Indef. Long</td>
<td>2-pin</td>
</tr>
<tr>
<td>15</td>
<td>7.0</td>
<td>0.40amp</td>
<td>500</td>
<td>2-pin</td>
</tr>
<tr>
<td>19</td>
<td>14.4</td>
<td>0.10amp</td>
<td>1,000 hr</td>
<td>2-pin</td>
</tr>
<tr>
<td>20</td>
<td>14.0</td>
<td>0.23amp</td>
<td>500</td>
<td>2-pin</td>
</tr>
<tr>
<td>29</td>
<td>10.0</td>
<td>0.10amp</td>
<td>3,000 hr</td>
<td>2-pin</td>
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<td>500</td>
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<td>159</td>
<td>6.3</td>
<td>0.15amp</td>
<td>Indef. Long</td>
<td>Wedge</td>
</tr>
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</table>
ing method, many of his lamps failed. Substitution of an inherently stronger lamp with the same outer physical dimensions eliminated the problem.

Then there were the manufacturers of 12-v auto radios who found intolerable speaker noises when the production line sets were tested. The pilot lamps were found to be the culprits. They became noise sources because the relatively long 12-v filaments were supported by twin anchors, looped around the coiled, incandescent section. Under impact, the filament moved around the inside of the anchor loops. This caused the resistances to vary slightly which, in combination with the particular circuitry in the radios, resulted in the high level of noise.

To Select A Lamp Type
Questions Should Be Asked

Some of the questions the engineer should consider when choosing a lamp type are:

1. Will the lamp undergo tumbling or excessive shock during the equipment’s manufacture?
2. Will the impact or vibration tests to which the equipment is exposed occur while the filament is lighted or not?
3. Will the lamp be subjected to intermittent or prolonged cycling during its expected life?
4. Will there be any momentary overload?
5. Will there be any ambient temperature extremes?
6. Will the lamp be subjected to sudden temperature changes?
7. Will the lamp be exposed to shock or vibration while the equipment is in normal use?
8. Will the lamp be difficult to replace; if so, should indefinitely long life be specified or should there be some provision in the equipment for easy replacement?
9. Will there be a possibility that “noise” can be generated in the circuit as a result of varying resistance within the lamp?

There are numerous types of panel bulbs to choose from. However, the catalog information is usually limited to listing the design voltage and current, the life, the candlepower and the physical size and configuration of the bulb and its base.

Several Facts Help
Answer the Questions

Here are a few general facts that should guide the selection of a lamp type:

1. Panel bulbs designed for 2.5 v, 3.2 v

These unique features show why Daystrom 341 Series Potentiometers have zero backlash and maximum resistance to shock and vibration.

Three things make these rotaries unique. (1): our patented V-guide design which eliminates backlash. (2): the use of our patented double wipers effectively doubles resolution. And (3): impossible to see with the naked eye, is the winding; the resistive element is wound tightly in a precision groove cut into the mandrel by a tiny diamond tool. As a result, each turn always stays securely in position, despite severe shock and vibration. — Only Daystrom 341 Series rotaries offer these features. Available in values from 1K to 600K, rated at 2.5 watts in still air, they are only 1⁄2” in diameter and 1” long, with or without our patented clutch for servo use. They meet or exceed all applicable MIL specs. — Start solving your potentiometer problems now: contact your Daystrom Representative (or the factory) for more information on specifications, prices, fast delivery.
How Raytheon can offer you
10 times better
Semiconductor
Reliability Assurance

Most of the commonly used quality control procedures for semiconductors follow MIL Std. 105 and normally result in a wide spread of customer risk, directly dependent on the quantities purchased. (See curves X, Y, and Z below for risk points.) Now, Raytheon offers reliability protection (under MIL-S-19500B, Method B — defining the Lambda \( \lambda \) concept), which specifically limits customer risk. This means that for the first time, you, the customer, can specify reliability assurance at a fixed confidence level, to a fixed low value, in terms of a lambda number.

To explain further, reliability assurance is generated by the manufacturer's life test procedures. These life test procedures, or plans, are best described by operating characteristic curves (see below), which describe the ability of each particular plan to discriminate between good and unacceptable product.

Who Takes The Risk?
Under most current procedures, the A.Q.L. (Acceptable Quality Level) and Lot Size determine the operating characteristic curves. Typical of such curves are X, Y, and Z. Note how the customer risk point shifts.

In contrast, curves A and B are typical of the new plan now in operation at Raytheon. Note that not only is the customer risk point fixed, but fixed at industry's lowest specified failure rate.

The first transistor types offered by Raytheon incorporating this new method are the Raytheon 2N404 and Raytheon 2N428 germanium PNP switching transistors. These products, now available in quantity, carry a reliability assurance of lambda \( \lambda = 2\% / 1000 \) hours, equivalent to 0.02 failures/1000 hours.

Here's The Difference
The essential difference is that a reliability specification, under the older system, carried implied customer risk failure rates varying from 15 to 25% / 1000 hours, depending on lot size. The lambda \( \lambda = 2\% / 1000 \) hours quality assurance (customer risk failure rate), now offered by Raytheon, averages a 10 fold reduction in failure rate. Stated positively, you can be 10 times more sure of getting good product. A truly important advance in product quality.

Ask your local Raytheon sales engineer about this program.

A new nomograph, relating lambda \( \lambda \) to sample size and accept number, as well as process average requirement, is now available. For this, along with the paper "A.Q.L. — What Is It?", by J. M. Gilkey, write or call your local Raytheon Semiconductor Sales Office.

or 6.3 v are inherently stronger than those designed for 12.0 v or 28.0 v because the filaments are shorter and heavier.

2. If noise is a problem, the 2.5-v, 3.2-v or 6.3-v panel bulbs are less likely to exaggerate the condition than the 12.0-v or 28.0-v types. This is because the filaments in the lower voltage lamps require no supports along the incandescent section of the coil.

3. Inherent-noise in a lamp is not necessarily troublesome unless the circuit in which it is used is very sensitive to minute changes of current.

4. The lamps having an indefinite "long life" (greater than 5,000 hr) rating have a better chance to survive shock than those of the normal life rating, all other factors being the same.

Tables List
Common Lamp Types
Table 1 lists the low-voltage lamps that have proved themselves rugged and highly reliable in many of the older circuits. Their use has been curtailed however by the trend toward 12.0 v automotive circuits and 28.0 v aviation circuits.

The group of 12.0 v panel lamps shows considerably wider performance levels from one lamp type to another. Table 2 lists the more common 12.0-v types. It should be pointed out that a lamp such as the 1898 does not use the twin anchor supports mentioned in connection with noisy auto radio performance. Instead the lamp uses two similar filaments in series, neither of which require supports.

In most cases it is advisable, if possible, to avoid the 28.0-v lamps. In these types the filaments are longer and of finer wire. This leads to a low inherent strength and a high inherent noise, although in certain circuits the noise may not be a problem.
For extreme acceleration or impact it is sometimes possible to improve the performance by shock mounting the socket.

Table 3 lists some of the 28-v types that are available.

"Baseless" and Wedge Types Can Also Be Used

"Baseless" lamps will survive higher ambient temperatures than the conventional lamps because there is no cement used in the construction that can soften or fume. The two-pin miniatures and the wedge types fall in the "baseless" category. They are also designed to withstand rapid changes in temperature.

Some of the two-pin miniatures have found applications in electronic organs where stability is especially important. They should also find many useful applications in printed circuits. In places where loading is particularly difficult, the "baseless" lamps lend themselves nicely to "rear" loading.

Some automotive panels use rear loading lamps. The lamp is inserted in a socket that adapts to a printed circuit panel. In position, the lamp is on the opposite side of the panel from where it was inserted.

A list of "2-pin baseless" and wedge lamps is given in Table 4.

The up-to-date lamp manufacturer has the facilities for evaluating his products for known conditions of use. In many instances, however, he is not familiar with the environment the lamp is expected to survive. Communication between the electronic engineer and the lamp engineer can be extremely important.

The following points should be considered when a lamp must be selected:

1. In general, where the circuit permits, use 2.5- to 6.3-v lamps for maximum ruggedness.

2. The choice of the lamp type should always be based on the environmental conditions to be survived before active service as well as after.

3. Some lamp types are inherently noisy while others are relatively quiet. The importance of the noise depends on the electronic circuitry. If the lamp and its switch are directly connected across the power source, noise is seldom generated. The fact that this is not always practical makes noise a definite consideration.

4. It is wise to contact the lamp manufacturer when a special condition requires a special characteristic.

E-200 HIGH TEMPERATURE CAPACITORS
Operable to +200°C.

The Bendix® E-200 series of lightweight, small size capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C.

High temperature capability and mica-like electrical characteristics enable the E-200 series to withstand extremely high orders of AC in small envelope size at all ambient under 200°C.

The new series is designed and manufactured to a Bendix specification which is patterned after the high reliability specification MIL-C-14157B, proposed.

Hermetically sealed in tubular or rectangular housings, these capacitors offer superior resistance to mechanical and climatic environments.

E-200 CHARACTERISTICS: • Wound mica papers • Solid impregnants • Exceptional stability • High insulation resistance • Radiation resistance • Outstanding dependability
High-Density Electronic Packaging — Structural Design

Welded assemblies constructed from High-Density Electronic Packaging (HDEP) designs must endure the rugged mechanical environments specified by military requirements. Reinforced and post-loaded structural design analysis, derived from the construction industry, has been applied to HDEP; the mathematical calculations and test results are presented.

The basic concept of HDEP was outlined in the April 12 issue, layout procedure discussed in the May 10 issue and resistance welding techniques covered in the May 24 issue.

Courtland B. Converse, Paul N. James
The Sippican Corp.
Marion, Mass.

The inherent compressive strength of encapsulated components can be used to achieve a reliable structural assembly for a High-Density Electronic Package. Reinforced and postloaded structural design analysis, applied to HDEP assemblies, has resulted in rugged units which have passed the stringent military requirements for shock, vibration and temperature cycling.

Although a single encapsulated module may be capable of withstanding compressive forces in the order of tons, a unified structure is required to brace groups of modules as well as cooling devices, connectors and cabling. Internal loads must be kept to a minimum and, under vibration stresses, amplifications must be low.

Postloading As Applied To Electronic Assemblies

Circuit Module Compression Techniques: One of the problems concerning present day specifications is that the required frequency range in vibration is so wide (from 5 to as high as 3,000 cps) that it is almost impossible to avoid resonances in structural members. If a highly loaded member operates continuously in a resonant range, this member usually must be quite heavy in order to keep the alternating stress levels below the endurance limits of the material being used.

Although a potting compound serves as an adequate means of uniformly supporting each electronic component, the encapsulated circuit module presents some complex problems because of the widely divergent properties of its composite materials. The qualitative properties of potting compounds are:
1. High compressive strength.
2. High coefficient of thermal expansion.
3. Low Young's modulus (which is the modulus of elasticity).
4. Low tensile strength.
5. Relatively high damping factor under vibratory conditions.

Experience indicates that the most serious problems exist in environments exhibiting large changes in temperature. When many modules are postloaded by a bolt having a low coefficient of thermal expansion, an increase in temperature will cause the bolt tension to increase because of the expansion of the modules.

Low coefficient of thermal expansion is an attribute of all materials having high tensile strengths, the property necessary to minimize the bolt diameter, which in turn influences the arrangement of circuitry within the module. The bolt must be capable of exerting enough compression on the module stack at the lowest environmental temperature to maintain the structural integrity of the module stack as a beam under vibratory load conditions, but not exceed elastic limit at the highest environmental temperature.

To keep the change in tension on the bolt to a minimum throughout the temperature range, components such as Bellville washers and springs can be used. In most cases, however, a wide range of bolt tensions can be accepted, because it can be shown that a high bending load has to be put on the module stack in order to separate the modules on the tension side of the beam. The exception to this is when heavy modules, resulting from the use of a high specific gravity potting compound, are operating at a high acceleration level.

Postload Methods: High-Density Electronic Packages lend themselves particularly well to the reinforced and postloaded structural technique. Because most of the epoxy potting compounds in use today exhibit high compressive strength, electronic subassemblies such as circuit modules can be postloaded in “stacks” to produce a homogeneous structural beam (Fig. 1). The module stacks, held in compression by a tensioning bolt and appropriate hardware, are clamped against structural webs. These webs, usually fabricated of aluminum or magnesium, are inserted at calculated locations in the module stacks and serve to transmit the loads from the electronics to a point where the total loads may be carried by a vehicle. These parts are shown by Fig. 2. A case or frame assembly usually surrounds an array of circuit module stacks and serves to support the wiring module.
Another means of placing a circuit module assembly in compression, also based on the postload concept, is shown by Fig. 3. In this method, the individual circuit modules are cemented to cold plates by a thin layer of epoxy (0.0005 to 0.001 in. thick). In some designs, a module will be cemented to each side of a cold plate. The units thus formed are strung together by tension bolts through the cold plates. Intermediate webs may be used where compression of a large assembly of circuit modules is required.

Tensioning bolts are also used to tie the assembly together in the side-to-side dimension, these bolts being located through the longitudinal axis of the end-frames and intermediate webs.

This method results in an assembly of circuit modules and cold plates which is held in compression in two dimensions.

Wiring Module Structural Requirements: The many layers of film and ribbon in a wiring module tend to produce a good reinforced structure. Tests show that the many wire-wrap connections between the circuit modules and wiring module (from 12 to 24 per circuit module) cause the circuit module stacks to become structurally part of the wiring module. In other words, the deflection curve of the wiring module will look just like that of the circuit module beams.

In one way this is troublesome since structural loads are transmitted through the wire-wrap connections. On the other hand, there
are usually so many connections per module that each connection is loaded well below the ultimate tensile strength of 5 lb each.

To evaluate this connection qualitatively, a small wiring module, wire-wraped to four individual elements of 0.05 lb each, was run through an environment of 30 to 3,000 cps sinusoidal vibration at a level of 30 g. The mounting consisted of clamping the wiring module to a horizontal shake table. The elements were not bolted together, but were supported only by the wire-wrap terminals. It is noted that there was no instrumentation such as strain gages on the terminals, so that the stress levels encountered are. The wiring module had a circuit in series with each one of the circuit module terminals, and continuity was not interrupted at any time. The same specimen was subjected to a 100-g half-sine shock of 9.5 msec duration.

The above evaluation does not mean that the wire-wrap connections are adequate without the postloading bolt through the middle of the circuit modules, because on larger wiring modules, sizable, if not ultimate, forces would be imparted to the wiring module especially in the bending modes. Also, in the plane tested, the alternating flexural stresses in the wire-wrap terminals would present a serious fatigue condition in the more severe environments. This type of mounting may be considered, when supported by test data, for smaller machines.

Mathematical Analysis of Structural Characteristics

Circuit Module Beam Bending: In dealing with any structural system, one of the most important parameters is Young's modulus, or modulus of elasticity. In the case of most epoxies, the modulus in compression is nonlinear in the range of stresses under normal bol load loads. Fig. 4 is a plot of compressive load vs strain for a common epoxy used in encapsulation. If it is assumed that the base is 1.38 in. and the height 1.65 in., this works out to a surface area in compression of 2.29 sq in. If the bolt down the middle is an aluminum number 10-32, the highest load, based on the bolt diameter, that can safely be put on it is about 800 lb. Since \( S = P/A \), the compressive stress is 800/2.29 or 350 psi. Looking at the slope of the load-strain curve in the region of this load, it is apparent that a slight increase in bolt load could appreciably change the modulus of elasticity. Factors of safety must be applied to accommodate this increase.

Unfortunately, any formula for natural frequency of a beam contains \( E \) (Young's modulus) to the following extent. The natural frequency is:

\[
f_n = \frac{1}{2\pi} \sqrt{\frac{y}{E}}
\]

where \( E \) is the weight per unit length of beam. The effect of a nonlinear modulus is to change the natural frequency in a varying temperature environment where the bolt postload is changing.

Inconsistencies have also been found in analyzing pre-stressed structures in vibratory environments. Information is available on the pre-stressed theory of construction, but most of the data unfortunately deal only with the well known and tested properties of concrete. In the time that Sippican has been dealing with this type of structural support, a full evaluation of the different potting compounds has been impossible. Difficulty has been encountered in obtaining correlation between theoretical analysis and experimental results. However, there is an empirical method that can be used to determine the natural frequencies in bending.

If the shape of the static deflection curve is known, it is possible to calculate the natural frequency from the Stodola formula:

\[
f_s = \frac{1}{2\pi} \sqrt{\frac{g}{y}}
\]

To simplify the simple static test that must be performed to obtain various values of \( y \), beam can be loaded to about 20 times its weight and the deflections measured at different points. Since the deflection is a linear function of weight, the deflections are divided by 20 to obtain \( y \) under static loading.

To further simplify the above analysis, the maximum deflection can be measured and a second formula employed:

\[
f_s = \frac{1}{2\pi} \sqrt{\frac{g}{y}}
\]

This last method gives a more inaccurate result, but is adequate for preliminary design.

Also important is the fact that the deflection or natural frequency varies with the postload force on the circuit module stack. Therefore, the static deflections should be found for each condition of the bolt postload expected over the temperature environment spectrum.

Effect of Wiring Module on Circuit Module Stack Bending: There are two approaches that can be taken to find the effect of the wiring module on the circuit module stacks.

If preliminary static tests show that the natural frequency is greater than the frequency limit outlined in a given specification, it can be assumed that the presence of the wiring module will make the entire system stiffer or will have the effect of raising the natural frequency in the plane of wiring module bending. However, conventional designs have shown that this plane of bending is not the most critical, because the moment of inertia of the circuit module stack is greater than in the other bending plane.

In the plane parallel to the wiring module, the wire-wrap terminals behave as relatively flexible cantilevers. Because these terminals are long and slender, so as to pass through the wiring module, the only effect that they have shown in recent tests is damping. There does not seem to be enough of a structural connection to alter the natural frequency significantly.

Amplification Factors: In a complex postloaded system, such as the one that has been discussed above, calculation of the magnification factor, \( Q \), is nearly impossible. However, some general information was gathered during recent tests on two representative models. The first model tested was a 12-circuit module stack mounted in a jig with supports. An "O" ring at the end support served the
purpose of eliminating close tolerances between the boss of the pressure pad and the hole in the case. If the pressure pad was allowed to be loose in this hole, there would be a ringing at resonance, and a serious fatigue condition would exist. This model was vibrated in the two bending planes at two different postloads. The following summations can be made:

1. Increased postloads give higher natural frequencies and lower transmissibilities.
2. Low postloads give lower natural frequencies but higher transmissibilities. Knowledge of these factors permits the design of structures which have low amplification factors. The actual values of amplification depend on the stiffness of the case and wiring module connection, but values of Q from 3 to 7 are common.

The second model tested was an entire machine. This machine, which was designed with amplifications of 10 for the aluminum parts and 5 for the epoxy structure, was vibrated in all three planes from 5 to 3,000 cps up to levels of 30 g. In addition, a factor of safety of 1.5 was used in the design. The only instance of actual stresses higher than design loads was in bending of the end plate about its low moment of inertia axis. This was due to the long span with no support and the presence of a large number of holes.

Fig. 5 shows a typical vibration test setup.

**Bolt Postload:** In determining the proper postload to put on the bolt, two basic conditions, thermal stresses and bolt load increase due to bending, must be considered.

In calculating thermal stresses in the bolt, the general assumption can be made that, for equilibrium to exist, the compressive load in the circuit modules must be the same as the tension load in the bolt. Thus the load in the bolt can be equated with the load in the circuit module stack:

$$a_nLst + \frac{P_nL}{A_nE_n} = a_cLst - \frac{P_cL}{A_cE_c}$$

(4)

where the subscripts B and C are the bolt and circuit module, respectively. If the lengths are the same and the changes in temperature are equal, the above equation can be reduced to:

$$\Delta P = \frac{\Delta t(a_c - a_n)(A_nE_n)(A_cE_c)}{A_nE_n + A_cE_c}$$

(5)

The average value of a for most epoxy potting compounds lies in the region of $18 \times 10^{-6}$ in./in./F, while that of heat-treated stainless steel is $5.5 \times 10^{-6}$ in./in./F. These values indicate the problems involved, e.g., for a large change in temperature, there will be a large change in bolt tension. Because the potting compound has such a high value of ultimate compressive strength, it is not a problem at the higher temperatures. However, in order to maintain bolt tension at the lower temperatures, but not yield tension at the higher temperatures, a balance between the area of the bolt and the area of the circuit module must be achieved. This balance is achieved by use of Eq. 4.

This problem, coupled with that of electronic layout, structural strength, natural frequency and weight, implies a close working relationship between the electronic engineer, thermal engineer and the structural designer. That the problems are not insurmountable becomes apparent with the use of the calculation methods presented, and the advantages gained from the properties of the completed structure are substantial. If it turns out that the temperature extremes are too great, such schemes as Bellville washers or springs may be adopted.

The other factor affecting the size of the bolt concerns the reaction of the bolt to various modes and deflections in bending. Axial accelerations of the structure also influence the stress in the bolt.

The centerline of the bolt should go through the neutral axis of the circuit module stack. If an accurate value of the modulus of elasticity were known, the load required to cause separation of the modules could be calculated by letting the ultimate bending stress equal the postload stress along the face of the circuit modules. This bending stress can be calculated using the formula:

$$F_b = \frac{Mc}{I}$$

(6)

where c is the distance from the neutral axis to the outermost fibres on the surface of the tension side of the stack. This calculation is usually only significant at the low values of postload where module separation takes place at relatively low bending stresses. The weakest point will be the shear loads imposed on the bolt at the end of the module stack.

Axial loads down the circuit module stack, imposed by vibration or shock, can cause an increase in the bolt tension depending on the relative rigidity between the bolt and the potting compound. If the mass of the bolt is neglected, this change in postload will be

$$\Delta P = \frac{Q}{(AE)_b + 1}$$

(7)

where Q is equal to the added axial load imposed by the circuit modules. This value could be equal to their weight times the g forces in a shock test. Tests on completed modules have substantiated design steps. —

Potentiometers: 2 Sides to Reliability

Are manufacturers bending efforts to make potentiometers more reliable? They are indeed, report a cross-section of specialists in the field. The manufacturers made their views known in response to an editorial in the May 24, 1961, issue of ELECTRONIC DESIGN, calling for better potentiometers. Users were blamed in part by the makers for performance difficulties. One unfortunate inference drawn by some manufacturers is that systems companies can produce a more reliable potentiometer. This the editorial did not wish to convey. Nor did it wish to suggest that potentiometers are necessarily unreliable. Following are letters from manufacturers on the subject:

Not all pots are alike . . .

Your Editorial on p 31 of your May 24 issue calling for a gold-plate special potentiometer is certainly subject to dispute. As division manager of the Helipot Div. of Beckman Instruments, Inc., and also as president of the Precision Potentiometer Manufacturers Association I feel I cannot leave the remarks unchallenged.

Your Editorial tars all potentiometers with the same brush. This is highly unfair. Many manufacturers have been supplying highly reliable trimming potentiometers for years. The potentiometers used by the industrial and commercial instrument manufacturers have also been highly satisfactory over many years because these people have used the product most nearly as it should be used. Other types of pots have operated well into the millions of revolutions area.

None realizes more than the pot manufacturers themselves that the potentiometer, by its very construction, is a critical item under many conditions. What then makes pots unreliable? Acknowledging the nature of the product and its limitations, we believe the customer himself aggravates the problem. Some of these causes, as we see them, are:

1) Pot selection is too often relegated to a junior engineer . . .

2) Requirements demand poor pot design. As only one example, we find that resolutions and/or linearity requirements demand wires as small as 0.0005 in. in diameter. How long can you rub this wire with a brush before the wire breaks?

3) The demand that the pot compensate for most or all of the errors in the system. This requires accuracies that are at best marginal. When the pot will not hold these unrealistic accuracies beyond the first few thousand revolutions the system no longer performs to requirements so the pots fail.

4) Inadequate servo system design causes the pot to dither. This concentrates all the wear at a small point and early failure results.

5) Actual physical mistreatment of pots. For example, we see pots where the shaft was shortened by sawing halfway through the shaft and breaking off the rest of the way. Why be surprised when bearings fail or the pot doesn't perform because of a bent shaft?

6) Purchase on price alone without regard to value analysis. The constant pressure to reduce price and meet ever stronger specifications drives the manufacturer to short cuts or "tongue-in-cheek" acceptance of orders. I think we manufacturers know how to build pots of far better reliability but our customers will either not pay the price or they will not accept the performance level necessary.

Your Editorial intimates that the pot manufacturers are not doing anything to upgrade the reliability of our product. To this I strenuously object. Most of the manufacturers have spent, are spending, and will spend substantial amounts of money to upgrade our products and also to explore new areas. Perhaps we have not communicated well enough to the industry the efforts we are making. Speaking for my company, here is just a partial list of things we have done:

1) Tried every new material or lubricant that has shown any promise to try for greater reliability.

2) Worked with vendors to improve the quality of wire, housings, contacts, bearings, plating, etc.

3) Developed all sorts of non-rubbing contact pots such as photo-electric, variable impedance, magnetorerestrictive, variable pressure, etc. Unfortunately the users will not accept the linearity, temperature coefficient or accuracy limitations these units possess so we are forced back to the conventional type potentiometer.

4) Have spent substantial sums of money in the development of cermet type potentiometers for ultra high reliability.

D. C. McNeely, Division Manager Beckman Instruments, Inc. Helipot Div. Fullerton, Calif.

► ED supports intensive research like this to improve performance.

Reliable pots are here . . .

I am amazed that any reputable magazine would print an editorial such as that appearing in your May 24th issue, indicting an entire industry without taking the trouble to make any investigation whatever of the facts.

Reliable precision potentiometers can be made, and are being made every day by reputable potentiometer manufacturers, and we at Fairchild have the data to back up this statement as far as our own products are concerned. Fairchild alone has spent over half a million dollars in just the last five years in research and development on new
approaches to the problem of making potentiometers better and more reliable. In addition we have spent many hundreds of thousands of dollars on projects undertaken for specific customers, many of them at only a fraction of the total cost required to meet the almost impossible conditions requested by the customer, so that in effect far more was spent on improving performance and reliability than is indicated by the R&D figures alone. I am sure other major manufacturers of precision potentiometers have spent comparable amounts.

Briefly, the problem is that everyone talks reliability but almost everyone buys only price. Unfortunately, almost anyone with a lathe can get into the potentiometer business and there are probably a hundred or more, who have an engineer or technician and a few assemblers, who claim to make precision potentiometers—and their prices are much lower than manufacturers who maintain a large engineering staff and complete quality control department with facilities for all environmental tests and continuous surveillance of production units to assure the performance and reliability ordered by the customer. Then when these "bargain" units fail, your "engineer" and his "visitor" say "Potentiometers are no damn good."

Reliable precision potentiometers are available if the user is willing to pay for them, and if he will call in one of the major potentiometer manufacturers before all the rest of the design is frozen and the combination of requirements left over for the potentiometers becomes impossible.

H. E. Hale
Vice President & General Manager
Fairchild Controls Corp.
Hicksville, L. I., N. Y.

Use manufacturer's know-how...

Your Editorial in the May 24, 1961, issue of ELECTRONIC DESIGN, which makes reference to the need for a "Gold-Plate Special Pot," serves to stimulate thought, relating to the ever increasing demand for high reliability components to satisfy the need of our infinitely expanding systems.

Perhaps we have been guilty of attempting to satisfy all needs at one time in one unit. Our direct experience... with the military and systems engineers... [indicates] that...
LAMBDA
Convection Cooled
Transistorized Regulated Power Supplies

LA SERIES

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<td>75-330 VDC 3 AMP</td>
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SPECIAL FEATURES

- Convection Cooled—No internal blowers or filters—maintenance free
- Ambient 50°C
- No Voltage Spikes or overshoot on "turn on, turn off," or power failure
- Short Circuit Proof
- Remote programming over Vernier band
- Hermetically-sealed transformer designed to MIL-T-27A
- Easy Service Access
- Constant Current Operation—Consult Factory
- Guaranteed 5 years

CONDENSED DATA

DC OUTPUT (Regulated for line and load)

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<td>0-34 VDC 4 V</td>
<td>0-5</td>
<td>10</td>
<td>395</td>
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<tr>
<td>LA 100-03A</td>
<td>0-34 VDC 4 V</td>
<td>0-10</td>
<td>20</td>
<td>510</td>
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<tr>
<td>LA 200-03A</td>
<td>0-34 VDC 4 V</td>
<td>0-20</td>
<td>30</td>
<td>795</td>
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<tr>
<td>LA 20-05B</td>
<td>20-105 VDC 10 V</td>
<td>0-2</td>
<td>45</td>
<td>350</td>
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<tr>
<td>LA 40-05B</td>
<td>20-105 VDC 10 V</td>
<td>0-4</td>
<td>45</td>
<td>455</td>
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<tr>
<td>LA 80-05B</td>
<td>20-105 VDC 10 V</td>
<td>0-8</td>
<td>80</td>
<td>780</td>
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<td>LA 8-08B</td>
<td>75-330 VDC 30 V</td>
<td>0-0.8</td>
<td>39</td>
<td>395</td>
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<tr>
<td>LA 15-08B</td>
<td>75-330 VDC 30 V</td>
<td>0-1.5</td>
<td>56</td>
<td>560</td>
</tr>
<tr>
<td>LA 30-08B</td>
<td>75-330 VDC 30 V</td>
<td>0-3</td>
<td>86</td>
<td>860</td>
</tr>
</tbody>
</table>

Regulation (line)...... Less than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 105-140 VAC.

Regulation (load)..... Less than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.

Ripple and Noise...... Less than 1 millivolt rms with either terminal grounded.

Temperature Coefficient............ Less than 0.025%/°C.

(1) The DC output voltage for each model is completely covered by four selector switches plus vernier range.
(2) Center of vernier band may be set at any of 16 points throughout voltage range.
(3) Current rating applies over entire voltage range.
(4) Prices are for un-metered model. For metered models add the suffix "M" and add $30.00 to the price.
(5) Except for LA 50-03A, LA 100-03A, LA 200-03A which have AC input voltage of 105-140 VAC, 105-140 VAC available upon request at moderate surcharge.

AC INPUT

105-140 VAC, 60(5) = 0.3 cycle(6)

(6) This frequency band amply covers standard commercial power line tolerances in the United States and Canada. For operation over wider frequency band, consult factory.

Send for new Lambda Catalog 61

LAMBDA ELECTRONICS CORP.
515 BROAD HOLLOW ROAD, HUNTINGTON, L. I., NEW YORK 516 MYRTLE 4-4200
CIRCLE 57 ON READER-SERVICE CARD

Emphasis on reliability contributes the most to reducing the highest attainable level of reliability while pushing costs beyond the point of diminishing return on the dollar invested. It seems... that a component must be engineered to the nth degree of the various states of the art to satisfy a non-directional compilation of the most stringent specifications rather than the demands of a specific application. Yet, if we examine procurement specifications for our aircraft, missiles, control systems, etc. we too often find this condition prevails.

A simple approach to reducing the magnitude of this problem as well as holding costs down, in these times of close profit margins, might well be the full utilization of the component manufacturer's engineering know-how...

Robert P. Zupa, Fenimore Fisher
Analogue Controls, Inc.
Hicksville, L. I., N. Y.

If we stimulated thought, our editorial was not in vain.

Autotransformer pot is the answer...

It is my hope that the many readers of your Editorial "Wanted—A Gold-Plate Special Pot" (ELECTRONIC DESIGN, May 24, 1961) murmured to themselves "Vernistat." On the chance that none of these readers were prompted to take pen in hand, I feel obligated to do so.

Perkin-Elmer did "rise to the challenge" several years ago. Our approach was not to perfect the commonly used resistance potentiometer, but to analyze its shortcomings and design a component which would avoid them. This design process began by recognizing that a tapped toroidal autotransformer has the following characteristics:

1) Precise voltage division
2) High input impedance
3) Low output impedance (for low-loading error)
4) Low phase shift (quadrature)
5) Low power dissipation

Each of these characteristics is desirable in a potentiometer; to obtain them simultaneously would be to approach what one might call "an ideal potentiometer." The one remaining requisite of a precision potentiometer, resolution, is obtained in the Vernistat with a resistance potentiometer which interpolates between the several taps of the multi-section autotransformer.

The result of this "marrying" process is the Vernistat ac potentiometer, a component...
which is currently operational in many important military programs. In several of these programs it is the only potentiometer used. Our approach has truly produced reliability by design in that:

1) Transformer taps, which are the fundamental source of accuracy, cannot change with time, use, or environment.
2) The design permits use of larger potentiometer wire for a given resolution and input impedance than do conventional potentiometers.
3) Limited rotational usage is not detrimental to life (e.g. ground speed output in airborne navigational system.)
4) Noise and pick-up are low, due to the low-impedance circuitry possible with the component.

While your Editorial is timely as far as conventional potentiometers are concerned, we wonder if the industry is not "beating a dead horse". For years engineers have vainly tried to get reliability from potentiometers, and certainly some progress has been made. However, there is only one sure way to get reliability, whether it be in a system or a component, and that is by design.
Lionel Robbins
Sales Manager
Perkin-Elmer Corp.
Norwalk, Conn.

Conductive plastic pot is the answer...

We've been overlooked! Overlooked by ELECTRONIC DESIGN's May 21 Editorial ... We must have been by-passed! We, who've been performing successfully in all types of critical installations where reliability is the prime requisite!

To cite just one example of reliability that now exists, a group of our rotary conductive plastic pots run over 200 million revolutions at 600 rpm, and ... 

- Showed an average resistance increase of only 0.035% per million rev.
- Stayed within the original 0.5% linearity requirement for that same span;
- Maintained a noise level below the original value for over 100 million rev.

Some were tested under 70-g vibration at 5-2,000 cps, 100-g shock, 100-g acceleration in all axes, without discontinuity.
Morris Tarragano
Markite Corp.
New York, N.Y.

Mr. Design Engineer...
BELDEN Has It

Every electronic and electrical wire you need—from the finest drawn magnet wire to the most complex multi-conductor cable.

There is a Belden wire or cable in every insulation and shielding to meet your design and application requirements. Here is just part of this complete line. Available from stock.

One Wire Source for
Everything Electronic and Electrical

- electronic wire • magnet wire • lead wire • power supply cords
- cord sets • portable cordage

Copyright 1961 by Markite Corp.
now...high accuracy synchro and resolver testing

— GERTSCH STANDARDS REPLACE COSTLY ELECTRO-MECHANICAL METHODS

Gertsch Synchro Standards simulate the output of a master Synchro Transmitter (CX), with better than 2 seconds of arc accuracy. Ideal for checking Synchro Control Transformers (CTs), or complete systems. Units feature a low effective unbalance impedance which permits loading the output without introducing stator output errors.

When driven by a suitable signal source, unit provides stator outputs S, S and S, corresponding to the outputs of a master Synchro Transmitter as the shaft is rotated in 5° increments. Quadrant switching simulates operation over a full 360°. Series SS.

Gertsch Resolver Standards simulate the output of a master Resolver Transmitter (RX). Checks Resolver Control Transformer (RCT). Unit features low effective unbalance impedance, hence negligible loading error.

Driven by a suitable signal source, unit produces 2 isolated output voltages corresponding to the sine and cosine output voltages of a master Resolver Transmitter as the shaft is rotated in 5° increments. Full 360° operation. Series RS.

Synchro and Resolver Standards rotate throughout a full 360°, in 5° increments. Accuracy is better than 2 seconds of arc. Both single-switch and 2-switch models are available to cover all standard voltages and frequencies. Bulletins SS and RS on request.

Gertsch Divider Heads—for checking angular measurements on all types of rotary components. Accuracy is ±15 seconds. Repeatability: ±5 seconds. Large dial indicator provides direct readings with 3-second resolution. Unit rotates in 5° steps through a full 360° in either direction...is quickly set up, easy to operate, and fully portable. Bulletin DH-5.
True Rms Voltmeter Covers 7-Mc Bandwidth

REGARDLESS of duty cycle or amplitude characteristics, the true rms value of any waveform from 10 cps to 7 mc can be measured with a new meter that functions over a range of 100 µv to 300 v. The bandwidth of 7 mc is at least an order of magnitude greater than that of any other rms responding voltmeter available at the present time.

The model 910A true rms voltmeter, manufactured by the John Fluke Manufacturing Co., Inc., Seattle, Wash., has a sensitivity of 1 mv full scale and an accuracy of 1 per cent. Its applications include distortion measurements, double-power noise measurements and transformer copper loss measurements.

Model 910A accomplishes the direct conversion of the input ac voltage to a dc voltage, proportional to the effective heating (rms) value of the input voltage, by means of a low-impedance thermocouple. This thermocouple, situated in the feedback loop of a sensitive dc amplifier is chopper stabilized to operate at a constant level. Because the thermocouple is operated at this constant temperature level, the meter responds very rapidly to a change in input voltage and also maintains its calibration accuracy over long periods of time.

Other voltmeters with comparable bandwidth and sensitivity normally employ an indirect means to convert from ac to dc. The most popular methods are peak detection and diode rectification. In meters which use diode rectification, the average dc value is multiplied in the voltmeter by the form factor of 1.11 and the unit will indicate correctly the rms value of a pure sine wave. However,
SPECTROL SOLVES EQUATIONS LIKE THIS...

\[ \theta = \arctan \left( B \left[ 1 + 0.2 \left( \frac{c + d}{E_1} \right)^2 \right]^{7/2} - 1 \right) \]

to design non-linear potentiometers -faster, more accurately

The above equation is the mathematical expression for the non-linear function required of a precision pot to relate voltage ratio \( \frac{E_2}{E_1} \) to potentiometer shaft position \( \theta \).

This is a typical non-linear problem applied to Spectrol’s new IBM 1620 digital computer... equipment which eliminates days or weeks of design time, provides error-free results and makes it possible for Spectrol to issue quotations a day or two after receiving your request. For the past three years Spectrol—and only Spectrol—has used this technique.

Basically, it works this way: Computer input data is in the form of programmed equations or tabulated X and Y coordinates. Previously programmed tapes with general equations for non-linear applications (on file at Spectrol) operate on the data, to compute output in terms of winding equipment settings, cam angles and radii. An electric typewriter prints out this information on a form such as that shown above, which is sent directly to production, eliminating delays and potential transcription errors.

Speaking of production, Spectrol has precision equipment for winding non-linear resistance elements at its plants in New York and Toronto to supplement its California facilities. Using the computer in California, Spectrol can TWX winding instructions to either plant... another reason you can expect results sooner.

One more thought: Call us if you’re in a bind. Letters take time.

To assist engineers who have applications for non-linear pots, Spectrol has prepared a detailed specifications brochure. For your copy, contact your Spectrol engineering representative or the factory.
Because it never varies from birth to death, a fingerprint is the most reliable method of personal identification.

NAE silicon devices have fingerprint reliability because they never vary in performance, even under extreme conditions of temperature, shock or humidity. Test our semi-conductor devices. You can count on them to perform with reliability These hermetically sealed, corrosion resistant units perform at full capacity for the life of the equipment. Wherever reliability is important specify NAE.

Here, at North American Electronics, Inc., we manufacture Silicon Rectifiers, Controlled Rectifiers and Voltage Regulators to exclusive specifications. These give them the finest characteristics available. In process, reliability is further assured by 100% testing to all specified parameters.

Get acquainted with NAE devices. Write for specifications, data and details.

NORTH AMERICAN ELECTRONICS, INC.
71 Linden Street, West Lynn, Mass.
Permanently Tuned, Ceramic, IF Transformer Is Temperature Stable

A PERMANENTLY tuned, small, ceramic filter may well replace the bulky if cans in commercial broadcast receivers. Though not intended as a direct substitute for if transformers in existing equipment, the device can drastically cut the size of newly designed receivers while obviating if-strip alignment.

Manufactured by U. S. Sonics Corp., 63 Rogers St., Cambridge, Mass., the hermetically sealed, ceramic, if transformer provides a temperature stability of 10 ppm per deg C from -20 to +80 C. Insulated for 500 vdc, the filter can take an input voltage of 10 v rms. It can pass 100 g shock levels and 2.5 g vibration levels at any normal frequency.

Made of a lead-zirconate, lead-titanate compound, the filter does not require the metal shielding that takes up so much of the space around conventional wound transformers. Further, since it does not require tuning, it can be mounted in any convenient part of a chassis. The filter is only 5 16-in. long and 5/16-in. in diameter.

Typical power loss for the filter, a mere 1 db, compares with up to 12 db for conventional if transformers. The filter’s low loss is due, in part, to its high tolerance to impedance mismatch. A typical unit can be used with output impedances ranging from 500 ohms to 5 K without much change in resonant frequency.

The ceramic in the new filter vibrates in a fundamental mode rather than a harmonic mode so it has only one spurious response—and that isn’t related harmonically to the center frequency. For example, the spurious response for a 455-kc filter is about 100 kc.

One of the unique characteristics of this filter is that it acts as a symmetrical transformer: it can be wired into the
circuitry with either of its leads as input. Axial-lead construction of the device lends itself well to economical automatic assembly techniques.

The shell serves as the rf ground connection. It has no dc connection, so separate provisions would be necessary for biasing tubes or transistors.

Two models of the filter are now available, both tuned to 455 kc ±1 kc. One model, type A10019C, suitable for transistor circuitry, has a 10-K input impedance and a 1-K output impedance. The other version, type A25H4C, suitable for vacuum-tube circuits, has a 25-K input impedance and a 200-K output impedance.

In large quantities, over 10,000 units, the filter is available, on 15-day delivery, at 31 cents per unit. This cost is competitive with the cost of conventional, magnetic, if transformers. But, of course, one would also require an inexpensive choke (for dc return), and a capacitor.

In addition to their if applications, these ceramic filters are also available for other frequencies and bandwidths. Center frequencies can range from 100 kc to 1 mc and 6-db bandwidths can range from 1 per cent of center frequency to 20 per cent. Input and output impedances can range from 50 ohms to 15 K.

For more information on these small ceramic filters, turn to the Reader-Service Card and circle 252.
NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader-Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.

Silicon Rectifiers
Rated to 1 Kv Piv

Double-diffused silicon rectifiers IN3289 through IN3295 have piv ratings from 200 to 1,000 v. Current rating is 100 amp; transient voltage rating of the 1-kv unit is 1,300 v. Hard solder construction enables the devices to perform reliably in applications where large temperature excursions are encountered.

General Electric Co., Rectifier Components Dept., Dept. ED, W. Genesee St., Auburn, N. Y.
Price: $9.50 to $44.00 ea, OEM quantities.

Ceramic Diodes
Operate at 400 C

Designed for high-temperature applications, these ceramic diodes withstand 400 C continuously, up to 500 C intermittently. Type Z-5437 ratings are: piv, 200; current, 10 amp; filament, 2.5 v, 85 w, and peak cathode current, 125 amp. The 2-amp Z-5434 is rated at 750 v piv. Type Z-5365 is a small unit with anode piv of 1 kv. Filament operates at 1 v, 10 w. The rectifiers withstand 50 g for 11 msec, 20 g at 2 kc.

General Electric Co., Power Tube Dept., Dept. ED, Schenectady, 5, N. Y.
P&A: $146 to $315 ea; samples from stock.

Piezoelectric Transducer
In Rigid Mounting

A variable piezoelectric transducer, the Variducer has a rigid mounting and positive electrical contact for accurate, low-noise measurement of shock velocity, blast pressure, compression and expansion wave durations, force, and other parameters. Pressure range is 0 to 1,000 psi, rise time 1 μsec, and voltage sensitivity 30 mv per 1 psi. Operating temperature is 300 C max. Type V-1 uses barium titanate sensor, type V-2 lead zirconate.

Mirax Chemical Products Corp., Dept. ED, St. Louis, Mo.
P&A: $100 up; 30 days.
Servo Galvanometer
Is Accurate to 0.25%

Galvanometer servometers provide full-scale accuracy of 25% in any position, under shock, vibration, and varying temperatures. There are no magnetically induced errors, and no damage occurs under 1,000% overload. Full-scale response time is 50 msec max. Power required 1.5 w max.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L. I., N. Y.

P&A: $275 up; 30 to 45 days.

Low-Noise Amplifier
Uses GaSb Tunnel Diode

Noise figures of 2.5 to 3.5 db have been achieved in stable, high gain, circulator-coupled amplifiers for use at uhf and L bands. The compact, all solid-state unit has very low power requirements. Noise constant of the GaSb diodes is about 0.7 as compared to 1.35 for Ge. Cut-off frequency is between 2 and 4 Ge. Peak-to-valley ratio is about 20:1.

Micro State Electronics Corp., Dept. ED, Murray Hill, N. J.

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makes power supply news for '61

with a design for general purpose, continuous duty applications:

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DC OUTPUT RANGE</th>
<th>VDC</th>
<th>AMPS</th>
<th>RIPPLE</th>
<th>DIMENSIONS</th>
<th>PRICE</th>
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<tbody>
<tr>
<td>PR 15-10M</td>
<td>0-1.5 to 10</td>
<td>4</td>
<td>3.5</td>
<td>3.5</td>
<td>19</td>
<td>15%</td>
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<td>0-0.5 to 5</td>
<td>2</td>
<td>3.5</td>
<td>3.5</td>
<td>19</td>
<td>15%</td>
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<td>PR 80-2.5M</td>
<td>0-0.25 to 2.5</td>
<td>1.5</td>
<td>3.5</td>
<td>3.5</td>
<td>19</td>
<td>15%</td>
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<td>0-0.1 to 1</td>
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<td>3.5</td>
<td>3.5</td>
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<td>3.5</td>
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<tr>
<td>PR 38-15M</td>
<td>0-0.15 to 15</td>
<td>2</td>
<td>7</td>
<td>19</td>
<td>13%</td>
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<td>7</td>
<td>19</td>
<td>13%</td>
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<td>PR 155-4M</td>
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<td>7</td>
<td>19</td>
<td>13%</td>
<td>$430.00</td>
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<tr>
<td>PR 310-2M</td>
<td>0-0.2 to 2</td>
<td>0.5</td>
<td>7</td>
<td>19</td>
<td>13%</td>
<td>$385.00</td>
</tr>
</tbody>
</table>

REGULATION:

LINE: ±1% for 115 ± 10 v ac line change at any output voltage within specified range.
LOAD — at maximum output voltage:
Less than 2% output voltage change for 50-100% load change (3% for PR 15-10M and PR 15-30M).
Less than 4% output voltage change for 25-100% load change (6% for PR 15-10M and PR 15-30M).

(See Graph below for typical load characteristics)

NEW 32 PAGE POWER SUPPLY CATALOG!

Featuring:
- 11 Kepco design groups including new "SM", "HB", and "PR" models.
- Separate listing and description of programmable current/voltage regulated models.
- Special nomograph of voltage drop vs. wire size and supply current.
- Dual index to all models:
  - by DESIGN GROUP (inside front cover)
  - by OUTPUT VOLTAGE (inside rear cover).

Kepco Inc.
131-38 Sanford Avenue • Flushing 52, N. Y. • In 1-7000 • TWX # NY 4-5196

CIRCLE 63 ON READER-SERVICE CARD
New Products

Thermoelectric Module

Cooling and heating of electronic systems are provided by the Coron thermoelectric module. Units are available in one, two, four and eight couple modules, in encapsulated and non-encapsulated form.

Sela Electronics Co., Dept. ED, 545 West End Ave., New York 24, N. Y.
P&A: $19.00 to $24.00; from stock.

Cleaning Chemicals

For electronic components. Made for processing semiconductors and other components, cleaning chemicals include de-scaling solutions, bright dips, carbon removers, special paint removers, and epoxy strippers.

Fidelity Chemical Products Corp., Electronic Chemicals Div., Dept. ED, Newark, N. J.

Adjustable Pot Cores

Operating to 3 mc, Ferrokor adjustable pot cores have final adjustment accuracy of better than 0.02%. Each core size is available in three standard effective permeabilities. Made to close tolerances, the units are easily assembled.

Ferroxcube Corp. of America, Dept. ED, Saugerties, N. Y.

Humidity Chamber

 Automatically controlled humidity chamber H-104 provides humidity time cycles in conformance with MIL-E-5272C. It will attain a relative humidity of 96 per cent at a dry-bulb temperature of 160 F. Fail-safe control system and variable thermostat are incorporated. Interior is stainless steel.

Wyle Laboratories, Manufacturing Div., Dept. ED, El Segundo, Calif.
P&A: $1,290; 30 days.
Oscillograph

Two-channel pen-and-ink oscillograph measures 11-1/4 x 4-3/16 x 5-7/8 in. and weighs 12-1/2 lb. Galvanometer resistance is 1,500 ohms; sensitivity is 1 mm/v, down 3 db at 60 cps. Recording width is 4 cm per channel. Paper speed is 1 or 10 cm per sec, and can be changed while paper is running.

Keystone Development Corp., Dept. ED, 2813 Westheimer Road, Houston 6, Tex.

Check-Out System

Universal automatic check-out system model 301 ATE will locate single faulty components or circuits in large systems. The programmer selects test stimuli and routes them to test points, commands performance of a function, and connects system response to detectors. Accuracy is one part per 1,000 at a rate of 1,200 unique tests per min. Operator can select one of six functional modes. The system is assembled from stock to meet user needs.

Radiation Inc., Dept. ED, Melbourne, Fla.

Phosphor

Improved picture brightness up to 10 per cent is claimed for the CR408 phosphor, made for television picture tubes. The phosphor can be produced in the varying colors and particle sizes required by manufacturers.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N. Y.

Signal Amplifier

High-gain airborne dc-to-dc signal amplifier SA9-0 provides 0 to 5 v output from 0 to 10 mv input. Gain is continuously variable from 50 to 500; operating temperature range is —65 to +165 F. Power required is 30 ma at 28 v dc ±10%. Weight is 8 oz, volume less than 8 cu in.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.
NEW PRODUCTS

Heater 429

Ceramic film heating elements in this heater will not glow, support combustion, or emit odor. System dissipates 8.7 kW, operates from 120/208-v, three-phase power, and weighs less than 4 lb. Requirements of MIL-E-5272C are met.

Therm-O-Lab Corp., Dept. ED, 6940 Farmdale Ave., North Hollywood, Calif.

Radioisotope Unit 452

Portable radioisotope unit, called the Pipelinliner, offers 10, 20, and 30 curie power. Radiation source is Iridium 192 housed in a lead-tungsten alloy. Unit weighs 60 lb, including controls. Device can be operated remotely, and AEC-recommended radiation levels are maintained.

Picker X-Ray Corp., Dept. ED, 1275 Mamaroneck Ave., White Plains, N. Y.

P&A: Unit, $1,505; IR source, $250 to $350; 2 weeks.

Transformer 449

For laboratory testing. Called Lab-Pac, this transformer furnishes three phases for any output voltage from 100 to 640 v, 50 to 60 amp ac. Tap switches are changed on three phases simultaneously. An ac voltmeter is provided.

Strong Electric Corp., Dept. ED, 464 City Park Ave., Toledo 1, Ohio.

Variable Transformer 420

This 20-amp variable transformer, model VT20, replaces other transformers of comparable size. Shaft can extend from either side of transformer, and has a collet-type lock to permit repositioning.

Ohmite Manufacturing Co., Dept. ED, 3665 Howard St., Skokie, Ill.

Multi-Range Standards 426

Accurate to 1/2% of full scale, dc voltmeter model 1700 and dc milliammeter model 1702 each provide 10 ranges from 0 to 1.5 to 1,500. Meter is compensated from 15 to 35 C. Mirror scale length is 5.5 in. Deep core magnet movement has spring-mounted sapphire jewels and hardened steel pivots.

Simpson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

Price: Model 1700, $160; model 1702, $135.

Switch 419

Subminiature switch, model B-2, requires an operating force of 3 oz max. Movement differential is 0.0002 max and operating force differential is 1/2 oz max. The switch is supplied with either turret or solder-type terminals.

Milli-Switch Corp., Dept. ED, 105 Town Center Road, King of Prussia, Pa.

Timer Motor 435

Synchronous timer motor has all moving parts sealed in oil for dependable, noiseless operation. Package OD is 1-1/16 in. A spring-loaded packing gland prevents the oil from working out of the housing when motor is operating.

Controls Co. of America, Lake City, Inc., Dept. ED, 110 W. Woodstock, Crystal Lake, Ill.

Ceramic Insulators 453

Miniature dense alumina wafers 0.014 in. thick are available in 0.03, 0.05, and 0.07 in. squares. Wafers are metalized and gold plated on both sides with no overlap on thin edges. They can be soldered to transistor bases and components.

Ceramics International Corp., Dept. ED, 39 Siding Place, Mahwah, N. J.

Price: $0.75 each for small quantities.

Selenium Rectifier 451

High-current rectifier, called Hi-I, is available in ratings from 200 ma convection-cooled to 33 amp forced-air cooled, half-wave. Stacks rated at up to 5,000 amp are available. Cells rated at 33 v ac can be stacked in series for higher voltage ratings. Applications include electroplating, anodizing, battery charging, welding, and dynamic braking.

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Radiation Monitor 424

Fountain-pen size personal radiation monitor clips onto the wearer's clothing. It emits high-pitched chirps and flashes a neon light to warn of exposure to radiation. Designated model ORNL, the device uses a mercury cell which gives about 30 days of uninterrupted operation.

Victoreen Instrument Co., Dept. ED, 5806 Hough Ave., Cleveland 3, Ohio.
Wirewound Resistor

Molded wirewound resistor type BWH is made in ±5% and ±10% tolerances, with resistance range of 0.24 to 1,000 ohms. Performance requirements of MIL-R-11C are met or exceeded. In RC-32 size, rating is 2 w at 70°C, 1/2 w at 137°C.

International Resistance Co., Dept. ED, 401 N. Broad St., Philadelphia 8, Pa.
Availability: Two weeks.

Glass-Epoxy Laminates

Slit coils and fabricated parts can be made from continuous glass-epoxy laminates with Mylar facing. The material is said to have excellent electrical properties and chemical resistance, and a high strength-to-weight ratio. It meets AIEE Class F temperature rating and MIL-P-18177B specifications. Thicknesses from 0.007 to 1/16 in. are available.

Spaulding Fibre Co., Inc., Dept. ED, 310 Wheeler St., Tonawanda, N. Y.

Vacuum Evaporation Unit

Automatic control of vacuum system valves and pumps is provided by this vacuum evaporation unit. It evacuates a 10-in. bell jar to 0.1 micron in 2 min, and reaches an ultimate pressure of 0.001 micron. Two pairs of insulated electrodes are on a 16-in. base plate, and six spare feedthroughs are provided.

Mikros, Inc., Dept. ED, 7620 S. W. Macadam Ave., Portland 19, Ore.
P&A: $2,250 to $2,750; 15 days.

NEW MIL RESISTORS...from OHMITE

Wire-wound, Sealed in Silicone-Ceramic

NEW MIL-R-26C AMENDMENT 2 IN BRIEF: By means of this new amendment, specification MIL-R-26C is extended to include three sizes of insulated, wire-wound resistors with axial leads. The new insulated resistors meet all requirements of MIL-R-26C including a dielectric strength test (1000-volt, V-block) and an insulation resistance test (150-volt, V-block). Currently, tolerance is specified as 5% and maximum ambient temperature rating as 275°C.

INSULATED RESISTOR CONSTRUCTION: A single layer of resistance alloy wire is wound on a ceramic core. Metal end caps, with axial leads attached by welding, are then fitted snugly over each end of the core. A molded jacket of silicone-ceramic material completes the unit by sealing the entire assembly.

Through research and advanced production know-how, Ohmite is able to introduce this advanced product line to meet the demanding new requirements of its Military and Industrial customers.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RW67</td>
<td>V</td>
<td>6.5</td>
<td>0.10 to 3600 ohms</td>
<td>0.917</td>
<td>0.323</td>
</tr>
<tr>
<td>RW68</td>
<td>G</td>
<td>5.0</td>
<td>0.10 to 8200 ohms</td>
<td>1.823</td>
<td>0.343</td>
</tr>
<tr>
<td>RW69</td>
<td>V</td>
<td>3.0</td>
<td>0.10 to 910 ohms</td>
<td>0.542</td>
<td>0.230</td>
</tr>
</tbody>
</table>

*MIL-R-26C limit for single-layer winding.

"INSULATED" MIL-R-26C RESISTORS

RESISTORS SHOWN TWICE SIZE

Anticipating Industry's Needs in Quality Components

All Sizes and Values Available From Distributor or Factory Stock—Write for Bulletin.

OHMITE MANUFACTURING COMPANY
3643 Howard Street, Skokie, Illinois

Rheostats • Power Resistors • Precision Resistors • Variable Transformers • Tantalum Capacitors • Tap Switches • Relays • R.F. Chokes • Germanium Diodes • Micromodules
The General Electric TV Receiver Department is one of the major manufacturers of television sets sold in the United States. Contributing to this high volume has been the quality achieved through rigid manufacturing procedures. Part of the strict specifications call for Textolite 11571 XXX PC Copper-Clad laminate for use as circuit boards in all of their TV home receivers.

According to a TV Department spokesman, 11571 was selected because of its excellent insulation resistance under humid conditions. It has superior punching characteristics, stands up well in soldering and has good peel strength. Mr. W. W. Ward, Supervisor, Components, TV Receiver Department, said, "Since changing to 11571, production quality has been materially improved. It is the best laminate we've ever used."

Especially designed for use in television and radio receivers, G.E. Textolite 11571 reliably meets UL testing standards, MIL-P 13949B and MIL-P 3115, type PBE-P specifications as well as NEMA XXX PC requirements. If you manufacture TV or radio equipment, you probably have an application in which 11571 would assure added reliability at a low cost. We will be happy to supply you complete information and samples. Write: Laminated Products Department, Section ED-71, General Electric Co., Coshocton, Ohio.

NEW PRODUCTS

Size-5 Synchros

Miniature line of size 5 synchros has 1/2 in. diameter case. Stainless steel housing protects against environment and temperature change. Frequency is 400 cps; excitation is 49 ma at 10.2 v. Temperature range is -55 to +95 C. Accuracy is ±10 min. MIL-E-5272 application requirements are met.


Power Supplies

For missiles and instrumentation. Model PS-100 power supply has a 20 v dc, 1-amp output from 24 to 32 v input. Regulation is 0.5%; ripple is 20 mv rms max; efficiency is 90 to 95%. Components meet MIL specs, are rigidly mounted and encapsulated. Unit is hermetically sealed and meets MIL-E-5272 environmental specifications.

Dynex Industries, Inc., Dept. ED, 170 Eileen Way, Syosset, N. Y.
Available: Eight weeks.

Multiple Counter

With eight or more switches. Multiple programmer counter is made for applications requiring a number of switch contacts at predetermined numbers. Double-deck, end-drive unit will close from one to eight or more switches. Four basic designs are available, with variations to user order.

Durant Manufacturing Co., Dept. ED, Milwaukee 1, Wis.

ELECTRONIC DESIGN • July 19, 1961
Cabinet Racks

Open side walls provide access for rack-to-rack wiring when several racks are arranged side by side in a row. Series PR racks have rear doors only, and series FR racks have both front and rear doors. Standard fittings and accessories are available. Heights range from 48-1/8 to 83-1/8 in.

Par-Metal Products Corp., Dept. ED, 32-62 49th St., Long Island City 3, N. Y.
P&A: $80.60 to $257.20; from stock.

Potentiometer

Molded carbon potentiometer series 63M is 1/2 in. in diameter, and is rated at 1/2 w at 70 C, derated to 120 C. Unit is made for instrumentation and airborne equipment. MIL-R-94B, style RV-6 specifications are met. Resistance values range from 100 ohms to 5 meg ±10%, with linear tapers.

Clarostat Manufacturing Co., Dept. ED, Dover, N. H.

Thermionic Test Cell

ANNOUNCING another superior Motorola Mil-type semiconductor - The 2N1412 (USN)

Motorola's new 2N1412 (USN), produced to the requirements of MIL-S-19500/76A, is the first Mil-type power transistor offering a collector voltage of 100 volts. This husky Motorola unit dissipates a full 150 watts, and its thermal resistance (0.5°C/W max) enables it to run cooler for increased circuit reliability and longer life.

In addition, the Motorola 2N1412 (USN) is rated for 100°C continuous junction operation and its "low silhouette" TO-36 case requires far less heatroom than conventional TO-36 packages. It's ideal for application in high-power, high-efficiency amplifier and switching circuits, and in most cases will replace the commercial 2N1100.

MOTOROLA

SEMICONDUCTORS

for the military equipment designer looking for a complete, single source of reliable, field-proven transistors, rectifiers, and diodes

With its line of Mil-type semiconductor devices continually expanding, Motorola now offers 84 high reliability devices of the "preferred" types as well as many "guidance" types listed by the Department of Defense. This comprehensive selection includes power transistors, milliwatt transistors, rectifiers and zener diodes.

In addition to the quality proven by their ability to meet stringent military tests, many of these devices have proven their reliability in such major missile systems as the Minuteman, Polaris, Atlas, Nike-Zeus and others. Also, Motorola is the first to offer military users components that were developed to meet the high reliability requirements of the Minuteman program. These are the 101 and 201 Mesa switch and amplifier types.

If you are working on military equipment, we suggest you call your local Motorola representative for further information on the types listed below as well as other types that are presently being tested to the appropriate military specifications.

LISTED BELOW ARE SOME OF THE MORE POPULAR LINES OF MOTOROLA MIL-TYPE TRANSISTORS, RECTIFIERS AND SILICON ZENER DIODES.

<table>
<thead>
<tr>
<th>POWER TRANSISTORS</th>
<th>SILICON ZENER DIODES (SIG.C)</th>
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<tbody>
<tr>
<td>2N174 (JAN)</td>
<td>1N2970B</td>
</tr>
<tr>
<td>2N297A (SIG.C)</td>
<td>1N2985B</td>
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<tr>
<td>2N1011 (SIG.C)</td>
<td>1N3001B</td>
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<tr>
<td>2N11220 (SIG.C)</td>
<td>1N2971B</td>
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<tr>
<td>2N120 (USN)</td>
<td>1N2986B</td>
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<tr>
<td>2N1412 (USN)</td>
<td>1N2970B</td>
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MILLIWATT TRANSISTORS

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<th>2N467 (SIG.C)</th>
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<tr>
<td>2N461 (USAF)</td>
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MESA TRANSISTORS

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<tr>
<th>2N700A (SIG.C)</th>
<th>2N705 (USN)</th>
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SILICON RECTIFIERS (JAN)

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<td>1N254</td>
<td>1N258</td>
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<td>1N255</td>
<td>1N257</td>
</tr>
</tbody>
</table>

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In addition, the Motorola 2N1412 (USN) is rated for 100°C continuous junction operation and its "low silhouette" TO-36 case requires far less heatroom than conventional TO-36 packages. It's ideal for application in high-power, high-efficiency amplifier and switching circuits, and in most cases will replace the commercial 2N1100.

MOTOROLA

Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA INC.

5005 EAST MCDOWELL ROAD - PHOENIX 8, ARIZONA

ELECTRONIC DESIGN • July 19, 1961

CIRCLE 67 ON READER-SERVICE CARD

ANNOUNCING another superior Motorola Mil-type semiconductor - The 2N1412 (USN)

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NEW PRODUCTS

Mica Capacitors

Custom-molded capacitors, type RE, have silvered-mica dielectrics and epoxy encapsulation. Expendable flexible molds formed to any desired contour without tooling or dies permit shaping single or multiple capacitors to customer's requirements. Units meet MIL-C-5 specifications. Tolerances of ±0.1% are available.
Federal Pacific Electric Co., Cornell-Dubilier Electronics Div., Dept. ED, 50 Paris St., Newark, N. J.

Power Supplies

Rack-mounting modules and power supplies are made in a wide range of ratings and sizes. Ripple is less than 1 mv rms; regulation is ±0.05% or ±0.5%, line and load. Input is 105 to 125 v, 40 to 400 cps. Output is adjustable over a 10% range.
Technipower, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.
P&A: $50 up; two weeks.

Photoconductive Cell

For low light levels and low voltages, type NSL-33 cadmium-sulfide photoconductive cell has a spectral response resembling that of the human eye. Recommended illumination range is 0.01 to 1,000 ft-c. Device, intended for photometric applications, is tubular and hermetically sealed. Diameter is 0.378 in., length is 1.25 in.
National Semiconductors Ltd., Dept. ED, 230 Authier St., Montreal 9, Canada.

Magnetic Rectifier Control

Silicon controlled rectifiers can be fired by model MRC-6203 magnetic rectifier control. Unit is full wave, isolated, with no common connections between the SCR load and the control windings. A high, narrow 3-msec output pulse of 9 v, 1 amp is generated. Module measures 4-9/16 x 3-1/16 x 3-5/8 in.
Fairfield Controls, Inc., Dept. ED, 114 Manhattan St., Stamford, Conn.

Instrument Counter

High-speed digital readings provided by instrument counter model D indicate tool movements within 0.001 in. Maximum speed is 1,500 rpm, giving up to 150,000 increments per minute. Counter is applicable to navigational and tracking instruments.
Durant Manufacturing Co., Dept. ED, Milwaukee 1, Wis.

Cable Identification Tapes

Coded identification tapes called Identitape can be used to mark cables in assembly procedures. Markers are supplied on cards from which they are easily removed. A range of materials and colors, as well as shrink-on type, is available. Military specifications are met. Tapes are made to reduce time and guesswork at assembly.
Manger Electric Co., Inc., Dept. ED, Miller St., Stamford, Conn.
Availability: Two days.

Millivolt Source

Calibration, linearity and drift measurements are easily made with millivolt source model 205. Linearity, step attenuator accuracy, and stability are 0.1% each. Full-scale outputs are 1,000, 100, and 10 mv. Mercury battery supplies power for 1,000 hr of operation.
Monroe Electronic Laboratories, Inc., Dept. ED, 21 Vernon St., Middleport, N. Y.

Vane-Axial Fans

Produce 50 to 500 cfm. Series 60 vane-axial fans operate at 3,400 rpm on 115-v. single-phase, 60-cps current. They provide from 50 to 500 cfm at static pressures ranging from 1/3 in. through 1 in. of water static pressure. There are 10 standard models.

Power Transistors

Industrial power transistors, types 2N538 through 2N540A, have a maximum dissipation of 30 W at a base-mounting temperature of 25 C. Each transistor weighs less than 6 g and requires 1/3 sq in. of chassis space. Units are made for servo motor controls, power amplifiers, converters, regulated power supplies, and low-speed power switches.
CBS Electronics, Dept. ED, 100 Endicott St., Danvers, Mass.

ELECTRONIC DESIGN • July 19, 1961
Solar Sensors

For rocket and satellite sun trackers, photovoltaic sensors have various angular characteristics for servo control, spin detection, and aspect determination. Type EA-3 amplifier conditions sensor signals for servo or telemetering applications, providing a 5-v output. Weight of sensor assemblies is about 10 g, of amplifier, about 30 g.

Ball Brothers Research Corp., Dept. ED, Boulder Industrial Park, Boulder, Colo.

Digital Recording Head

Photographs and digital data can be recorded simultaneously on the same film with this digital recording head. The device converts transducer signals to code suitable for digital photo recording. Codes can be recorded at rates up to 300 frames per sec. A code scanning unit types out data recorded on all frames. Any number of code bits can be accommodated.

FMA, Inc., Dept. ED, 142 Nevada St., El Segundo, Calif.

Heat-Resistant Coating

Temperatures over 4,000 F are withstood by PyroShield 21 coating. Furnished in powder form and mixed with water, it is applied by brush, spray, or dip. Coating withstands 2,000 F for more than an hour, while protected surface remains under 350 F. Coating can be washed away after a fire, or, for permanent protection, can be covered with paint or enamel.

Columbia Technical Corp., Dept. ED, Woodside 77, N. Y.

HAMILTON STANDARD ANNOUNCES...

4 new static inverters specifically designed for aircraft and missiles

Hamilton Standard has developed a new line of 100-VA and 500-VA inverters that establishes an important increase in inverter reliability and performance. The units are specifically designed for airborne use. They possess extremely high overload and short circuit capacity and offer wide operating ambient temperature ranges. The basic design is modular and utilizes silicon transistors throughout. The packages are small, compact and deliver high over-all power-to-weight ratios.

AS MAIN OR STANDBY AC POWER SOURCE, these new inverters can now replace much of the rotary equipment presently in use on aircraft and missiles for supplying power to:

- Gyros
- Radar
- Telemetry
- Instrumentation
- Guidance systems

### CHARACTERISTICS OF 100-VA and 500-VA STATIC INVERTERS

<table>
<thead>
<tr>
<th>RATING PART NO.</th>
<th>100 VA</th>
<th>100 VA</th>
<th>100 VA</th>
<th>100 VA</th>
<th>500 VA</th>
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<tr>
<td></td>
<td>555546</td>
<td>566480</td>
<td>566470</td>
<td>570250</td>
<td></td>
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<tr>
<td>Output Voltage (Nom.) Frequency</td>
<td>1156 ± 0.25%</td>
<td>115 or 200 v ± 0.25%</td>
<td>115 v ± 0.25%</td>
<td>115 or 200 v ± 0.25%</td>
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</tr>
<tr>
<td>Phases</td>
<td>Three</td>
<td>Single or three</td>
<td>Single</td>
<td>Single or three</td>
<td></td>
</tr>
<tr>
<td>Transient Protection</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Temp. Ranges</td>
<td>5°C to 125°C</td>
<td>5°C to 125°C</td>
<td>5°C to 125°C</td>
<td>5°C to 125°C</td>
<td></td>
</tr>
<tr>
<td>Input Voltage (Range)</td>
<td>18-29 or</td>
<td>20-29 or</td>
<td>20-29 or</td>
<td>14-29 or</td>
<td></td>
</tr>
</tbody>
</table>

SEND FOR YOUR COPY of this illustrated Static Power Conversion Guide, Clip coupon and mail to:

HAMILTON STANDARD, Electronics Department
Section 71, Broad Brook, Connecticut.

Name
Position
Company
Address

UNITED AIRCRAFT CORPORATION

HAMILTON STANDARD DIVISION

ELECTRONICS

CIRCLE 68 ON READER-SERVICE CARD
NEW PRODUCTS

Antenna Multi-Coupler 414

Made for vlf, lf, and mf bands, the type NV-2 multi-coupler feeds up to six independent receivers. Input and output impedance is 60 ohms, gain is 3-db max, and interaction between outputs is 35 db below signal level. Unit weighs 16-1/2 lb and mounts on a 19-in. rack.

Rohde and Schwartz Sales Co., Inc., 111 Lexington Ave., Passaic, N. J.

AC Millivoltmeter 701

Accuracy is 1%. Model VT-3A ac millivoltmeter, for measurements as low as 10 mv, has a response of 20 cps to 600 kc, at 1% accuracy, or 1/2 cps to 5 mc. It has a total of 12 voltage ranges; input impedance is 22 meg max on all ranges. Weight is 3-1/2 lb; dimensions are 6 x 9 x 5 in. It is portable.

Electronic Applications Co., Dept. ED, 10916 Basye St., El Monte, Calif.

Price: $295.

Time Delay Relay 412

Miniature, hermetically sealed time delay relay has ranges from 15 sec to over 30 min with 2% accuracy. Contacts are rated for 3 amp at 125 v ac, 30 v dc; lifetime is 50,000 operations min. Unit measure 1 x 2 x 4 in., have flange or bracket mountings, and meet MIL specs.

Giannini Controls Corp., Cramer Div., Dept. ED, Centerbrook, Conn.
Now! 100% power testing of 1N536-1N561 series rectifier cells gives greater reliability ...at no extra cost!

Now you can get Westinghouse power semiconductor quality in this popular, low-current rectifier series. Complete in-service reliability is assured by 100% Power Testing. Each and every one of these rectifiers is tested under full-load conditions—which simulate actual field operation. This exclusive Westinghouse procedure, developed through years of experience in high-power silicon rectifiers, has resulted in high reliability standards.

Each cell is completely tested under the severest combination of current, voltage, and temperature. Westinghouse gives this assurance of extra reliability, yet the Westinghouse 1N536-1N561 series rectifiers cost no more than other makes.

Features Include: ■ New fused, double-diffused construction ■ Ambient operating temperature minus 65° to plus 165° ■ Typical forward drop at 1 amp instantaneous at 25°C—.95 volts ■ Hermetically sealed encapsulation.

The 1N536-1N561 series rectifier cells are immediately available in quantities for all requirements. Why settle for less? Insist on rectifiers which have been 100% Power Tested. Whether the rectifiers you want are large or small ... You can be sure ... if it's Westinghouse.

For "off the shelf" delivery, order from these Westinghouse Distributors:

**EASTERN**
ACK SEMICONDUCTOR INC.
Burlington, N. J., (PA 7-5619)
CAMEL RADIO
Cleveland, Ohio (216 361-7711)
CROMER ELECTRONICS, INC.
New York, N. Y. (212 521-1771)
ELECTRONIC WHOLESALERS, INC.
Baltimore, Md. (301 682-3111)
GENERAL RADIO SUPPLY CO., INC.
Cleveland, Ohio (216 351-4656)
GENESEE RADIO PARTS CO.
Buffalo, N. Y. (716 881-8561)
KARR-EILERT ELECTRONICS, INC.
Baltimore, Md. (301 685-3471)
MILBRAE ELECTRONICS
New York, N. Y. (212 771-4800)
RADIO & ELECTRONIC PARTS CORP.
Cleveland, Ohio (216 346-6400)
SCHNEIDER ELECTRONICS
Long Island, N. Y. (516 244-7795)

**MIDWESTERN**
ELECTRONIC COMPONENTS FOR INDUSTRY CO.
St. Louis, Mo. (314 525-5515)
HALLMARK INSTRUMENTS CORP.
Dallas, Texas (214 744-6711)
INTER-SATE ELECTRO & SUPPLY CO.
Cleveland, Ohio (216 351-4656)
LENERT CO.
Houston, Texas (713 656-3200)
RADIO DISTRIBUTING CO., INC.
Indianapolis, Ind. (317 635-7571)
SEMICONDUCTOR SPECIALISTS, INC.
Chicago, III. (312 975-0000)
S. STERLING CO.
Detroit, Mich. (313 324-7000)
UNITED RADIO, INC.
Cleveland, Ohio (216 346-6530)

**WESTERN**
ALAMO ELECTRONICS
Oakland, Calif. (415 891-3311)
HAMILTON ELECTRO SALES
Los Angeles, Calif. (213 795-5154)
NEWARK ELECTRONICS CO.
Newark, Calif. (415 884-0040)


**Portable Meters**

Taut-band suspension mechanisms are used in a series of portable ac and dc ammeters and voltimeters. Scale lengths are 6 and 10-1/2 in., with arcs of 100 and 240 deg. Accuracy is within 1/2%.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

**Electron Beam Power Supply**

Output of 6 kw is provided by this electron beam power supply. Model A2632, made for welding, cutting, vacuum melting, and metal purification. Bias, focus, over-voltage trip and overcurrent trip are adjustable. Input power is 208 v, 30 amp, 3 phase.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mount Vernon, N. Y.

**Missile Battery**

Activates in 1 sec, automatically. Model 79 24-v missile battery has a discharge time of 0.83 min when discharged at 10 amp, a capacity of 0.14 amp-hr and an output of 5.06 w-hr per lb and 0.19 w-hr per cu in. It performs at an altitude of 50,000 ft. Weight is 1.1 lb.

Electric Storage Battery Co., Missile Battery Div., Dept. ED, P. O. Box 11301, Raleigh, N. C.

**Solenoid Valves**

Seven sizes: 3/8, 1/2, 3/4, 1-1/4, 1-1/2 and 2 in. are offered. Types Q and Q-1 solenoid valves are UL listed. General purpose type Q is for air and water at 5 to 400 psi, temperatures to 250 F and steam pressure to 15 psi. Type Q-1 handles steam only from 5 to 150 psi and temperatures to 365 F.

J. D. Gould Co., Dept. ED, 4707 Massachusetts Ave., Indianapolis 18, Ind.
NEW PRODUCTS

Power Supply 465

Dynamic regulation of ±0.1% line and ±0.5 v load is maintained by dc power supply MTR28-30 over its output range of 24 to 32 v dc, 30 amp. A transistor series regulator eliminates transients; a magnetic amplifier provides static regulation of ±0.1% line and load. Ripple is 5 mv, dynamic impedance 30 milliohms max from 0 to 20 kc.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

Tape Cartridges 423

Continuous-loop tape cartridges, models M-4, M-6, and M-8A, accommodate tape lengths from 6-1/2 ft to 1,700 ft, and, using double-oxide tape in a moebius loop, play from 10 sec to 128 min at 3-3/4 ips. Lock automatically secures tape during shipping and handling.

Viking of Minneapolis, Inc., Dept. ED, 9600 Aldrich Ave., S. Minneapolis 20, Minn.

Capacitor Retaining Clamp 486

For plug-in capacitors. Clamps are open-loop type with a built-in tension loop, and are available for several case diameters. Cam-action locking clips are said to hold capacitors securely against vibration and to permit fast closure and removal. Design conforms to MIL-C-8603 (ASG) specifications.

Birtcher Corp., Industrial Div., Dept. ED, 745 S. Monterey Pass Road, Monterey Park, Calif.

INDIANA STEEL PRODUCTS

From the Indiana Steel Products Division of INDIANA GENERAL CORPORATION

INDIANA'S INDOX CERAMIC PERMANENT MAGNETS NOT ONLY OPEN THE DOORS TO NEW AND BETTER DESIGN — THEY GIVE YOU THE ADDED BONUS OF TESTED, PROVED RELIABILITY.

INDOX® magnets for creative designers... and tough inspectors, too

TYPICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>INDEX I</th>
<th>INDEX V</th>
<th>INDEX VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coercive Force (H_c) Oersteds</td>
<td>1,825</td>
<td>2,000</td>
<td>2,550</td>
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<tr>
<td>Residual Induction (B_r) Gauss</td>
<td>2,000</td>
<td>3,840</td>
<td>3,300</td>
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<tr>
<td>Peak Energy Product (B_H max.) TYPICAL</td>
<td>1.0 x 10^4</td>
<td>3.5 x 10^6</td>
<td>2.4 x 10^6</td>
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<tr>
<td>Reversible Permeability</td>
<td>1.2</td>
<td>1.05</td>
<td>1.06</td>
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<tr>
<td>Reversible Temperature Coefficient (Magnetic)</td>
<td>-0.19%/°C</td>
<td>-0.19%/°C</td>
<td>-0.19%/°C</td>
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<tr>
<td>Magnetization Field For Saturation, Oersteds</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Chemical Composition</td>
<td>BaFe_2O_19</td>
<td>BaFe_2O_13</td>
<td>BaFe_2O_19</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>4.7 or 0.17 lb/cu in</td>
<td>5.0 or 0.181 lb/cu in</td>
<td>4.5 or 0.162 lb/cu in</td>
</tr>
</tbody>
</table>

INDIANA'S INDOX CERAMIC PERMANENT MAGNETS not only open the doors to new and better design — they give you the added bonus of tested, proved reliability.

Build it smaller, build it cheaper, build it better. How? With INDOX ceramic magnets.

Why? INDOX provides high resistance to demagnetization and radiation environments; high resistivity means low eddy current losses; low incremental permeability; high energy per unit weight.

Where? Some of the performance proven INDOX applications include loud-speakers, ion pumps, traveling wave tubes, holding devices, sonar magnetostriction units, synchronous designs, generators, motors.

Why Indiana? Because nobody in the business has the wealth of experience in ceramic magnet manufacture and engineering know-how. We can cite examples of INDOX success stories where other materials have failed. If you want to know more about this outstanding material in relation to your own designs, write or call us. Ask for Bulletin 18.
Another New High Order of Reliability!

**ELMENCO**

**CAPACITORS**

in quantities up to

500 Per Item

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ELMENCO INDUSTRIAL DISTRIBUTORS

**ARIZONA**: Radio Specialties & Appliance Corp., 917 W. 7th St., Phoenix.


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**DISTRICT OF COLUMBIA**: Capital Radio Wholesalers Inc., 3120 14 St., N.W., Wash., D. C.


**ILLINOIS**: Newport Electronics Corp., 223 W. Madison St., Chicago 6.


**NEW JERSEY**: Federal Purchaser Inc., 1021 U.S. Rte. 22, Mountainside; General Radio Supply Co., 600 Penn St., Camden 2; Radio Electric Service Co., 513 Cooper St., Camden 2.

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**NORTH CAROLINA**: Dayton-Radio Supply Co., Inc., 938 Burke St., Winston-Salem.


**TENNESSEE**: Electra Distributing Co., 1914 West End Ave., Nashville 4.

**TEXAS**: All-State Elect. Inc., 2411 Ross Ave., Dallas; Bassett Elect. Equip., Inc., 1216 W. Clay, Houston 19; Engineering Supply Co., 6000 Cenlen Dr., Dallas 52; Midland Specialty Co., 500 W. Pasko Dr., El Paso; The Perry Shafter Co., 1001 S. Flores St., San Antonio.

**UTAH**: Carter Supply Co., 3214 Washington Blvd., Ogden.

**WASHINGTON**: C & G Radio Supply Co., 2221 Third Ave., Seattle.

**CANADA**: Electra Eemic Supply Co., Ltd., 543 Yonge Street, Toronto 5, Ont.

**ENGLISH DESIGN • July 19, 1961**

CIRCLE 71 ON READER-SERVICE CARD

CIRCLE 72 ON READER-SERVICE CARD

85
NEW!
Model 135 AUTOGRAPF

Ultra-compact, transistorized circuitry. Built-in calibrated X-axis time sweeps, 16 calibrated ranges (each axis) plus stepless range control. Portable, rack or table mount, 10 1/2” x 16 1/8” x 4 1/2”, weighs only 20 lbs. Includes all popular AUTOGRAPF features for maximum usefulness, versatility.

Data and price subject to change without notice.

AUTOGRAF recorders

F.L. MOSELEY CO.
Dept. K-7, 408 N. Fair Oaks Avenue, Pasadena, California
Murray 1-6208
Field representatives in all principal areas

NEW PRODUCTS

Film Resistors

Microminiature film resistors are 0.135 in. in diameter and 0.05 in. long. They are rated at 1/8 w, 250 v at 100 °C, and are derated to 150 °C. The resistance range from 25 ohms to 110 K is covered with 1% and 2% tolerances. The noble metal film resists oxidation and moisture, and is not affected by low temperatures.

American Components, Inc., Dept. ED, 8th Ave. and Harry St., Conshohocken, Pa.

P&A: $4.00 to $1.00; from stock.

Infrared Equipment

Produces up to 3,000 F. High-intensity infrared equipment uses fluid cooling to obtain the maximum capabilities of quartz lamp sources. Product temperatures up to 3,000 °F can be produced in continuous operation. The equipment can be readily adapted to custom designs.

Fostoria Corp., Engineered Products Div., Dept. ED, Fostoria, Ohio.

Solenoid Valves

Miniature three-way, brass solenoid valves, series BM-300, handle differential pressures up to 200 psi. ON, NC, directional, and freewheeling types are available. Valves weigh 15 oz, measure 3-47/64 in. over-all. Liquids and gases from -45 to +150 °F are handled. Operating time is 8 to 12 msec. Special models rated at 500 psi and -60 to +350 °F are available.

Allied Control Co., Inc., Dept. ED, 2 East End Ave., New York 21, N. Y.
Presenting...

still another new transistor development

by PSI.

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Pacific Semiconductors, Inc.
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72 high performance triple diffused silicon mesa transistors available now from PSI!

FOR IMMEDIATE ACTION—MAIL CARD

Postage paid reply card below will bring you, by return mail, complete specifications on the PSI Triple Diffused Silicon Mesa Transistors you check—including curves, electrical characteristics, dimensional drawings—and complete, up-to-the-minute short-form PSI transistor catalog. All Free—mail now.

Gentlemen: Please send full data on transistors checked:

□ 2N1409  □ 2N1409A  □ 2N1410  □ 2N1410A  □ 2N1409  □ 2N1409A  □ 2N1410  □ 2N1410A
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□ 2N1409  □ 2N1409A  □ 2N1410  □ 2N1410A  □ 2N1409  □ 2N1409A  □ 2N1410  □ 2N1410A

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NEW!

PSI TRANSISTOR

TO-51 PACKAGE

2N958 • 2N959

HIGH PERFORMANCE COMPUTER LOGIC SWITCHES

\[ T_s < 25 \text{ ns} \quad \text{V}_{\text{CE (sat)}} < 0.2V \quad 250\text{mW Dissipation @ 25}^\circ\text{C} \]

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Max.</th>
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<tr>
<td>( V_{CBO} )</td>
<td>25</td>
<td>Volts</td>
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<tr>
<td>( V_{BE} ) (R=10 ohms)</td>
<td>20</td>
<td>Volts</td>
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<tr>
<td>( V_{CE} )</td>
<td>15</td>
<td>Volts</td>
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<tr>
<td>Power Dissipation @ 25 C</td>
<td>.250</td>
<td>Watts</td>
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**DIMENSIONS**

There's a PSI Micro-Transistor for every design requirement and every assembly technique. If you're planning a new and original computer design let us hear from you. Just call Bill Eckess, Osbourne 9-2281, TWX: HAW CAL 4270 or write PSI Micro-Electronics Division.

Ask for your copy of the new up-to-the-minute "Micro-Electronics Catalog" and "PSI Micro-Diode Reliability Report."

Pacific Semiconductors, Inc. 12955 Chadron Avenue, Hawthorne, Calif.  \( \text{P&A: PSILOCAL} \)

---

Narrow-Band Crystal Filters

Bandwidths of 2 kc to 30 kc at 6 db with a center frequency at 10.7 mc are provided by a series of six crystal filters. Designated series FB, the units are hermetically sealed. Insertion loss is 4 db max.; in-band ripple, 0.8 db max.; ultimate rejection, 105 db min. Units occupy less than 2.5 cu in. and operate from -55 to +90 C.

Midland Manufacturing Co., Dept. ED, 3155 Fiberglas Road, Kansas City 15, Kan.

Availability: From stock.

DC Driver

Flip-flop fan-out capabilities are extended to 64 AND or OR gate loads per output with the T-165 dc driver. Standard T-series container measures 7/8 in. diameter by 2-3/16 in. seated height, with 9-pin plug-in base.

Engineered Electronics Co., Dept. ED, 1441 E. Chestnut Ave., Santa Ana, Calif.

P&A: $32.50 ea; stock.

Digital Readout

Four-unit digital readout assembly 20000P features quick disconnect and plug-in. Entire assembly may be removed from panel front, or lamp and terminal assembly may be disconnected from the rear. Assembly may be potted to specification.


P&A: $129.50; 30 days.
Concerned about these radiation

NEW YORK—Pulse nuclear radiation which could temporarily disable avionics controls in a weapon system and thus jeopardize the success of the weapon's mission is becoming the subject of serious military and industry concern.

The extremely brief, but very high intensity pulses of radiation that occur immediately following a nuclear explosion can produce disrupting transients or erratic operation of avionic equipment at distances from the detonation point that were once considered to be safe for equipment.

AVIATION WEEK, 8/8/60, Page 58

G. E. OFFERS THREE ANSWERS TO

1. G-E 5-STAR TUBES

Special heavy-duty construction, highest quality materials, and low boron-content glass envelopes give G-E 5-Star tubes an increased tolerance to steady-state radiation and provide faster recovery time to pulsed gamma radiation. Integrated gamma dosage up to $10^9$ røntgens and approximately $10^9$ integrated fast neutron flux (NVT) can be sustained without permanent damage. For temperatures up to $220^\circ$ C., G-E 5-Star tubes offer the ultimate in high-output performance and reliability under the most adverse conditions of vibration and shock.

2. CERAMIC TUBES

Microminiature ceramic tubes, when adapted to your present circuitry, can increase steady-state radiation tolerance to as high as $10^9$ røntgens and $10^9$ NVT. In addition, the effects of pulse radiation are reduced considerably if the tubes are operated at higher temperatures. These reductions are proportionately greater as the tube operating temperature is increased to its maximum, up to $500^\circ$ C.

Rigid, compact construction of ceramic tubes makes them extremely resistant to shock and vibration and provides the smallest equipment package using standard circuitry components.
NUCLEAR RADIATION PROBLEMS

3. TIMM CIRCUITS

TIMM circuits, inherently resistant to radiation, are made of ceramic and titanium components which tolerate nearly 10,000 times the steady-state radiation of circuits employing solid-state devices, and more than 1,000 times greater high-intensity pulse radiation. No transients were produced in the output of a test TIMM during a 5 x 10^7 R/sec. dose rate pulse.

TIMM circuits operate at 580° C., utilizing normal heat losses to increase efficiency. B+ power usage is no more than solid-state circuitry. High, constant temperature provides improved circuit stability. Rugged, micro-miniature construction is highly resistant to shock and vibration and allows component densities as high as one million parts per cubic foot.

Write for your free radiation file folder containing all the latest information on components and applications data. To: General Electric Co. Receiving Tube Dept. Room 7139 B. Owensboro, Kentucky

Progress Is Our Most Important Product

GENERAL & ELECTRIC

Time Generator

For oscilloscope calibration and time measurements. Model 166B time generator gives intensity-modulated time markers synchronized to the trace of the firm's 160B and 170A oscilloscopes. It provides marker intervals of 10, 1 or 0.1 usec with an accuracy of ±0.5%.

Hewlett Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.
P&A: $130; 10 weeks.

Transistor Testers

An electronic servos automatically sets transistor biases in the series TAB transistor testers. Basic parameters of npn and pnp, small and medium power transistors can be measured. Collector voltage range is 0 to 30 vdc; current range is 0.1 to 100 ma; base current, -1 to 100 ma.

Price: $240 to $305.

Ripple Meter

For aircraft and missile dc power supplies, model T256 ripple meter measures peak-to-peak, plus peaks, minus peaks and rms. It can be battery or line powered.

Avtron Mfg., Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.
Price: $350.
NEWS! API NOW HAS A CONTINUOUS READING METER-RELAY. No signal-sampling interrupters necessary. The CRMR indicates continuously, controls continuously, resets automatically. Built around an unrestrained D'Arsonval movement, it will monitor and control any variable translatable to analogous voltage or current values. Sensitive enough to operate on inputs as small as 5 millivolts or 10 microamps full scale, it will accept low-level signals without amplification. Compact as a panel meter, it needs only a power supply and load relay (both of which API can furnish) to make a complete little control system. Or, you can build it into an equipment control network. Bulletin S-2-1 will give you details on operation, along with specifications and price information. A copy is yours for the asking.

ASSEMBLY PRODUCTS, INC.
CHESTERLAND 17, OHIO
NEW PRODUCTS

High-Voltage Capacitors

Paper-dielectric capacitors type RA are available in 10 different voltage ranges from 10 to 60 kv dc. Operating from –55 to +115 C, they are rated for 10,000 hr at 85 C. Capacitors are impregnated with polybutene oil.
Corson Electric Manufacturing Corp., Dept. ED, 540 39th St., Union City, N. J.

Indicator Light

Miniature indicator light, called Mini-Cator, consists of a replaceable lamp cartridge and mating lamp holder. Holder mounts in a 3/8-in. diameter hole. Cartridge has nylon shell and stainless steel pins.
Industrial Devices, Inc., Dept. ED, Edgewater, N. J.

DC Relay

Sensitive dc relay of SP series operates as low as 15 mw, spdt, and 70 mw, dpdt. Contacts are rated for 5 amp resistive, 115 v ac or 26.5 v dc. Size is 2 x 2-1/8 x 1-3/4 in., temperature range –45 to +85 C. Standard coil resistances are 2.5, 5, and 10 K.
P&A: About $3 ea; stock to 6 weeks.

Why Die Stamped Circuits by Dytronics?

ELECTRICAL PROPERTIES UNIMPAIRED

Die stamped circuits are produced by a dry technique which employs a heated metal-cutting die to delineate the conductor pattern and bond it to the base material by activating the adhesive between the metal foil and the insulating material.

The electrical properties of the base material are unimpaired, because no chemicals are used, and there is no adhesive residue or residual metal on the insulating surfaces. This gives the designer the advantage of selecting base materials for physical and electrical properties without considering chemical resistance.

A new booklet, "Designing with Dytronics Die Stamped Circuits," will help you evaluate and design with die stamped circuits. Write for your free copy today.

Dytronics INCORPORATED
ROCHESTER 48, MICH.
A subsidiary of Taylor Fibre Co.
Norristown, Pa.

CIRCLE 78 ON READER-SERVICE CARD
ELECTRONIC DESIGN • July 19, 1961
Telemetry Filters

All standard bands, transmit and receive, are covered by the series N filters. Output is within 1.5 db of input over ±7.5% of center frequency for channels 1 through 18, and ±15% for channels A through E. Insertion loss is less than 3 db. Distortion over entire band is less than 1%. Units, epoxy-encapsulated, have a temperature range of −55 to +85 C.

Key Resistor Corp., Dept. ED, Gardena, Calif.
Availability: 30 days.

Cable Strap

Self-locking cable strap can be inserted into a blind mounting hole and locked by thumb pressure without tools, forming a hermetic seal. Construction is of grey plastic. Insulating straps resist chemicals, corrosion, wear, and vibration. Various sizes are available.

Budwig Manufacturing Co., Dept. ED, P. O. Box 4212, Glendale 2, Calif.

Radio Beacon Transmitter

Re-entering space vehicles can be identified and located with this transistorized beacon transmitter. Transmitter is crystal controlled and amplitude modulated with two or more audio frequencies, one for identification and others for telemetering. Telemetering modulation frequencies are variable.

Cook Electric Co., Dept. ED, 2700 Southport Ave., Chicago 14, Ill.

Now, you can save time and insure reliability... by specifying DK Coaxial switches in your design

It's easy. DK Coaxial switches are available in scores of shapes, sizes, and functions from factory stock. RF Products' new DK Coaxial switch catalog lists over 130 variations of 16 basic coax switch designs, covering a proven 90% of all known applications. All the facts and figures on the industry's most complete line of coaxial switches are at your finger tips.

You'll also find that these switches successfully combine ruggedness with the highest standards of precision: spring-leaf switching blades, gold-plated silver contacts and impedance matched connectors keep insertion loss and VSWR (1.3 @ 4,000 MCs) low, Crosstalk high (in decibels down); electro-mechanically actuated models operate and release in 8 to 20 milliseconds, depending on type and function, with a proven mechanical life of 1,000,000 cycles minimum when operated under 10 cps.

And, don't forget that RF Products, pioneers in the development of the coaxial switch, will continue to offer you design and engineering services whenever you need them. Whether you order a switch from the catalog or a switch designed to meet your exact specifications, you can be assured of the same high quality and service.

For details on our new line of standard switches, write for catalog DK 61.
The Untouchables

Specify Crucible Charges of Deposited Hyper-Pure Silicon

Pre-packaged single piece crucible charges... in sizes and weights to meet the exact requirements of your Czochralski crystal growing equipment... are now available from Dow Corning.

Accurately Pre-weighed, these single piece crucible charges assure easy handling... smallest surface area... highest purity... an exceptionally clean melt and a savings in crucible costs.

High Quality is inherent in Dow Corning crucible charges. The deposited polycrystalline silicon in these charges has never touched a mold. Result — highest purity.

This High Purity means consistently higher quality crystals — simplifies doping procedures — increases device yield. Typical resistivity of N-type crystals grown from Dow Corning pre-packaged crucible charges is greater than 100-ohms centimeter for 80% of the crystal; maximum boron content, 0.3 parts per billion atoms; maximum donor impurity, 2.0 parts per billion.

Now You Specify the Weight and Diameter, up to 38 mm (about 1½"), best suited for each crucible of your Czochralski crystal growing machines. Your crucible charges will be supplied in the appropriate length to provide the exact weight you require in just one piece.

Protective Packaging guards initial deposited purity right through crucible charging. Charges are individually wrapped in special cellophane, and sealed in airtight polyethylene envelopes to assure untouchable purity.

Whatever your need — deposited silicon crucible charges; polycrystalline rod or chunk; high resistivity P-type single crystal rod; single crystal rod doped to your specifications — Dow Corning should lead your list of sources.

Profile of Crystal Growth from Pre-Packaged Charge

Free brochure—"Hyper-Pure Silicon for Semiconductor Devices." Write Dept. 4019.

Dow Corning CORPORATION

MIDLAND, MICHIGAN

NEW PRODUCTS

Digital Modules 681

Encapsulated digital logic modules of series 200 operate from dc to 250 kc, in temperatures from -54 to +71 C. Included are active NAND and OR elements, diode gating, and logically gated flip-flops. Terminals match 0.200-in. grid.

Data Systems Div., Harman-Kardon, Inc., Dept. ED, Ames Court, Plainview, N. Y.

Price: $5 to $20 ea in quantity.

Log Frequency Converter 680

With 2% accuracy. Model HLFC-120 log frequency converter provides a dc voltage output which varies in proportion to the log of the frequency of an input signal. Used with X-Y plotters, the unit has full-scale output of 100 mv at 400 ohms. Interchangeable discriminators cover 1, 2 or 3 decades from 5 cps to 20 kc. Accuracy is 2% from 20 cps to 20 kc.

Houston Instrument Corp., Dept. ED, P. O. Box 22234, Houston 27, Tex.

P&A: $355; 45 days.

Sequencer 691

Miniature, modular sequencer type SSL-101 is designed to produce signals on separate output lines at a rate equal to that of the input clock. The 10-count unit allows only one output to be energized at a time. Size is 0.7 x 3.0 in. max; weight is under 1 oz.

Alpha-Tronics Corp., Dept. ED, 1033 Engracia, Torrance, Calif.

Availability: 30 days.
Linear Potentiometer

Low-noise linear pot series 431 is made with strokes from 0.5 to 12 in., power rating 1.2 w per in. Stability is under 30 ppm per deg C to 150 C: resistance range is 50 ohms to 1 meg. Accuracy is ±2% to ±0.5%. Unit withstands heavy shock and vibration.

Hyres Electrical Div., Hydraulic Research and Manufacturing Co., Dept. ED, 11675 Sheldon St., Sun Valley, Calif.

P&A: $200; 30 days.

Insulation Tester

With megohmmeter. Model 2955 Vibrotest is designed for dielectric absorption tests and plotting of insulation resistance vs. time. The dc test potential is continuously adjustable from 0 to 2,500 v. Meters with 4-1/2 in. scale indicate test voltage and insulation resistance from 100 K to 50,000 meg.

Associated Research, Inc., Dept. ED, 3777 W. Belmont Ave., Chicago 18, Ill.

Digital Printer

Front-feed printer model 400DT can be coupled to any electronic counting equipment or control system that provides 1-2-4-8 binary-coded decimal output with a swing of -6 v. The six-digit unit has a cycling rate of four lines per sec max. Printer mounts in cabinet or rack.

Computer Measurements Co., Dept. ED, Sylmar, Calif.

P&A: $1,700; 60 days.

To meet increased demand for a wide range of subcarrier oscillator configurations Dorsett Electronics now offers its extremely reliable solid state subcarrier oscillator in three new package forms.

Dorsett's three new configurations provide the systems engineers with unmatched mechanical flexibility in telemetry system design, without sacrificing component reliability and stability.

These new subcarrier oscillators are only a few of the many state of the art telemetry components currently in production at Dorsett Electronics. Put Dorsett's experience to work for you on your next telemetry requirement. Your inquiries and specifications will receive a prompt reply.

DORSETT ELECTRONICS, INC.
P.O. BOX 862 • NORMAN, OKLAHOMA • JEFFERSON 4-3750

CIRCLE 81 ON READER-SERVICE CARD
Cary Electrometers measure insulation resistance of $10^{15}$ ohms at potentials of one volt or less with ±1% accuracy

Provide fast accurate leakage measurements; eliminate instrument loading of the test circuit

In addition to measuring large resistance values Cary Electrometers are used for measuring charging phenomena, hysteresis and photo effects of semi-conductors and insulating materials. Applications include air ionization studies, measurement of ion currents in mass spectrometry, radioactivity measurements of solids, liquids and gases and Hall effect studies.

Cary Electrometers detect currents as small as $10^{-17}$ amperes; charges to $6 \times 10^{-16}$ coulombs; and voltages as low as 20 microvolts.

High stability (less than $5 \times 10^{-10}$ amperes steady drift), high accuracy (±0.25% using a precision potentiometer), and operation independent of changes in vacuum tube and component characteristics are just a few of the features contributing to the superior performance of Cary Electrometers.

Choose from several models: Model 31 for measuring currents from grounded sources and voltages from ungrounded sources; Model 31V for voltage measurements from grounded sources; Model 31-31V for measuring voltage or current from grounded sources.

Additional information on Cary Electrometers and Accessories is yours for the asking. Write for data file M14-71

APPLIED PHYSICS CORPORATION • 2724 So. Peck Rd., Monrovia, Calif.
NEW PRODUCTS

Delay Line

685

Lumped-constant delay line provides a delay of 0.21 μsec, with a rise time of 0.08 μsec max. The line withstands 800 v min; maximum continuous operating temperature is 125 C. Attenuation is 20% max. Diameter is 0.3 in, length 1.5 in.

Andersen Laboratories, Inc., Dept. ED, 501 New Park Ave., West Hartford 10, Conn.

Silicon Diodes

660

Diffused-junction silicon diodes MA-4413 and MA-4414 have a junction capacitance of 1.8 pF max at −6 v bias, and combine low leakage with 2-nsec switching speed. They are rated at 10 ma at 1.0 v forward with breakdown voltages at 0.1 μA of 40 and 30 v. Made for computer applications, the diodes are sealed in a subminiature glass case.


Reflecting Tape

661

Pressure-sensitive tape Y-9050 is capable of performing continuously at temperatures of 500 to 600 F, and can withstand more than 3,000 F radiant heat for short periods. Thickness is 0.006 in, weight 0.0038 lb per ft/in. width, tensile strength 75 lb per in. width. Roll lengths of 36 yards are 1/4 to 36 in. wide.

Minnesota Mining and Manufacturing Co., Dept. J1-1, Dept. ED, St. Paul 6, Minn.

Limit Stop

689

Screw adjustment from 0 to 40 turns is provided by mechanical limit stop model 40. The size 10 device has 0.04 oz-in. starting torque with 0.50 oz-in. load limit. Weight is 1-1/2 oz, length 2 in.

Elm Instrument Corp., Dept. ED, 30 Chasner St., Hempstead, L. I., N. Y.

P&A: $62.80 to $78.50; stock.

The quickest most practical way to put strong threads in soft materials

THE TAP-LOK® INSERT

IN SOFTER METALS AND PLASTICS... Has full V-form external threads to provide maximum locking torque and permit wide choice of mating hole sizes. Recommended for soft aluminum, zinc die castings, sand castings and plastics. Meets requirements of MIL-MS-35914.

FOR HIGHER STRENGTH MATERIALS... Has heavy wall and truncated root external thread and three-hole cutting edges for hard-to-tap higher-strength materials and to meet MIL and other specs calling for Class 3B thread fit for gaging after installation.

ELIMINATES CAMPS... The F-Series Form-Lok self-tapping insert is thread forming and firmly locks itself in the base material. Available from stock in sizes 4 through 6.

FOR WOOD... Has coarse pitch external threads offering maximum strength in combination with ability to be driven into thin sections without splitting them. For furniture, cabinets and other wooden parts where strong, permanent threads are needed, or that are frequently assembled and disassembled.

Another fastener development from—

TAP-LOK®/GROOV-PIN CORPORATION

1146 Hendricks Causeway, Ridgewood, N.J.

CIRCLE 82 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
For computer applications, these digital cards include a BCD-to-decimal decoder, an accumulator and a decade counter. The BCD-to-decimal decoder has repetition rates of 100 kc; flip-flops are used as basic storage device. The accumulator has five adder sections and the decade counter contains two full decimal digits of serial counters.

Computer Techniques Inc., Dept. ED, 3500 Northern Blvd., Long Island City 1, N. Y.

Zener Diodes

Highly stable Zener reference diodes PS1511 through PS1517 are available with temperature coefficients ranging from 0.01% to 0.0005%. Made for 10-v decimal readout in differential and digital voltmeter applications, the units have low dynamic impedance characteristics and are not position-sensitive.

Pacific Semiconductors, Inc., Dept. ED, 12955 Chadron Ave., Hawthorne, Calif.

Price: $7.65 to $10.00 ea, 100 to 999.

Long-Delay Relays

Accuracy is ±5% for relays with time delays ranging from seconds to over 1-1/2 hr. Models can be furnished for on-time delay, off-time delay and interval timing. Contacts are 5 amp, 3pdt. Adjustable units have calibrated, etched dial. They can be surface mounted or flush-panel mounted.

Clearview Electronics Corp., Dept. ED, 140 E. Main St., P. O. Box 294, Elkton, Md.

Cinco MANUFACTURING COMPANY

1026 South Homan Avenue • Chicago 24, III.

Division of United-Carr Fastener Corporation, Boston, Massachusetts

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; and St. Louis, Missouri
NEW PRODUCTS

Servo Amplifier

For motors to size 15. Model A429 germanium servo amplifier, rated at 400 cps ±10%, operates servomotors at 6-w output over the temperature range of -55 to 71 C. It is supplied with two parallel summing signal inputs each having independent gain.

Westamp, Inc., Dept. ED, 112 Massachusetts Ave., Los Angeles 25, Calif.
Availability: 1 week.

Crystal Ovens

Temperature stability is ±0.1 C for cycling; operating temperature is 75 to 85 ±2 C. The JK09S1 crystal oven holds two HC-6/U crystals; the JK09S115 holds two HC-13U crystals. Units with other ranges can also be furnished.

James Knights Co., Dept. ED, Sandwich, Ill.

Microminiature Capacitor

Capacity is 0.075 μf. Measuring 0.5 x 0.5 x 0.125 in., this capacitor has a voltage rating of 200 vdc with a capacity variation of less than 10% from -55 to 150 C. Units with ranges from 47 pf to 0.01 μf are also available. Dielectric is barium titanate.

American Components Corp., Dept. ED, 15222 Grevillea St., Lawndale, Calif.
P&A: $0.30 to $2; stock.
in "engineered" voltage regulation

The most significant thing about past performance is the promise it holds for the future. Each day, our engineering moves forward toward new milestones. We will welcome your problems in ac or dc power regulation. For immediate attention, write or phone Mr. A. Steichen, Product Manager, Electronics, Sola Electric Company, Elk Grove Village, Illinois.

Laboratory Electromagnet

Rotating 6-in. laboratory electromagnet type V-4007-2 features pole pieces of which the air-gap width may be adjusted from 1/32 to 5-1/2 in. by means of an integral gap-adjusting mechanism. The gap-adjusting device can be furnished separately.

P&A: $6,430; 45 days.

Tube-Replacement Rectifiers

Provide long life inherent in silicon rectifiers. Types are 1N5070, 1N1262, 1N2650, 1N2631, 1N2632, 1N2633, 1N2634, 1N2636. They feature all-welded construction, are rugged and can be mounted in any position. They are suitable for new designs as well as replacement.

Ling-Temco Electronics, Inc., Dept. ED, P. O. Box S-1, Anaheim, Calif.

Dual-Speed Drive

Accuracy is 12 min of arc. Designed for positioning a variety of rotary components, model DSD-40 dual-speed drive meets MIL-E-4970. An outer dial, for fine positioning, has a velocity ratio of 10:1; an inner dial, for coarse positioning, is directly coupled to the output shaft.

Technology Instrument Corp., Dept. ED, 533 Main St., Acton, Mass.
NEW PRODUCTS

**Portable Oscilloscope**

Measures 5-1/8 x 6 x 7 in. and weighs 5-1/2 lb. The Nuscope oscilloscope is for modulation control, production-line testing and equipment servicing. The vertical amplifier has a flat response from 40 cps to 225 kc and can be used from 10 cps to 500 kc and over. Sweep frequencies are 20 to 30 cps.

National Union Electric Corp., Electronics Div., Dept. ED, Bloomington, Ill.

**Antenna Pedestal**

Weights 300 lb. Model 3606 azimuth antenna pedestal can be used at the top of a tower as well as at lower levels. It develops a torque of 1,000 ft-lb at 1.5 rpm. A mast of up to 5-1/2 in. may be installed through the vertical axis. Either ac or dc motors may be used.

ANTLAB, Inc., Dept. ED, 6330 Proprietors Road, Worthington, Ohio.

**Double Pentode**

Miniature 9-pin double pentode ELL80/6HU8 is made for audio output stages. Tube has common cathodes, delivers 9 w with low distortion and can be used in push-pull or two single-ended circuits.

ITT Components Div., Dept. ED, Clifton, N. J.
Power Amplifier Attenuator

Dummy load bank is combined with power attenuator in model 511A. The attenuator has a rating of 50 W and is for use where a power amplifier is used to drive a low-power amplifier. An rf input can be connected from any 50-ohm coaxial line to the input connector.

Seco Electronics Inc., Dept. ED, 5015 Penn Ave. S., Minneapolis 19, Minn.

Sound Meter

Range is 5 cps to 30 kc. Model 412 sound meter is designed to meet ASA S1.4-1961 standard. Sound-level range is 24 to 150 db. A ceramic microphone permits use over wide temperature range. It has a built-in electroacoustic calibrator and operates on two batteries plus a single bias cell.

H. H. Scott, Inc., Dept. ED, 111 Powdermill Road, Maynard, Mass.

Static Inverter

Rated at 1,200 va, model SI-4 static inverter delivers 115 v ac at 60 cps from 48 v dc. Other features are: maximum harmonic distortion, 7%; power factor, 0.8; temperature ranges, -20 to +60 C. Uses include standby sources for microwave broadcast equipment.

Kidde Electronic Laboratories, Dept. ED, Brighton Road, Clifton, N. J.

The only true measure of eyelet price

Installed Cost

and here's JUST ONE of the ways UNITED helps you cut IC:

TOOLING COSTS REDUCED UP TO 90%!

for all the dollar-saving facts...

With United's system of standardized eyelet sizes, only 7 sets of tools are required for all 65 eyelets. One tool can set up to 12 different lengths of the same diameter! Initial tooling costs are greatly reduced, ... and the high quality and long life of United's setting tools keep replacement costs to a minimum as well. Where special eyeleting jobs call for special tooling, the ready availability of United's complete tool engineering service will help you save time and money. Savings in all these areas can help you cut your total tooling costs up to 90%!
New from Unitek—a coordinated line of accessories to keep space clear, to make operations fast and easy, to reduce eye strain, and to increase reliability in every step of the process. Write for detailed information and prices.

950 Royal Oaks Drive, Monrovia, California
NEW PRODUCTS

Control Switch 430
Made for lamp or relay drive at currents up to 200 ma and voltages up to 32 v, model 600100 operates with nominal input voltage levels of 0 v and ±3 v or more, with maximum loading of 100 µa at −5 v. Sensitivity is under 30 µa. Size is 0.88 x 0.88 x 2.00 in.

DC Signal Amplifier 373
Gain is 50 to 500, continuously variable. Model SA9-0 dc signal amplifier accepts inputs from thermocouples, thermal sensing to bridges and dc transducers. Output is 0 to 5 v; input is 0 to 10 mv; power required is 30 ma at 28 v ±10%. It operates under environmental extremes and is suitable for airborne use.
Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Transistor Tester 378
Displays beta as a function of collector current. Model T3A-2 transistor tester shows a complete plot of beta vs It from 0 to 500 ma peak at 1 to 10 kc. Provision is made for plots to 1 mc. Accuracy is 5%. The unit may be used with any dc scope.
Orbitec Corp., Dept. ED, 512-30th St., Newport Beach, Calif.
Price: $1,125.

Multi-service, rack and panel, 14-contact connector has two RGU coaxial fittings. They are designed for either RGU 50 or RGU 70 ohm-matched impedance cable. Contacts are for AWG 20 wire; pin diameter is 0.040 in. Positive polarizing guide hardware is of nonmagnetic passivated stainless steel.
Precision Connectors, Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

Rated at 1.15 to 3 v with tolerances of 2% and 5%. Types SS3140 through SS3145 voltage references consist of series strings of silicon and germanium diodes. Dynamic resistance ranges from 20 to 40 ohms at 10 ma; average current at 25 C is 50 to 200 ma max; temperature coefficient is 2.4 to 5.6 mv per deg C.
Price: $2.50 to $4.00.

ELECTRONIC DESIGN • July 19, 1961
Connectors
For wire-wrap terminations. Type FT-WJ-100 Press-Fit Teflon connector is rectangular with truncated circular ends. When properly seated, it provides extremely high torque. Over-all height is 1.2 in., above-the-chassis height is 0.46 in. and below-the-chassis is 0.469 in.
Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.

Logic Element
For 10 to 16 mc. Type LE-40 logic element can be used as a static flip-flop or dynamic logic element. It consists of four input AND gates which buffer into a steering circuit. It is compatible with the firm's 3C-PAC series H units.
P&A: $249; stock.

Milliwatt Relay
Requires 40 mw. Series AV pillbox relay withstands 15-g vibration and 50-g shock. Header terminals are placed on the flat side of the relay. It can be supplied as spdt or 2pdt with contacts suitable for 2-amp or dry-circuit loads.
Filtors, Inc., Dept. ED, Port Washington, N. Y.

Telemetering Transmitter
Used in rotors of high-speed machinery, telemetering transmitter WTT-102 transmits data on the subcarrier oscillator frequency directly, with no rf carrier, through noncontacting slip rings. Subcarrier frequency deviations of ±40% are readily obtained. Cylindrical model WTT-103 is also available.
Wiley Electronic Products Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

Isolator
Circuits at 25,000 v can be controlled from ground-level circuits through a high-voltage isolator. A light source operates a photosensitive cell in the separate high-voltage unit. Type CK-1105 isolator requires a control potential of 120 v; and CK-1108, 5 v. Signal resistance off is over 107 ohms, on is less than 10 ohms for the CK-1105 and less than 500 ohms for the CK-1108.
Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.
P&A: $24.50; immediately in sample quantities.
precise
5 VOLT
POWER
SUPPLY
for instrumentation and telemetry

This compact, reliable DC to DC converter provides conversion of 28 ±4 volts DC to a precision 5 volts DC @ 100 ma. or 1 amp. Measuring only 4¾" x 3½" x 1¾", weighing only 20 ounces, it gives a completely accurate power supply and maintains it, with no change, within the temperature range. Designed, developed and produced by Temco Electronics, the converter is a solid state, off-the-shelf package that meets or exceeds mil specs. It will meet your airborne or ground telemetry and instrumentation power supply specifications with no necessity for change in configuration. We invite your inquiries on this unit. It is also available in other voltages to meet specific applications.

LING-TEMCO ELECTRONICS, INC.
TEMCO ELECTRONICS DIVISION • DEPT. 221N
P.O. BOX 8181 • DALLAS 22, TEXAS
CIRCLE 89 ON READER-SERVICE CARD
PROJECT ADVENT!

BENDIX REACTION WHEEL
FOR SATELLITE CONTROL
AND STABILIZATION

Precision reaction wheels developed at Bendix meet requirements for attitude control of space vehicles and satellites. For example, these wheels will be used for Project ADVENT—advanced Army research program which will use satellites as relay stations for global communications.

Since reaction torque is directly proportional to applied voltage, the reaction wheel provides a means for proportional control of vehicle attitude. An integral tachometer senses wheel speed and direction of rotation.

Several wheel configurations are now available, and the basic design concept offers flexibility to meet still broader requirements. Individual wheels can be tailored to specific voltage, torque, inertia, and momentum storage requirements.

ADVANTAGES AND FEATURES
- Minimum weight and power
- Brushless motor and tachometer
- Low friction
- Flexible design
- Consistent performance over environmental range

Eclipse-Pioneer Division
Teterboro, N.J.

District Offices: Burbank, and San Francisco, Calif.; Seattle, Wash.; Dayton, Ohio; and Washington, D.C.
Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N.Y.

CIRCLE 90 ON READER-SERVICE CARD
NEW PRODUCTS

DC Power Supplies

### Regulation

Regulation is ±0.1%. Six of the power supplies in the MRST series have an output of 24 to 32 V at 100 to 600 amp and one has an output of 24 to 40 V in two ranges at 250 amp. Applications are in plant-central supplies and laboratory testing. Response time is 20 to 200 msec.

Perkin Electronics Corp., Dept. ED, 345 Kansas St., El Segundo, Calif.

### Electric Heater Blankets

For defrosting, curing plastics or adhesives and standby temperature control for solid propellant missiles. In sizes to 30 x 10 ft, the Heat Sheet electric heater blankets use resistance-alloy foil which is etched to shape and laminated in Neoprene, epoxy or silicon rubber to meet MIL and U1 specification.

Thermal Circuits, Inc., Dept. ED, 59 Park St., Beverly, Mass.

### Volt-Millivoltmeter

Vacuum-tube millivoltmeter model 100 has 12 ranges from 1 mv full scale to 300 V and 12 dB ranges from −72 to +52 full scale. Accuracy is 1%; readout is on a 5-in. scale. It operates from 115 or 230 V at 50 to 1,000 cps and is portable.

Sun Electric Corp., Dept. ED, Harlem and Avondale, Chicago 31, Ill.

P&A: $284; from stock.
Relay Receptacle

For subminiature relays with plug-in design. Series 3030 relay receptacles use a wide-bevel receptacle which allows for misalignment of relay pin contacts. Thickwall socket contacts provide for high-spring tension. Various terminations can be furnished.

Precision Connectors Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

Linear Potentiometer

Operates at 500°F. Model 147 long-travel linear potentiometer provides a linearity of ±0.25%, resistance of 5 K ± 5%, resolution of 0.045% and a power rating of 1 Watt at 500°F. The potentiometer element is platinum alloy wire. Dimensions are 1.4 in. in diameter and 12 in. in length.

Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Connector Housing

With split-backshell design. The firm’s DPJ connector can be completely wired before this housing is applied. Maximum cable size is 0.937 in. Solder-pot area is fully protected.

Glenair, Inc., Dept. ED, 1211 Airway, Glendale, Calif.

AC-DC Converter

Accuracy is ±0.15% absolute from 0.5 to 1,000 volts ac. Model C-100AR converter features a frequency range of 30 cps to 10 kc, solid-state circuitry and standard rack mounting design. Suitable for use with differential and digital voltmeters, it operates from 115 volts ac.

Calibration Standards Corp., Dept. ED, 1025 Westminster Ave., Alhambra, Calif.

Price: $455.

Proven Reliability

Eighteen months ago, TSI introduced the Model 361 as the industry’s first completely transistorized 1 Mc digital Counter/Timer. It won immediate acceptance. The integrity of the original design has been preserved through eleven successive production runs.

Field reports on the 361 are consistently impressive. We have rarely received a valid report of malfunction due to a manufacturing or design defect.

There are good reasons for this record of proven reliability. The NOR-logic design of the 361, for example, drastically reduces its semiconductor count over that of conventional instruments. Our inflexible attitude toward derating, and our refusal to use “selected” components or transistors add significantly to the performance margins this instrument will maintain over wide ranges of power line voltage and ambient temperature. Like all TSI instruments, the 361 is 100% solid-state. It runs cool, despite its compact design.

Engineers who use it tell us that the 361 has the best amplifier of any 1 Mc Counter/Timer... sensitive, wideband, and unaffected by noise and jitter. They also compliment the straightforward readout, the flexibility provided by its dual-channel logic, and its crystal-clock stability.

It will pay you to consult TSI when you need digital instrumentation in the real-time domain.


One of 17 Solid State Instruments by TSI.

TRANSISTOR SPECIALTIES INCORPORATED
Sophisticated Digital Instrumentation
TERMINAL DRIVE, PLAINVIEW, NEW YORK • WELLS 5-8700

CIRCLE 92 ON READER-SERVICE CARD
NEW PRODUCTS

Power Supply 431

Solid-state power supply has separate electronic and magnetic overload-sensing systems; either can independently sense voltage and current, and adjust or shut off as required. Input-output efficiency is about 80%. Special features simplify maintenance.


Trimming Potentiometer 428

Square trimming potentiometer weighs 3/4 g and is rated at 1 w at 50 C. Resistance range is 10 ohms to 50 K. Maximum operating temperature is 125 C; temperature coefficient is 20 ppm per deg C. Equivalent noise resistance is 0.1%. Trimmer measures 3/8 in. square and meets applicable military requirements.

Techno-Components Corp., Dept. ED, 18232 Parthenia St., Northridge, Calif.

Ceramic Capacitor 374

Rating is 100,000 pf. The Cerol capacitor meets MIL-C-11015B. Specs include: 50 wvdc from -55 to +85 C, derated to 25 wvdc at 125 C; series resistance of 0.2 ohm max from 8 to 10 mc; power factor 2% max; temperature coefficients of +10% or -30% from -55 to +125 C at 0 v and +10% or -40% at rated voltage.

Aerovox Corp., Hi-Q Div., Dept. ED, Olean, N. Y.
In electronic equipment...

SWITCH
RELIABILITY
SAFEGUARDS YOUR
PRODUCT'S REPUTATION

If you manufacture electronic equipment, remember that the success of your product often depends on a switch. The design of switches for complex electronic applications is a specialty. By specifying MICRO SWITCH Precision Switches you can open new possibilities for automatic control. You can also be sure of precision and reliability that is thoroughly tested in the industry's most complete test laboratory for small and subminiature switches. Find out about the important new switch ideas being added to the MICRO SWITCH line, every one with MICRO SWITCH reliability.

MICRO SWITCH... FREEPORT, ILLINOIS
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In Canada: Honeywell Controls, Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Printed-Wiring Board

Shatter-proof printed-wiring board type CU-SIL uses NEMA grade G-17 glass silicon, meeting MIL-P-997. It withstands continuous exposure to temperatures of 150 to 250°C. Conductive pattern is pure copper. Uses include environmental testing of semiconductors and other devices, power supplies, computer modules and airborne apparatus.

Conductorlab, Inc., Dept. ED, Groton, Mass.

Speech Compression System

Bandwidth is 150 cps. Speech compression system based on format tracking communicates speech in a total bandwidth of 150 cps. Speech signal can be digitized and transmitted at 1,000 bits per sec. System weighs less than 50 lb and occupies 1.3 cu ft.

Melpar, Inc., Dept. ED, Falls Church, Va.

Power Supply

For plasma research. Output of this power supply is 0 to 8,000 v at 0 to 3 amp from an input of 240 v, 60 cps, three phase. Either current or voltage can be regulated. Ripple is below 2% rms. Regulation is 0.25% for up to 100% load charge or 10% line charge.


Induction Motor

Pancake-type, 12-pole induction type 113 motor is rated to deliver 0.025 hp at 3,750 rpm. Stator windings are encapsulated in a Fiberglas reinforced epoxy. Temperature limit is 350°F. Input is 115 or 200 v, 400 cps, three phase. Dimensions are 3-13/16 in. in diameter and 1-1/2 in. long.

Curvin Development Co., Dept. ED, 13735 Saticoy St., Van Nuys, Calif.
Small Size and Long Life Make G-E Glow Lamps Ideal as Indicators

There are over 60 General Electric glow lamps made especially for use as indicators in appliances, business machines, military equipment—wherever indicating devices are needed. They’re small, rugged, usually low-cost, operate on standard AC voltage at low wattage and give off very little heat. All of which makes them ideal for use as indicators. Here are details on a few of them:

**NE-2H** lasts 25,000 hours on standard AC voltage,* only ¼ inch long, operates on just ½ watt, is a high brightness lamp and costs much less than a dime including an attached resistor (5 different resistors are available).

**NE-2J** another high brightness lamp with a 25,000 hour life* on standard AC voltage, operates on ½ watt, is less than one inch long, has a single contact midget flange base and will fit most standard indicator fixtures. This lamp is not available with attached resistor.

**NE-45** has a 7,500 hour average useful life on standard AC voltage: operates on ¼ watt, is 1½ inches long, has 30K resistor built into screw base and big electrode that presents a large glowing area when lit.

*With a 30K resistor.

For detailed information on the 18 most popular General Electric glow lamps, write for bulletin #3-0193. General Electric Co., Miniature Lamp Dept. M-134, Nela Park, Cleveland 12, Ohio.
NEW PRODUCTS

Use Timers

Ranges to 1,000 hr. Called Time Totalizers, these time clocks are for preventive maintenance of electronic gear in ground and airborne applications. They are essentially mercury coulombimeters, operated by an integral electrical network which compensates for temperature differences and supply-voltage variation.


Price: $12 to $15.

Telemetering Transmitters

For use on rotors of high-speed rotating machinery. These transmitters permit transmission of data on the subcarrier oscillator frequency, with no rf carrier, through capacitively coupled noncontacting slip rings. Model WWT-102 measures 1.75 x 1.75 x 2.25 in. and model WWT-103 measures 1.25 in. in diameter and 3.1 in. long.

Wiley Electronic Products Co., Dept. ED, 2045 W. Cheryl Drive, Phoenix, Ariz.

Single-Turn Potentiometers

Wirewound types. Series 2490 potentiometers are in 3 in. in diameter for ranges from 100 to 200,000 ohms; series 2480, 2 in. for 20 to 125,000 ohms; series 2460, 1-7/16 in. for 20 to 100,000 ohms; series 2440, 7/8 in. for 10 to 50,000 ohms. All are gangable in up to eight units except for the 2440 which is gangable in up to six units.


Availability: sample quantities only until Aug. 15.
YOU GET THIS MUCH MORE
SELECTIVITY WITH A COLLINS MECHANICAL FILTER

Choose Collins filters, and you don't have to choose between small size and selectivity. The steep, flat-topped curve above is the work of a few dime-size discs sealed in a case often smaller than a penlight battery. These resonant discs have Q's of 8,000-12,000, up to 150 times that of bulky electrical LC filter elements. Collins mechanical filters also offer you unprecedented stability. Frequency shift can be held between 1.5 and 2 parts per million per degree centigrade over the range -25°C to +65°C, and there is no observable drift with age.

For carrier systems, single sideband equipment, bandpass filtering in high-performance receivers — in fact, for any filtering job between 50 and 600kHz, a Collins mechanical filter does a better job in less space.

Made to take it, Collins mechanical filters meet MIL-Spec requirements for humidity, corrosive environments, shock, vibration — the works. Literally hundreds of thousands now demonstrate their reliability throughout the world in communications equipment made by major electronic companies. A Collins filter may be your best answer, too.

Write for literature describing our line of more than 100 mechanical filters. Ask for Data File C-181A.

Collins also offers a full selection of compact crystal filters, which cover the range of frequencies from below 10khz to as high as 30mhz.

COLLINS RADIO COMPANY • NEWPORT BEACH, CALIFORNIA • DALLAS, TEXAS • CEDAR RAPIDS, IOWA

COLLINS RADIO COMPANY
19700 San Joaquin Road
Newport Beach, California
World’s Largest Producer of Mechanical Filters

Check Collins at WESCON, Booths 1301-1302.

CIRCLE 96 ON READER-SERVICE CARD

Power Supply

Rated at up to 60 V, 7.5 amp, type 810B power supply can be voltage or current regulated. Load regulation for constant voltage operation is less than 0.02% or 10 mv from no load to full load, and for constant current operation, less than 0.05% or 3.5 ma. Ripple and noise are less than 1 mv rms for constant voltage and less than 3 ma rms for constant current.

Harrison Laboratories, Inc., Dept. ED, 45 Industrial Road, Berkeley Heights, N. J.

Glass Mount

Electron gun mount glass M-10 is made in rods of standard round, square, or D shape, and in custom configurations. Annealing point is 507 C, softening point 780 C. Thermal expansion coefficient is 2.8 ppm, density 2.17. Ten colors are produced.

Mansol Ceramics Co., Dept. ED, Belleville, N. J.

Distribution Amplifier

For closed-circuit television. Unit is of modular construction. Bandwidth with six outputs is over 8 mc. Gain variation is to 190% of unity. Unit fits into 3-1/2 in. of 19 in. rack space and is 12 in. deep.

Nassau Laboratories, Dept. ED, 42 Valley Road, Plandome, N. Y.

Price: Under $400 for six outputs.

Wire Cutter

Accuracy is ±0.005 in. Model MMP-203 wire cutter is for cutting and handling wire, ribbon and rods for welded or micromodular circuit work. It handles AWG 40 or larger wires, bare or insulated, and ribbon as small as 0.064 x 0.015 in. Speed is 1,200 pieces per hr.

Dickinson & Assoc., Dept. ED, 334 N. Central Ave., Glendale 3, Calif.

Price: $542.
How to shrink a filter!

Magnetics Inc. "120" solves the problem of core size vs. inductance in miniaturized circuits. Trying to squeeze high core inductance into a small space for use in miniaturized resonance, filter, audio, or carrier frequency circuits usually ends in a compromise. You either force more out of a smaller core, or you use a larger one. Not so, however, if you’re familiar with the Magnetics Inc. "120."

This molybdenum permalloy core has a .655 inch outer diameter—just between the .500 and the .800 inch core you may be using. What makes this little fellow unique is its inductance per 1,000 turns... higher than either of its neighbors, whether 60, 125 or 160 permeabilities.

Note, too, that like all Magnetics Inc. powder cores, the "120" is performance-proved and rated within realistic inductance limits. All permeabilities are available from stock now. What’s more, the 125 permeability core is inductance stabilized within ±0.1% from 0° to 55°C.

More information on this and other cores in the Magnetics Inc. line is contained in design bulletin PC-203 R. It’s yours by writing Magnetics Inc., Department ED-91, Butler, Pennsylvania.
High-Impedance Amplifier  639

Response is 1 db from 5 cps to 100 kc, or 3 db from 3 cps to 300 kc. This solid-state amplifier has an input impedance of 15,000 meg shunted by 1 to 1.5 pf and an output impedance of 1 meg shunted by 3 to 10 pf. Power gain is to 35 db; voltage gain is to 0.5 db; noise level is 50 to 100 mv at output with input open; output voltage is 0.6 v max.

Denro Lab, Dept. ED, 2801 15th St., N. W., Washington 9, D. C.

Price: $37.

Traveling-Wave-Tube Base  609

Ceramic-to-metal tube base for traveling-wave tubes withstands repeated welding operations and bakeout in air at 700 C for 72 hr without leaking. Assembly consists of a nickel cap supporting 4 to 8 ceramic-to-metal tubular feedthroughs, together with an integral ceramic-to-metal input adaptor and copper evacuation tube.

Ceramics International Corp., Dept. ED, 39 Siding Place, Mahwah, N. J.

Magnetic Tape Translators  641

Honeywell and IBM computers are made compatible with these tape translators. Honeywell 800 and 400 EDP systems work from tapes written by IBM machines and write tapes acceptable by IBM equipment with the translators. Model 36 is for the 800 series and model 436 is for the 400 series.


P&d: 336: $93,600, rents for $1,950 mo; 436: $43,875, rents for $975 mo. 12 to 15 mox.

RF Transformer  634

Range is 50 kc to 30 mc. Type 1008 rf transformer is an output transformer for a crystal filter used in airborne single-sideband communications transceivers. It meets environmental requirements of MIL-C-15305A, Grade 2, Class B.

Applied Components Inc., Dept. ED, 401 E. Beach Ave., Inglewood, Calif.

Availability: made to meet customer specs.

Never before has a glass been developed that is so compatible for use with 52% nickel alloy leads.

The result is a compression between the glass and pins so tight that twisting and bending of the pins to the breaking point will not cause rupture or leakage. (Determined by Veeco Leak Detector with sensitivity at 10^-10 std. cc/sec.) Thermal shock is excellent with this new TR-Glass. Salt spray resistance exceeds 100 hours.

Every performance feature is well in excess of Mil Specs. The use of TR-Glass may be considered for all types of Fusite solid glass headers as well as many other style terminals.

Samples on request. Write Fusite, Department G-4

Fusite Corporation, Cincinnati, O.
Fusite N. V., Konigweg 16, Almelo, Holland
Fusite GmbH, Dieselstrasse 5 Karlsruhe, W. Germany

The Fusite Corporation
6000 Fernview Avenue, Cincinnati 12, Ohio

Circle 98 On Reader-Service Card
all the cards...

125° C. HIGH RELIABILITY. SMALL ENCAPSULATED

ACDC R. F. CHOKE

As always, ACDC RF Chokes are 1st choice of the industry... and, as always, they are available for immediate delivery from stock. 
- 125 Standard Values to choose from
- Inductance ranges from 0.1 μH to 10 MH
- Temperature range -55°C to +125°C
- Designed to meet MIL-C-15305-A
- Epoxy encapsulated for maximum resistance to moisture and immersion.

In circuits where RF inductors are required and the equipment design objective includes maximum reliability under the most stringent environmental conditions, these ACDC RF Chokes will help you attain optimum circuitry performance.

Put this combined experience and know-how to work for you.

In the long run you will find it will save you both time and money; like holding 4 aces, you can't do better!

Full specifications included in Bulletin 125-A, write for yours today.

ACDC ELECTRONICS, INC.
2979 North Ontario Street, Burbank, California

Manufacturers of regulated power supplies, inductive devices from power to radio frequencies, pulse circuitry components and magnetic amplifiers

CIRCLE 99 ON READER-SERVICE CARD

NEW PRODUCTS

Welding Power Supply

Rated at 30 kva. The Weldpower ac welding power supply features a half-cycle timing switch for use with single or dual-synchronous timers. Transformers are made for use at 550 and 440 v ac, for outputs of 30 kva at 50% duty cycle, and 220 v for 22 kva. Unit has a 0.5 to 10-cycle timing range and a 6 to 30-cycle timing range with the heat program timer.


Logic Test Panel

For maintenance testing of logic areas and functions, a selective test panel has been incorporated in the firm's DynaPath-20 numerical control systems. Each logic area is isolated through a series of switches. Measurements are taken in each area to determine marginal operating level. Flow of information can be controlled stage-by-stage.

The Bendix Corp., Industrial Controls Section, Dept. ED, 21820 Wyoming, Detroit 37, Mich.

Magnetic-Tape Cleaner

Sonic and ultrasonic cavitation at the tape surface removes loose oxide, base chips and dirt from magnetic tape. Model CT-2 magnetic-tape cleaner handles 1/4, 1/2 or 3/4 in. tape in thicknesses of 1/2 to 5 mils. Speed is 300 ft per min. Water is used as the cleaning fluid.

General Kinetics Inc., Dept. ED, 2611 Shirlington Road, Arlington 6, Va.
P&A: $4,454; 30 to 60 days.
From Sylvania comes the first major performance improvement to the popular 6146 and associated family since their introduction 7 years ago. The new Sylvania-originated 6146A, 6883A, 6159A eliminate communications fade-out caused by decreased heater voltage supplies. Designed for use as an AF power amplifier and modulator, RF amplifier and oscillator, they offer the same excellent output capabilities (at normal heater ratings) and reliability that characterize their prototypes.

At Sylvania even established types undergo intensive and continuous field examination to incorporate up-to-the-minute design requirements. In fact, it was in just this way that the well-known line of Sylvania Gold Brand premium tube types was originated. All are specifically designed to fill critical application requirements—effectively, efficiently, reliably.

If your industrial or military design demands specialized tube types, call on the creative engineering and production capabilities of Sylvania. Your Sylvania Sales Engineer will be pleased to work with you. For tech data on specific types, such as the new Sylvania-6146A, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N.Y.

*Minimum output limit for an individual tube (CCS) measured in a single-tube self-excited oscillator circuit. Conditions: plate voltage—600Vdc; grid #2 voltage—180Vdc; grid #1 resistor—30,000 ohms; plate current—100 to 112mA; grid #1 current—2 to 2.5 mAdc; frequency—15MC.
Sylvania Ka Band Magnetrons offer a remarkable range of powers, fill virtually all your Ka band requirements. They include extremely compact types with exceptional power-to-weight ratios. All are fixed-frequency types for pulsed operation, utilize stabilized magnets, and exhibit outstanding reliability and longevity.

**Sylvania-5789**, first commercially available U. S. type for Ka band, uses 22-vane “rising sun” anode, and improved dispenser-type cathode. With hermetically sealed input and pressurized output, it is highly adaptable to high altitude operation.

**Sylvania-6799** features 120KW peak power output and is a proven high-power millimeter wave source. It is available for use with longer pulses and higher duty cycles at slightly reduced power.

**Sylvania M-4155A**, ruggedized version of the 5789, features compact size and weight of only 9 lbs., improved heat dissipation and excellent stability. It utilizes a special cone-shaped cathode support and “building block” mounting arrangement for added mechanical strength. M-4155A possesses both long- and short-pulse capabilities.

**Sylvania XM-4064**, ruggedized magnetron, offers exceptional stability under severe environmental conditions. Only 9 lbs. in weight, it provides peak power output of 70KW for a remarkably good power-to-weight ratio.

**Sylvania XM-4158**, ruggedized magnetron, provides 120KW peak power output. Weight is only 27 lbs. It uses E type magnets for a uniform, flat surface configuration that can be used as a structural part of the chassis. XM-4158 is compatible with either long- or short-pulse operation.

**Sylvania XM-4218**, ruggedized tube, provides a power-to-weight ratio of 8:1 making it especially suited for portable, field-type radar. It uses metal-to-ceramic seals, ceramic cathode capsule, cantilever cathode support. The tube withstands 50g shock, 10g vibration tests. XM-4218 provides a lower pushing factor than tubes of comparable performance. Weight is only 4 lbs.

**Sylvania XM-4206** is a ruggedized, compact tube with encapsulated cathode. Only 10.5 lbs., it provides 40KW peak power output.

<table>
<thead>
<tr>
<th>Sylvania Ka Band Magnetrons</th>
<th>Frequency (KMC)</th>
<th>Peak Power Output (KW)</th>
<th>Max Duty Cycle</th>
<th>Max Pulse Width (Usec)</th>
</tr>
</thead>
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<tr>
<td>5789</td>
<td>34.512</td>
<td>40</td>
<td>0.006</td>
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<td>6799</td>
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<td>XM-4206</td>
<td>34.7</td>
<td>40</td>
<td>0.006</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Investigate the design advantages of Sylvania Ka band magnetrons and associated Ka band TR tubes. Contact your Sylvania Sales Engineer for complete information. For technical data on specific types, write Electronic Tube Division, Sylvania Electric Products Inc., Dept. MDO-D, 1100 Main St., Buffalo 9, N. Y.
Pulse Counter 597

Dual-channel, 10-mc pulse counter type HW consists of two separate seven-decade units in module form. Each channel consists of a 10-mc decade scaler followed by six 1-mc scalers. Readout is in neon-lighted decimal digits. The 8-4-2-1 binary-coded decimal count in each scaler is available for performing logic operations.

Harvey-Wells Electronics, Inc., Dept. ED, 14 Huron Drive, Natick, Mass.
P&A: $2,500; 2 weeks.

Frequency Divider-Clock 596

Accuracy is ±10 μsec for time comparison. Model 113BR frequency divider-clock provides comparisons between local time or frequency standards and hf or vlf broadcasts. Drive rates can be recorded over long periods and time or frequency differences can be determined between oscillators in widely separated systems. Requirements of MIL-E-16400 are met.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.
P&A: $2,750; 3 weeks.

Pressure Transducer 602

Silicon-semiconductor, strain-gage pressure transducer provides 250 mv output without an amplifier from 10 to 30 v dc. It is sensitive to static and hf dynamic pressures. Range is 0 to 100 through 0 to 10,000 psia or psig. Standard linearity is 0.25% max. Uses are in steel, missile, underwater and nuclear fields.

Fairchild Controls Corp., Dept. ED, 219 Park Ave., Hicksville, L. I., N. Y.

Miniature Amplifier 600

Rated at 5 w, type C70 3146 001 1-cu in. amplifier is designed for use at ambient temperatures of 125 C. Component leads are interconnected by means of electrical-resistance spot welding. Completely potted in epoxy, the unit is suitable for missile and aircraft applications where extremes in shock and vibration are encountered.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Universal Motor 599

Rated up to 1/10 hp at 10,000 rpm, type GR ac-dc motor is 2-1/4 in. in diameter and 3-1/4 to 4 in. in long. Output torque at 10,000 rpm is 10 oz-in. with a current of 1.3 amp at 115 v ac, 60 cps. Field and armature windings can be varied to provide different speed-torque characteristics. Units meet Mil specs.

New Philbrick 6033 solid-state power supply

BALANCED OUTPUTS, COMPUTING GRADE. The 6033 is the latest addition in the distinguished line of Philbrick power supplies. It will energize at least 10 Philbrick P2 amplifiers and other transistorized electronic equipment. Like the P2, its remarkable characteristics speak for themselves.

- **Low internal impedance:** less than 2 milliohms.
- **Low noise and hum:** guaranteed less than 150 microvolts rms (0.001%).
- **Highly regulated outputs:** against load, less than 300 microvolts; against line, less than 200 microvolts.
- **Low long term drift:** typically 0.1%.
- **Short transient recovery time:** no load to full load, less than 1 millisecond.
- **Unique short circuit overload protection:** inherent in the 6033's design with no extra circuitry to deteriorate performance.
- **Truly low cost:** about half that of supplies with comparable performance: $285.

Operates from 115 volt, 50-400 cycles, providing up to 150 ma at plus AND minus 15 volts, slaved to a common reference. Conveniently packaged, cool running, and highly reliable. Available as bench model or modular plug-in. Bench model dimensions: 3½" h x 5½" w x 7½" d. Also available with 300 ma output.

Complete facts are waiting for you. Please write:

GEORGE A. PHILBRICK RESEARCHES, INC.

127 CLAFLIN ST. BOSTON 16, MASS.
COMMONWEALTH 6-3726. TWX: 66 1032. P.A.X. 284H
REPRESENTATIVES IN PRINCIPAL CITIES
EXPER OFFICE: 25 W. 17TH ST. N.Y. 11, N.Y.
TEL. CINEMA 5-3530. CABLE: TRILRUSH

CIRCLE 101 ON READER-SERVICE CARD
Glass-fiber reinforced plastic circuit board offers superior electrical performance and resistance to breakage. The material processes easily and punches at room temperature. It is self-extinguishing.

Cimastra Div., The Cincinnati Milling Machine Co., Dept. ED, Cincinnati 9, Ohio.

Laser Materials 644
Barium fluoride doped with various rare earths and transition elements is available in single crystals 3/4 in. in diameter and 1 in. long. The crystal can be used as a laser material. Chips of the material, suitable for investigating properties of the various dopings, are also available.

P&A: Chips, $15; Crystals, $400 each. From stock.

RF Voltmeter 666
For avionics and laboratory use. Model 400 rf voltmeter measures input and output voltages in rf, video, audio and servo systems. Alpha transistors permit calibration as an rf indicator or null detector up to 30 mc. Transistorized, the unit is portable.

R-K Labs, Dept. ED, Box 700, Wantagh, N.Y.
P&A: $245; 45 days.

Diode Module 396

High-density packaging for 12 diodes is provided by this module. Individual pin terminations connect module to the master board. Contacts are silver-plated with gold flash.

Precision Connectors Inc., Dept. ED, P. O. Box 86, Mineola, L. I., N. Y.
rectifiers and Zener diodes

An average of 16 separate life, electrical, mechanical and environmental tests prove out the quality that has been built into General Electric low current rectifiers and zener diodes. The use of "getters", the finest hermetic seal available, hard soldered joints, and welded main and tube seals are only a few of the reasons they test out so well. Silicon rectifier type 1N538, for example, was put through torturous life test studies over a period of 10,000 hours at maximum temperature, current and PRV . . . and came through with a 99% survival percentage.

For complete technical information, just call your Semiconductor Products District Sales Manager. Or write Rectifier Components Department, Section 23G26, General Electric Company, Auburn, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 E. 42nd Street, N.Y. 17, N.Y.

For fast delivery of selenium, germanium, and silicon rectifiers at factory-low prices, see your authorized G-E distributor

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 102 ON READER-SERVICE CARD
Positive Proof: TI HARD GLASS ENCAPSULATED RESISTORS Give You Unexcelled Resistance to Thermal Shock

Make this dramatic test yourself and discover why Texas Instruments hard glass encapsulated carbon film resistors outperform those of any other construction. First torture the resistor by immersing it in molten solder at 350°C — then quickly dip it in water. Now, test the device for electrical stability and mechanical intactness and you'll find as we have that these precision hermetic resistors are completely unaffected by violent thermal shock. Such performance is possible ONLY because TI type CG 1/4 and CG 1/2 resistors are protected by a hard glass encapsulant and entirely solderless construction. These same features virtually eliminate possible damage to the resistors during installation in your assemblies.

The extreme thermal shock test is only one of many tests that have proven over the past two years that TI type CG 1/4 and CG 1/2 resistors are virtually indestructible. Over eleven million unit hours of test data have been compiled on moisture resistance, thermal shock, extended overload, and load life to prove that TI hard glass encapsulated resistors give you reliable performance under all environments and operating conditions. When you specify TI CG 1/4 and CG 1/2 hermetic resistors, you can be assured of getting the most rugged, reliable, precision resistors available ... at prices you would pay for ordinary resistors!

Take advantage of the proven reliability of TI hard glass resistors ... order them today through your nearby TI Sales Office or authorized TI Distributor.

---

**NEW PRODUCTS**

Rotary Switch Kit 356

Engineers can design and build miniature rotary switches with kit No. PK-20-S. Up to 25 four-section switches similar to the firm's types PA1000 and PA2000 switches can be constructed with factory precision.

Centralab Div., Globe-Union Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Availability: From distributors.

Receiving Tubes 388

Novar tubes in four types have integral 9-pin all-glass bases. A low-temperature heater is used. Types RCA-6AY3, RCA-12AY3 and RCA-17AY3 are half-wave rectifier tubes rated at 5 kv plate piv. Peak plate current is 1.1 amp max, with dc plate current of 175 ma max. Type RCA-7868 is a high-pervenance power pentode for audio output. A push-pull pair can deliver a signal power output of 44 w max, with 5% total harmonic distortion.

Radio Corp. of America, Electron Tube Div., Dept. ED, 30 Rockefeller Plaza, New York 20, N. Y.

Motor-Generator 361

This 5-kw motor-generator is a power source in laboratory testing. Equipment includes a static regulator, output meters, a selector switch and rheostat adjustment. Voltage regulation is within 1%, no-load to full-load. Input is 60 cps, 1,200 rpm, 220 or 440 v with a 10-hp motor.

Kato Engineering Co., Dept. ED, Mankato, Minn.
High-voltage diodes can be tested with these curve tracers which provide 0 to 5 kv at 60 cps. Reverse current is 20 µa to 1 ma. Model 1031-2A, providing true peak meter readings and oscilloscope plotting, is made for precision on-line inspection. Model 1031-2B, giving a calibrated oscilloscope plot, is made for economical on-line inspection with moderate accuracy.


Wire Markers

Up to 50 circuits can be coded on both ends with Trace-Tab wire markers. Divided strips, numbered from 1 to 10, are printed on a color coded, adhesive-backed cloth tape. Five colors are used.

Pyramid Instrument Corp., Dept. ED, 630 Merrick Road, Lynbrook, N. Y.

Image Orthicon TV Camera

For live-image or closed-circuit monochrome use at 600-lines minimum resolution. Type V-600 camera can be used in military and industrial plants without intense illumination. It reduces radiation hazard in survey, medical and radiological uses. It occupies 2 cu ft and weighs 25 lb.

Foto-Video Electronics, Inc., Dept. ED, 36 Commerce Road, Cedar Grove, N. J.
In one versatile new BR-12 micro-miniature series, Babcock offers relay types suitable to a wide range of novel uses in extreme environments.

The BR-12P is an especial boon to those designing for both sides of the component card due to low profile and side header mounting arrangement. A second type, the BR-12K, provides sensitivity down to 20 mw. Both types have contacts rated at dry circuit through 3 amps resistive.

Performance characteristics are generally shared with other types in the BR-12 Series. All are available with activated getter material, providing lifetime prevention of contamination effects at dry circuit to rated current on contacts.

You are invited to request complete technical data.
NEW PRODUCTS

Flush Circuit Devices

Selector switches and pulse generators are typical applications of these flush circuit devices called Permadics. Precious metals deposited on insulating board create pie-section terminals in concentric circles. Height difference between conductor and board is 0.0001 in. There is no electrical noise at 50 rpm. Temperature range is -65 to +125 C.

Precision Circuits, Inc., Dept. ED, 87 Weyman Ave., New Rochelle, N. Y.

Pressure Switches

Water columns of 0.25 to 16 in. will actuate these signal and differential pressure switches. Known as the Deltadyne series, the devices have a spring-biased diaphragm, and activate a switch at a preselected pressure. Units measure about 2 x 3 in., and are vibration-resistant.

Pall Corp., Dept. ED, Glen Cove, N. Y.

Vacuum Transfer Relay

Interrupts 18 kw dc. Vacuum transfer relay RB1R handles 18 kv peak and 15 amp rms. It will interrupt 18 kw dc for over 100,000 operations at 3 amp or 6 kv. Size is 2-3/4 in. overall. Operate time is 3 msec max, release time 5 msec max.

Jennings Radio Manufacturing Corp., Dept. ED, P. O. Box 1278, San Jose 8, Calif.

Contactors and Starters

Size 3 and 4 contactors and starters have been added to the firm’s 100-line. Size 3 devices are rated for control of up to 50 hp, 600 v; size 4 for up to 100 hp, 600 v. They use a horizontal straight-line magnetic action. Contacts are slanted.

General Electric Co., Dept. ED, Schenectady 5, N. Y.

Direct-Recording Oscillograph

Built-in timing circuit of the Visicorder 906C can be triggered externally. Timing intervals of 0.01, 0.1, 1 sec, and 0.01, 0.1, and 1 min are available. Device records as many as 14 channels simultaneously at frequencies to 5 kc. Optical system uses mercury ultraviolet light on photosensitive paper.

P&A: $2,145 to $2,700; immediate delivery.

ELECTRONIC DESIGN • July 19, 1961
Decade Counter
Compact decade counter tube CK7978 is a bi-directional, ring stepping type with maximum dimensions of 2.3-in. heights, 1.16-in. width. The cold-cathode, gas-filled tube provides visual and electrical readout up to 5 kc. Total anode current ranges from 0.30 to 0.60 ma.

Magnetic Probe
Ac magnetic field evaluation probe operates with an ac vtvm for determining ac magnetic field intensity. Calibrated probe consists of an air core inductor, cast in epoxy, within a shielded enclosure. Shielded cables and connector are included.

Copper-Clad Laminate
Developed for printed circuits, this copper-clad epoxy paper base laminated plastic is designated grade EP-492-1. Specimens 1/16 in. thick have flexural strength of 25,000 psi lengthwise, 23,000 psi crosswise. Dissipation factor is 0.031 to 1 mc; dielectric constant is 4.17. Insulation resistance is 190,000 meg. Material is flame-resistant.
National Vulcanized Fibre Co., Dept. ED, 1061 Beech St., Wilmington 99, Del. P&A: $1.55 sq ft in maximum quantity; 3 weeks.

Clutch/Brake
Integrally matched with a customer-specified precision servo pot, this clutch/brake is said to eliminate shaft misalignment, backlash and end play. Power is 2 w, 24 v dc. Clutch torque is 10 oz-in. min brake torque 6 oz-in. min. Response time is 8 msec, weight 1.3 oz.
Dynamic Instrument Corp., D ED, 59 New York Ave., Westbury, N. Y.

Ratio Drives
Concentric ratio drives use ballbearings rather than gears to transfer power. Designated type RDLCC, drives have ratios of 2.66 to 1 and 7.08 to 1. Units, permanently lubricated, are made for servo-mechanism and instrumentation applications. Drives can be panel-mounted.
Jan Hardware Manufacturing Co., Dept. ED, 38-01 Queens Blvd., Long Island City 1, N. Y.
Up to 19.6% less
cost per megohm!

Up to 14.1% more
ohms per pound!

HOSKINS ALLOY
815·R
Precision Resistor Wire

The trouble with using only one type of alloy wire in all of your precision resistors is that very often you and your customers end up paying for something that really isn't required so far as the end use is concerned. Now take Hoskins Alloy 815-R, for example. It's a relatively new custom-quality iron-chromium-aluminum composition. But a number of alert and cost-conscious manufacturers have already found that it possesses all of the physical and electrical properties necessary for many precision resistor applications. High strength, good ductility. Excellent resistance to corrosion. Controlled low temperature coefficient. What's more — and more to the point these days—they've also found that Alloy 815-R's lower density and higher electrical resistivity combine to give them very worthwhile savings. Up to 14.1% more ohms per pound—up to 19.6% less cost per megohm!

Yours for the Asking—If you're a man who fancies such figures, we'd like to send you an eyeful—namely, a handy little "Cost-per-Megohm" Comparator, plus a 12 page catalog that's loaded with technical data. If you also happen to make precision resistors, sample spools of 815-R wire are available for testing and evaluation.

Hoskins Manufacturing Company
4445 Lawton Avenue • Detroit 8, Michigan • Tyler 5-2860
In Canada: Hoskins Alloys of Canada, Ltd., 45 Racine Rd., Rexdale P.O., Toronto, Ontario
Producers of Custom Quality Resistance, Resistor and Thermo-Electric Alloys since 1908

CIRCLE 106 ON READER-SERVICE CARD
All Sangamo Type TR High Reliability Electrolytic Capacitors have this highly effective end seal. It gives them an unusually long operating life...gives you dry electrolytics that you can depend on for at least ten years when operated within their ratings.

Available in ratings from 3 to 450 D.C., and designed to operate in a temperature range from $-20^\circ$C to $+85^\circ$C, Sangamo Type TR capacitors are perfect for low-frequency filter, by-pass and coupling applications in communication systems, electronic industrial controls, laboratory test instruments, computers, and similar equipment. For more complete information write for Engineering Bulletin 2227.

NEW PRODUCTS

DC Power Supply 494

Delivers 120 w. Power supply MC-40VSS, measuring 4-11/16 x 6 x 7-1/2 in., delivers 0 to 40 v dc at 3 amp. Load regulation is 0.01%, line regulation 0.005%; ripple is 1 mv rms. Transient recovery time is 50 $\mu$s, efficiency 80%. Input is 105 to 125 v ac.

Valor Instruments, Inc., Dept. ED, 13214 Crenshaw Blvd., Gardena, Calif.

Price: $380.

Extra-Strong Plastic 436

For printed-circuit boards, insulators, switch gear and electromagnetic devices. Lexan plastic offers excellent heat stability, impact strength, creep resistance and dielectric properties. Sheets are 1/4 to 1-1/2 in. thick in widths to 12 in. and lengths of 3 or 4 ft. Rods are 1/4 to 8 in. in diameter and 6 ft long.


Potentiometers 366

Weatherproof potentiometers, called Cap-Pot, have their electrical element within the operating knob which serves as a moisture- and dust-proof housing. Terminations are brought through the rear of the unit and are sealed. Resistances are from 10 ohms to 10 K, ±10%. Units are made for weatherproof, explosion-proof, and pressurized equipment.

Clarostat Manufacturing Co., Dept. ED, Dover, N. H.
Diallyl Phthalate Cases 358

Made to encapsulate components thin-wall tubular and rectangular diallyl phthalate cases are molded as small as 0.055-in. OD, 0.055-in. ID, and 0.125-in. long. Glass-fiber-filled and Orlon-filled styles are available. Material is said to have good dimensional stability and moisture permeability.

Industrial Electronic Rubber Co., 31945 Aurora Road, Solon 39, Ohio.
Availability: Samples supplied on request.

Data Printer 389

Cards or continuous paper forms are handled by the 1404 printer, operating directly from the output of the 1401 data processing system. Card output is 800 per minute max.; card size is 51 to 160 columns. Continuous paper forms are printed at 600 lines per minute max. A read-compare feature is optional.

International Business Machines Corp., Data Processing Div., Dept. ED, 112 E. Post Road, White Plains, N.Y.
P&A: $85,500; two years.

Telemetry Transmitter 354

Solid-state, crystal-controlled telemetry transmitter, model N15A-125, measures 5 x 5 x 1-7/8 in. and weighs less than 20 oz. Supplies fm or cw signals on the 135-mc band. Requires a 20- to 24-v power supply and provides 0.5 to 1 w output. The transmitter withstands extreme conditions of shock, vibration and temperature.

DuKane Corp., Government Div., Dept. ED, St. Charles, Ill.

CIRCLE 108 ON READER-SERVICE CARD ▶

The smallest rotary switch ever made!

Daven's New Series G Sub-Miniature Switch...1/2" Diameter!

A new sub-miniature rotary selector switch, developed by DAVEN, is specifically suited for application in missiles, aircraft, handy talkies, field pack sets, frog-man communication equipment, and all types of mobile apparatus. This explosion-proof, waterproof switch has the same reliability as its bigger brothers...but in a fraction of the space. It meets applicable military specifications on temperature, humidity, corrosion, vibration, acceleration, shock and immersion.

This unit is available as a single pole, 10 position switch and can be obtained with up to four poles on a single deck.

Contact Resistance: Less than 0.008 ohm.
Contact Rating: 1 ampere, 250V D. C. into resistive load
350 MA, 100V D. C. into inductive load.

Insulation Resistance: 200,000 megohms between any two terminals or between any terminal and shell.

Life Expectancy: 50,000 cycles minimum
Shaft and case: Stainless steel
Panel and hub: Glass filled epoxy
Contacts and terminals: Silver alloy
Rotors: Rhodium plated beryllium copper

Write today for comprehensive technical report on the new Series G Sub-Miniature Rotary Switch.
Tyco Semiconductor brings you a complete line of silicon controlled rectifiers designed and precision produced to meet and exceed MIL-S-19500 requirements.

You can now design with the assurance that a reliable source can deliver silicon controlled rectifiers in the 10 and 16 ampere range with each current rating available in voltage increments up to 500 volts.

Tyco silicon controlled rectifiers feature all welded hermetically sealed construction—uniform gating characteristics and low forward voltage drop. You will find the 2N1842 through 1850 and the 2N681 through 689 ideally suited for your industrial and military applications that require a reliable efficient method for the switching and control of power.

NEW PRODUCTS

Silicon Rectifiers

Rating is 1 amp continuous duty. Silicon rectifiers with ratings of 200 to 1,000 piv do not require heat sink. Double-diffused silicon junction is hermetically sealed in cylindrical case with all parts silver-plated for minimum contact resistance, good solderability of leads and thermal conductivity.

Electronic Devices, Inc., Dept. ED, 50 Webster Ave., New Rochelle, N. Y.

Accelerometer-Amplifier

Solid state accelerometer-amplifier combination model 50X2 has continuously variable gain from 0 to 50, with a maximum sensitivity of 2 v per g. Frequency response is 5 to 4,000 cps for acceleration levels from 2 to 100 g. Size is 2-3/4 x 1 x 1-1/8 in., weight 4 oz. Power is 3.8 ma at 28 v dc.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.

Junction Capacitance Tester

Semiconductor junction capacitance test set model 705 Cm measures 0 to 43 pf in four ranges. Accuracy is ±0.2 pf on all ranges. The low-cost set provides adjustable junction rf voltage, limited to 0.2 v rms.

Summers and Mills, Inc., Dept. ED, 1511 Levee St., Dallas 7, Tex.

Power Supply

RF type, high voltage power supply provides continuously variable dc output voltages in a range from 10 kv to 40 kv. High voltage limit
control sets the upper voltage limit from 35 to 45 kv. Line regulation is better than 0.05%; load regulation is 0.5%; ripples is less than 0.5%.

P&A: $550 to $600; 15 days.

Power Supply 604

Rated at 150 v, 70 ma. Model 22-130 modular dc power supply has an output adjustable from 130 to 170 v and from 0 to 70 ma. Input is 105 to 125 v, 2.5 amp, 50 or 400 cps. Line regulation is 300 mv or 0.2%; load regulation is 150 mv or 0.1%. Ripple is 3 mv rms.

P&A: $198.50; 30 days.

Magnetic Memories 398

With a cycle time of 6 µsec, coincident current magnetic memories type 3300 provide storage capacities from 128 to 4,096 words and from 4 to 64 bits per word. Digital data are accepted either synchronously or asynchronously, and stored in randomly specified or sequential addresses.


Differential Amplifier 380

For airborne use, model A differential amplifier occupies less than 3/4 cu in. Response is flat within ±1% to 150 kc, 3 db down at 400 kc; linearity is better than ±0.05% at 5 v; gain is up to 40; standard input is 20 v dc; temperature range is −100 to +350 F.


Electronic Design • July 19, 1961
UTICA UNWRAPS A NEW BENT CHAIN NOSE PLIER

"Electronic Plier-of-the-Month" - July and August

Never before available on an industry-wide basis! This month's Utica special is the #25-5...a new bent chain nose plier designed to grip, twist and loop very fine wire in closely confined areas. It's ideal for work on chassis as well as other subminiature electronic assemblies. Special features include 60° angle bent chain nose • Beveled edges full length of jaw • Fine serrations in jaws to prevent nicking or marking • Primer coated dipped cushion grip handles and Bauer spring to reduce operator fatigue • Induction hardened edges • Gleaming finish • Backed by Utica's famous full guarantee. Write for complete information on the #25-5 or the Utica Electronic Plier of the Month program. Or ask to have your Utica distributor call!

UTICA DROP FORGE & TOOL DIVISION • KELSEY-HAYES COMPANY, UTICA 4, NEW YORK

UTICA

122
NEW PRODUCTS

Novar-Socket Tubes

These receiving tubes have ninepin novar sockets. Types 6AY3, 12AY3, and 17AY3 are half-wave rectifiers designed to serve as damper diodes in horizontal deflection circuits. Plate voltage is 5,000 max; plate current is 1,100 ma peak-to-peak or 175 ma dc. Type 7868 is an audio power output pentode.

Radio Corp. of America, Dept ED, 30 Rockefeller Plaza, New York 20, N. Y.

VLF Timing Receiver

Used at 16, 18, or 20 kc for reception of the major standard frequency stations, model 400 receiver provides an accurate means of checking local standards. Sensitivity is better than 1µV. A built-in 100-kc oscillator is optional.

Interstate Electronics Corp., Dept. ED, 707 E. Vermont Ave., Anaheim, Calif.

Rotary Solenoid

No linkages are required to convert linear motion to rotary with his solenoid, whose action is pure rotation of a balanced rotor. Unit, originally designed for missile applications, resists shock and vibration.

Singer-Bridgeport, Dept. ED, 915 Pembroke St., Bridgeport 8, Conn.

TRIPLE PURPOSE TRIPLICATE SERVICE

L&N's Stabilized 9835-B Microvolt Amplifier

Designed for low-level d-c measurements of thermocouples, strain gages, etc., in research and production testing, this amplifier combines the functions of three instruments in one:

1. A Direct Reading Indicator that has a sensitivity of 0.25 µv;
2. A Recorder Preamplifier that extends the range of any Speedomax® (type G or H) 0-to-10 MV Recorder;
3. A Null Detector that provides a short period of only two to three seconds.

Ranges: 25 to 25, 25 to 25, 25 to 100 to 25, 250 to 450, 500 to 500 and 1000 to 1000 microvolts.

Accuracy: ± recorder preamplifier, ±(0.4% of range +0.5 µv). As direct reading indicator, ±(1.4% of range +0.5 µv).

Source Resistance: 10,000 ohms, max.

Response Time: Within 1% of balance:
(1) 2 sec, for 2,000 mV max, source resistance; (2) 3 sec, for source resistance from 2000 to 10,000 ohms.

Switches: (1) Six-position range switch;
(2) Three-position selector switch: non-linear meter response, linear meter response, recorder-output to recorder connector; (3) Off-on line power switch.

Amplifier Output at Recorder Connection—
with extremes of meter scale: (1) ±5 mv across 500 ohms, null recorder; (2) ±750 volts for external indicator having resistances of 20,000 ohms or higher.

Case: 10¾" (h) x 19¾" (w) x 8¾" (d). Weight is approximately 45 lbs.

Power Input: 115 volts, 60 or 50 cycles.


LEEDS & NORTHUP Instrument Makers of Automatic Controls & Instruments

CIRCLE 112 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
Transistorized FM Transmitters

If you've a need for light—17 ounces—extremely compact—20 cu. in.—215 to 260 telemetry transmitters, specify Tele-Dynamic's Type 1053A and Type 1055A.

Providing one- or two-watt true FM output respectively, they employ dependable silicon transistors for high efficiency and offer better than 0.01% frequency stability. Type 1055A uses germanium transistors in the output stage. Each will operate reliably at any altitude and under any environment. Pressurized aluminum cases seal out the effects of altitude, humidity, salt spray, sand and dust.

These units, representative of Tele-Dynamic's latest creative effort in the complete telemetry field, are capable of being combined into various custom systems and are low in cost.

For detailed technical bulletins, call the American Bosch Arma marketing offices in Washington, Dayton or Los Angeles. Or write or call Tele-Dynamics Division, American Bosch Arma Corporation, 5000 Parkside Avenue, Philadelphia 31, Pa. Telephone Trinity 8-3000.

ELECTRONIC DESIGN • July 19, 1961

Welding Head

Subminiature electrical and mechanical parts can be welded with the model JA head. The instrument has a fast forging force and adjustable steel bushings. Operation is by foot-treadle. Forging force range is 1 to 10 lb. Device measures 8 x 3 x 9 in. with welding heads extended. Weight is 9 lb.

P&A: 8131; immediate.

Electro-Optical Devices

Relay and potentiometer, made for noise-free signal control, incorporate a light source and a photocell in a light-proof casing. The CK-1111 relay can be used with 300 v dc or peak ac, with typical “on” resistance of 13 K. The CK-1112 provides continuous control in potentiometer function, operating to 10 v at 20 ma input.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.
P&A: 811 ca, 1 to 9, immediate.

Commutators

For wide variety of uses, including telemetry, multi-point checkout and commercial instrumentation. These commutators use Drreed contacts which are rated for 1 billion operations. The unit shown is single-pole with 12 channels and is 1-9/16 in. in diameter and 1-1/4 in. long.

Just because the frequency response of our new 6 watt transistorized servo amplifier is extra good, someone had to suggest its use as a Hi-Fi component. He proved his case, too, by playing MANTOVANI through it without losing a string!

Actually, the exceptional bandwidth which permits its operation on either 60 or 400 cycle carriers is only one of many features that make this amplifier outstanding.

Low dynamic output impedance insures good linearity and minimizes distortion between "motor-line performance" and "motor-amplifier performance." High (30K) input impedance permits operation from most of the common input sources.

And high reliability has been achieved without the finality of potting: aluminum oxide articles provide good thermal conductivity at the same time affording protection against adverse environments.

For additional information on this servo amplifier No. TA006-0A-100 write: Diehl Manufacturing Company, Somerville, New Jersey.
A new concept in contact design

New Wire-Form Contact Cuts Miniaturization Costs

As you can see, it's quite different from conventional solid pin and socket contacts—and for good reason.

Spring action of the beryllium-copper beam sections exerts an equalized force at 4 separate points on the wall of the socket contact. This eliminates the need for a costly and space-consuming spring member in the socket contact. Result: economical micro-miniaturization...with densities of 100 to 175 contacts per square inch. Tests show that Wire-Form Contacts retain consistently low resistance after 1,000 cycles of repeated insertions and withdrawals. And unlike solid pin contacts, Wire-Form Contacts can be easily realigned, even after severe bending.

The Wire-Form design makes possible a completely new series of AMPHENOL Micro-Miniature Connectors. Included are 52- and 104-contact Micro-Rac rack and panel connectors with integral body-dielectric construction. They provide up to 20% more contacts in an equivalent space—at nearly half the "standard" cost. And with Wire-Form Poke-Home Contacts, assembly time is shortened, since all wire terminations are made independent of the connector.

Multi-Purpose Strip Connectors are also available. Applicable to a wide range of uses, they are especially suited for use as printed circuit, tape cable and modular connectors. Bulk Wire-Form Contacts are also supplied for use where it is desirable to plug in modules and components to printed circuit boards and other miniaturization devices.

A complete description of this new micro-miniaturization technique is available by writing: Vice-President, Marketing, Amphenol Connector Division, 1830 S. 54th Avenue, Chicago 50, Illinois.
Telephone-Type Relay 574

For aircraft, ship-to-shore communications and mobile radio installations. Series 995 telephone-type relay carries up to 4pdt contacts, rated at 150 w, 3 amp max for palladium types and platinum-ruthenium and rated at 150 w, 1-1/2 amp for silver types. Coils are available from 3 to 110 v dc.

Carbon-Metal Resistors 438

Offered in three types: military, commercial and epoxy sealed, designated MP, CP and EP. Power ratings are 1/8, 1/4, 1/2, 1 and 2 w; resistance range covered is from 10 ohms to 50 meg. These resistors have additives of metal as well as the usual pyrolysis of carbon.
American Components, Inc., Dept. ED, 8th Ave. at Harry St., Conshohocken, Pa.

Vacuum Furnace 442

Cold-jacket type, this vacuum furnace operates continuously at 2,500 C. It is heated by six pairs of tungsten strips suspended by water-cooled, low-thermal-loss feedthroughs. The hot zone is 3-1/2 in. in diameter, 5 in. high. A 40-kw saturable-core reactor control is used.
F. J. Cooke, Inc., Dept. ED, 145 Water St., S. Norwalk, Conn.

NEW from TI

4-CHANNEL servo/riter RECORd

RECORDS 4 CONTINUOUS CHANNELS ON A WIDE SINGLE CHART

You can now record four continuous channels of data on a wide single chart . . . four overlapping pens continuously recording on the full width of the 9 3/4" chart. For the first time in a potentiometric recorder four variables can be traced with high resolution on a single sheet of chart paper! The recorder is the proved servo/riter in the flush-mounting configuration for use in standard 19" relay racks.
Amplifiers are separate from the recorder and may be mounted as far as 15 feet from the recorder chassis. An optional factory-assembled package places the four amplifiers in a standard rack-mounting case for location adjacent to the recorder case.
In addition, five- and six-channel servo/riter recorders are available, utilizing overlapping pens on dual side-by-side 4 1/2" charts. Two- and three-channel recorders are offered in both the narrow and wide configurations, with all pens writing on only one sheet of chart paper.
The same industry-proved performance characteristics and wide ranges of the single and dual-channel servo/riter recorders are designed into the new multi-channel instruments. These include:

- HIGH SENSITIVITY—1.0 mv to 100 mv full-scale
- HIGH INPUT IMPEDANCE—4 megohms off-balance
- FAST RESPONSE—.5 second full-scale rise time
- HIGH REJECTION RATIOS—
  "Transverse" ........................................ 1,000/1
  "Longitudinal" ...................................... 330/1
d-c Common Mode ................................. 30,000/1
d-c & a-c Guard ................................. 30,000,000/1
- HIGH RELIABILITY—Non-lash gearing and conservatively rated electronics.

Write for complete information.

Texas Instruments INCORPORATED
3609 Buffalo Speedway
P. O. Box 6027
Houston 6, Texas

*Trademark of Texas Instruments
NEW PRODUCTS

Power Converter

Rated from 10 to 100 W for 6 or 12 V dc operation, commercial and industrial power converters measure 11/2 x 11/2 x 3 in. The transistorized units are complete with rectifier and filter system.

James Electronics Inc., Dept ED, 4050 N. Rockwell St., Chicago 18, Ill.

P&A: $11.95 to $39.95; stock.

Energy-Storage Capacitors

Complete line offered. Using single-unit and multi-unit block construction, these energy-storage capacitors are for applications such as high-energy pulses for radar, electrolytic metal forming and arc-air heating for wind tunnels.

Westinghouse Electric Corp., Dept. ED, P.O. Box 2099, Pittsburgh 30, Pa.

Availability: Stock or made to order.

Shaft Position Encoder

Analog-to-digital shaft position encoder CG-733 uses a U-scan technique for simplicity of design and performance. Binary outputs of 128, 8192 and 524,288 counts are provided with an accuracy of ±1 count. Conforming to environmental requirements, the units operate from -65 to -85°C.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

DC Converter

Voltage-to-frequency converter changes 0 to 5 V dc into pulse or square-wave output. Frequency varies linearly within 1% with the dc input. Full-scale output frequencies range from 500 to 2,000 cps. Models with 0.1% linearity and 50 ppm per deg C temperature sensitivity are also available.

Pioneer Magnetics Inc., Dept. ED, 850 Pico Blvd., Santa Monica, Calif.
3-Mode Controller

Transistorized 3-mode controller SCD-1001-P accepts input signals of 60 or 400 cps, 50 mv. Proportional settings from 5 to 1,000%, reset time of 0.1 to 300 repeats per min and rate times of 0.005 to 2 min are standard. Current or voltage outputs can be obtained.

Plug-In Instruments, Inc., Dept. ED, 1416 Lebanon Road, Nashville 10, Tenn.

Laboratory Standards

Voltmeter, milliammeter. Model 1700 dc voltmeter and model 1702 milliammeter both have 10 ranges and provide an accuracy of 0.5% of full scale. They are temperature compensated from 15 to 35 C. Self-shielded core magnetometer movements protect the instruments from external fields.

Simson Electric Co., Dept. ED, 5200 W. Kinzie St., Chicago 44, Ill.

Pyrolytic Graphite

Plates, cylinders, and special shapes of pyrolytic graphite are available in sizes up to 1/2 in thick and 4-1/2 ft long. The crystal structure of the material permits it to conduct heat and electricity in one plane, but to insulate perpendicular to that plane. High-temperature tensile strength is 60,000 psi at 2,750 C. The material polarizes infrared light.


Pulse Transformer Kit

With 25 units. Pulse transformer Test-Chest contains 25 different units, in 20 case styles, providing over 500 variations. Turns ratios are 1:1:1, 2:1:1, 4:1:2, and 4:1:4. Inductive values range from 50µh to 140 mh.

Pulse Engineering, Inc., Dept ED, 560 Robert Ave., Santa Clara, Calif.
FOR LARGE COMPONENTS AND SMALL SUBSYSTEMS... the new ITT ST-300 offers a 250 force-pound exciter for vibration and shock testing. This latest in a series of dynamic new vibration equipment utilizes the unique concepts of lateral motion excitation and air-bearing support—both developed by ITT engineering and proved on ITT's other vibration exciters of the 100 and 200 Series.

The exceptionally flat frequency response of the ST-300 permits precise testing without the need for elaborate compensating devices. Natural resonances are unaffected by table loadings. In addition, by checking shock and vibration on the same instrument, testing time and cost are substantially reduced. Other significant features of the ST-300 include:

- no significant distortion throughout normal test range
- first major resonance above 5 Kc
- useful frequency from 5 cycles to 50 Kc
- shock testing to over 5,000 g's
- table size: 5” x 8”

For complete information and applications data, call an ITT Instruments representative or write for Data File ED-1426-1

Other ITT vibration exciters include:

- ST-150 for testing one ounce loads to over 100 g's
- ST-100 for small component production testing and accelerometer calibration

ITT Industrial Products Division
International Telephone and Telegraph Corporation
15191 Bledsoe Street • San Fernando, Calif. • 7More 7-6161
power conversion • instruments • closed circuit TV • avionic • mobile radio/telephone

CIRCLE 123 ON READER-SERVICE CARD
NEW PRODUCTS

Accelerometer 401

Ranges from 0.03 to 40,000 g, with frequency response flat within ±5% from 0.2 cps to 12 kc, are provided by model 504 miniature accelerometer. Sensitivity is 20 mv per g, amplitude linearity ±1%. Temperature range is -65 to +350 or +500 F. Height is 0.53 in., weight 15 g.

Columbia Research Laboratories, Dept. ED, MacDade Blvd. & Bullens Lane, Woodlyn, Pa.
P&A: $139.50 ea, 6 to 10; two weeks.

Switching Transistors 643

High-speed npn epitaxial switching transistors have high breakdown voltages, low saturation voltages, and low output capacities. Designated types NS-381 through NS-384, the devices come in TO-18 packages.

National Semiconductor Corp., Dept. ED, Danbury, Conn.
P&A: $20.90 to $22.90 for 1-99; from stock.

RF Transformer 635

For low-power radar receivers in airborne and ground equipment, type 1044 rf transformer is used at frequencies under 100 mc. Ratings are: primary windings, 1 to 1.5 μh with a Q-factor of 26 min; secondary windings, 0.1 to 0.14 μh with a Q-factor of 66 min.

Applied Components Inc., Dept. ED, 401 E. Beach Ave., Inglewood, Calif.

Availability: made to meet customer specs.

Linear Actuator 402

With stroke to 6 in. Polynoid linear actuators provide reliable, easily controlled motion at low cost. They can be used to hold underload at any position or provide reciprocating motion. Stroke is up to 6 in. standard. Foot mounting is provided.

Skinner Precision Industries, Inc., Dept. ED, New Britain, Conn.

Select the transistorized DYNA-EMPIRE GAUSSMETER best suited to your needs

Completely transistorized Dyna-Empire gaussmeters accurately measure flux density and determine "flow" direction. Ideal for measuring and locating stray fields, plotting variations in strength and performing rapid comparisons of production lots against a standard. Easy-to-operate—no jerk, pull, ballistic readings or circuit breaking required.

NEW TRANSISTORIZED GAUSSMETER MODEL D-874

Special Features:

FIVE RANGES: 300 gauss full scale, 1,000 gauss full scale, 3,000 gauss full scale, 10,000 gauss full scale, 30,000 gauss full scale.

LINEAR OVER ENTIRE OPERATING RANGE PORTABLE, OPERATES FROM OWN SELF.

CONTAINED BATTERIES.

BATTERY LIFE—1,000 HOURS.

REQUIRES NO EXTERNAL POWER SOURCE.

INTERNAL CALIBRATION STANDARD.

WEIGHT—1 LBS.

UNIVERSAL PROBE SUPPLIED IS 0.025" THICK X 0.200" WIDE. ACTIVE AREA IS ONLY 0.0079 SQUARE INCHES LOCATED NEAR THE TIP OF THE PROBE.

Complete with Universal probe $195.

TRANSISTORIZED GAUSSMETER MODEL D-895

This quality precision built Gaussmeter reads flux densities to 30,000 Gaus full scale ±2.5%. It is a highly sensitive instrument and provides tremendous flexibility. Complete with two linear probes—one high sensitivity probe for measurement of low density fields and one probe for measurement of high density fields. Special probe available for reading 3 gauss full scale.

Write to

Dyna-Empire, Inc.
1075 Stewart Avenue, Garden City, N. Y.

CIRCLE 124 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
Microminiature connectors have contact densities of 100 to 175 per sq in. Series 220 Micro-Rac is a rack and panel connector, and series 221 Strip is for in-line, stacked, and special configurations. Current rating is 3 amp max, and temperature range is -65 to -250 F. Contacts, beryllium-copper, are spring-tempered and resist deformation.

Amphenol - Borg Electronics Corp., Amphenol Connector Div., Dept. ED, Broadview, Ill.

Rotary Solenoid 367

Requires 0.0033 amp input at room temperature or 0.005 amp at -55 C. Voltage range is 25 to 29 V. Type 9931-04 rotary solenoid meets MIL-1-22075 and is for devices requiring 35-deg rotation.

John Oster Manufacturing Co., Avionic Div., Dept. ED, Racine, Wis.

Availability: 60 days.

Switchlight Adaptors 368

Snap-in adaptors simplify mounting of the firm’s switchlights and indicators. They can be supplied with legend engraved or stamped. Round and square types are available. They are made of nylon with cadmium-plated spring-steel retaining clips.

Pendar, Inc., Dept. ED, 14744 Arminta St., Van Nuys, Calif.

P&A: under $1; stock.

General Instrument Silicon Planar Microdiodes

This planar microdiode could help a designer make a new reputation. Here are the parameters of a “big” planar diode... but this is the first and only planar diode available in micro size. You get the high reliability advantages of planar structure in a package 0.080” by 0.045”... microdiodes which have passed 10-day JAN humidity test cycles and ionic salt immersions with no degradation of electrical parameters... true surface passivation only available from General Instrument’s unique Molecular Shield™ process. Here is instant availability of a full line of planar microdiodes for computer and general purpose design, in any quantity, either as individual devices or pre-assembled as complete nanocircuits in standard TO-5 cans (up to six diodes per can). For full information on General Instrument microdiode types MD 4, 6, 8 and 10 call the sales office or franchised distributor nearest you.

In addition, the same reliability benefits of true passivation planars are available in General Instrument’s microtransistors. Write today to General Instrument Semiconductor Division, 65 Gouverneur Street, Newark 4, New Jersey.

TYPICAL SPECIFICATIONS @ 25°C

- Max power dissipation: 250 mw
- Reverse Recovery: JAN 256 cathode 100 Kohms in 0.3 sec switching from 5 ma forward current to 40v reverse voltage
- BDV: 100v: continuous working voltage: 80v
- Average rectified current: 75 ma DC
- Minimum forward current: 20 ma DC @ 1v DC
- Reverse current: 80v DC: 0.005 ma, 5 ma @ 150 C
- Storage and operating temperature range: -65 °C to +150 °C

Typical Nanocircuit Assemblies Available in TO-5 Packages...

NC-1: Six Diode Assembly

NC-2: Diode-Transistor Logic Assembly

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION
GENERAL INSTRUMENT CORPORATION
Why should a publication have a booth at WESCON? So that our editors can meet you in person to discuss what you like—or would like to see—in ELECTRONIC DESIGN. So that we can find out about the projects you are working on that would interest many of your 38,500 fellow subscribers.

If you are thinking of writing an article yourself, so much the better. Come in and talk it over. And while you are in the booth, you can pick up a copy of the new tabloid size Electronic Daily ... it's published each day to bring you all the latest news, announcements, and the significance of behind-the-scene developments at the show.

ELECTRONIC DESIGN— Electronic Daily

BOOTH P1—AT WESCON
NEW PRODUCTS

Shock Recorder

Statistical recorder has four channels, each of which can be set from 1 to 25 g. Accuracy is ±5%. Frequency response is 0 to 40 cps min. Temperature range is -65 to +250 F; unit meets MIL-E-5272 specifications. Electrical output is optional. Devices are made to monitor shocks received in shipping.

Inertia Switch, Inc., Dept. ED, 311 W. 43rd St., New York 36, N. Y.
P&A: $75.00 per channel; one week.

Surge Suppressors

Ranges are 2 to 85 amp, maximum discharge current, and 30 to 480 rms v ac. Available in polarized or nonpolarized units, the Voltrap surge suppressors protect silicon and germanium cells, controlled rectifier cells and similar devices. Multiple units are available in a single assembly.

Westinghouse Electric Corp., Dept. ED, P. O. Box 2099, Pittsburgh 30, Pa.

Thermo-Converters

For frequencies to 400 mc, the UF7 series coaxial thermo-converters are for rugged remote monitoring or recording of rf and af voltages and currents. Full-scale voltage ranges are from 0.1 to 101 v.

Altron Electronics Co., Dept. ED, P. O. Box 141, Ridley Park, Pa.
P&A: $155; 15 days.

Right-Angle Connector

For circuit boards. Right-angle plug and receptacle series 6040 is designed for printed circuit applications where a soldered joint is required between board and connector. Contacts match 0.100-in. grid. Closed-entry socket receptacles and die-cast aluminum protective shells are optional.

Precision Connectors Inc., Dept. ED, P. O. Box 96, Mineola, L. I., N. Y.

G-M provides continuous quality control

Your need for a full margin of reliability in servo systems is matched by the continuous quality of G-M Servo Motors and Generators. The extra design experience that goes into every G-M unit is guided through production by test, after test, after qualification test. Sizes range from 5 to 18, with prompt availability that promises quick adaptation to your servo development and production programs.

Qualify G-M Servos for all of your projects, now, in advance of actual need. Send procurement specs and prints, today.

Phone: Pensacola 6-1800 (TWX CG-3264)

G-M Servo Motors
G. M. LABORATORIES INC
4284 N. Knox Avenue • Chicago 41

Other offices in principal cities
CIRCLE 127 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
Hand dispenser for epoxy adhesives and potting compounds, called the Epoxer, provides fingertip control of epoxy flow, with positive cut-off. Unit, pressure-charged, dispenses filled or unfilled materials over a range of viscosities. It can dispense dots, drops, and beads.

Kenics, Corp., Dept. ED, P. O. Box 27, Greenwood Station, Wakefield, Mass.
P&A: $48.00; from stock.

Cryogenic Sensors

Measure to 4 K or —269 C. These miniature cryogenic sensors are germanium semiconductors for use in test and operation of space vehicles using liquid helium and nitrogen, and for use in calibration and standards laboratories. One type measures surface temperatures; the other is for internal applications.


Modular Delay Lines

Delays of 10 to 100 nsec are provided by modular sections, each an encapsulated LC circuit. Lines comprising 6 to 60 modules are available, and may be stacked to provide over 200 sections. Called Wee Lines, the units have 500-ohm impedance and include phase correction for proper pulse response. Taps may be pulled at any increment of delay without distorting pulse shape.

Nytronics, Inc., Dept. W-1, Dept. ED, 500 Springfield Ave., Berkeley Heights, N. J.
Availability: From stock to 8 weeks.
May we have your verdict?

Trade Mark, Sperry Rand Corporation

THE CIRCUIT JUDGE

...and it's up to us to present the facts.

Here's evidence on Sperry's PNP alloy junction silicon transistors:
1. All units are baked at 200°C for 200 hours and each device is doubly tested for a perfect hermetic seal — through a 150°C hot oil check and a separate hydrostatic test at 100 psi.
2. Sixty-three QC checks are performed before and during mechanized manufacture.
3. Our newly-built 65,000 square foot facility in Norwalk, Connecticut incorporates the latest techniques to produce the quality and quantity you require.
4. We offer you a wide variety of PNP types from which to choose. May we have your verdict?
THE CALL OF THE TALOS COMES IN LOUD AND CLEAR through CECO's compact, low noise, telemetering preamplifier

CECO's Model 3010, wide band, telemetering preamplifiers, used aboard the Navy's new CLG-series cruisers, boost air-to-surface signals, minimize noise, reduce output and size requirements of missile transmitters. Used in the AN/UKR-10 telemetering and AN/USQ-11 miss-distance systems manufactured by Aircraft Armaments, Inc., for the Talos, Terrier, and Tartar missiles, the Model 3010 is simple, highly compact and flexible in physical configuration. It is characterized by extremely low noise and stable gain and features new tube types and conservatively rated components for trouble-free operation. CECO specializes in the design and manufacture of amplifiers. For additional information...

WRITE FOR BULLETIN AB

COMMUNITY ENGINEERING CORPORATION
STATE COLLEGE PENNSYLVANIA

CIRCLE 129 ON READER-SERVICE CARD
NEW PRODUCTS

Square-Wave Generator

Adjustable 850 to 1,150 cps. Designed for modulating microwave amplifiers, signal generators, and traveling-wave tube amplifiers, model 305 provides a square wave up to 60 V peak-to-peak. Rise time is 0.4 μsec, with 5 μsec fall. Frequency stability is ±0.2%. Size is 3-3/8 x 6 x 5-3/8 in. Weight is 2-1/2 lb.

Alfred Electronics, Dept. ED, 897 Commercial St., Palo Alto, Calif.

C-Band Transponder

Recovery time is 30 μsec. Beacon transponder model SC-702 operates in the 5.4 to 5.9 Gc range. It can decode 38 different codes. Solid-state modulator gives recovery time of 30 μsec. Output stage uses pulsed triode for reliability; input power is less than 30 w. Transmitter output is 1 kw peak. Weight is 10 lb.

General Dynamics/Electronics, Public Relations Dept., Dept. ED, 100 Carlson Road, Rochester 3, N. Y.

VHF-UHF Power Oscillators

50 mw to 50 w of power are provided by the firm’s model 408 and 410 power oscillators. Frequency ranges are from 200 to 550 mc and 600 to 1,050 mc for the two instruments respectively. Dial resettability is within 0.002%.

You’ll find a whole new world of application in Electronic Measurements Constant Current Power Supplies. Take the husky Model C638A shown here. It’ll deliver up to 1500 V dc at any output current from a few microampere up to 100 ma. There are other features too... a modulation input, programmability, less than 0.015+1 μa ripple... and the all-important voltage control that lets you set the maximum voltage compliance.

For complete information ask for Specification Sheet 3072B.
A meter indicates proper loading. Modulation can be cw, external, pulse, internal square wave (1 kc 100%) or, on special order, am. Stability is ±0.1 db per hour.
Microdot Inc., Dept. ED, 220 Pasadena Ave., South Pasadena, Calif.

Sweep Generator

Model SP-1200 sweep generator has a center frequency range of 5 to 1,200 mc and a sweep width of 5 to 1,200 mc. An automatic gain control circuit continuously samples the swept output to insure a uniform signal level over the entire range. Flatness is within ±0.2 db over a 100 mc width and within ±0.75 db over-all. RF output is over 0.25 v rms into 50 ohms and can be adjusted in steps of 0, 10, 20, 30, 40 or 50 db.
Telonic Industries, Inc., Dept. ED, Beech Grove, Ind.

Coaxial Isolator

L-band coaxial isolator is 6.45 in. long weighs less than 2 lb. Standard units covering 1.0 to 2.0 Gc have a 10:1 isolation/insertion loss ratio, vswr of 1.15 max. Narrow-band models with higher isolation/insertion ratios are also made.
E & M Laboratories, Dept. ED, 15145 Califa St., Van Nuys, Calif.
P&A: $325; 3 weeks.

Tunable Magnetron

Voltage-tunable magnetron ZM-6014 covers the 500 to 1,200 mc range with a power output of 1/2 w. It can sweep the band in 0.01 usec or less; tuning rate is 0.65 mc per v. Tube operates at 2.5 kv max, anode current of 20 ma max, filament current of 3.2 amp max. Weight is 3-1/2 lb.
General Electric Co., Power Tube Dept., Dept. ED, Schenectady 5, N. Y
P&A: $950; 180 days.

Encapsulation with putty-type Alkyd permits need for reliability by resistor maker and customers.

Today's creative engineers design with PLASKON Alkyd in mind for the manufacture of delicate electronic components. Here are reasons why electronic engineers prefer PLASKON putty-type Alkyds as the encapsulation medium:
• Simple to fabricate...molds quickly at extremely low pressures...permits rapid production cycles.
• Clean to handle...nothing to mix.
• Dimensional stability prevents distortion or damage to delicate inserts.
• Coefficient of linear thermal expansion is similar to that of popular wire alloys...reduces strain in service...aids the functioning of encapsulated units.
• Thermal conductivity helps to dissipate heat faster, resulting in less change in resistance value before and after encapsulation.
• Available in colors, for coding.
• More economical than most encapsulating processes.
A Complete
New Line of
Electronic Cooling Fans
JOY Axivane Series 60

Developed by Joy specifically for 60 cycle commercial
duty, the Series 60 vanaxial fans operate at 3400
rpm, 115 volts, single phase, 50/60 cycles and produce
from 50 to 500 cfm at static pressures of $\frac{1}{4}''$ through
1'' wg. They are extremely compact and ruggedly built
of anodized aluminum. There are only four major
parts: rotor, housing, motor, and separately mounted
capacitor. Production quantities are available on order
and small quantities are available off-the-shelf. For
more information write for bulletin 3313-57.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Design CFM ±3%</th>
<th>Max CFM at Free Flow</th>
<th>Design Pressure PS ±7%</th>
<th>Max Pressure</th>
<th>Motor Data</th>
<th>Mechanical Dimensions (Inches)</th>
<th>1/8'' Holes Per Flange</th>
<th>Total Weight Pounds</th>
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<td>1.20</td>
<td>.068ungan</td>
<td>6.62 6.87 7.50 8.12 5.00</td>
<td>1.5</td>
<td>8 8.7</td>
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<td>560</td>
<td>0.75</td>
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<td>6.87 7.12 7.75 8.37 5.00</td>
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<td>625</td>
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<td>1.40</td>
<td>.083ungan</td>
<td>7.12 7.37 8.00 8.62 5.00</td>
<td>1.5</td>
<td>8 9.1</td>
</tr>
</tbody>
</table>

*Rated 230 VAC—
Note: Screen aluminum inlets and aluminum wire inlet bend screens are available to fit all sizes of fans.

NEW PRODUCTS

Coaxial Switches and Attenuators 714
Solid-state devices are made for microwave receiver applications. Series MA-3460 switches operate from 210 to 2,850 mc with a typical switching speed of 4 nsec. Insertion loss is 0.2 db max closed and 20 db min open. Driving power is 10 to 100 mw. Series MA-3441 variable attenuators have the same frequency range and insertion loss characteristics. Bias is $-300 v$ at 10 $\mu$A to $+1 v$ at 10 ma.


Coaxial Attenuators 704
Operate to 5 Ge. Carbon film resistive elements are used in this series of coaxial attenuators. Attenuation accuracy is ±0.1 to ±0.5 db up to 3 Ge; vswr is 1:2 to 1.3:1, de to 5 Ge. Power handled is 1 w for cw, 1 kw peak. Input and output impedance is 50 ohms. Type C connectors are standard, with other types available.

Ad-Yu Electronics Lab., Inc., Dept. ED, 249-259 Terhune Ave., Passaic, N. J.
P&A: 336; 2 weeks.

Traveling-Wave Tube 715
An 8-db over-all noise figure is achieved by a radar using the N1042M traveling-wave tube. Under typical operating conditions, the tube requires a magnetic focusing field of 525 gauss, has a gain of 25 db, noise factor of 6.5 db, and saturated output of 1 mw.

English Electric Valve Co. Ltd., Dept. ED, Chelmsford, England.

Helical Antennas 394
Made for 2-Gc band, helical antennas of the TY-52 and TY-53 series are designed for easy maintenance accessibility. Two-bay models have a 9.4 gain, three-bay 14.1. The antennas withstand wind up to 112 mph, and can be deiced by passing low-voltage, high-current power through the helix.

General Electric Communications Products Dept., Dept. ED, P. O. Box 4197, Lynchburg, Va.
There are many reasons why Brush's newest oscillograph is the ideal choice for today's most advanced telemetry and computer systems. Its precision and reliability are proven. You get analog data instantly recorded on eight 40mm channels... and the sharpest traces on rectilinear coordinates you've ever seen. Thirteen electrically controlled chart speeds take the guesswork out of interpretation. All functions are operated by pushbutton... including an ingenious auto-load chart changing arrangement. But... the most important reason of all is that this vertical panel oscillograph carries the name "Brush". No one is as qualified. See for yourself. Call, write or wire.
SCOTCH® BRAND MAGNETIC INSTRUMENTATION TAPES
OFFER A RIGHT TAPE FOR EVERY APPLICATION

Knowledgeable tape users realize that magnetic tapes are not all alike—that it takes specific constructions to meet the needs of specific applications. And they’ve learned to rely on "SCOTCH" BRAND to supply the one right tape for each application. Not only does "SCOTCH" BRAND offer a complete line, it offers that something extra that makes all the difference in performance—the uniformity and reliability that result from 3M's experience, technical skill, and continuing research. Make the "SCOTCH" BRAND label your guide in buying instrumentation tapes. Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

The wide "SCOTCH" BRAND line provides many tapes, including these broad classifications:

- **SANDWICH TAPES 488 and 489**—exclusive with "SCOTCH" BRAND, offering 30 times the wear of standard tapes, drastic reductions in head wear, elimination of oxide rub-off. In standard or extra-play lengths.
- **HIGH RESOLUTION TAPES 458 and 459**—offering superior resolution in high frequencies, greater pulse density in digital recording. In standard and extra-play lengths.
- **HEAVY DUTY TAPES 498 and 499**—offering exceptional life, good resolution, high resistance to temperature and humidity, reduction in the build-up of static charge. In standard and extra-play lengths.
- **HIGH OUTPUT TAPE 428**—offering top output in low frequencies. Performs well even in temperature extremes.
- **STANDARD TAPES 403 and 408**—offering the good all-round performance at low relative cost which has made them the standards of the instrumentation field.

"Scotch" and the Plaid Design are registered trademarks of 3M Company, St. Paul 6, Minnesota. Export: 99 Park Avenue, New York, N.Y. In Canada: London, Ontario

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CIRCLE 134 ON READER-SERVICE CARD
Fixed Magnetron

Operating at 3.04 to 3.06 Gc, the M561 fixed-frequency magnetron handles 80 kw peak, 80 w avg. Pulse length is 1.0 μsec, prf 1.000 pps. Size is 6.28 x 6.11 x 3.28 in., weight 3-1/4 lb. Peak anode current is 15 amp, peak potential 13 kv.


Hybrid Mixer

The V-8302B hybrid mixer is designed for waveguide coupling in both local oscillator and signal arms. It performs without adjustment over 8.5 to 9.6 Gc frequency range. Maximum vswr in both signal and local oscillator arms is 2.0; isolation is 20 db min. Typical noise figure is 8.5 db; it weighs three oz.


Price $385 fob Palo Alto.

Traveling-Wave Tube

Low noise traveling-wave tube, model 2110A, is periodic permanent magnet focused and of metal-ceramic construction. The tube operates from 2.3 to 4.45 Gc and provides 10 mw output. Gain is 30 db with a 10-db max noise level. Power consumption is less than 3 w; auxiliary cooling is unnecessary. The unit weighs 6 lb and measures 17-1/8 in. long x 2-1/4 in. in diameter.

Microwave Electronics Corp., Dept. ED, 4061 Transport St., Palo Alto, Calif.
P&A: $3,500; 30 days.

Ferrite Material

Microwave ferrite type 1-101 is for use in devices requiring a high phase shift and low insertion loss in the medium power range. In some applications this material may be used down to S-band frequencies. Characteristics are: saturation magnetization, 2,000 gauss; line width, 400; dielectric loss tangent, 0.0005; dielectric constant, 13; cure temperature, 300 C.

This small, 4-pole relay has the happy faculty of maintaining its original operating tolerances over an exceptionally long life. Example: tests (by customers) show this relay has variations in electrical characteristics of less than 5% after more than 100 million operations.

But that's far from all. This is a small relay ... about a one inch cube. This relay is easy to install using the conveniently spaced solder lugs or a socket. Thus you save time and production costs. This relay is versatile ... its 4PDT contacts will switch loads from dry circuit up to 3 amperes. This relay—well, why not order samples and see for yourself! Order today from your P&B representative or call us at Fulton 5-5251, in Princeton, Indiana.

KMP SERIES SPECIFICATIONS

CONTACTS:
Arrangement: 4 Form C, 2 Form Z.
Material: 14g dia. Silver standard. Silver cadmium oxide and gold alloy available.
Ratings: 3 amps @ 30 volts DC or 115 volts AC resistive for 100,000 operations.

COILS:
Resistance: 11,000 ohms max.
Temperature: Operating Ambient: —43°C to +70°C.
Power: 0.5 watts min operate @ 25°C, 0.9 watts nom. @ 25°C, 2.0 watts max. @ 25°C.

TIMING VALUES:
Nominal Voltage @ 25°C. Max. Values
Pull-in time 15 ms
Drop-out time 5 ms

INSULATION RESISTANCE: 1500 megohms min.

DIELECTRIC STRENGTH:
500 Volts RMS 60 cycles between lugs.
1000 Volts RMS 60 cycles between other elements.

MACH. LIFE: In excess of 100 million cycles.

SOCKET: Solder lug or printed circuit terminals. Available as accessory.

TERMINALS: Solder lug and top end tab.

NEW PRODUCTS

Radiation Dosimeter 621

Pen-type dosimeter is worn in pocket. Known as SCRAM (Self-Contained Radiation Monitor), device chirps like a cricket when radiation increases. In normal backgrounds, SCRAM chirps every two minutes. As radiation increases, chirps blend to produce a steady tone. Device runs for about one year on a single mercury cell. It measures 6 in. long and 3/4 in. in diameter.

Radiation Equipment and Accessories Corp., Dept. ED, 665 Merrick Road, Lynbrook, N. Y.

Price: $75.00.

Interlock Switch 617

Thirty-six gang interlock switch cannot be actuated until reset button is pressed, and no two buttons can be actuated simultaneously. Bounce rate is less than 500 μsec. Switches are rated at 3 amp inductance, 5 amp resistance at 115 v ac. Lens has dual lamps. Switch withstands shock test of 50 g. Panel measures 16-1/2 x 4-1/2 x 2-3/4 in. MIL specs are met.

Pepco, Inc., Dept. ED, 2080 Placentia Ave., Costa Mesa, Calif.

Circuit Tester 558

Automatic circuit checker model R1 100 tests 100 circuits for shorts, opens, and reversals. Faults are unambiguously on display panel. Test output is 24 v at 50 ma.

Pearce-Simpson Electronics Div. Dept. ED, 3950 N.W. 28th St., Miami, Fla.

Circle 136 on Reader-Service Card
Circuit Board Retainer 632
Eliminates grooving operations in module construction by becoming a finished slot. Two lanced tabs hold board under a 3-g shock load. Material is beryllium copper. It is 4-1/4 in. long and is made for 3/32 or 1/16 in. boards.
The Birtcher Corp., Industrial Div., Dept. ED, 745 S. Monterey Pass Road, Monterey Park, Calif.

Data System 612
Alarm scanning, telemetering, and recording is performed by the series 7000 data system, which measures, converts, transmits, and records analog values in digital form. System is of modular design. Operation can be manual or automatic, controlled by a digital timing clock. System automatically checks itself. Any number of remote stations can be accommodated.

Multi-Turn Limit 525
Positive mechanical limit stop can be set for any number of shaft revolutions from 1 to 1,500 turns. Operating speed is 1,800 rpm max. Anodized aluminum case measures 1-1/16 x 2-1/4 x 3-1/4 in. Military specifications are met.
Computer Sciences, Inc., Dept. ED, 605 Main St., Westbury, N. Y.

Low-Temperature Cabinet 393
For storing epoxy compounds. Model E-40-2 has a 2-cu-ft capacity and provides temperatures to −50 F. Cabinet measures 32 x 24 x 43 in. and is mounted on casters.
Cincinnati Sub Zero Products, Dept. ED, 39/2 Reading Road.

Only Ampex AR-300/FR-700 systems make all these wideband recording techniques practical and routine

It takes 4 mc response to fully encompass all the above applications. Increasing tape speed past static heads would demand 1,300 ips and record only 3 minutes, using massive 19" reels...but Ampex puts a full hour on standard 10½" reels. by rotating the recording heads at 12,000 rpm transversely across slow-moving tape (12½ and 25 ips) to get the needed relative head-to-tape speed for 4 mc. In so doing, the AR-300 and FR-700 recorders borrow from Ampex’s VIDEOTAPE® Recorders, which use an identical technology to capture TV frequencies.

More bits per hour, another bonus from rotating heads. Rotating heads reconcile two ideals: relative freedom from information dropout, and maximum information recorded per reel of tape. With head-to-tape speed to spare, each bit of information can be permitted to occupy a greater wave length along the track to minimize dropout. At the same time, rotating heads are ideal for recording very narrow, closely-spaced tracks across the tape. This narrow spacing puts 64 tracks into each inch. Up to 5,000,000 bits of PCM data can be recorded per second, or 1.8 x 10⁶ bits on a one-hour reel.

750 similar recorders have written the reliability record. Better than 99% reliability from over 750 VIDEOTAPE Recorders in worldwide use is a matter of record. Sole routine replacements necessary are heads and tapes. On a megacycle-hour basis, life compares favorably with lower performance recording methods.

Radar reconnaissance and tracking
Radar simulation and training
Pre- and post-detection recording
Wideband communications
Infrared recording
NEED CABLE DATA?

Whatever your part in engineering and building electronic equipment, here's the NEW catalog that should be at your fingertips for CABLES! New Catalog No. 4C-61 gives complete charts on Royal RG and special application cables, physical and electrical characteristics, testing procedures, engineering tables (impedance, attenuation, etc.). Valuable information, too, on MIL-spec, signal, control and other multi-conductor cables.

WRITE for your copy — TODAY!
Royal Electric Corporation
301 Saratoga Avenue
Pawtucket, Rhode Island

In Canada: Royal Electric Company (Quebec) Ltd.
Pointe Claire, Quebec

NEW PRODUCTS

Delay Line

Magnetostriective delay line model 20Mol provides a time delay of 60 μsec. Adjustment range is ±3 μsec; input impedance is 550 ohms; output impedance is 2,000 ohms, attenuation is 50 db; signal ratio is 12:1. Uses are in computers, data processing and airborne instruments.

ESC Electronics Corp., Dept. ED 534 Bergen Blvd., Palisades Park, N. J.

Availability: 8 weeks.

Operational Amplifier

Loop gain of 10⁷ is provided by model TR-1 amplifier. The device, all-transistorized, is stable within 10 μv in 24 hr. Output from 0 to 1 kc at 20 ma is ±50 v. For ±25 v output, current is 100 ma. Input impedance is about 1 meg. Output loop impedance is 250 ohms. For a loop gain of 10, output impedance is 0.1 ohm. Unit weighs less than 2 lb.


Telephone-Line Filter

With 100-db attenuation from 14 kc to 10 Gc, Type WFT-3111-1 telephone-line filter permits the use of a telephone inside a shield room. Other applications include use on teletype machines or other data-transmitting lines which enter into interference-free areas.


Slip Ring Assemblies

For −200 to +200 C use, these Teflon-clad slip ring assemblies handle high voltages without arcing damage, even under conditions of extreme humidity. They maintain high resistance between circuits.

Electro-Tec Corp., Dept. ED, 10 Romanelli Ave., S. Hackensack, N. J.

HOW TO SAVE TIME WHEN YOU NEED CORNING COMPONENTS IN A HURRY

Check this list for the Corning Electronic Components distributor located nearest to you...Clip and save.

You can get immediate delivery from him at factory prices on virtually the full line of top-reliability Corning components...tin oxide resistors, from the 6¢ C line through the environment-proof NF type; capacitors, axial leads and wafer types; shock- and vibration-resistant precision trimmers; rugged, high stability inductors and inductor kits, and printed circuit grid boards and grid board kits.

All you need: your distributor’s name, a telephone and a purchase order. Your distributor will do the rest...quickly.

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Radio Specialties & Appliances Corp.
TUCSON
Standard Radio Parts, Inc.

CALIFORNIA
SOUTHERN CALIFORNIA
Federated Purchaser, Inc.
Universal Radio Supply Co.
Western Radio & TV Supply
Newark Electronics Co., Inc.
R. V. Weatherford Co.
NORTHERN CALIFORNIA
Elmar Electronics, Inc.
R. V. Weatherford Co.

COLORADO
DENVER
Interstate Radio & Supply Co.

FLORIDA
MELBOURNE
Electronic Wholesalers, Inc.
MIAMI
Electronic Wholesalers, Inc.

ILLINOIS
CHICAGO
Newark Electronics Corp.

INDIANA
FORT WAYNE
Ft. Wayne Electronic Supply, Inc.

INDIANAPOLIS
Graham Electronics Supply, Inc.

IOWA
CEDAR RAPIDS
Desco, Inc.

LOUISIANA
NEW ORLEANS
Electronic Parts Corp.

MARYLAND
BALTIMORE
Wholesale Radio Parts Co., Inc.

MASSACHUSETTS
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Cramer Electronics, Inc.
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MICHIGAN
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MINNESOTA
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George Smoker, Inc.

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Federated Purchaser, Inc.

NEW MEXICO
ALAMOGORDO
Radio Specialties Co., Inc.

ALBUQUERQUE
Radio Specialties Co., Inc.

NEW YORK
BUFFALO
Radio Equipment Corp.

NEW YORK CITY AREA
Intersate Electronics, Inc.
Midgray Electronics, Inc.
Milo Electronics Corp.
Terminal Hudson Electronics, Inc.

POUGHKEEPSIE
Higgin & Sheer Electron Distributions

ROCHESTER
Quiveroh, Radio Supply Co., Inc.

SYRACUSE
Morris Distributing Co., Inc.

UTICA
Valley Industrial Electronics, Inc.

VIRGINIA
NORFOLK
Priest Electronics, Inc.

WASHINGTON
SEATTLE
Seattle Radio Supply, Inc.

WASHINGTON, D.C.
Electronic Wholesalers, Inc.
Siberne Radio & Electronics Co.

CORNING ELECTRONIC COMPONENTS
CORNING GLASS WORKS, BRADFORD, PA.

CIRCLE 138 ON READER-SERVICE CARD

CIRCLE 139 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
NOW TIN OXIDE RESISTOR RELIABILITY FOR JUST 6¢

Now you have a happy combination you can play two ways. Use our C resistors in place of composition types to boost product performance at virtually the same cost or to maintain the high performance of precision type resistors while cutting costs markedly, saving space.

These C resistors are available in 1/2 and 1 watt sizes. Both are available in ±5% tolerance. They have the inherent stability of a tin oxide conductor fired onto a glass substrate. We add a special solventproof insulation. Current noise level is less than 0.1 microvolt per volt of applied signal.

The C is the ideal resistor for any of your applications which involve radio or television components, instruments, computers, or other communications equipment.

If you're interested in higher wattages, you can get the same basic construction in our low-cost LPI series, which ranges from 3 to 10 watts.

 Typical values of Corning C resistors:

<table>
<thead>
<tr>
<th>Type</th>
<th>Resistance</th>
<th>Wattage</th>
<th>Load Life</th>
<th>Moisture Resistance</th>
<th>Temperature Coefficient</th>
<th>Nominal Dimensions</th>
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<tbody>
<tr>
<td>C-20</td>
<td>51 to 150K</td>
<td>1/2</td>
<td>0.3%</td>
<td>150 ppm/°C</td>
<td>-55°C to +150°C</td>
<td>0.375&quot;x.138&quot;</td>
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<tr>
<td>C-32</td>
<td>51 to 470K</td>
<td>1</td>
<td>0.3%</td>
<td>150 ppm/°C</td>
<td>-55°C to +150°C</td>
<td>0.562&quot;x.200&quot;</td>
</tr>
</tbody>
</table>

You can get off-the-shelf delivery from your local Corning distributor.

For complete specs on both C and LPI types, write to Corning Glass Works, 540 High St., Bradford, Pa.

Vertical Sensing Element

Snap-action, subminiature type 228571-1 vertical sensing element has a tilt angle of 0.75 deg. Differential output is 18 v; maximum current through either contact is 18 ma; range is 75 to 135 min of arc. Design is single-axis.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

Vacuum Furnaces

Cold-wall vacuum furnaces produce temperatures up to 2,500 °C at 10⁻³ mm Hg. Made for materials research, development, and production programs, the ovens have internally heated hot zones which may be either vertical or horizontal, providing from 60 to 2,700 cu in. Heating-element life is practically unlimited. Automatic control is optional.


DC Signal Amplifier

Low-level, dc signal amplifier model MA-100 is for measurements such as temperature or strain in industrial and military applications. Output is 0 to 5 v dc from 0 to 10 mv dc input. Input resistance is 10 ohms ±10%; output load is 1 to 100 k; frequency response is 0 to 2 cps; response time is 100 msec. Dc voltage gain is 500 v ±10%.

Dynex Industries, Inc., Dept. ED, 170 Eileen Way, Syosset, N. Y.

Availability: custom units, less than 8 weeks.

Pressure Transducer

High-line, low-differential pressure transducers, series 4-351, are rated at 5,000 psi with less than 1% range shift, and withstand 8,000 psi. Differential pressure range is ±15 to ±100 psid. Compensated temperature range is -65 to +250 °F. Units measure 2-3/4 in. in diameter and 2-3/8 in. long.

Consolidated Electrodynamics Corp., Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.
AMCO 1000 G'S CERTIFIED SHOCK TESTS

Amco Aluminum and Semi-Custom Modular Frames qualify for Airborne, Shipboard and Ground Support Applications

Certified Independent Tests prove Amco Aluminum and Semi-Custom Frames withstand shock & vibration under Mil E-5272C; Procedure X I (5-300cps), Procedure III (approx. 1000g's shock Mil-S901), Procedure II (10g's and drop Mil-S4456). Write for Test Report Supplement E.

ALUMINUM...Unique! Meets any size... Flush or recessed mounting of panels. Almost any shape from 13 basic parts...3 castings & 10 extrusions. Units from 6' to 20 ft.; slopes from 0° to 90° standard. MilSpecs 6962-T6 extrusions and 536-T6 castings.

SEMI-CUSTOM...Heavy-duty, more internal clearance...14 ga. box-channel steel frames, 12 ga. gusseting provides exceptional rigidity both front-to-back and side-to-side. Frames based on 22½" increments provides clearance for recessing 19" wide panels. Meets EIA Standards.

CUSTOM...When space and appearance are critical...16 ga. double-channel steel frames, based on increments of 19½" widths, supports in excess of 3000 lbs. Multi-width panels and cowlings give single-unit appearance with series mounted racks. Meets EIA Standards.

Amco manufactures all necessary blowers, chassis slides, doors and drawers, writing surfaces, cowling lights and other accessories. Check the extra savings you get thru Amco's combined-discount system of racks and accessories. PLUS FREE ASSEMBLY.

Amco is your one complete source of Modular Instrument Enclosure Systems and Accessories. Write today for catalog of complete specifications.

REALISTIC 3 WEEK DELIVERY

Factory trained representatives in principal cities of U.S. and in Canada.

AMCO ENGINEERING CO.
7333 West Ainslie Street, Chicago 31, Illinois

CIRCLE 141 ON READER-SERVICE CARD
NEW PRODUCTS

Tape Recorder

Continuous-loop recorder/reproducer GL-2510 uses tape lengths up to 75 ft at speeds from 1-7/8 through 60 in. per sec. The self-contained system has 14 analog, fm, or pdm amplifiers, power supply, and ventilating blower unit housed in a single cabinet.

Consolidated Electrodynamics Corp. Dept. ED, 360 Sierra Madre Villa, Pasadena, Calif.

Panel Meter

The 1-1/2 in. model 15LP panel meter, in clear or black acrylic case, conforms to industrial and military mounting standards. Core magnet movement is used. Other meters to 7 in. are available.

Pace Electrical Instruments Co., Dept. ED, 70-31 84th St., Glendale 27, N. Y.

Phenolic Rods

Paper base phenolic rod, Insurok T-308R, has high density, low moisture absorption, good electrical properties and is suitable for high-speed machining. Uses include cam-actuated pins, machine screws and inside-threaded caps. Rod is available in 42-in. lengths with diameters from 0.093 to 0.509 in. Natural tan and black colors are supplied with standard and special finishes.

The Richardson Co., Dept. ED, Melrose Park, III.

Solar Cells

Conversion accuracy is 10% or greater. N-P silicon solar cells type N120CG-10 are designed for use in solar power supplies in space vehicles.


Metal-Film Resistors

Ratings are 1/8 to 2 w, 250 to 750 v, from 25 to 10 meg. Type EE Noble-Met resistors surpass MIL-R-10509C, Characteristic C. All types can be furnished with temperature coefficients of 25, 50 or 100 ppm per deg C. Standard tolerance is ±1%.

American Components, Inc., Dept. ED, 8th Ave. at Harry St., Conshohocken, Pa.

Model F-296 makes full-size photo record of single transients or identical repetitive phenomena.

With these Fairchild-Polaroid Oscilloscope Cameras you can . . .

PERMANENTLY RECORD OSCILLOSCOPE TRACES in 2 to 10 seconds!

No special photographic skills are needed with a Fairchild-Polaroid Oscilloscope Camera. Two models are available. One records single, direct-reading, full-size scope images; the other, two half-size images on one print. Operation of both is fast and simple, hardly interrupts lab procedures. You can evaluate prints as fast as you can pull them from the camera, enter photo evidence into reports at once.

For literature and prices, write to Industrial Products Division, Fairchild Camera and Instrument Corp., 580 Midland Ave., Yonkers, N.Y. Dept. ED-5.

FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
580 MIDLAND AVENUE
YONKERS, NEW YORK

INDUSTRIAL PRODUCTS DIVISION
CIRCLE 142 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
Encapsulated Transformers

For printed-circuit applications, these encapsulated transformers are offered in five sizes of 0.08 to 1.2 cu in. A total of 64 units, all meeting MIL-T-27A Grade 5 Class 5 requirements, offer a wide choice of power levels.

ADC Inc., Dept. ED, 2833-13th Ave. S., Minneapolis 7, Minn.

Price: $5.40 up.

Strain Gage Amplifier

Variable gain device provides excitation voltage to a Wheatstone bridge. Subcarrier oscillator provides 75 mw excitation. Unit has a negative feedback amplifier and a phase-sensitive demodulator. Gain is continuously variable over a range of 20 to 1. Amplifier is a plug-in module measuring 1.725 x 1.875 x 2.75 in.

Natel Engineering Co., Dept. ED, 15922 Strathern St., Van Nuys, Calif.

P&A: $375 to $495; 3 weeks.

Heat Sinks

Natural-convection aluminum coolers, models 10106 and 20107, can be adapted for forced-convection requirements. Made for transistors, diodes, rectifiers, and similar components.

Anderson Machine Inc., Dept. ED, 50 Brook Road, Needham Heights, Mass.

Vertical Sensing Element

Two-axis vertical sensing element type C70 1807 000, for such uses as initial alignment of a gyro platform, has a sensitivity of 20 ±2 mv per min for up to ±10 min. Linearity is within 5% of 3 min of arc sensitivity; output symmetry is within 5% for up to 20 min. Damping ratio is up to 100.

General Precision, Inc. Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

NOW COMMERCIALY AVAILABLE FOR TV AND HIGH-FIDELITY CIRCUITS

Novar, RCA's line of 9-pin all-glass integral-base tubes, provides superior performance at lower cost than those high-dissipation type receiving tubes, regardless of base configuration, which were previously manufactured with octal bases and T9 or T12 envelopes.

Among all-glass integral-base receiving tube designs only novar offers:

Larger internal lead diameter—for strong cage support, and high thermal conductivity for very effective heat dissipation.

Wider spacing between pins (0.172")—to assure freedom from voltage breakdown and, therefore, to provide greater assurance of reliability.

Pin length of 0.335"—to insure firm retention of tube in socket.

Pin-circle diameter of 0.687"—large enough to accommodate both T9 and T12 envelopes.

Revolutionary “Dark Heater”—found only in RCA receiving tubes, is additional assurance of high reliability.

First Commercially Available Novar Types Are:

RCA-6AY3, 12AY3, 17AY3 HALF-WAVE VACUUM RECTIFIERS—These novar types are specifically designed for use as damper diodes in horizontal-deflection circuits of TV receivers. Rated to withstand a maximum peak-inverse plate voltage of 5000 volts, they can supply a maximum peak plate current of 1100 ma and a maximum dc plate current of 175 ma. The heater-cathode insulation withstands negative peak pulses up to 5000 volts with a 900 volts dc component. Low-impedance cathode coating withstands high-voltage pulses encountered in TV damper circuits. New RCA “Dark Heater” assures unusually long tube life and reliability.

RCA-7508 POWER PENTODE—For high-fidelity audio amplifier applications, two of these novar high-perveance power pentodes can deliver up to 44 watts of power output in Class AB push-pull service. Extra base-pin connections for grids #1 and #2 and special radiator on sides of grid #2 assure cooler operation...and, of course, the RCA-7508 has the revolutionary “Dark Heater.”

Sockets are readily available for novar tube types. For additional information on novar types, call your RCA Field Representative or write RCA Electron Tube Division, Commercial Engineering. Section G-18-DE-2, Harrison, N. J.

RCA ELECTRON TUBE DIVISION FIELD OFFICES

EAST: 744 Broad Street, Newark 2, New Jersey, HUmboldt 5-3900; MIDWEST: Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois, WHEATHALL 4-2900; WEST: 6801 E. Washington Boulevard, Los Angeles 22, California, RAYmond 3-8361.

The Most Trusted Name in Electronics
Shell a basket of assorted Duncan potentiometers and you'll find a similarity that's more than skin deep. Designs have been stand-
ardized to yield higher reliability, lower production costs. It's a

garden fresh approach that's paying off at the market place. Check
ever the Duncan crop yourself. They're all in season now! Send

for our new Spring Catalog.

Vine ripening above top to bottom:
1-3/4" Model 3704; 1-3/4" 1602 and
1-7/16" 1502. All feature dialyl
phthalate housing to withstand shock
and protect against fungus or attack
by acids or alkali. Servo or bushing
mountings and operating tempera-
tures to 150° C are available.

DUNCAN ELECTRONICS, INC.
2865 FAIRVIEW ROAD • COSTA MESA, CALIFORNIA
CIRCLE 144 ON READER-SERVICE CARD
NEW PRODUCTS

Thermoelectric Material 410
Gadolinium selenide, a thermoelectric material with a high $Z$ factor, is available in a powdered form for further processing by the customer into rods. Undoped material, as well as n-type and p-type material are available. Semi-Elements Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

Pressure Transducer 409

Provides high continuous output, type 78-C pressure transducer provides an output of 500 mv with 10 v, 60 cps input; over 1 v at 400 cps. It is available in ranges 0-5 to 0-350 psi, gage, absolute or differential. Excitation is 6 to 10 v from 50 to 20,000 cps. Temperature range is from $-115$ to 500 F; OD is 1-1/4-in.

United Aero Products Corp., Dept. ED, Burlington, N. J.

Thermocouple Kit 408
For many applications. Thrift/Therm test kit has a spring-loaded thermocouple for internal surface measurements, a ceramic-beaded unit for multiple surface temperatures, a probe-type unit for liquids and gases, capable of handling 3,500 psi, and an exposed-junction type for fluids, suitable for 3,000 psi.

Harco Laboratories, Inc., Dept. ED, New Haven, Conn.

Ultrasonic Cleaner 405
For small parts, model 100 ultrasonic cleaner can be operated with detergents, mild acids, solvents and alkaline cleaners. It has a capacity of 1-1/4 qt. It is suitable for hard-to-clean intricate assemblies. Other standard models hold up to 14 gallons.

Hermes Sonic Corp., Dept. ED, 13-19 University Place, New York 3, N. Y.

Parametric Amplifier 406
Reliable, low-noise parametric amplifiers are made for use in tropospheric scatter, radio relay, radar and telemetry systems. Unit includes diode mount and klystron pump, power supply and automatic level and frequency control may be included as optional extras.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, N. Y.

How to buy a down payment on a new home for $1.25 a day

Will he ever save the down payment? He'll be in his new home sooner than he thinks, if he saves something every payday. The effortless, automatic way is the Payroll Savings Plan for U.S. Savings Bonds.

Saving for a new home, or anything else in fact, is simply a matter of spending less than you earn. Thousands of Americans have found an automatic way: the Payroll Savings Plan where they work. Through this plan your payroll clerk sets aside a certain amount each payday for U.S. Savings Bonds. As little as $1.25 a day buys a $50 Bond a month (cost $37.50). In 5 years you'll own Bonds worth $2,428.00 —enough for a substantial down payment and closing costs.

Six nice things about U.S. Savings Bonds

- You can save automatically on the Payroll Savings Plan or buy Bonds at any bank • You now earn 3 1/4% to maturity • You invest without risk • Your Bonds are replaced free if lost or stolen • You can get your money with interest anytime you want it • You buy shares in a stronger America.

You save more than money with U.S. Savings Bonds

This advertising is donated by The Advertising Council and this magazine.

ELECTRONIC DESIGN • July 19, 1961
Material-Level Control

Heavy-duty relay rated at 10 amps is an optional feature of the L-400 rotary-paddle material-level control. The unit is mounted on bin, hopper or tank walls by 1-1/4-in. pipe coupling. Control signal is from a circular magnet mounted on the motor shaft. Enclosures can be weather-and-dust tight or explosion-proof.

Flo-Tronic, Inc., Electronics Control Div., Dept. ED, 712 W. Ontario Ave., Minneapolis 3, Minn.

Power Supplies

Photomultiplier power supplies in the PM series have line regulation of ±0.005% and load regulation of 0.002%. Ripple is less than 1 mv rms; stability is 0.01% per hr. Three models have ratings of 300 to 1,000 and 2,500 v dc at 0 to 10 ma, and 1 to 3.5 kv at 0 to 5 ma.

PRL Electronics, Inc., Dept. ED, 242 Westcott Drive, Rahway, N. J.
P&A: $290 to $360; stock to 4 weeks.

High-Voltage Transformers

For high-power uses, a line of 49 models of high-voltage transformers is offered. Single-phase and three-phase rectifier-plate transformers range from 1 to more than 250 kva. Applications include areas such as microwave, broadcast, laboratories and electronic heating.

Electro Engineering Works, Dept. ED, San Leandro, Calif.

Tape Editing System

Automatic magnetic-tape editing system model MT-1 provides an edited composite record of any two telemetry tapes received from the same missile. Final tape can be processed through PAM and PDM commutators without data dropout. Both switched and continuous editing are possible.

Gulton Industries, Ortholog Div., Dept. ED, Princeton Junction, N. J.

Meet Thousands of Application Needs with these Five Basic Switch Types

STANDARD MODELS in a wide range of dimensional and characteristic designs—from the tiny, powerful sub-subminiature type to the large, general-purpose type where size is not important. See each switch series for application suggestions and brief specifications.

VARIATIONS—hundreds available—designed and engineered to meet such specific requirements as:

ACTUATORS—toggle, push-button, leaf, roller leaf, lever, roller lever, etc., available.

Choose the Switch Series that meets your basic application needs. Then tell us the specific characteristics you want. Chances are, we have a standard ready for your use. We are fully equipped to make the switch you need in any quantity.

STANDARD MODELS in a wide range of dimensional and characteristic designs—from the tiny, powerful sub-subminiature type to the large, general-purpose type where size is not important. See each switch series for application suggestions and brief specifications.

VARIATIONS—hundreds available—designed and engineered to meet such specific requirements as:

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Choose the Switch Series that meets your basic application needs. Then tell us the specific characteristics you want. Chances are, we have a standard ready for your use. We are fully equipped to make the switch you need in any quantity.

Perfect for super-sensitive uses...

Ideal for compact, precision control uses...

For rugged, low-cost, easy wiring uses...

For general purpose, high in-rush and repeatability uses...

For more details on these basic precision switch types write for catalog No. 110.
ELtronic 880

World's first all-electronic, digital voltmeter with full-five-digit accuracy!

Consider what you get with the new ELtronic 880. Twenty readings per second. True, absolute 0.01% accuracy. Solid state reliability and coolness. Silent operation. Only the ELtronic 880 can give you these advantages.

Switching is accomplished electronically. There are no moving parts. No contacts to clutter and wear. Hence, no noise. Exclusive “conductance adder” logic tracks varying voltages, permitting exact values to be read instantly.

For operator convenience, measurements are digitally displayed on a unique readout which tilts to three different positions. Measurements can be easily and accurately read whether the 880 is used on a bench, at eye level or high in a rack. Clear, bright, digital indicators have 10,000-hour life, eliminating troublesome bulb changing.

Reliability too, is exceptional. Each component, circuit board and sub-assembly is rigorously “pyramid” tested. Each completed 880 is subjected to a program of accelerated aging, simulating 100 hours of actual use. Questionable components are discovered before delivery, sharply increasing field reliability.

The ELtronic 880 is available now. Its cost is surprisingly low, so why settle for less? Get in touch with your nearest EL field office today.

Another significant breakthrough in digital instrumentation from

Electro Instruments, Inc.

8511 Balboa Avenue, San Diego 11, California

Engineers: Challenging opportunities now available. Contact Mr. Harvey Fleming.

NEW PRODUCTS

Semiconductor Strain Gage

For general-purpose use, Series DB semiconductor strain gages include matched gages for a variety of materials, gages for dynamic measurements. Small gages for limited space and gage factors of -140 to +170. Resistance ranges are 120 to 5,000 ohms.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.
P&K: 890 per pkg; stock.

VHF Triode

A 100-w triode for af and vhf rf applications, the PL-254W operates at 4,000 v max plate potential. Filament requires 5.0 v at 7.5 amp. The tube is suitable for class C cw or fm uses.

Penta Laboratories, Inc., Dept. ED, 312 N. Nopal St., Santa Barbara, Calif.

Lightweight Reflectors

Accuracy is 1 min of arc for surface deviation. These all-metal, lightweight reflectors are furnished with diameters of less than 1 in. to over 5 ft and weigh from 0.4 to 1.5 lb per sq ft. Aperture ratio is from f/8 to f/0.4.


Navigational Counters

Slew speeds to 1,800 rpm can be furnished. These navigational counters include digital counters, bevel-gear driven units, geared high-speed latitude and longitude counters and miniature counters. Units can be designed to meet customer requirements.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N. J.

CIRCLE 148 ON READER-SERVICE CARD
Data Commutator 631

Four-channel data commutator type DC-11 has an input-output speed of 480,000 characters per sec. The unit is designed for use with the firm's G-20 computer. Sorting operations are sufficiently fast for 100,000 records of 80 alpha-numeric characters to be sorted in less than 18 min.
The Bendix Corp., Computer Div., Dept. ED.

Disk Brakes 619

Floor-mounted, through-shaft disk brake has its own ball-bearing mounted shaft. Designated series 55,200, he devices are applicable where it is necessary to drive through the brake. Brakes are ac-operated and have torques of 1-1/2, 3, 6, 9, and 15 lb-ft.
Stearns Electric Corp., Dept. ED, 120 N. Broadway, Milwaukee, Wis.

Universal Recorder 633

Has 23 ranges, extending from 30 ma to 15 amp ac and dc and from 30 to 600 v ac and dc. Other features of model 802 universal recorder include permanent magnet moving-coil movement, three-speed transmission, synchronous 60-cps chart drive and inkless or ink recording. It measures 13-3/4 x 11-3/4 x 11 in. and is portable.
Curtiss Wright Corp., Princeton Div., Dept. ED, Princeton, N. J.

Radio Receiver 697

For am, cw or ssb. Model NC-190 radio receiver has an hf ferrite filter for sensitivity of adjacent channels. Three positions are provided: 600-cps for single-signal cw reception, 3-ke for single sideband and am reception and 5-ke for clear channel speech and music reception.
P&A: $199.50; immediate.

CIRCLE 147 ON READER-SERVICE CARD

Crimp-type Connectors

These solderless, coaxial connectors are available in a variety of mounting configurations, including snap-locking versions. Male and female connectors may be mounted interchangeably. Mated length is 1 1/2". Working voltages: 1,000 V. maximum, at sea level; 500 V. maximum, at 60,000 feet. VSWR, less than 1.2 up to 2,000 mc.
Life: 5,000 matings, minimum, without electrical deterioration. Tensile strengths of the crimps exceed the breaking strength of the cable. Hard gold plated Beryllium copper and TFE plastic are extensively used to assure optimum reliability.
Microdot, Inc., 220 Pasadena Ave., South Pasadena, California
CIRCLE 247 ON READER-SERVICE CARD

Coaxial Switch

SPDT miniaturized switch features a case volume of 1/8 cu. in. and weight of 1/2 oz. Design allows direct insertion into miniaturized circuit without cumbersome adapters. Toggle action is positive. \(\text{rf}\) characteristics are highly efficient. VSWR is less than 1.25 to 2.0 kmc. Insertion loss is 0.8 db at 2.0 kmc.
Contact rating is 3/4 amp at 150 V. resistive. Operating is 50,000 operations, minimum. Special stripline manufacturing technique provides low loss, wide frequency band properties.
Microdot, Inc., 220 Pasadena Ave., South Pasadena, California
Microdot's Cable Facilities specialize in precise metallic braiding of microminiature coaxial cables. In a new, ultra-modern plant, special advanced techniques of cylindrical weaving are combined with the utilization of highest quality materials and rigid quality control methods, to produce a wide range of miniaturized RF frequency cables...cables designed and produced to yield the same matched impedance as required for larger cables.

"Mini-Noise" cable, a result of Microdot research, is specially processed to minimize self-generated noise—prevents noise interference with low strength signals. These cables also offer high performance in extreme temperature ranges.

Twinax cable produced by Microdot is a shielded, twisted pair of conductors utilizing prime dielectrics for low loss, featuring controlled capacitance and impedance. Shield is added after insulation and conductors are arranged in a balanced to ground configuration.

Triax cable by Microdot offers rf leakage below the level experienced with Double Shielded Coax. Three active conductors permit feedback to cancel a known noise source. Capacitance-cancelling hook-ups are possible for cathode followers.

Use reader service card in this publication, or write today for 4-page folder of performance charts, design characteristics, and specifications on the following cables: Coax 50, 70, 75, 93, 95 ohm, Twinax 125 and 160 ohm, Triax 50 and 93 ohm.
PRODUCTION PRODUCTS

Welding Machine

Pincer and vertical heads are interchangeable. The pincer head has a pressure range of 0.5 to 5 lb; the vertical head, 0.5 to 8 lb. Throat depths are 9 and 7 in. This welding machine requires no adjustment of electrodes, heads or power settings. Power supply is regulated to ±0.05 w-sec or ±2%

Sippican Corp., Dept. ED, Marion, Mass.
Price: $950

Eyeleting Machine

Is fully automatic. Eyeleting machine automatically feeds, sets and resistance fuses eyelets as small as 0.020 in. inside diameter to boards as thin as 1/64 in. Through connections conform to Military Standard 275A. Mechanical dwell time and heat cycle are variable up to 1 sec.

Edward Segal, Dept. ED, 132 Lafayette St., New York 13, N. Y.

Transistor Marker

Speed is 3,000 units per hr max. Model U1038 marker prints trademarks, date codes, part numbers and other data on tops and sides of JETEC transistors. Offset printing heads compensate for dimensional differences. Components are automatically fed to the printing positions and ejected into a gravity chute.

Markem Machine Co., Dept. ED, 172 Congress St., Kenne, N. H.

Microcircuit Machine

Prototype or production microcircuits up to 1.25 in. sq can be made with model 410 microcircuit machine. Tools and parts are mounted in positioners accurate to a few millionths of an inch. Microscope is mounted on a joystick X-Y positioner with 1.25-in. travel. Indexing tool mounts hold 8 tools; a complete assortment of tools is available. The machine is suitable for research and high-speed production.

FOR THE ELECTRONIC ENGINEER
FREE-$2,800.00
EXTRA IN 1961

It's true. This is the average increase in salary of the Electronics Men placed through Cadillac in 1961.

The nation's largest placement service, Cadillac is employed by 320 of the nation's leading electronic firms—from coast-to-coast. Our service is completely confidential and available to you absolutely free of charge. In all probability, at least 3 dozen of our clients are looking right now for a man of your background.

FREE-Opportunities Bulletin
Find out the top positions in electronics every month. Send us your name and home address direct or circle Reader Service Card No. 888

LON D. BARTON
President
CADILLAC ASSOCIATES, INC.
29 East Madison Bldg.
Chicago 2, Illinois
Financial 6-9400

CIRCLE 888 ON READER-SERVICE CARD

Dust-Free Cabinet
Distortionless plexiglass provides unobstructed view over 34 x 28 x 16 in. work area inside this molded dust-free cabinet. Filter system removes 99.97% of all particles of 0.3 micron size, and all larger particles. Optional under-the-hood equipment is available.

Gerwen Electronics, Inc., Accessory Dept., Dept. ED, 7-22 149th St., Whitestone 57, N. Y.
P&A: $300; 30 days.

Wafer Sorter
Automatically gaging germanium or silicon pellets, the TSK Auto-Sorter has consistent repetitive accuracy to within 0.00040 in. The machine will gage and sort 2,400 pellets per hour into any one of 10 categories. A variety of automatic controls is included as standard equipment.

D. M. Gaskill & Associates, Inc., Dept. ED, 342 Buclong Road, Cranston 10, R. I.

Solderless Terminal Tool
Cuts, strips and crimps. Type 9900 solderless-terminal tool cuts solid or stranded wire and accommodates AWG sizes 22 through 10. It is made of spring steel and has a ground cutting edge. A sliding set screw is provided on one handle.

R. N. Hunter Sales Co., Dept. ED. 9851 Alburtus Ave., Santa Fe Springs, Calif.
Price: $2.50.

Cutting Machine
For shielded cable. Having semi-automatic operation, this cutting machine provides rates of 600 to 1,200 per hr for most cables. Stripping length can be adjusted from 1/2 to 1-1/2 in. As the machine cuts, it fuses together the ends of the shielding.

Ewald Instruments, Dept. ED. Box 124, Kent, Conn.
P&A: $1,000 to $1,500; 4 to 6 weeks.
Reliability...
locked in and guaranteed

Working on the problems plaguing electronic systems design, CAMBION® engineers developed a new device to keep coils and coil forms in proper adjustment.

This exclusive development is the CAMBION Internal PERMA-TORQ, a miniaturized, constant tensioning unit located completely within the CAMBION ceramic coil form. Allowing tuning cores to be locked while still tunable, it considerably reduces harmonics, provides increased stability and decreases oscillation in high gain IF strips. Reliability under all conditions keynotes the performance.

New Internal PERMA-TORQ is available in coil forms with the normal yellow, red, green and white slugs — (range: 0.2-300 MC) and with purple slugs (range: 2-40 MC) and blue slugs (range: 40-300 MC). Mechanically, PERMA-TORQ is very easy to adjust. Only a special tuning tool is needed.

CAMBION makes more than 1500 coil forms with varying collar-and-terminal arrangements — including ceramic, phenolic and shielded forms for conventional and printed circuits. All are guaranteed to meet your specifications.

The broad CAMBION line includes plugs and jacks, solder terminals, insulated terminals, terminal boards, capacitors, shielded coils, coil forms, panel hardware, digital computer components. For a catalog, for design assistance or for both, write to Cambridge Thermionic Corporation, 457 Concord Ave., Cambridge 38, Massachusetts. In Europe contact Maitland Engineering, Ltd., 50 Heaton Moor Rd., Stockport, England, or Uni-Office, N.V., P.O. Box 1122 Rotterdam, The Netherlands.
PRODUCTION PRODUCTS

Hard Water Stills

Electric and steam heated, the Hy-Thermo stills produce high ionic-pure water that is free of organic and bacteria impurities. Capacities are from 1/2 to 10 gallons per hr; heating elements are side mounted.


Inspection System

Length and diameter of parts are gauged by automatic inspection machine. Up to 1,200 parts per hr are checked and sorted into acceptable and reject categories. Machine can be quickly adjusted for various part sizes.

Radio Corp. of America, Dept. ED, 12605 Arnold Ave., Detroit 39, Mich.

Drawer Oven

A five-drawer oven with mechanical convection and horizontal airflow is said to increase production and reduce cost per part. Temperature ranges are 100°F to 356°F and 600°F. Drawer size is 18-1/2 x 20 x 5 in.

Blue M Electric Co., Dept. ED, 138th & Chatham St., Blue Island, Ill.

Clean-Room Uniforms

For special environments, uniforms can be furnished for protection against contamination in white rooms or for use in Class II, III and IV clean rooms. Gloves for liquid oxygen applications are also available.

Angelica Uniform Co., Dept. ED, 1429 Olive St., St. Louis 3, Mo.

Sleeve Cutting Machine

Operation is automatic. Up to 200,000 lengths of 1/4 and up to 50,000 lengths of 1 in. are produced per hour. The Richmond sleeve cutting machine cuts paper, plastics, nylon, rub-

IDEAL FOR CRITICAL LABORATORY VACUUM BAKE NEEDS

TEMPCOR COMPACT TABLE MODEL VAC-U-HERM OVENS

Electronics, food, drug, chemical and steel laboratories find this table model VAC-U-HERM OVEN ideal when accelerated drying operations are required for rapidly drawing off moisture in test samples. Prevents decomposition through oxidation and throws off inflammable gases and explosive vapors. Table top design and portability features allow for use of storage space beneath unit and controls and working chamber at convenient height.

Bakes materials in temperatures up to 250°C at 1x10⁵ MM hg.

Hydraulic type thermostat.

Compound vacuum gauge.

Aluminum sheathed nickellchromium alloy heaters operate with consistency at black heat.

Stainless steel shelves with prepositioned tracks.

Stainless steel meshed glass viewing window.

MODEL 1425 (shown) . . . 8" x 8" x 9" . . . $190.00 F.O.B. Riverton, N.J.

Other models . . . table or flange types . . . aluminum or stainless steel . . . sizes to 13" x 14" x 18" . . . prices to $2970.00.

Write for complete technical information

CIRCLE 155 ON READER-SERVICE CARD

ENGINEERING CORPORATION

300 Tempcor Boulevard,
Riverton, N. J.
ber, fiber glass, tinned copper wire and other materials.

Martin Engineering Co., Dept. ED, 40 Woodbine Lane, Holyoke, Mass.

Wire Bonder

Thermocompression wire bonder model 401C, for microcircuit construction, provides a vacuum pickup needle for handling components. A supply tray for components is mounted on a swinging arm. Extra-force bonding hammer and flat-top heat column are standard. The machine handles circuits up to 1 in. square.


Orienting Table

An orienting table for semiconductor crystal slicing is accurate to 1 min of arc. It can be installed on machines now in operation or supplied as optional equipment on new machines. The fully automatic slicing machines produce wafers with thickness from 0.025 to 0.005 in. An automatic back-off mechanism minimizes surface imperfections.


Fluxing Machine

Solders printed circuit boards. The FWL automatic fluxing machine pumps flux through an elongated nozzle so that the liquid forms a continuous, double-sided, standing, laminar wave. The wave is 1/4 to 3/4 in. high, controlled to ±1/32 in. high, for resin-based or water-soluble flux.

Electrovert, Inc., Dept. ED, 124 E. 40th St., New York 16, N. Y.

Wire Stripper

Capacity is 32 through 50 AWG. Model WR-6 has two abrasive wheels to remove the wire coating without damage to the conductor. Wheels of various densities are available. Motor requirements are 1,725 rpm, 115 v, single-phase, 60 cps.

High Speed Hammer Co., Dept. ED, 313 Norton St., Rochester 21, N. Y.
NEW Time Delay Relays

INSTANTANEOUS RESET...
VOLTAGE-TEMPERATURE COMPENSATED

Designed with an instantaneous reset feature, these relays provide the same time delay for a series of cycles when temperature and voltage vary.

They are pre-set from 3 to 180 seconds, are chatter-free and will withstand severe shock and vibration. Because of this unique combination of features, these relays are now being used in such new circuit applications as:

- Sequential timing for missiles
- Automatic reset on digital readout equipment
- Oscillator stabilization
- Overload protection
- Computer sequencing

"DM" SERIES STEPPING MOTORS

Curtiss-Wright Stepping Motors convert digital pulses into mechanical work or motion. Units are bi-directional with high starting torque.

Write for complete Components Catalog 260 to help you select Curtiss-Wright electronic components for use where dependability is of prime importance.

COMPONENTS DEPARTMENT • ELECTRONICS DIVISION
CURTISS WRIGHT CORPORATION • EAST PATerson, N. J.

CIRCLE 157 ON READER-SERVICE CARD
Helitrimg® 1/2" square trimming pots give you...

**UNIQUE SLIP CLUTCH STOP • SEALED ALL-METAL HOUSING**

as standard features!

Where small size and high operating temperature are important considerations, choose between two 1/2" square Helitrimg trimming potentiometers. The Model 70 has Teflon leads. The Model 71 has gold-plated pins. Both are precision-built by Helipot to give you special features as standard!

These Helitrimg extras include a slip clutch stop that prevents open circuits - positively keeps the wiper from going off the end of the coil and into dead space. And sealed all-metal housings that provide humidity-resistant operation under the most severe environmental conditions.

Just as important is ease and accuracy of adjustment. There's no guesswork with Helitrimg potentiometers - the adjustment screw makes 42 complete turns. This gives extra meaning to the pot's outstanding resolution - as fine as 0.083% in the upper resistance values.

Performance? Take a look at these specs. You'll see why top performance, too, is standard with Helipot.

**STANDARD SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance range, ohms</td>
<td>10 to 50,000</td>
</tr>
<tr>
<td>Resistance tolerance</td>
<td>±5%</td>
</tr>
<tr>
<td>Resolution in percent</td>
<td>1.01 to 0.083 (depending upon total resistance)</td>
</tr>
<tr>
<td>Adjustment screw rotation</td>
<td>42 turns, ±1 turn</td>
</tr>
<tr>
<td>Power rating, watts</td>
<td>1 at 50°C</td>
</tr>
<tr>
<td>Torque, max. oz. in.</td>
<td>10</td>
</tr>
<tr>
<td>Life expectancy, adjusting screw revolutions</td>
<td>10,000</td>
</tr>
<tr>
<td>Temperature range</td>
<td>-55°C to +150°C</td>
</tr>
</tbody>
</table>

Price? Helitrimg pots are competitively priced at $5.35 for the Model 70 and $5.95 for the Model 71. Considerably less in quantity!

Availability? Your nearest Helipot representative has both models in stock - ready for immediate delivery. Call him today.

Beckman INSTRUMENTS, INC.
HELIPOT DIVISION
Fullerton, California

CIRCLE 158 ON READER-SERVICE CARD
NEW LITERATURE

General Equipment 278
Catalog No. 161, 240 pages, describes electric ovens, furnaces, baths, environmental cabinets, related temperature control equipment and accessories for laboratory, pilot plant and production applications. Supplementary scientific data in charts and tables is included. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

Power Supplies 279
Transistorized power supplies are described in this 12-page catalog, No. 61A. Wide-range, high-current supplies, ac-dc modular supplies, general purpose supplies, and high-current, switching type power supplies are included. Consolidated Avionics Corp., 800 Shames Drive, Westbury, N. Y.

Reliability Nomograph 280
Designed for application to semiconductors, this nomograph allows computation of the acceptance number for any given sampling plan. Success rate can be predicted from life test data either at a 90 per cent confidence level or for individual risks. Instructions are included. Raytheon Co., Semiconductor Div., 215 First Ave., Needham, Mass.

Silicon Rectifiers 281
Six-page short form data folder gives electrical and physical characteristics of the firm's JEDEC-type silicon rectifiers. Over 600 types are included. Bradley Semiconductor Corp., 275 Welton St., New Haven, Conn.

Miniature Bearings 282
A line of miniature bearings is described in Catalog 3E. Radial, roller, pivot, and special bearings are covered. Dimensional data, photographs, and full-sized drawings are included. Installation information is given. Landis and Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

Fans and Blowers 283
A line of fans and blowers for ventilating electronic equipment is described and illustrated in this 48-page catalog. Mechanical and electrical characteristics, performance curves and engineering drawings are included. Solid state and vacuum tube cooling are considered in a special section. McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J.

Numerical Control 284
Entitled "Numerical Control, as applied to the complete integration of product testing with a manufacturing business", this nine-page brochure discusses numerical control in testing procedures. The paper finds that the benefits of numerical control extend beyond the actual testing procedures. Designers for Industry, Inc., 421 Fulton Parkway, Cleveland 9, Ohio.

Universal Timing Set 285
Applications of digital time signals to coordinate remote equipment in complex instrumentation and data-processing systems are described in this 18-page, spiral-bound brochure. The Hallicrafters Co., 4401 W. Fifth Ave., Chicago 24, Ill.

Electronics Catalog 286
Electronic equipment, components, radio and TV supplies of over 115 manufacturers are listed in a 268-page catalog. It is cross indexed and includes an industrial tube cross reference. Wedemeyer Electronic Supply Co., Dept. ED, Ann Arbor, Mich.

Electron Tubes 287
Condensed 16-page catalog provides quick reference specifications and photos describing the firm's line of microwave tubes, display devices, and operational accessories. Litton Industries, 960 Industrial Road, San Carlos, Calif.
Magnetic Shields 288
Curves and tables to aid in the selection of magnetic shields are given in this 16-page booklet. Nicoloi and Mu-Metal shields for electron tube applications are discussed. The firm’s shields and shaft hardware are cataloged. James Millen Manufacturing Co., Inc., 150 Exchange St., Malden 48, Mass.

Transistor Circuitry
Entitled “Transistor Guide for Communications Circuit Designers”, this guide surveys the basic rules pertaining to transistorized communications circuits. Practical information, circuit diagrams, curves and equations which aid in design of circuitry for audio, video, and rf equipment are presented. Write on company letterhead to: Philco Corp., Dept. ED, Church Road, Lansdale, Pa.

Transformer Catalog 289
Electrical and physical specifications are given for almost 900 industrial transformers in a 36-page catalog. It is cross-indexed and includes units for military and commercial applications. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill.

Precision Switches 290
Catalog 104 describes precision switches for various applications. It has photographs and condensed descriptions of over 200 items including miniature switches, limit switches, proximity switches and electronic switch-circuit assemblies. Micro Switch, Div. of Minneapolis-Honeywell, Freeport, Ill.

Glass History 291
“This Is Glass,” 68 pages, gives the history of glass and details the basic types of glass. It includes glass-ceramic materials and a two-page chart giving properties of selected glasses and glass-ceramics. Corning Glass Works, Public Relations Dept., Corning, N.Y.

Electronics Catalog 292
Product data for electronic parts, equipment and accessories are given in a 236-page catalog. Radio, TV, audio, amateur radio and industrial components of 115 manufacturers are listed. Tydings Co., Electronics supplies, 933 Liberty Ave., Pittsburgh 22, Pa.

Electronic Components 293
Catalog No. 105, 204 pages, lists the products of approximately 100 component manufacturers. Test equipment, high fidelity and recording equipment, intercom systems, hand tools and hardware are also included. Star Electronic Distributors, 7736 S. Halsted St., Chicago 20, Ill.

Piezoelectric Devices 294
Applications of piezoelectric devices are discussed in this 16-page illustrated booklet. Performance characteristics of major piezoelectric substances are outlined and compared. Clevite Electronic Components, Bedford, Ohio.

Aircraft System 295
Bulletin GER-1704, 16 pages, describes GE’s integrated ac electrical system aboard the F4H Mach II all-weather aircraft. It includes a discussion of the system components, schematic diagrams, technical drawings and photographs of the equipment. General Electric Co., Schenectady 5, N.Y.

Welding Techniques
“Fabrication of Welded Motor Rocket Cases” is described in this 72-page booklet. Illustrations, tables and diagrams are given. Areas covered are materials, design, welding and quality assurance. Chemical compositions of the ultra high strength steels are given along with their mechanical properties, heat treatment and fracture toughness data. Send $2.50 to American Welding Society, Dept. ED, 33 W. 39th St., New York 18, N. Y.
KEARFOTT NAVIGATIONAL COUNTERS

Direct visual counter display provides the advantage of enabling lower valued increments of various angles to be easily read in terms of minutes and seconds of arc by means of relatively large size numerals. This advantage is achieved without the necessity of having vernier dials or similar devices. These counters are precision designed and their rugged construction assures a long life of trouble free service. B422 units are provided with either odometer or Geneva drives, while MK II units use Geneva drives. Gears, wheels, housings, and mounting flanges are constructed of durable materials, and Kearfott design techniques provide maximum readability in a relatively small amount of space. Kearfott counters operate reliably throughout a temperature range of -65°C to +90°C and meet the military requirements for shock, vibration, and case size.

FEATURES:
- Long Operational Life
- Compact Design
- High Speed
- Lightweight

CHARACTERISTICS:
All Counters Below Incorporate Geneva Drive

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PART NUMBER</th>
<th>NO. OF DIGITS</th>
<th>MAXIMUM COUNT</th>
<th>COUNTS PER REV.</th>
<th>MAXIMUM SPEED RPM</th>
<th>MAXIMUM BREAK AWAY TORQUE (°)</th>
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</thead>
<tbody>
<tr>
<td>B422 SERIES:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANGLE (center scale)</td>
<td>B422-Q</td>
<td>5</td>
<td>179° 59'</td>
<td>20°</td>
<td>1200</td>
<td>.75</td>
</tr>
<tr>
<td></td>
<td>C16/0432-Q</td>
<td>5</td>
<td>179° 59'</td>
<td>20°</td>
<td>1200</td>
<td>.75</td>
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<tr>
<td></td>
<td>C16/0431-Q</td>
<td>6</td>
<td>179° 59.9°</td>
<td>2°</td>
<td>1200</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>C16/0435-Q</td>
<td>4</td>
<td>179.9°</td>
<td>2°</td>
<td>1200</td>
<td>.75</td>
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<tr>
<td>DECIMAL (center scale)</td>
<td>C16/0433-Q</td>
<td>3</td>
<td>99.9</td>
<td>2.0</td>
<td>1200</td>
<td>.75</td>
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<tr>
<td></td>
<td>C16/0434-Q</td>
<td>4</td>
<td>999.9</td>
<td>2.0</td>
<td>1200</td>
<td>.75</td>
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<tr>
<td>MK II</td>
<td>MK 2 MOD 1</td>
<td>4</td>
<td>359.9</td>
<td>2.0°</td>
<td>1800</td>
<td>.35</td>
</tr>
<tr>
<td>Mod 1</td>
<td>MK 3 MOD 1</td>
<td>3</td>
<td>359.9</td>
<td>2.0°</td>
<td>1800</td>
<td>.35</td>
</tr>
<tr>
<td>SERIES:</td>
<td>C16/04070045</td>
<td>4</td>
<td>359.9</td>
<td>2.0°</td>
<td>1800</td>
<td>.35</td>
</tr>
<tr>
<td></td>
<td>A403-20B</td>
<td>4</td>
<td>359.9</td>
<td>2.0°</td>
<td>1800</td>
<td>.35</td>
</tr>
<tr>
<td></td>
<td>A403-20B</td>
<td>4</td>
<td>359.9</td>
<td>2.0°</td>
<td>1800</td>
<td>.35</td>
</tr>
</tbody>
</table>

1 Available in left or right Shaft, End or Side Mount, Mask readout of N-S, E-W, (+), (-)
2 Same as C16/0432-Q except .040 shorter length (C16/0432 preferred for new designs)
3 Available in various shaft extensions and white or bare aluminum numerals

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION. INC.

Little Falls, New Jersey

CIRCLE 159 ON READER-SERVICE CARD
WIDER
RANGE WITH GREATER ACCURACY!

This Vought Electronics Servo Analyzer is an all-electronic instrument covering the dynamic range of most servo systems without the troublesome maintenance requirements of mechanical multipliers.

Modulation rates of .005 to 1000 cps in five ranges are provided in sinusoidal, step, and ramp functions either directly or in suppressed carrier form. Modulation frequency accuracy readings of 2% are possible.

Other important unit specifications are:

- carrier frequency range of 50 to 10,000 cps
- carrier phase shift of less than 2° to 5 kc
- signal attenuation of 0 to 99 db in 0.1 db steps
- phase measurement accuracy of 2°

Use of Vought Electronics Servo Analyzer has been demonstrated successfully with Titan and Minuteman missiles as well as in industrial laboratory applications. It is available in both bench and rack mounted models.

For more complete information about this versatile instrument, contact:

Chief of Product Sales  
Chance Vought Electronics Division  
P. O. Box 1500, Arlington, Texas

CHANCE VOUGHT ELECTRONICS

CHANCE VUGHT ELECTRONICS

ANTENNAS • AUTOMATIC CONTROLS • NAVIGATIONAL ELECTRONICS • GROUND SUPPORT ELECTRONICS

CIRCLE 160 ON READER-SERVICE CARD
NEW LITERATURE

Insulation Products 296
Catalog A-61 covers laminated plastics, printed circuit boards, flexible insulation, molded plastics, vulcanized fibre and mica products. Capabilities for advanced military and industrial applications are listed. A product materials directory for critical electrical insulation and mechanical applications is also included. Continental-Diamond Fibre Corp., Subsidiary of the Budd Co., Newark, Del.

Spring Design 297
A 16-page manual summarizes basic information concerning helical springs, flat springs, wire forms, special fasteners, precision metal stampings and assembled spring-like devices. Mechanical properties and recommended uses of commonly used spring materials are presented in tabular form. Associated Spring Corp., Bristol, Conn.

Business Automation 298
Operations of the engineering documents section of the United States Army Rocket and Guided Missile Agency are described in an eight-page pamphlet. The instant mechanical retrieval of engineering drawings from a file of over two million drawings, 850,000 of which are active, is outlined. Minnesota Mining and Manufacturing Co., 900 Bush Ave., St. Paul 6, Minn.

Test Instruments 299
Information on spectrum analyzers, frequency response plotters, communications systems analyzers and telemetry test instruments is included in Catalog Digest E. Frequency range of the instruments is 1/2 cps through 44 kmc. Block diagrams illustrate applications. Panoramic Radio Products, Inc., 520 S. Fulton Ave., Mt. Vernon, N. Y.

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Systems and Instruments 300
Programable systems for data handling, component testing, automatic measurement and control applications are described in a 16-page catalog. Special purpose test and measurement equipments are also described in the catalog. Specifications and prices are given for each item. Dymec Div. of Hewlett-Packard, 395 Page Mill Road, Palo Alto, Calif.

Digital Modules 301
Series 300 transistorized digital system modules are covered in a 16-page catalog. It describes the system functions which are packaged on each gold plated module. Block diagrams, logical design considerations and input-output specifications are included. All data necessary for the design of a digital system are provided. Navigation Computer Corp., Valley Forge Industrial Park, Norristown, Pa.

Safety Starters 302
Bulletin GEA-7321, four pages, describes combination safety magnetic motor starters that offer protection against unauthorized entry and personnel injuries. Photographs illustrate safety devices and how to perform inspection or maintenance with or without power interruption. Pricing information is also included. General Electric Co., Schenectady 5, N. Y.

Resin System Pumps 303
A 10-page booklet illustrates and gives complete specifications for 20 basic models of the Tripematic pump and the available variations of each model. These pumps are designed for multi-component resin systems. Also included is an outline of the technical services available from the company and a series of questions and answers about resin system technology. H. V. Hardman Co., Inc., 571 Cortlandt St., Belleville, N. J.
HIGH-ACCURACY, WINDING COMPENSATED RESOLVERS

Kearfott precision resolvers are high accuracy units particularly applicable to analog computers and automatic control systems. The resolvers are capable of holding the angular arc error to accuracies within 20 seconds from electrical zero. A compensator winding provides feedback voltage for a resolver isolation amplifier. Unity gain from the amplifier input to resolver rotor output is made possible by adjustment of a resistor. Since compensator and rotor winding voltages vary with temperature and frequency in a parallel manner, the feedback loop is automatically adjusted to compensate for these variations.

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>R980-41D</th>
<th>T980-003</th>
<th>CZ05180202</th>
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</thead>
<tbody>
<tr>
<td>Size</td>
<td>11</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Accuracy (Max Error from E.Z.)</td>
<td>5 minutes</td>
<td>5 minutes</td>
<td>20 seconds</td>
</tr>
<tr>
<td>Function Error</td>
<td>.1% max</td>
<td>.05% max</td>
<td>.01% max</td>
</tr>
<tr>
<td>Excitation (400 cps)</td>
<td>60 volts</td>
<td>60 volts</td>
<td>115 volts</td>
</tr>
<tr>
<td>Transformation Ratio (Rotor to Stator)</td>
<td>980±.020</td>
<td>980±.010</td>
<td>980±.2%</td>
</tr>
<tr>
<td>Phase Shift</td>
<td>7.5 lead</td>
<td>8.5 lead</td>
<td>2.5±1 min</td>
</tr>
</tbody>
</table>

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.
Little Falls, New Jersey

CIRCLE 163 ON READER-SERVICE CARD
how to measure ac ratios to one part per million... at a sensible price

In fact, any of North Atlantic's field engineering representatives can quickly demonstrate how the Models RB-503 and -504 Ratio Boxes will meet all your requirements for high accuracy at lowest cost.

Designed for either bench or rack mounting, both models provide rated accuracy over their full ratio range, with six-digit, in-line window readout for best readability. Both incorporate heavy duty switches with transient suppression, fold-away legs, easily removable end plates and voltage dividing transformers to MIL-T-27A.

Abridged specifications are given below:

<table>
<thead>
<tr>
<th></th>
<th>RB-503</th>
<th>RB-504</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio Range</td>
<td>0.000000 to 1.111110</td>
<td>-0.111110 to +1.111110</td>
</tr>
<tr>
<td>Accuracy Of Ratio For All Ratios (at 400 cps)</td>
<td>± 0.0001 +</td>
<td>± 0.000025</td>
</tr>
<tr>
<td>Accuracy (%)</td>
<td>(Ratio) %</td>
<td>(Ratio) %</td>
</tr>
<tr>
<td>Frequency Range (Useful)</td>
<td>50 to 10,000 cps</td>
<td>50 to 10,000 cps</td>
</tr>
<tr>
<td>Nominal Input Impedance (at 400 cps)</td>
<td>50K-60K</td>
<td>250K</td>
</tr>
<tr>
<td>Max. Input Voltage</td>
<td>0.5V, Volts, (f in cps) (not to exceed 350 V.)</td>
<td>1.0V, Volts, (f in cps) (not to exceed 350 V.)</td>
</tr>
<tr>
<td>Max. Effective Series Resistance</td>
<td>3.5 ohms</td>
<td>8 ohms</td>
</tr>
<tr>
<td>Resolution</td>
<td>5 decades plus</td>
<td>5 decades plus</td>
</tr>
<tr>
<td>Size</td>
<td>13 1/2&quot; h. x 19&quot; w. x 8&quot; d.</td>
<td>3 1/2&quot; h. x 19&quot; w. x 8&quot; d.</td>
</tr>
<tr>
<td>Price</td>
<td>$295.00</td>
<td>$450.00</td>
</tr>
</tbody>
</table>

Also from North Atlantic: Model RB-510 for high precision at 10 kc and RB-520 for MIL Spec applications.

If you're up against critical jobs of ac ratio measurement—in the laboratory, on the production line, or in the field—it will pay you to talk to the North Atlantic man in your area. For his name, call or write today. Or request Bulletin RB 503-504 for complete data.
NEW LITERATURE

Diodes 304
Most standard EIA cool-junction diodes are listed in this catalog. Included are computer switching diodes, high-conductance all-purpose diodes and high-voltage silicon subminiature rectifiers for commercial or military applications. Delta Semiconductors, Inc., 835 Production Place, Newport Beach, Calif.

Transducer Data 305

Microwave Equipment 306
The firm's line of microwave equipment is described and illustrated in this 25-page catalog. Physical and electrical specifications are given for attenuators, rf sources, tuners, terminations, and related devices. Weinschel Engineering, 10503 Metropolitan Ave., Ken- nington, Md.

Cathode Ray Tubes 307
Physical dimensions, electrical characteristics, and line width specifications of over 200 cathode-ray tubes are given in this 12-page brochure. Included are oscilloscopes, radar monitors, video records, flying-spot scanners, industrial monitors, receiver check tubes and spiral accelerator tubes for precision scope applications. Sylvania Electric Products, Inc., 1100 Main St., Buffalo, N. Y.

Electric Ovens 308
A line of electric ovens, furnaces, magnetically agitated baths, environmental cabinets and related temperature-controlled equipment is described in this 64-page pocket-size catalog. Photographs and brief descriptions are included with technical specifications. Blue M Electric Co., 138th and Chatham St., Blue Island, Ill.

How to make more money on payday without getting a raise

You save more than money. You make sure of enjoying the things you're saving for. Every U.S. Savings Bond helps your Government keep the Peace.

Why wait for a raise when you can do something now about increasing your income? More than 8 million Americans are doing it every payday by buying U.S. Savings Bonds on the Payroll Savings Plan. It works like this: each payday your payroll clerk sets aside whatever amount you wish, buys your Bonds, and delivers them. You receive $4 for every $3 you put in, guaranteed. Why not start planning a bigger payday this easy way today?

Why U.S. Savings Bonds are good to buy and hold

You can save automatically on the Payroll Savings Plan. You now earn 3 3/4% to maturity. You invest without risk. Your Bonds are replaced free if lost or stolen. You can get your money with interest anytime you want it. You buy shares in a stronger America.

You save more than money with U.S. Savings Bonds

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Antenna Calculator

Frequencies from 30 to 30,000 mc are covered by this parabolic antenna calculator. The scales include: frequency, wavelength, beamwidth, vswr, windloading and focal length, as well as spectrum scale for band designation, conversion scales for inches, and vswr-return loss. Send $2.00 to Gabriel Electronics, Dept. ED, Main and Pleasant Sts., Millis, Mass.

Transformers

Electrical and physical specifications on 870 transformers for a wide range of radio and television, industrial and communication applications are listed in this 32-page catalog, No. S-106. Output transformer chart indicates the recommended output transformer to be used with various standard and high-fidelity output tubes. Stancor Electronics, Inc., 3501 Addison St., Chicago 18, Ill.

Digital Data Applications

A quarterly company magazine, Datex Digest, has begun publication. It intends to report significant achievements in digital data recording and control. The first issue contains a survey article on radiotelescope antenna position recording and control systems. Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

Knobs

Over 200 different knobs in a variety of sizes, shapes and colors for radio, television, automotive and electronic instrument applications are illustrated in this 24-page full color brochure. Shaft mountings and miscellaneous parts are also described. Rohden Manufacturing Co., 4739 Montrose Ave., Chicago 41, Ill.

Microwave Instruments

Noise and field intensity meters, impulse generators, power density meters, modulation meters, coaxial attenuators and other microwave components are described in this 56-page catalog, No. 614. Each item is described with its applications and specifications. Photographs, charts, tabular data, formulas, and line drawing are included. Empire Devices, Inc., Amsterdam, N. Y.
**KEARFOTT MICROWAVE ANTENNAS**

1. **X-BAND MONO PULSE ANTENNA** utilizes the principle of multiple modes in waveguide. It features extremely deep nulls (50 DB) and a very compact configuration.

2. **PARABOLIC ANTENNAS** of conventional design for X-Band and KU-Band are also available in the Kearfott line.

3. **HORN ANTENNA** This dielectric lense horn antenna is phase compensated to give optimum patterns and side lobe levels.

4. **X-BAND PLANAR ARRAY ANTENNA** consists of a phased array of waveguide slot radiators. The pattern consists of two conical beams at a carefully controlled angle with respect to vertical.

5. **K_B BAND CONICAL SCANNING ANTENNA** achieves a high rate of electrical scanning through use of a tri-slot device that gives 3 electrical scans for each mechanical scan. Compactly designed, it provides extremely close control (less than .1 DB) over the cross over.

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KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

CIRCLE 167 ON READER-SERVICE CARD
NEW LITERATURE

Crossbars 313
Technical bulletin No. 60-115 reviews six types of crossbars, the various means of actuation and control and suitable applications, as well as presenting the results of experimental tests on various models. Photographs, tables, drawings, and curves are included. James Cunningham, Son & Co., 33 Litchfield St., Rochester, N. Y.

Microwave Components 314
Specifications for a standard line of precision wavemeters, preselector-balanced mixers, bandpass and low pass filters are contained in six-page brochure. Information on a custom line of bandpass filters, discriminator cavities, diplexers, wave traps and reference cavities is also given. Frequency Standards, P. O. Box 504, Asbury Park, N. J.

Transistors and Diodes 315
A line of semiconductor products is listed with technical specifications and dimensional diagrams in this 10-page catalog. Included are transistors, diodes, rectifiers, controlled rectifiers, switches, microcomponents, regulators and references, capacitors and encapsulations. Transitron Electronic Sales Corp., 168-182 Albion St., Wakefield, Mass.

Nickel-Chromium Wire 316
Nonmagnetic nickel-chromium wire is described in this eight-page brochure. Temperature resistance, specific resistance, efficient tolerances, yield strength vs diameter and elongation vs diameter at different temperatures are given. Molecu Wire Corp., Eato-town-Freehold Pike, Scobeyville, N. J.

Frequency and Time Standard Systems
A general discussion of problems related to frequency and time standards and detailed consideration of system operations are given in this 56-page manual, Application Note No. 52. Illustrations, tables, sample problems and solutions are included. Data sheets on some of the firm's equipment appear in the appendix. Write to Mr. Harry J. Lewenstein, Dept. ED, Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, Calif.
High-Voltage Rectifier Assemblies

A new line of double-diffused high-voltage potted rectifier assemblies, designated Series SDI, is covered in this 10-page catalog. Technical data and drawings on single- and three-phase rectifier assemblies rated up to 50,000 pvs and 1 amp dc are included. Other semiconductor products are also described. Solixtron Devices, Inc., 500 Livingston St., Norwood, N. J.

AGC Characteristics of Transistors

Forward and reverse agc characteristics of vhf germanium mesa transistors are described in this eight-page booklet. Characteristics at 45, 100 and 200 mc are detailed. Operating curves are given. A simplified design procedure is outlined. Texas Instruments Inc., Semiconductor-Components Div., P. O. Box 5012, Dallas 22, Tex.

Transistor Substitutions

Called the "International Transistor Substitution Guidebook," this 64-page publication recommends inter-changeabilities among transistors manufactured in the U. S. and six foreign countries. Physical dimensions of the transistors are included. Send $1.50 to John F. Rider Publisher, Inc., Dept. ED, 116 W. 14th St., New York, N. Y.

Bearings


Thyratons

Two bulletins, No. PA-223 and PA-503, are entitled "Thyratrons Are Different" and "The Care and Control of Thyratrons." They discuss how thyratrons differ from high vacuum tubes, ionization and deionization, temperature effects, installation precautions, dc control, ac control, and how to interpret thyratron ratings. A separate section describes applications. CBS Electronics, Information Services, 100 Endicott St., Danvers, Mass.
IDEAS FOR DESIGN

Fifth $50
"Most Valuable of Issue"
Award for Cable Shielding Method

H. W. McCord, engineer in the Electron
Tube Div. of the Radio Corporation of
America, Harrison, N. J., has won ELECTRONIC DESIGN's fifth $50 Most Valuable
of Issue Award.

Mr. McCord receives the award for his
Idea for Design "Ungrounded Shield Reduces Effective Cable Capacitance," which
appeared in the April 26 issue. The idea
pointed out that the input capacitance of
a cable feeding a cathode follower can be
reduced by connecting its shield to the
stage input instead of to ground.

Circuit Squares
DC Input Voltage

Here's a circuit we designed whose output
is proportional to the dc input, squared. Its
operation is based on the fact that the area
of a right triangle is proportional to the
product of its sides.

With a direct voltage applied at the in-
put, the wave-shapes at the emitter, point 1,
of the 2N491 unijunction and at the base,
point 2, of the 2N336 are as shown in the
figure. The clipping level at point 2 set by
the dc input, with the average value of the
waveform given by:

\[ E_{dc} = \frac{A_p}{2} - \frac{A_1^2}{2t_e} \]  \hspace{1cm} (1)

where

\[ A_p = kt_e \]
\[ A_1 = k t_s \]

\[ E_{dc} = \frac{A_p}{2} \left[ 1 - \frac{t_e^2}{t_0^2} \right] \]
\[ = \frac{A_p}{2} - \frac{A_1^2}{2t_e^2} \]  \hspace{1cm} (2)

But $A_p/2$ is a dc offset level, and hence:

\[ \Delta E_{dc} = \frac{A_1^2}{2t_e^2} = K t_s^2 \]

Since $t_e = A_1/k$ and $A_1$ is the input level,
the output is proportional to the input
squared, within the range of $0 < t < t_0$.

Robert L. Coleord, Radar Engineer, Mag-
narox, Fort Wayne, Ind.

If this Idea is valuable to you, give it a vote by
circling Reader-Service number 741.

Output voltage of circuit is directly proportional to the
dc input voltage squared.

Vote for Ideas Valuable to You

Vote for the Ideas which are valuable to
you. Other engineers will vote for the
Ideas which are most valuable to them. The
Idea which receives the most "Valuable"
votes will be judged "Most Valuable of
Issue." Its author will receive a $50 award.

Choose the Ideas which suggest a solu-
tion to a problem of your own or stimulate
your thinking or which you think are
clever.

The Ideas chosen as the most valuable
in each issue will be eligible for the $1,000
Idea of the Year award.

So vote for the Ideas you find most val-
uable. And, after you've voted, why not
send in an Idea of your own?

Inverted Exclusive-OR
Circuit Compares Binary Bits

Binary bits taken from a film store had to be
compared with binary numbers set on
switches. The comparison was made with a
circuit, Fig. 1, which uses a single transistor
to perform the inverted exclusive-OR function:

\[ \bar{AB} + \bar{BA} = AB + \bar{AB} \]

With the preset switch open, the output
signal will be high (+12 v) only if the film-

Fig. 1. Transistor and diodes are used to provide in-
vverted exclusive-OR function for comparing binary bits.

Fig. 2. Basic circuit of Fig. 1 can be modified to per-
form exclusive-OR function.

operated switch is open. If the preset switch
is closed, the output will be high only if the
film switch is closed.

The circuit can be modified to perform the
exclusive-OR function:

\[ \bar{AB} + \bar{BA} \]

If the preset switch, Fig. 2, is open, the
output signal is high only if the film switch
is closed. With the preset switch closed,
the output is high only if the film switch is
open.

Both sets of conditions allow point $E$ to
drop below +12 v, so that the transistor is
turned on.

Frank Neu, Electronic Engineer, Law-
rence Radiation Laboratory, Berkeley, Calif.

If this Idea is valuable to you, give it a vote by
circling Reader-Service number 739.
SEVENTH ANNIVERSARY AWARDS

IDEAS-FOR-DESIGN

How You Can Participate

Rules For Awards

Here's how you can participate in Ideas for Design's Seventh Anniversary Awards:

All engineer readers of ELECTRONIC DESIGN are eligible.

Entries must be accompanied by filled-out Official Entry Blank or facsimile. Ideas submitted must be original with the author, and must not have been previously published (publication in internal company magazines and literature excepted).

Ideas suitable for publication should deal with:
1. new circuits or circuit modifications
2. new design techniques
3. designs for new production methods
4. clever use of new materials or new components in design
5. design or drafting aids
6. new methods of packaging
7. design short cuts
8. cost saving tips

Awards:
1. Each Idea published will receive an honorarium of $20.
2. The Idea selected as the most valuable in the issue in which it appears will receive $50.
3. The Idea selected as the Idea of the Year will receive a Grand Prize of $1,000 in cash.

The Idea of the Year will be selected from those entries chosen Most Valuable of the Issue.

Most Valuable of the Issue and Idea of the Year selections will be made by the readers of ELECTRONIC DESIGN. The readers will select the outstanding Ideas by circling keyed numbers on the Reader-Service cards. Payment will be made eight weeks after Ideas are published.

Exclusive publishing rights for all Ideas will remain with the Hayden Publishing Co.

IDEAS-FOR-DESIGN

Entry Blank

I submit my Idea for Design for publication in ELECTRONIC DESIGN. I understand it will be eligible for the Seventh Anniversary Awards—$20 if published, $50 if chosen Most Valuable of Issue, $1,000 if chosen Idea of the Year.

I have not submitted my Idea for Design for publication elsewhere. It is entirely original with me and does not violate or infringe any copyrights, patents or trademarks or the property rights of any other person, firm or corporation.

Hayden Publishing Company, Inc. shall have the exclusive publication rights to these Ideas for Design selected for publication in ELECTRONIC DESIGN. That right extends to the subsequent use of the Idea for Design by Hayden in any of its other publications. Honorariums, if any, for subsequent publication shall be solely in the discretion of Hayden Publishing Company, Inc.

I agree to furnish Hayden Publishing Company, Inc., with complete specifications or notes necessary to enable it to make a facsimile of the Idea submitted.

Name ___________________________ Title ___________________________

Company Name ___________________________

Address ___________________________

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New Flexi-core transformers offer—

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IDEAS FOR DESIGN

Voltage Changes Transmitted 736
As Shifts in Frequency

The difference of two signals, normalized to their sum, had to be accurately transmitted over very long cables. At first, voltage drops along the cables presented a great problem. However, this problem was soon solved by converting the information to frequency variations and transmitting frequencies rather than amplitudes.

Shown in the block diagram are the basic sections used in the circuit. As a unit they:

1. Convert a voltage to a frequency that is directly proportional to the voltage (digitizing).

2. Divide two voltages dynamically and with a fast response, digitizing the output.

The transfer ratio depends solely on the time constants chosen. The voltage may be either constant or varying, as long as the time constant is short compared to the period of the variation.

If $V_2$ is fixed and $V_1$ is integrated until a level of $V_2$ is reached, (at which the integrator is reset to zero), then

$$V = \frac{V_1 \tau}{RC}$$

When: $V = V_2$, $\tau = \frac{V_2 RC}{V_1}$

then: $f = \frac{1}{\tau} = \frac{V_1}{V_2 RC}$

or: $f = K \frac{V_1}{V_2}$ where $K = \frac{1}{V_2 RC}$ (1)

If $V_2$ is also varied:

$f = k \frac{V_1}{V_2}$ where $k = \frac{1}{RC}$ (2)

It may be necessary to restrict the frequency range, that is, to keep the frequency from

Voltage drops in cables did not have to be considered when voltage differences were converted to proportional frequencies.
going to zero when \( V_1 = 0 \). This can be done by adding \( V_1 \) to \( V_2 \) and, instead of integrating \( V_1 \), we integrate \( V_1 + V_2 \). Reset still occurs at a voltage level of \( V_2 \).

For the first case, with \( V_2 \) fixed:

\[
f = \frac{V_1 + V_2}{V_{RC}} = KV_1 + f_o
\]

where \( K = \frac{1}{V_{RC}} \)

and \( f_o = \frac{1}{RC} \)

For the second case, with \( V_2 \) varying:

\[
f = k \frac{V_1}{V_2} + f_o
\]

\[
= f_o + f_o \frac{V_1}{V_2}
\]

\[
\pm f_o \left( 1 + \frac{V_1}{V_2} \right)
\]

where \( k = \frac{1}{RC} \)

\( f_o = \frac{1}{RC} \)

There are many variations possible with this basic block diagram. In our application the circuit was used to indicate the proton beam location in the Brookhaven alternating gradient synchrotron.

I. Mart in Plotkin, Electrical Engineer, Brookhaven National Lab., Upton, L. I., N. Y.

If this idea is valuable to you, give it a vote by circling Reader-Service number 736.

**One-Shot Multi Fixes**

**734**

**Turn-On State of "Bistable" Unit**

Added circuitry is usually required when a bistable multi is to come "on" in its correct stable state after power is applied. This turn-on problem is, however, avoided if a one-shot multi can be used instead.

It is possible to use a one-shot when its timing cycle is longer than the time between the set and reset pulses. If this is the case, the output will have the desired pulse-width. And, because it has only one stable state, the one-shot will always be turned on correctly. It must be remembered, though, that the reset pulses must be large enough to overcome the bias caused by the timing components.

I rving B ayer, Principal Engineer, Budd Electronics, Long Island City 1, N. Y.

If this idea is valuable to you, give it a vote by circling Reader-Service number 734.

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IDEAS FOR DESIGN

Modified Circuit for Constant-Width Pulses

Alfred W. Zinn's circuit, Fig. 1, for making the pulse width of a monostable multivibrator independent of its circuit components (Ideas for Design, "Delay Line Added for Constant-Width Pulse," ED, Dec. 7, 1960, p. 194) can be improved by using the delay line to transmit a double pulse to a bistable multi, Fig. 2. The advantages of this circuit over Mr. Zinn's are that:
- Load does not affect output waveform.
- Pulse base line is clamped.
- Opposite polarity pulses may be obtained, since both sides of multi can be used.
- No critical time constants are required, as in the case of the "one-shot."
- There is no ringing on the output, since the delay line is on the input.
- Pulse width may approach the pulse repetition rates.

Monroe Landau, EDO Corp., College Point, N. Y.

Readers Zinn and Landau have suggested two delay line circuits for obtaining con-

Fig. 1. Alfred W. Zinn's circuit places a shorted delay line on the output side of a monostable multi to help form a constant-width output pulse.

Fig. 2. Reader Landau's circuit uses the delay line to transmit a double-pulse to a bistable multi.

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Two-Transistor Circuit

Two-Transistor Circuit
729
Increases Null-Detector Sensitivity

The sensitivity of null detectors can be considerably increased by using the amplifying circuit shown in the figure. This circuit was found to be particularly useful for in-the-field work. It permitted high-accuracy bridge measurements to be made with a rugged, relatively insensitive device.

Only five components are used in the circuit, including two complementary transistors operated push-pull. A current gain equal to the average beta of the transistors is provided. Voltage gain is unity. The circuit was found to be extremely stable, with drift over a few hours use between 0.02 and 0.10 μA. For more gain, circuits can be cascaded.

The resistance of the potentiometer is not critical. It is used as a zeroing control to center the needle of the null indicator. Matching of the transistors is not necessary although the circuit is more stable if they are matched. The resistance of the null detector is not critical either. Input impedance of the current multiplier is beta times that of the null device.

Yale Jay Lubkin, Senior Staff Engineer, Loral Electronics Corp., New York, N.Y.

If this Idea is valuable to you, give it a vote by circling Reader-Service number 729.
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CIRCLE 178 ON READER-SERVICE CARD
IDEAS FOR DESIGN

High-Power AND Gate 738
Uses Discharging Capacitor

Whenever a high current or high voltage AND function is required, the circuit shown in the figure can be used. A typical application would be the writing of information from a shift register into a core memory.

Initially, the signal source supplies sufficient current to charge capacitor $C$ through resistor $R$. The capacitor's final charge depends upon the RC time constant and must not exceed the back bias on diode $D_x$.

When the gate pulse occurs, it forward biases $D_x$. The capacitor then discharges through the transformer. Diode $D_y$ is used to clamp the backswing. The transformer can be either step-up or step-down, depending on whether the application requires high current or voltage.

Charles Becklein, Engineer, Sanders Associates, Plainview, N. Y.

If this idea is valuable to you, give it a vote by circling Reader-Service number 738.

Simplified Gate Driver 745
Reduces Delay Between Outputs

Six-diode gates are used extensively in electronic systems. Waveforms for driving these are opposite going square waves. For proper operation it is desirable that there be a minimum delay between waveforms.

![Simplified Gate Driver Circuit Diagram]

Gate driver uses one stage of common base amplification per channel.

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CIRCLE 179 ON READER-SERVICE CARD

ELECTRONIC DESIGN • July 19, 1961
new, millivolt discriminators

The new Keithley Models 710 and 711 are extremely stable, light-modulator dc amplifiers operating a thyratron tube and relay. They are identical except for method of trip level adjustment. Uses include a broad range of Go-No-Go automatic control applications such as testing of diode and capacitor leakage currents, controlling temperatures, sorting resistors in automatic bridges. They can also be used in nuclear safety installations and numerous process control functions. The discriminators are fail-safe in that failure of any component creates the alarm condition. They are immune to vibration, chatter-free, can be made locking or non-locking, and can be floated up to 500 volts above ground.

Sensitivity: 0.2 to 10 mv; can be extended with internal resistive divider.
Max. Source Impedance: 100 K
Repeatability of Trip Point: Better than 200 microvolts.
Speed of Response: 40 to 60 milliseconds with signal 50% larger than trip level.
Price: Model 710 $450.00
Model 711 $470.00

Because one waveform is the inverse of the other, the usual method of generation is to use separate channels for each output, one containing an odd and the other an even number of inversions. This means that high speed design techniques must be used to reduce the delay between outputs.

A very satisfactory approach is to use one stage of common base amplification in one channel. Because of the high speed of the common base mode, very little delay results between outputs.

The switch driver shown in the figure has a delay between outputs of less than 0.1 µsec. This can be reduced to a lower figure by the use of diodes to prevent saturation of the transistors and by adding speed up capacitors.

Jim Curry, Engineer, Tasker Instruments Corp., Van Nuys, Calif.

If this idea is valuable to you, give it a vote by circling Reader-Service number 745.

Diodes Checked Out On Single 60-Cycle Tester

Here’s a simple testing circuit we devised for the rapid processing of semiconductor diodes. With the diodes placed across the test clips, the set-up determines its polarity, or whether it is shorted or open. An alternating, rather than dc, voltage is used.

Diodes placed on test clips can be rapidly checked on this 60-cycle, rather than dc, tester.

The circuit works as follows:
Cathode placed to right — Relay No. 1 operates and lights L1.
Cathode placed to left — Relay No. 2 operates and lights L2.
Short circuit — Both relays and both lamps operate
Open circuit — Neither relay or lamp operates


If this Idea is valuable to you, give it a vote by circling Reader-Service number 737.
Rockbestos

Firezone Aerospace Wire

Resists Jet Engine Heat in B-52

Rockbestos Firezone Type 101 Aerospace Wire is used for power and control circuits in the B-52 jet bomber, renowned for its high performance and dependability.

Dependability is designed into Rockbestos Aerospace wire too. In jet aircraft Rockbestos Wire resists the high temperatures around engine and afterburner sections. It is also used for high impedance circuits in guided missiles.

Standard Rockbestos Aerospace wires cover a temperature range from 257°F to 750°F. Many special wires have been produced to operate at even higher temperatures. In addition to high temperature aerospace wire, Rockbestos supplies hook-up wire, coaxial cable, and ground support cable.

For complete information on Rockbestos Aerospace Wire & Cable write for Bulletin.

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CIRCLE 182 ON READER-SERVICE CARD
Electric Circuits and Machines  

This third edition presents the fundamentals of both direct and alternating current circuits and machinery. It is designed for use in technical high schools, technical institutions, community colleges, and in survey courses for non-electrical engineering students. Information on all major types of electrical machinery is included, and basic principles of electricity are presented with a minimum of detailed mathematical analyses. Material is also included on circuit protective equipment and the effective use of industrial symbols. Questions and problems are also provided with many numerical examples worked out in detail.

Microwave Transmission  

Described here is the general theory underlying the methods used for transmitting microwaves from point to point, from the generator in which they are produced to the receiver in which they are detected. Emphasis...
is on the fundamental theory of electromagnetic waves rather than on practical applications. Chapter headings include: Transmission Lines, Maxwell’s Equations, Plane Waveguides, and Reflection, Rectangular Waveguides, Radiation From Antennas, and Coupling of Coaxial Lines and Waveguides.

Field Theory of Guided Waves

An account of guided wave theory at the graduate level, this text sets forth the mathematical techniques and solutions of the more elaborate save-guiding structures, waveguide discontinuities, waveguide antennas and coupling apertures. Both the basic theory and mathematical techniques involved in this field are discussed. In addition, the book has been planned as a reference for the engineer or physicist. The treatment pre-
Transipads put a little extra security into printed-circuit assemblies. For a cost you count in pennies. A Transipad mounting is rock solid. It eliminates strain on delicate leads, provides vibration-proof separation between them. It isolates the transistor case from contact with printed conductors. And, perhaps most important, it provides a built-in air space to dissipate the heat of soldering (how many transistors have you lost lately through heat shock?). Transipads come in sizes and styles to fit most transistor types; some will convert lead arrangements from in-line to pin-circle, or vice-versa; others will widen lead spacing. Samples and drawings are yours for the asking. A note or a phone call will bring them.

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Steel Ribbon Converts Linear to Angular Motion

A steel ribbon helps convert linear to angular motion in a single-axis, flight-simulation table. At its lower end, the ribbon is secured to a flat tangent plate. At its upper end, it is secured to a rocker that drives the table.

A similar mechanism appears at the lower end of the voice-coil-driven rod that moves the tangent plate. The lower mechanism has a reverse arrangement, however. Here, the upper end of the ribbon is secured to the tangent plate while the lower end is secured...
to the rocker. This opposing arrangement maintains constant tension on both the upper and lower ribbons.

The unusually simple linear-to-angular-motion converter, designed by David S. York, vice president and chief mechanical engineer of MicroGee Products, Inc., 6319 Slauzon Ave., Culver City, Calif., provides several advantages. It offers very little noise, virtually no backlash, and a very high order of stability and linearity.

These factors are extremely important in testing systems for small perturbation stability. The usual mechanisms for converting linear-to-angular motion, like rack-and-pinion and other backlash-type devices, give a “staircase effect” in the input-output characteristics. This effect can be disastrous in measurements involving small displacements.

Liquid Lock
Makes Loose Fit Press Fit

A drop of liquid holds an aluminum collar securely in place in a subminiature trimmer potentiometer. The collar helps provide a hermetic seal for the resistance element in the Wee'Trim potentiometer, model 500, manufactured by Handley, Inc. of 12960 Panama St. in Los Angeles.

Handley could not use a press fit because the pressure required might distort the high-resolution, high-stability resistance winding. Instead, Handley used Loctite sealant, a liquid manufactured by American Sealants Co. of Hartford, Conn. This liquid hardens into a tough plastic bond when it is confined between close-fitting metal parts.

The Loctite is available in different grades offering shear strengths ranging from as low as 75 psi to as high as 1,500 psi.
Hi-Fi Die Obviates Milling In St-Erie-o Cartridge Element

A tiny ceramic element for a high-fidelity phonograph cartridge posed some unusual problems for Erie Technical Ceramics of State College, Pa. The engineers at Erie needed a special extrusion die to make a tight tolerance, X-shaped element for their “St-Erie-o” reproducer cartridge. Unfortunately, the “obvious” methods for making the die were difficult and costly.

The arms of the asymmetrical, X-shaped ceramic element were to be only 31 mils long and 15.5 mils wide and the tolerances were to be held to within 1/2 mil. The lengths were to be equal within 1/2 mil while the 7.5-mil radii between the arms of the X were to be held to within 1/2 mil.

A first glance at the problem suggested the use of an electro-erosion milling process for fabricating the die. But a second look indicated that this would require lapping to the final tolerances and lapping would have been impractical in such a tiny orifice. Furthermore, because of the large depth of the hole compared with its width, vibrations in the electrode would have made it extremely difficult to hold the proper dimensions.

Erie’s engineers found the solution when they turned to William C. Bobbitt, manager of the Punch & Die Div. of F. J. Stokes Corp. in Philadelphia. He designed a four-segment die, with the segments clamped to-
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EXPERT Help in
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Noisy Multivibrator Helps Locate Distress Light

Components and circuits which generate radio-frequency-interference should normally be designed out of electronic equipment. But in one case, an RFI-producing circuit was deliberately made even noisier.

A high-intensity distress light, manufactured by ACR Electronics Corp. of 551 W. 22nd St., New York, uses a modified multivibrator in a transistorized dc-to-dc converter. When the unit was first designed and found to be noisy, the first thought was, of course, to eliminate the noise. But Chief Engineer Morton Sunshine suggested, “Let’s make it noisier and let’s use the noise.”

In the production model of the distress light, the noise is passed through filters which pass the distress frequency, 243 mc. This distress signal can be picked up as far as 25 to 30 miles away. Rescue craft can follow this signal with radio direction finders to locate a person lost at sea.

The circuitry in the distress light is arranged so the discharge of a capacitor into a Zenon light acts as a pinger in the water. The pinging “noise” can be received as far as 15 miles away by standard sonar equipment.

Of course the basic function of the device is generating high-intensity light. This function is implemented with a “lens” made of a molded, clear epoxy resin which completely encapsulates the Zenon lamp. The “reflector” behind the lamp is a small strip of aluminized Mylar tape with a checkboard pattern. This low-cost material is similar to that used as automobile bumper strips.

The 1-lb distress light can be seen 50 miles away on a clear night. Its prime function is admirably supplemented by the use of both electrical and acoustical noise.

An Example of Synthane You-shaped Versatility

Do you have a materials problem? Perhaps laminated plastics is the answer: Why not discuss it with our field representative in your territory? He has behind him the entire Synthane organization with over 32 years of experience in the manufacture and fabrication of laminated plastics. Our engineers, technicians and field representatives are specialists in this field, and over two-thirds of our people have over 10 years' experience with Synthane. The solution to your materials problem can probably be found at Synthane.


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Only 1 1/4 in. square, less than 5 in. high, and weighs as little as 15 oz. Four adjustable models provide delays from .03 sec. to 3 minutes—on pull-in or drop-out. Electrically-operated, pneumatically timed for instant recycling and freedom from voltage-variation drift. Choice of ac and dc operating voltages, with solder lug, octal plug or AN connector terminals.

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CIRCLE 196 ON READER-SERVICE CARD
Objects to Superfluous Styling

Dear Sir:

Your editorial, “Good Styling a Critical Factor”, brings to attention a serious problem confronting design engineers today. Most electronic equipment is designed to fulfill some definite objective, toward which all design effort should be directed. In addition to the technical features inside the unit, various other factors such as layout, external appearance, color, etc., apparently may have subtle psychological as well as practical advantages in meeting this objective, and must be considered as an important part of the over-all design.

On the other hand, there are certain aspects to styling which can only be regarded as unrelated and superfluous. Their most obvious purpose is to increase sales appeal by purporting to demonstrate a pride in workmanship and design by the manufacturer over and above the “standard” (i.e. his competitors). Such “frills” have become increasingly evident in recent years, particularly in consumer products (automobiles for example). Not only are they sometimes crude, but worse still, they are often actually detrimental to the primary objective of the equipment. They also increase the cost.

Determining the dividing line between essential styling and superfluity is a job which calls for the highest degree of practical engineering judgment. It is not a job for artists, as your editorial would imply. Nor can it be judged very intelligently by walking past two miles of exhibits noting such trivialities as silk screen, “ordinary” engravings, etc. Before passing judgment on the styling of any instrument, I would suggest that a person first use the instrument.

The problem confronting design engineers is that currently popular styling frills are often expected (or even demanded) by the customer which are actually in conflict with the primary objective of the equipment, as
well as adding to the cost. This is particularly evident where specifications as well as expenditures are controlled by nontechnical personnel.

Stewart Coffin
Dynamic Controls Co.
Cambridge, Mass.

Need for “Impedance-Matching” Electronic Device Stressed

Having just read your editorial “Good Styling a Critical Factor” I should like to extend my thanks for your most complimentary remarks concerning our new packaging system. Much of the credit for its development belongs to our designers, Tom Lauhon, Allen Inhelder, Don Pahl, Andi Are, Dale Graye, Herb Beaven, and Ken Dinwiddie; and to Dick Payne and Ron Perkocha for the sometimes thankless job of drafting.

Since we regard ELECTRONIC DESIGN as one of our most important sources of information, it is especially encouraging to note the theme expressed in your editorial. We are in whole-hearted agreement. We have found that the value of an electronic device—just as of any other product—is determined on the basis of many attributes. Of course, most importantly, does it work at all? But of growing significance, as the complexity and sophistication of our industry increases, is the effectiveness of the coupling between the device and its human user. This coupling depends, to a great extent, upon a visual clarity of function and professional appearance, which serve not only to simplify the operation of the device, but to inspire the confidence of the operator. In this area lie the real challenges for the electronic industrial designer—and the real opportunities for making worthwhile contributions.

Carl J. Clement, Jr.
Manager, Industrial Design
Hewlett-Packard Co.
Palo Alto, Calif.

Accuracy Is Our Policy...

In the “Letter to the Editor” by Sam Ringel May 10, bond strength is printed as 320 psi when actually it is ten times as great—3,200 psi.
MINIATURE MOLDED OXIDE RESISTORS

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RELIABILITY — Failure rate is better than one per ten million hours.
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TOLERANCE — All Mil - R - 11C values at ±5%.
SIZE — Same as the Mil Type RC20.
SPECIFICATION — Exceeds materially Mil - R - 11C.
PRICE as compelling as the performance and related to 5% carbon composition resistors.

<table>
<thead>
<tr>
<th>Type</th>
<th>Rating °C Ambient</th>
<th>Mil Type</th>
<th>Rated Voltage</th>
<th>Minimum Resistance</th>
<th>Maximum Resistance</th>
<th>Dielectric Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>F20</td>
<td>1/2 Watt</td>
<td>RC20</td>
<td>350V</td>
<td>10 Ohms</td>
<td>500 K</td>
<td>1000 Volts</td>
</tr>
</tbody>
</table>

For complete data and specifications write to

Welwyn INTERNATIONAL INC.

For further information write for data sheet WJ014. 3355 Edgcliffe Terrace, Cleveland 11, Ohio. Factories in Canada and England.
where have the simple relays gone?

Many, of course, have disappeared along with the relatively simple jobs they were asked to perform. (A good telegraph relay* or pulse repeater today, for example, should not only be small but able to transfer its contacts on a milliwatt or so about 500 times a second for half a billion operations — and then be repairable, adjustable and lovable besides.) But there are still plenty of naive, uncomplicated loads around that ask only to be switched on and off, at reasonable intervals, by a device that doesn’t have so many parts and fancy thingamajigs that it may become temperamental and refuse to work without being coaxed.

For such applications we are happy to say we have a paragon of ingeniously simple, fool-proof relay design. It won’t make the same confidence-inspiring noise as the classic above and it’s not for telegraphy, but you can see through its enclosure and watch its contacts surely open and close. The designer started with the familiar enclosure and octal plug-in base and then developed the relay accordingly (with UL requirements in mind); he didn’t just take an existing relay and tack on a new base and enclosure. As a result, the parts make the best use of the volume (1¾” square x 2½” high) and are big, simple, rugged and few in number. The base is specifically designed to carry the 10 amp. loads the relay will switch.

The relay is designated “Series 46” and intended for general purpose, heavy-duty DPDT switching on AC or DC inputs. Rated DC loads are 5 amps at 28 volts, 1 amp. at 120 volts; AC, 1200 volt-amperes per pole with 240-volt and 10-amp. maximums. Life ranges from 10 million operations with 1-amp. loads to half a million with 10-amp. loads. The relay can be as sensitive as 200 milliwatts DC, or 0.2 v-a AC.

We’ve looked at what else is available for the same modest price and the “46” specs give us considerable hope. If your problem has been the right specs but the wrong price, or vice-versa, perhaps you’d like the 46 AC and DC bulletins. In the meantime, always remember: You can be sure if it’s Sigma, it’s simple.

* Plug (octal, that is) for Sigma Series 72 relay

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LETTERS

MRC-66 Not Wideband

Dear Sir:

Your article on wideband communications, April 26, 1961, p 4, may be somewhat misleading to your readers in referring to the AN/MRC-66 system as having been part of the groundwork for the current wideband investigations. To clarify the point, the MRC-66 “Communication Central” is a narrow-band ssb system employing 4,750 privately assigned channels in a 33-mc spectrum beginning at 132 mc.

Arthur T. Klingberg
Motorola, Inc.
Chicago, Ill.

Let’s Talk the Same Language

Dear Sir:

A recent advertisement in one of the electronics magazines demanded that vendors adhere to specs, delivery, and other essentials. Illustrated with a photo of two men—one an engineer, the other a purchasing agent—the ad was headed, “Don’t Play Games With These Boys.”

The time has come to expand on this theme. We in the electronics industry must stop “playing games.” One of the most costly of the games many of us have been playing is that of over-specifying—or of specifying without understanding.

We at Mid-Eastern Electronics had two dramatic examples of such specifying recently. Two of our representatives reported that some important customers wanted us to convert our entire line of transistorized power supplies to fully programable units. This would have required new design, more inventory, and substantially higher costs.

Rather than jump into a large conversion program blind-folded, Mid-Eastern’s president, William W. Hartz, visited the engineers who had insisted on “programable” supplies.

In the first case, the engineer required tamper-proof power supplies. It was essential that the voltage be adjustable only at the rear of the power-supply units. A simple screwdriver adjustment with a locking nut and a modified panel solved this problem. In the second case, the engineer needed only a means of remotely controlling the output voltage—a far cry from true remote programing. An inexpensive pushbutton-controlled, gear-motor drive, built into the power supplies, solved this problem.
In both these cases there was but a small additional cost per unit. The cost of the "fully programable units," originally specified, would have been at least double the standard prices, since 100-v, 10-amp, and 18-v, 55-amp units were needed. Space required would also have been doubled. Delivery would have been two months for programable units instead of two weeks for the slightly-modified units.

It would be to everybody's advantage if we thought twice before talking, and if we talked twice before acting. We're not playing games! Language is a tool for exchanging ideas and facts and for clarifying thought. When it serves only to confuse, to impress, or to please the speaker with the sound of his own voice, valuable time and effort are going up in hot air.

Whether we're buying or selling—let us know what we're talking about. The growing number of new terms is increasing the possibility of misunderstanding. This makes it imperative that both user and supplier take time to work together and understand each other.

Gunther A. Bielefeld
Mid-Eastern Electronics, Inc.
Springfield, N. J.

The Puff's Have It

Referring to his letter in your 7 June issue, I am confident that it will please Mr. D. C. Friedmann to know that his idea is so good that, in fact, one of his suggested abbreviations, "puff," for picofarad was adopted by British engineers about a generation ago. Let us hope that the more elderly of these engineers will not now, at this late stage, be deprived of their puff by Americans who, as Madison Avenue now has it, are "on their way up."

F. D. Harris
British Radio Electronics Ltd.
Washington, D. C.

Referring to the correspondence from Mr. Friedman on a nickname for picofarads, I'd like to argue for "puff" as being it, because the picofarad has been in use in the United Kingdom for quite a while and this is their slang for it. We so often find ourselves separated from our English cousins in the field of electronic terminology, so let's not start still another separation.

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The Art of Tacking

"Tacking" a breadboard together with a soldering iron has much in common with tacking a sailing craft against the wind. Uncommon skill is needed to do both well. Here a seasoned "tacker" sets forth his Six Johnson Laws of Tacking.

R. W. Johnson
Consulting Engineer
R. W. Johnson Co.
Anaheim, Calif.

ALL PROFESSIONS have artistic elements. The skilled trial attorney masters the sly innuendo and the subtle suggestion to the jury, the surgeon deftly knots the stitch, the dentist undercuts the filling, and the most adroit electronics engineer knows the art of tacking.

Although many seek to proceed from notebook to production, this species is all but extinct, lost in the company failure statistics. We are thus inflicted with the breadboard, the artistic masterpiece of electronics. The breadboard stands as the electronic engineers' sole remaining bastion against regimented conformity in these days of plug-in modules; its sole opportunity for exercise of the creative, artistic urge; his single link to a happier and more relaxed era.

As a timely and highly significant contribution to the art, this article presents Johnson's Six Laws of Tacking.

LAW ONE
Never twist. Although an engineer might naively (or even smugly) believe that some components at least have been calculated correctly and will not change, such belief is foolhardy. This can be amply demonstrated in any breadboard by simply twisting the wires of any two or more components tightly together and soldering. It is a fundamental law that whenever this is done, at least one of these components will change during the inventing process. To avoid this in tacking, never twist.

LAW TWO
Never cut. The economy minded prefer to use components over and over again. Using parts from the Private Collection also avoids renewing old battles with the purchasing department, stock room clerks, inspectors, value analysts and others. The extent to which re-use is possible depends on two factors: the length of the lead and how much overheating has occurred. The two factors are not independent; for the shorter the lead, the more heat from soldering.

Again, simple demonstration can prove another fundamental truth: cut the lead off any component (diode, resistor, capacitor, transistor, or what have you) and leave just enough to solder it into the circuit. One will see that inevitably this component is precisely the one that must be changed, thereby leaving a useless component with leads too short to use as the next time. So, never cut.

LAW THREE
Avoid parallelism. What stereo does for good music, what solid state does for reliability, added dimensions can do for a breadboard. Three-D circuits are the ultimate in electronic artistry; one can always follow the leads, make contact with probes, test leads and iron, and there is less mutual magnetic and capacitive coupling when wires are skew rather than parallel. The best bread-board circuits expand outward in geometrically spherical fashion akin to a galactic nova. Thus, no two components or wires should ever be parallel.

LAW FOUR
Always use old solder. Bright, shiny, new 60/40 solder is attractively packaged these days in handy dispensers, and the temptation is strong to use it. Unfortunately the dispenser can never be located among the pile of used components, tools and test leads on the bench. Anyhow, old used solder is far superior for tacking. In fact, the more crystalline and pithy, the better. Like vintage wines, solder improves with age for tacking purposes.

One therefore develops the habit of picking up bits of old solder from the bench with the tip of one's iron and using this for tacking. This helps keep the bench clean (at the expense of an occasional burn), saves money on solder, and avoids the splatter of resin. But most important, the joint barely stays together. So for good tacking, always use old solder.

LAW FIVE
Never tack more than two wires. In the art of tacking one soon learns the difficulty of tacking more than two wires together. One genuine artist has even mastered the finesse of holding "N" wires in contact by skilled use of an alligator clip while he places a tiny drop of solder (old solder; remember Law Four) at precisely the right spot.

But not all engineers can achieve such creative heights; so when more than two wires are to be tacked, there is a problem. When the engineer goes to tack the third wire, the others ungratefully fall apart. Without violating Law One (never twist), the recourse is to tack each succeeding component further up the lead of its neighbor. This is of assistance in satisfying Law Three as well, as there will be a more rapid geometric expansion of the circuit. So for all but the purist: Never tack more than two wires at a time.

LAW SIX
Stop at 11 changes! No discussion of this subject is complete without a reference to etched circuits. It could be argued that by the time one has reached this stage, he should be over the breadboard phase. Statistics show, however, that 78.2 per cent of all electronic
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engineering is done on the production line and after delivery. In these cases the engineer must cope with a temporary regression to what might be called the etched-circuit breadboard. Here one has the annoying problem of how to tack on various components as fixes for the defect without heating the board so much as to loosen the glue.

Painstaking research by the author has disclosed that with the soldering iron operating at precisely 93 v, it is possible to tack a component on an etched board and remove it a total of 14 times, provided that Law Three (use old solder) has been obeyed. Beyond this cut-off point, one of two things is most apt to happen: the component already on the board becomes overheated and changes its value, correcting the defect; or the copper separates from the board, so one can blame the defect on the etched-circuit board manufacturer. It's a good idea to remember: Make fewer than 14 changes in each component after release for production.

So much for the laws of tacking.

Now a corollary to the art of tacking is the art of untacking. If what goes up must come down, what is tacked must be untacked. One untacks to change one of the added components. And, of course, one untacks when he is finally satisfied with the design—to save the components for his Private Collection, so the same design mistakes can be corrected the next time.

Fortunately, if Johnson's Six Laws have been observed, untacking becomes a relatively simple matter. One simply touches the iron to the joint, and the breadboard flies apart like a mainspring. In fact, this is the test of a really good breadboard—every tack should fly apart by itself when touched by an iron. About the only precaution in untacking is to leave enough old solder on the leads so they can be tacked again the next time without violating Law Four.

A number of the more artistic breadboards constructed according to the Johnson Laws that do not always obey strict engineering laws, the results have an artistic “essence” of their own. •

Note: Readers who have found this article helpful will look forward to a future article on the semiconductor properties of cold-soldered joints.

Credits: Photo by courtesy of DLE-GT Productions.

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