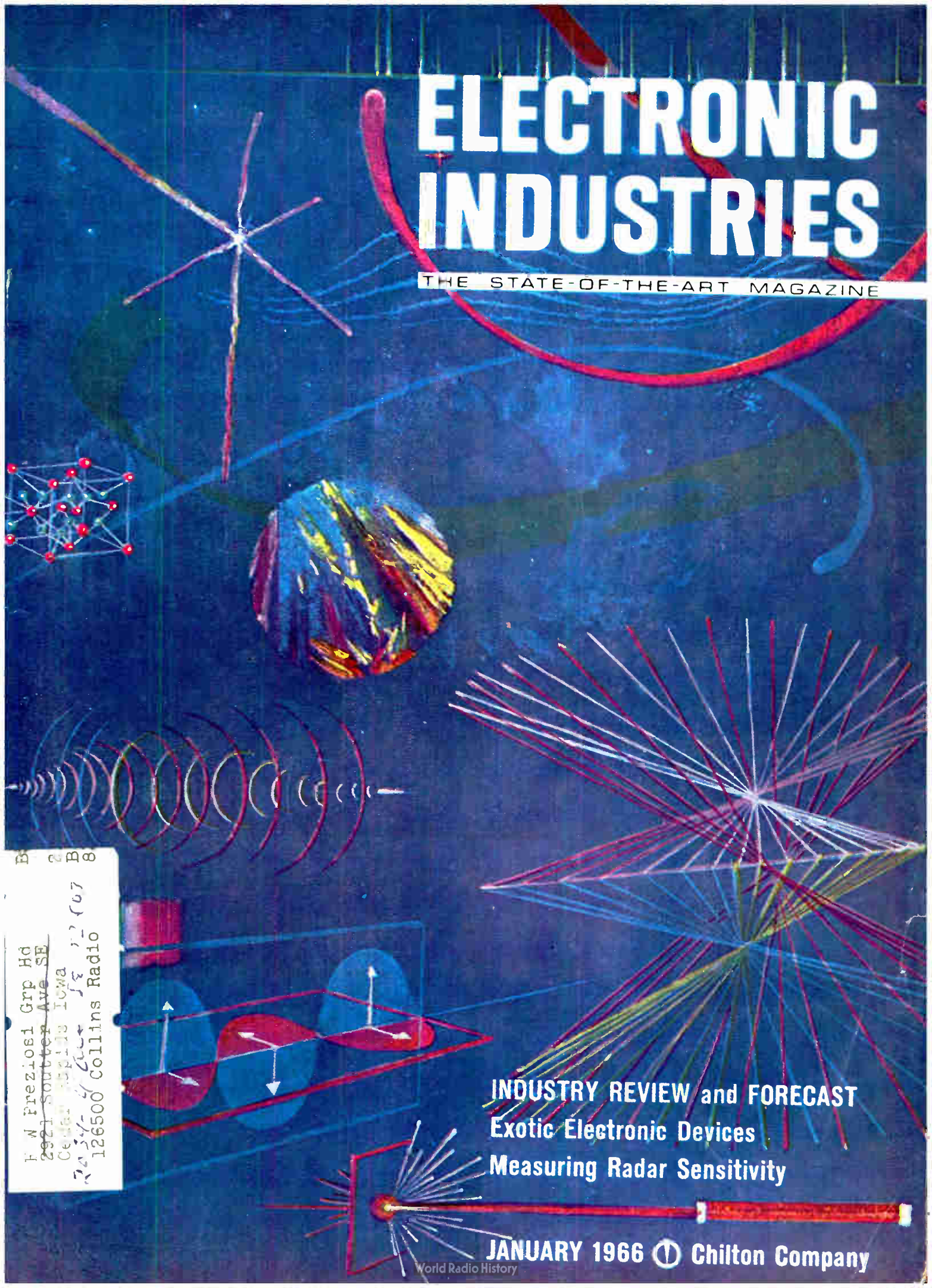


HI-FI

Transistor output; matches any PP transistor to 4, 8, 16 Ω speaker. Primary 48, 36, 12 Ω C.T.; 20 — to 20 KC; 40 watts.

MINIATURE MIL TYPE

Metal case hermetically sealed to MIL-T-27B. Gold Dumet leads spaced on 0.1 radius, for printed circuit application.

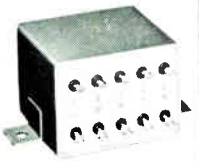
CHOPPER

Magnetic shielded plus electrostatic shield for voltage isolation of 2×10^4. Primary 200K C.T. to within 0.1%. Secondary 50K.

HIGH POWERED AUDIO

Low distortion 2.5 KW output transformer. PP 450 TH's 18,500 ohms C.T. to 24 6 ohms, 20 KV hipot. 520 lbs.

CATHODE FOLLOWER OUTPUT



Provides equal voltages to 5 loads. Primary inductance maintained to 5% with 20% change in DC unbalance and 30% change in AC voltages.

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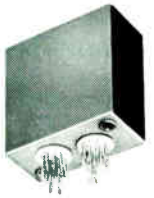
HI-FREQUENCY CARRIER TO MIL-T-27B

Electrostatically shielded, humbucking. −30 dbm level. Within .5 db 250 cycles to 110 KC. 600 135 600 centertapped to .1% tolerance.

HYBRID TRANSFORMER



Two transformers each 600 Ω primary. 40K Ω C.T. secondary 250 cycles to 5 KC within ¼ db. 40 db isolation over band.

MICROMODULE

Life tested per micromodule specs.: no failures. 10K Ω C.T. to 10K Ω, 100 mw from 400 — to 20KC.

SUBMINIATURE MOLDED TRANSFORMER

Grade 3 with printed circuit leads for transistor application. 150 Ω to 150 Ω at 10 dbm level. Size ½ x ½ x ½", weight 5 grams.

BOLOMETER TRANSFORMER

Primary 10 ohms, secondary 530K ohms, 230 1 ratio, response from ½ cycle to 25 cycles. 120 db magnetic shielding, plus full electrostatic shielding.

ULTRA-MINIATURE

Electrostatically & magnetically shielded output transformer 5/16 D. x 1⅜" H. Pri. 15K CT, Sec. 8K CT; max. level 50 mw; audio range response. To MIL-T-27B, grade 4.

Exceptional quality and reliability is provided in all UTC designs. Over 30 years of engineering knowledge and experience substantiated by extensive field performance assure the highest quality and most reliable components in the industry. Complete environmental testing facilities are incorporated to prove out new designs. Full analysis and evaluation of materials are conducted in UTC's Material and Chemical Laboratories. Rigid quality control measures coordinated with exhaustive statistical findings and latest production procedures results in the industry's highest degree of reliability. Range covered in Audio Transformers is from 0.1 cycles to 400 MC . . . microwatts to 50 KW.

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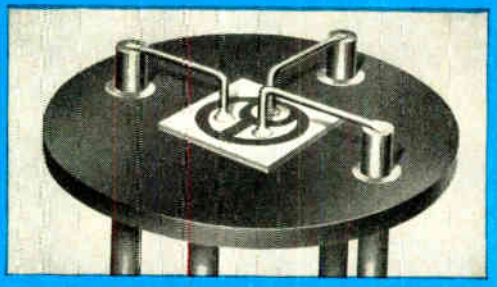

CHECK THESE FEATURES!

- BV_{EEO} > 25 VOLTS
- $|V_O|$ < 250 μV
- $|\Delta V_O/T_A|$ < 2.3 μV per °C
- f_T > 6 mc

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Sprague offers more dual-emitter transistor types than any other source!

TYPE No.	BV_{EEO} (volts)	V_O (μV)	TYPE No.	BV_{EEO} (volts)	V_O (μV)	TYPE No.	BV_{EEO} (volts)	V_O (μV)	TYPE No.	BV_{EEO} (volts)	V_O (μV)	TYPE No.	BV_{EEO} (volts)	V_O (μV)
3N90	30	50	3N95	50	200	3N104	20	50	3N109	50	150	3N116	12	200
3N91	30	100	3N100	10	50	3N105	15	250	3N110	30	30	3N117	20	50
3N92	30	200	3N101	30	50	3N106	30	250	3N111	30	150	3N118	20	100
3N93	50	50	3N102	40	50	3N107	50	250	3N114	12	50	3N119	20	200
3N94	50	100	3N103	50	50	3N108	50	30	3N115	12	100	3N123	25	250

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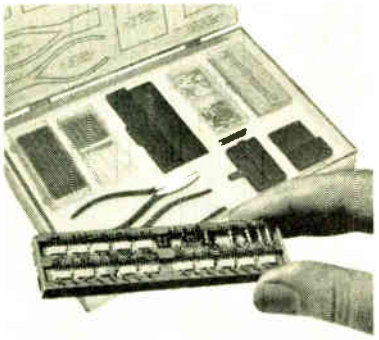

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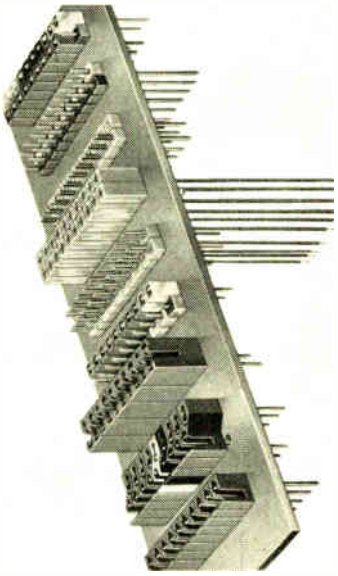

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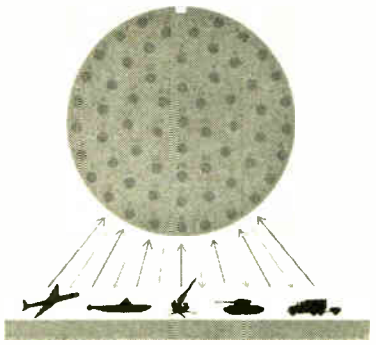
CONNECTORS



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JANUARY 1966, Vol. 25, No. 1

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

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1966 Survey of Potentiometer Specifications
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COVER: Artist Les Greer of the Western Electric Co. here combines mathematical and pictorial illustrations to describe the broad aspects of electronics. Perhaps readers will recognize: an exploding star, radio signals, molecular structure, radar signals, a laser beam, a plane-polarized wave, sulfonethyl methane crystals, radio waves and mathematical projections.

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

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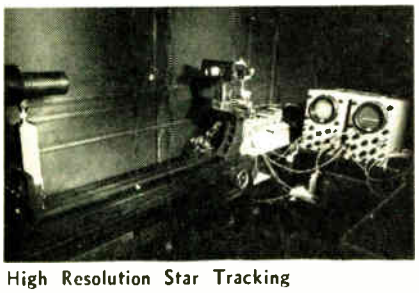
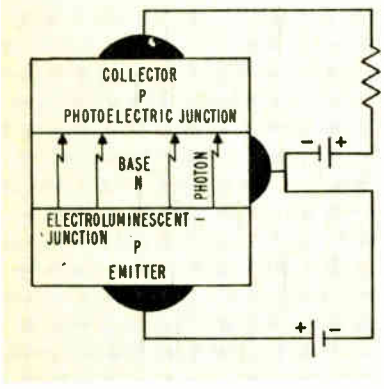
HIGHLIGHTS

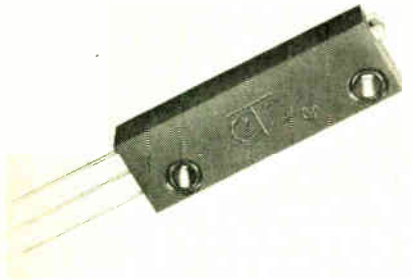
Infrared TV System



High Resolution Star Tracking

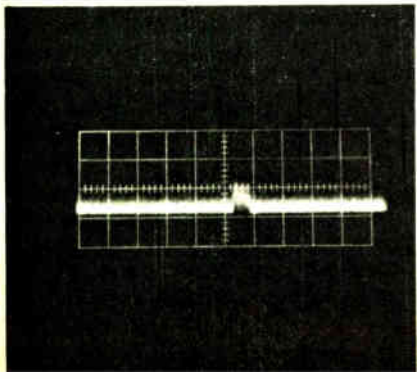


Exotic Devices



Potentiometer Specifications

Measuring Radar Sensitivity



1966 REVIEW & FORECAST FOR THE ELECTRONIC INDUSTRIES 36

A brief review of previous year's sales of electronic products in various segments of the total electronic market, both domestic and abroad. Tables and graphs illustrate years just past, the current market, and predictions and forecasts for the market through 1967.

A PRACTICAL INFRARED TV SYSTEM 48

Here is a relatively inexpensive infrared transmission system that is being used for TV and scientific data transmission. The authors describe the design problems encountered and how they solved them. The information can be used to develop other systems.

HIGH RESOLUTION STAR TRACKING 54

Use of a magnetoresistance multiplier as the source of scanning signals in a precision star-tracker eliminates the traditional mechanically-driven shutter and paves the way for seconds-of-arc tracking resolution. A new kind of image dissector is used in the star-tracker. It functions by scanning a field of view like an image-orthicon camera tube, yet provides sensitivity equal to the state-of-the-art in multiplier phototubes.

EXOTIC DEVICES OF THE FUTURE 59

This article describes some recently developed devices, some of which show promise of importance to the electronic industry, and others which are merely intriguing but presently impractical curiosities of science.

1966 SURVEY OF POTENTIOMETER SPECIFICATIONS: PART 3—TRIMMER POTS 62

Describing key characteristics of trimmer potentiometers of interest to the design engineer. Includes a complete listing of the technical specifications of individual trimmers, grouped by manufacturer.

MEASURING RADAR SENSITIVITY 94

Two methods are presented for measuring sensitivity of radar receiving equipment having quantized output video—(1) the usual analog method; (2) unique time selection scheme employing a gating circuit and electronic counter for precision readout and automatic monitoring.

COMMUNICATIONS—PAST, PRESENT & FUTURE 102

Statements are presented concerning various aspects of technological developments as viewed by some of the key personages in the industry. The purpose is primarily to acquaint engineers with advances in technological areas outside their particular specialties. Trends revealed point the direction to new devices, equipment and systems made possible by advancing state-of-the-art.

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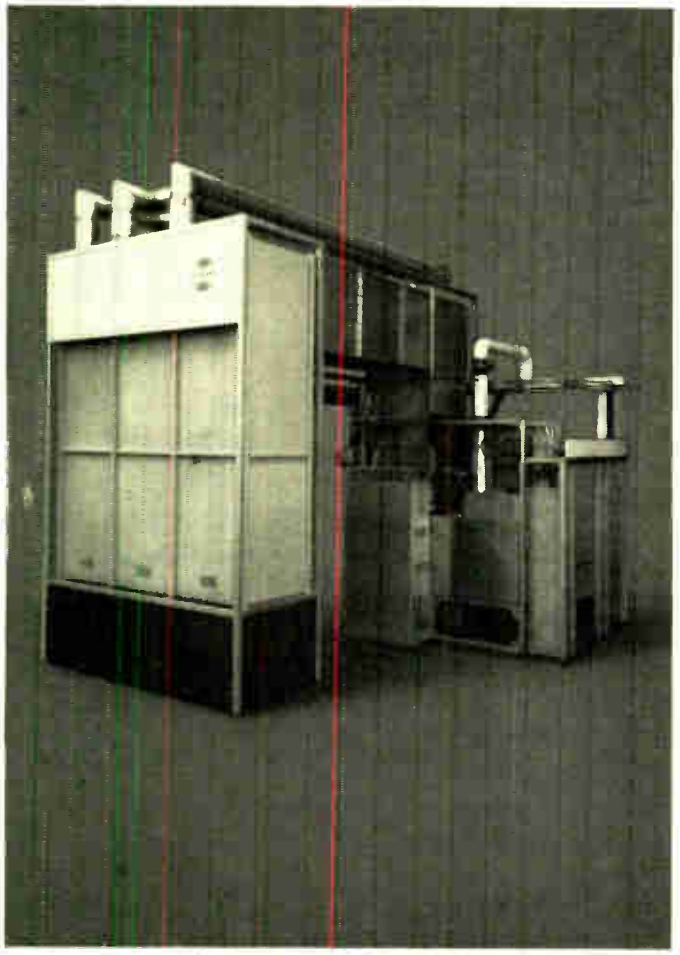

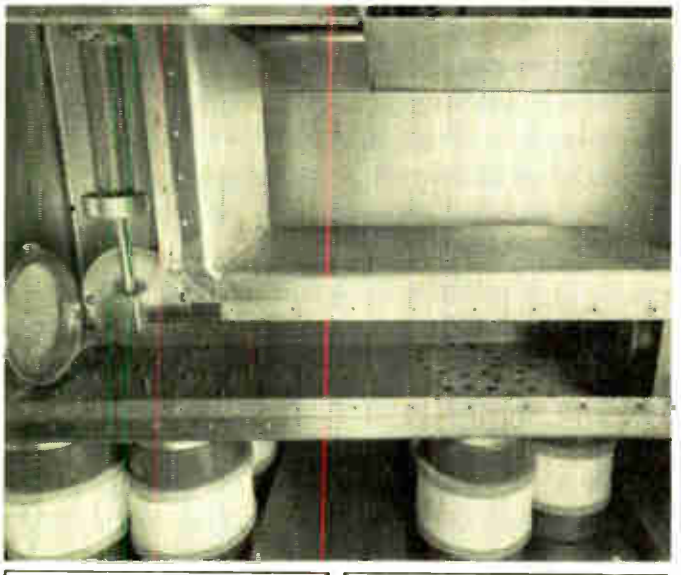

250 KW Transmitter Achieves Extremely High Tank Circuit Efficiency With Jennings Vacuum Capacitors

Two of the most significant features of Collins Radio Company's 821A 250 KW transmitter are the unusually high efficiency of the tank circuits in the final amplifier and the completely automatic tuning techniques. The output network employs large coaxial line sections which are automatically resonated by new internally forced-air cooled Jennings vacuum variable capacitors. It also utilizes the wide capacity range, high frequency response, and high voltage rating of Jennings capacitors to aid in automatic tuning anywhere in the frequency range of 3.95 to 26.5 megacycles.

This permits completely automatic tuning in a maximum of 20 secs and avoids the loss of valuable air time, usually 5 to 15 minutes, consumed by conventional transmitters.

In addition to the low loss dielectric and lowest inductance of any other capacitor Jennings new vacuum capacitors offer (1) highest maximum to minimum capacity change ratios (2) long life (3) high current capability (4) light weight (5) built-in corona rings on many models (6) shock resistant glazed ceramic envelope (7) wide variety to solve most desired combinations of capacitance, voltage, and current.

Whether it's 250 KW or 5 KW, Jennings vacuum capacitors will contribute more to superior transmitter performance than any other capacitor known. A brief examination of our new line of ceramic vacuum capacitors will suggest many new ways in which circuit design can be improved. We will be pleased to send complete details at your request.

JENNINGS TYPE
CVHC 650

Capacitance Range:	30-650 pf
Voltage Rating:	45 kv peak
Current Rating:	250 amps rms

JENNINGS TYPE
CFHP 1000

Capacity:	1000 pf
Voltage Rating:	45 kv peak
Current Rating:	215 amps rms

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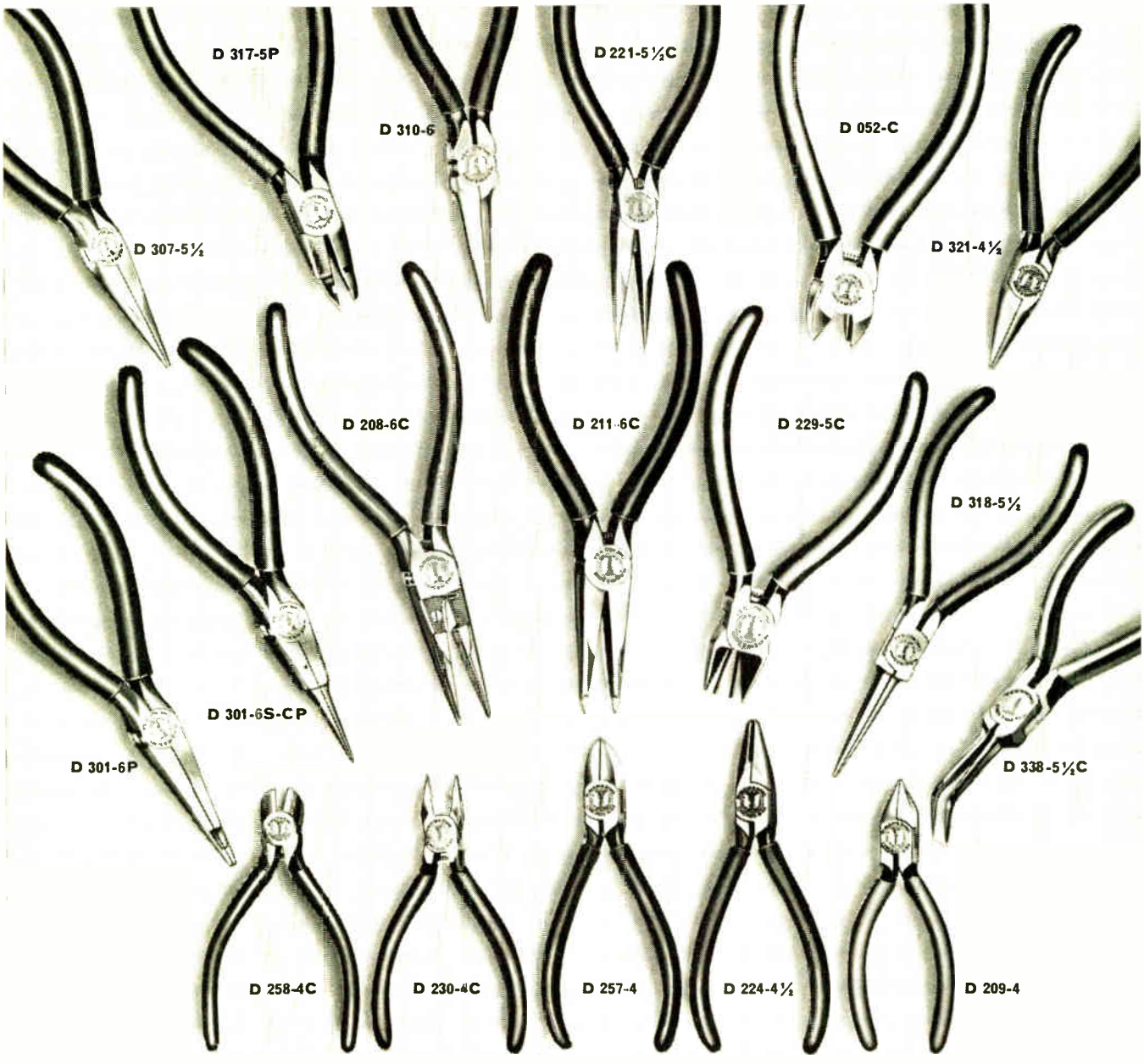

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Bourns Introduces INFINITRON™ Element 10-Turn Precision Potentiometers*

Here at last are multi-turn precision potentiometers that offer long life and essentially infinite resolution without asking you to compromise on your specifications. Noise in Bourns INFINITRON-element units is so low you can test them as if they were wirewounds. You don't have to hook up special filter circuits or contrive "output smoothness" tests. No need, either, to limit these potentiometers to voltage-divider applications or to guess where the resistance element starts and ends. Precise end points make our linearity specification a reality in your circuits.

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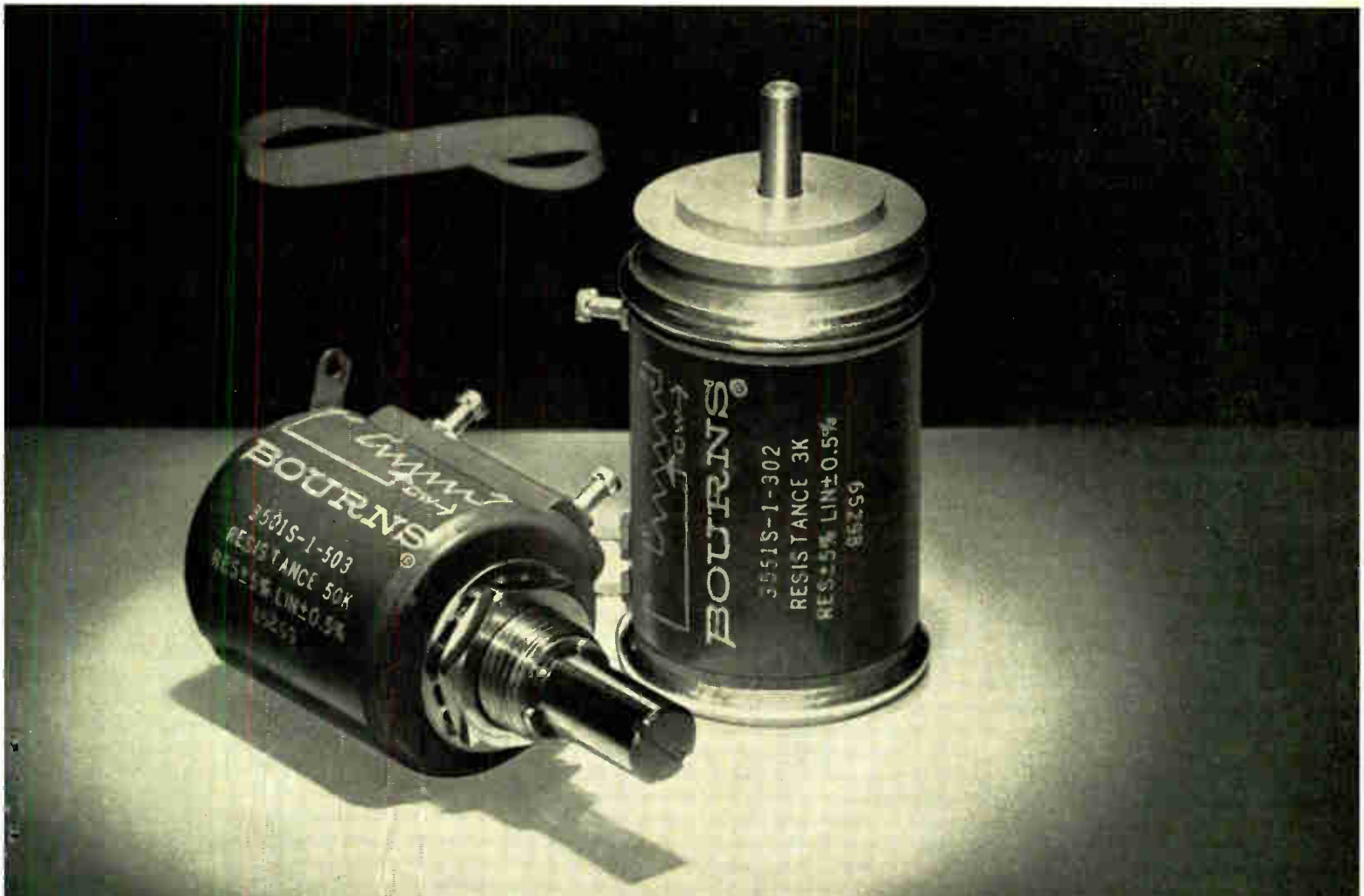
STANDARD SPECIFICATIONS
⅞" Diameter, 10-Turn, Bushing Mount Model 3501
⅞" Diameter, 10-Turn, Servo Mount Model 3551

Noise Performance:	100 ohms or 1% of total resistance, whichever is greater
Humidity Performance:	MIL-STD-202, Method 103
Independent Linearity:	±0.5%
Temperature Coefficient, All Resistances:	±300 PPM/°C
Total Resistance Tolerance:	±5%
Rotational Life:	Model 3501: 4,000,000 shaft revolutions Model 3551: 10,000,000 shaft revolutions
End Resistance:	1 ohm or .1% max., whichever is greater
Electrical Rotation	3600° (+10°/−2°)
Power Rating:	2 watts at 70°C
Operating Temperature Range:	−65°C to +125°C
Environmental Stability:	Resistance shift < 5%
Approximate Weight:	1 oz.
Resistance Range:	1K to 500K
Price, 1-9 pieces:	Model 3501 (Bushing Mount): $14.00 Model 3551 (Servo Mount): $30.00

Long life, ball bearing shaft supports, standard in the servo-mount model, are also available in the bushing-mount unit.



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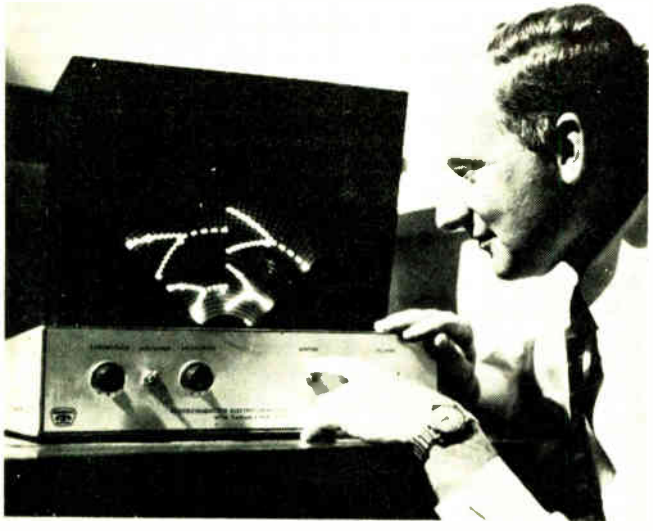
DEVELOPMENTS AND TRENDS AFFECTING THE STATE-OF-THE-ART OF TECHNOLOGIES THROUGH-

A SUBSTITUTE for relatively low-Q inductances that is made by microelectronic methods has been reported by ITT. Developed in a British laboratory of ITT, the experimental device, a lumped twin-T can provide a useful filter element. It is possible, according to the report, to build thin-film resistance-capacitance combinations mutually distributed in 2 dimensions. By sequentially depositing resistance, dielectric, and conducting films and by adding a resistor, a resistance-capacitance notch filter is obtained. It has electrical properties similar to a lumped twin-T network. Q of the filter can be improved by tapering the resistance film.

AN ELECTRONIC SYSTEM capable of suspending oceanographic instruments at predetermined depths to gather scientific data has been developed by Sylvania. It automatically seeks a required depth and hovers during an experiment, returning to the surface after its task is completed. Designed to be launched from aircraft, surface vessels or submarines, it can also be programmed to change depths as desired.

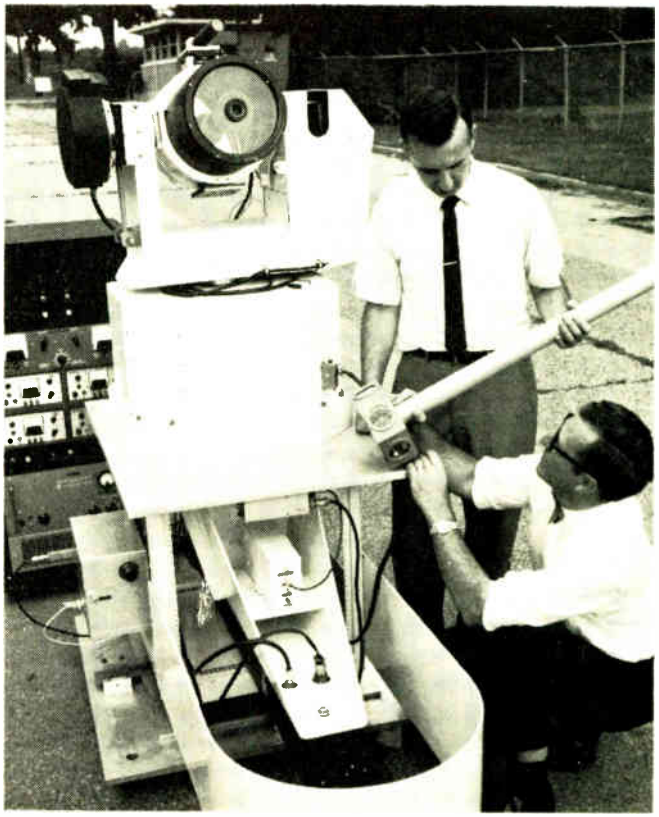
A COMPUTER-BASED SCANNING SYSTEM to study bacteria, viruses, and other microorganisms which infect man is being built by the Univ. of Calif. under a Public Health Service grant. The new system will identify microbes by comparing them with stored images of all known types. Thus, identification may be possible within 12 to 18 hours after examining a patient, rather than after the 48-hour incubation period commonly needed now. The system will be controlled by a PDP-6 computer being supplied by Digital Equipment Corp., Maynard, Mass.

GENERATING AND SETTING any style of type, in any language, on the screen of a cathode-ray tube has been accomplished at Bell Telephone Laboratories. The system has successfully generated and set 150 letters a second of typewriter quality. Its potential is several thousand characters a second, much faster than any other way of setting type, with good quality. This system can produce a variety of typefaces, line drawings, mathematical equations, musical scores, and scientific graphs. Images or letters dis-



▲ **SOLID STATE DISPLAY**

Engineer John Blank checks SS display panel recently announced by General Telephone & Electronics Corp. Designed to vary the time images from sonar signals can be retained, it consists of electroluminescent and photoconductive layers. Advantages over CRT displays are its compact size and adjustable persistency.



played on the CRT screen are photographed; and the film negative then makes, by normal methods, a plate for later printing. The experimental set-up includes a digital logic network, a CRT, and a camera. The type faces are stored in digital form. To change type faces, only the program instruction must be changed.

NEW NASA REPORT surveys aerospace advances in microelectronics that may be exploited for non-aerospace uses. The survey reviews work with commercial potentialities in which nearly every NASA center and contractor for NASA has been involved. It describes fabrication of circuits in and on thick and thin films, and on single-crystal substrates. Copies on this survey on "Microelectronics in Space Research" (NASA SP-5031) may be obtained from the Supt. of Documents, U. S. Govt. Printing Office, Washington, D. C. 20402 for 60 cents.

AUTOMATIC ALARM SYSTEM developed by Westinghouse engineers detects intruders by earth tremors. The system forms a "no man's land" around the perimeter of a protected property. Any intruder attempting to cross this protective strip of ground generates tiny earth tremors. Sensitive transducers buried below ground in the strip pick up these tremors and convert the pressure changes into electrical signals which trigger an alarm.

OPTICAL "READER" recently installed in the Detroit post office is designed to sort incoming and outgoing machine-printed, ZIP Coded mail to 300 separations at a rate of 36,000/hr. Attached to an existing letter sorter, it also has the capability of reading the second line of the address and of sorting incoming and outgoing mail directly to the letter carrier delivery routes. The reader, developed by Philco Corp., is 15 times faster than hand sorting. According to the P. O. Dept., it is the first reading machine to be used by any postal service in the world.

◀ INFRARED-AIMED LASER RADAR

Experimental IR-aimed laser radar is set up for a test at Sperry Rand Corp., Great Neck, N. Y. It will track and range on cooperative targets with less than a 2-foot error at ranges up to 7 miles. The two engineers shown in the photograph are preparing to mount a corner reflector on a distant target structure for a ranging check.

EXPERIMENTAL SATELLITE "BAKE OVEN"

"Bake oven" at Westinghouse Research Laboratories uses the sun's rays to heat solar cells. Such cells are damaged by radiations in space, but proper heating quickly repairs this damage. Company researchers are seeking ways to do the heating aboard the satellite itself by concentrating the sun's rays with a flat "burning" lens.

SEMICONDUCTOR DEVICES that can generate and amplify microwaves at higher power levels than transistors and tunnel diodes are being investigated at Bell Telephone Laboratories. These "transit time" devices have generated up to 60 mw of continuous power in the 2-11 GHz range. They are referred to as "transit time" devices because their frequency is, in part, determined by the time needed for electrons to move ("transit") through a region in the material. They operate as self-excited generators or oscillators. Amplification is also achieved from the same devices by using external stabilizing circuitry. All the devices operate at room temperature. Three types are being studied at Bell Labs. They are: bulk gallium arsenide, silicon avalanche diodes, and Read avalanche diodes.

THREE HIGH-SPEED COMPUTER MEMORIES were displayed by IBM at the recent Fall Joint Computer Conference. The experimental devices shown were a magnetic core with a 7.5-thousandths-of-an-inch inner diameter; a tunnel diode "scratchpad" memory; and a 32-circuit monolithic memory chip. A *ferrite core memory* with a density of 4,000 bits of information/in.^{2} was built using the cores. The memory has a cycle time of 375 nsecs. The *"scratchpad"* has a capacity of 64 48-bit words. Cycle speeds in the 25-nsec range have been proven feasible with this unit. In the *monolithic memory module* two silicon chips are mounted on a ½ in. square ceramic substrate to form the 32-bit unit. Each chip contains 148 components. These form 16 circuits, with each of the circuits storing one bit of information.

NEW MOTOROLA DEVICES GIVE THAT "SOMETHING EXTRA" To Your New Equipment Designs

Here are new semiconductor devices that put an added measure of performance in the designer's tool box – devices that make it possible to build those "temporarily shelved" designs that needed "just a little better device" to make them work.

Look them over . . . order evaluation units from your nearest Motorola semiconductor distributor . . . see how these new units solve your design headaches. Then, contact your local Motorola district representative for the quantities you'll need in production.

If you would like specific details about a particular device mentioned here, write to the Technical Information Center, Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona 85001.

NEW MOTOROLA VARIABLE THRESHOLD LOGIC SOLVES INTEGRATED CIRCUIT NOISE PROBLEMS!

MC650G – Dual 3-Input Gate
MC651F – Dual 4-Input Gate
MC652G/F – Gated R-S Flip-flop

- Noise immunity selectable from 2 to 5 volts
- 10-volt logic swing — allows direct interfacing without extra buffer stages
- Direct interfacing with conventional DTL circuits
- For applications up to 1 mc

A new circuit design approach for computers intended for industrial applications where high-noise environments create special problems for logic engineers.

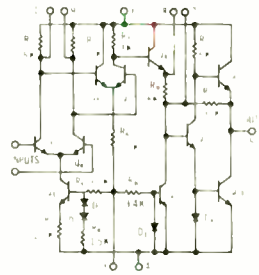
MEDIUM and HIGH POWER SILICON TRANSISTORS for BOTH DRIVER and OUTPUT APPLICATIONS!

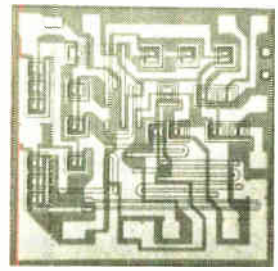
MEDIUM-POWER
(25 watts — P_D) 60 V and 80 V (TO-66)
NPN – Types 2N3766-2N3767
PNP – Types 2N3740-2N3741

HIGH-POWER
(150 watts — P_D) 60 V and 80 V (TO-3)
NPN – Types 2N3713-2N3716
PNP – Types 2N3789-2N3792

New high-performance, low-priced silicon power transistors now offered in complementary specifications to provide a new level of design flexibility.

HIGH-INPUT-IMPEDANCE MONOLITHIC INTEGRATED CIRCUIT OPERATIONAL AMPLIFIERS



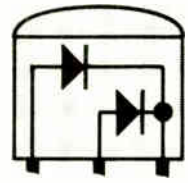


- Choice of input impedance levels
  — conventional input 20 k ohms (MC1530)
  — Darlington input 2 megohm (MC1531)
- Drive a 1000 ohm load
- Open-loop gain of 6000/3500

Two new Motorola monolithic operational amplifiers offer a choice of conventional (MC1530) or Darlington (MC1531) inputs. The units feature high input impedance and superior output voltage swing.

TWO-IN-ONE UNIBLOC* DUAL SWITCHING DIODES

. . . priced lower than 2 individual diodes!

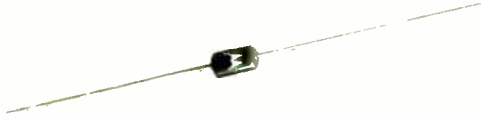


MSD6100

- High Voltage — BV_R = 100V (min)
- Low Recovery Time — t_{rr} = 4 nsec (max)
- Low Diode Capacitance — 1.5 pF (max), VR = 0V

An entirely new approach to diode pairs, the Motorola MSD6100 dual switching diode offers the common cathode configuration in the high reliability Motorola "Unibloc" plastic package.

HIGH-VOLTAGE SURMETIC* RECTIFIER SERIES (1000-3000 V)



- Low leakage currents @ rated PRV
- Packaged in high-reliability, silicone polymer encapsulation — types MR990 thru 994

A true inorganic glass surface passivation, a silicone plastic package, and conservative ratings give these high-voltage "Surmetic" rectifiers top reliability and performance.

NEW COMPACT, LOW-COST ELF* SCR LINE

8-AMPS (rms), MCR2304/5 and MCR2604/5 Series

MCR2304

- New low-silhouette packaging
- New low prices
- New welded, lug-type terminals

Economy, compactness, and mounting ease combine to highlight this "second generation" series of 8-amp SCR's from Motorola . . . permitting less costly, simpler circuit assembly and wiring.

NEW HIGH-POWER RF OUTPUT SILICON ANNULAR TRANSISTORS

. with your choice of voltage levels!

	12 VOLT SUPPLY	25 VOLT SUPPLY
4 Watts @ 175 mc (TO-39)	2N3924	2N3553
5 Watts @ 175 mc (102 pkg)	2N3925	2N3961
7 Watts @ 175 mc (TO-60)	2N3926	2N3375
12 Watts @ 175 mc (TO-60)	2N3927	2N3632 (13.5W)

— All are triple diffused for larger safe area operation!

Choose either a 12 or 25 volt power supply, then pick the Motorola RF transistor that provides the required output. Use them as driver-output combinations, too!

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Under this growing program, we keep about 205 types of relays, switches and accessories on hand at all times. In quantities large enough to fill your ordinary requirements within one week.

*U S Patent Pending

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COMING EVENTS

January 1966

Jan. 25-27: 12th Annual Symp. on Reliability, IEEE, ASQC, et al; Sheraton Palace Hotel, San Francisco, Calif.

Jan. 30-Feb. 4: IEEE Winter Power Mtg., IEEE; Statler-Hilton Hotel, New York, N. Y.

Jan. 31-Feb. 2: Int'l Symp. on Information Theory, IEEE; UCLA, Los Angeles, Calif.

February

Feb. 2: Integrated Circuits Seminar, IEEE; Stevens Inst. of Tech., Hoboken, N. J.

Feb. 2-4: 7th Western Conv. on Aerospace & Electronic Syst., IEEE; Los Angeles, Calif.

Feb. 9-11: Int'l Solid-State Conf., U of Penna., IEEE; Univ. of Penna., Sheraton Hotel, Phila., Penna.

'66 HIGHLIGHTS

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

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

Nat'l Electronics Conf., Oct. 3-5, IEEE; McCormick Place, Chicago, Ill.

March

Mar. 2-4: Scintillation & Semiconductor Counter Symp., IEEE; Shoreham Hotel, Washington, D. C.

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

Mar. 26: Quality Control and Reliability Conf., American Society for Quality Control; Hofstra Univ., Hempstead, L. I., N. Y.

April

Apr. 4-5: Rubber & Plastics Industries Tech. Conf., IEEE; Sheraton-Mayflower Hotel, Akron, Ohio.

Apr. 12-14: Int'l Symposium on Generalized Networks, IEEE, OSA, Brooklyn Polytech, et al; Hotel Commodore, New York, N. Y.

Apr. 12-15: 4th Quantum Elect. Conf., IEEE; Towne House, Phoenix, Ariz.

Apr. 18-21: Spring URSI-IEEE Meeting, URSI, IEEE; Nat'l Academy of Sciences, Washington, D. C.

Apr. 20-22: Southwestern Conference & Exhibition, IEEE; Memorial Auditorium, Dallas, Tex.

Apr. 26-27: 14th Annual Nat'l Relay Conf., Oklahoma State U., Nat'l Assn. Relay Mfrs.; Student Union Bldg., Stillwater, Okla.

Apr. 26-28: Spring Joint Computer Conf., IEEE, AFIPS, ACM; Boston Civic Center, Boston, Mass.

Apr. 26-28: Future Engineering for Earth and Space Conf., IEEE; Pioneer Int'l Hotel, Tucson, Ariz.

Our Elmenco capacitors get burned. So you won't.

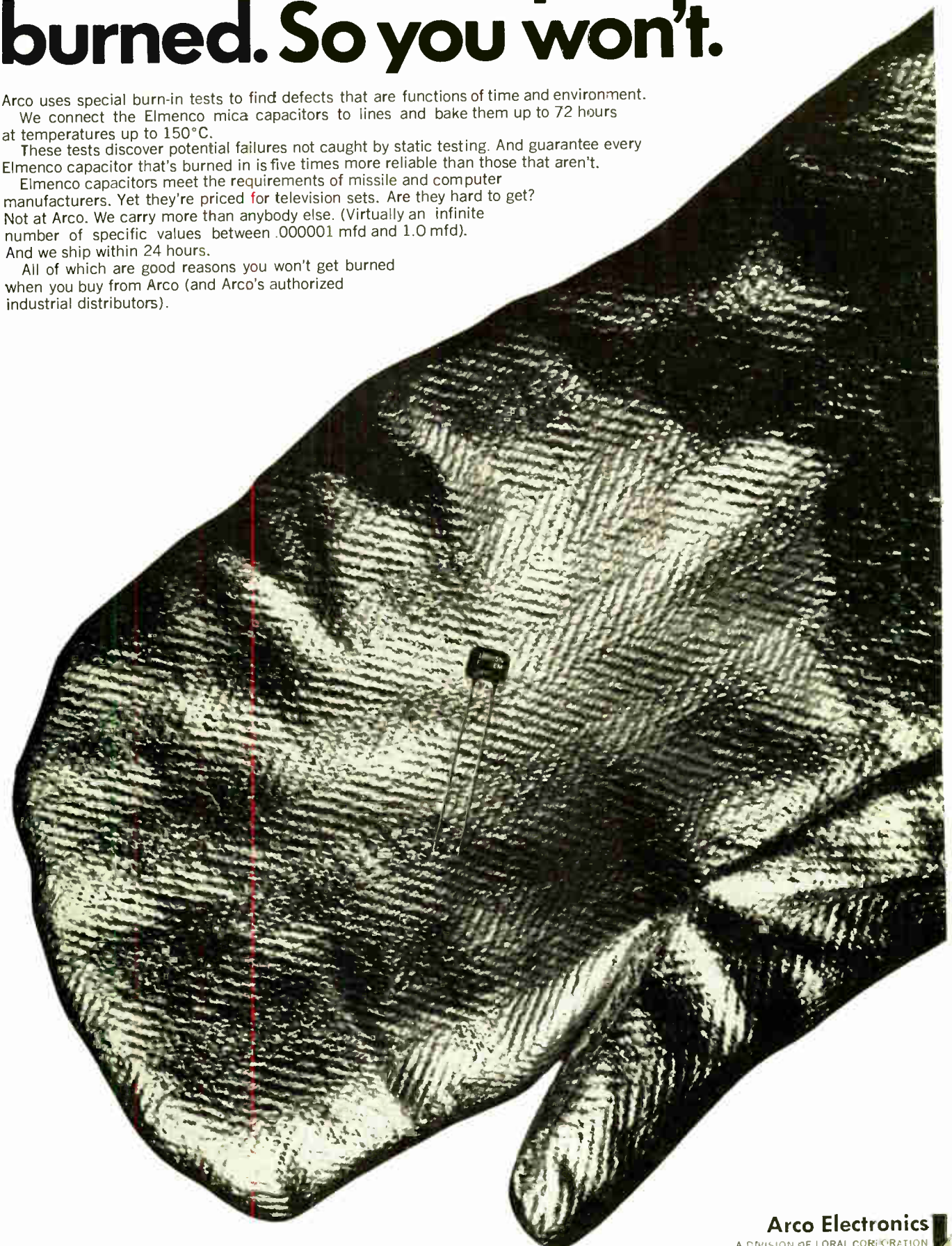
Arco uses special burn-in tests to find defects that are functions of time and environment.

We connect the Elmenco mica capacitors to lines and bake them up to 72 hours at temperatures up to 150°C.

These tests discover potential failures not caught by static testing. And guarantee every Elmenco capacitor that's burned in is five times more reliable than those that aren't.

Elmenco capacitors meet the requirements of missile and computer manufacturers. Yet they're priced for television sets. Are they hard to get? Not at Arco. We carry more than anybody else. (Virtually an infinite number of specific values between .000001 mfd and 1.0 mfd). And we ship within 24 hours.

All of which are good reasons you won't get burned when you buy from Arco (and Arco's authorized industrial distributors).



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COMMUNITY DRIVE, GREAT NECK, N.Y./DA. LAS, TEXAS/PASADENA, CALIFORNIA WRITE FOR OUR FREE CATALOG

ELECTRONIC INDUSTRIES WASHINGTON TRENDS

GOV'T BRIEFING SET—The Defense Dept. will hold at least five regional briefing sessions in 1966 for defense contractors and prospective defense contractors. The broad subject matter is Advanced Planning. The schedule: Boston, March 3, 4; Atlanta, March 9, 10; St. Louis, March 16, 17; San Francisco, April 12, 13, and Washington, D. C., April 27, 28. Military and civilian officials will preside.

NEW TV NETWORK IN '67—A fourth national commercial TV network in 1967 is forecast by FCC Commissioner Robert E. Lee. Mr. Lee bases his prediction on the "brisk rate" of conversions (about 1.25%/month) to UHF, plus sales of VHF-UHF TV sets. New Census Bureau data indicates that about 22% of all consumer sets can now receive UHF, although this figure varies from one area to another.

ELECTRONIC PRINTING—Government communications experts are keenly interested in a new electronic printing process being developed at the University of Pittsburgh. In the new process, typists punch tape fed into an electronic reader (actually a complex of computers) that automatically makes photograpic plates of the text. Printing is then done from these plates.

MORE RADIOS ON SHIPS—The U. S. Coast Guard is formally calling for more shipboard radio gear. Specifically, the USCG wants bridge-to-bridge radio communication on all ships of 300 tons (power; not sail) or more, on all passenger ships of 65 ft or more, and on all towing vessels of 26 ft or more. The radio equipment should be designed for operation on the 156-174 MC band.

U. S. SHOWS PRODUCTS IN YUGOSLAVIA

Computer systems such as one exhibited here by Control Data Corp. attracted attention of Yugoslavs as they toured U. S. Exhibit of recent international trade fair at Zagreb. More than 494,000 persons saw products of some 71 American manufacturers at this 10th exhibition in Zagreb, reports U. S. Bureau of International Commerce.

CONTRACT DISTRIBUTION—A new Senate subcommittee on national research policy plans to investigate and improve distribution of federal R&D contracts. Sen. Frank R. Harris (D.-Okla.) subcommittee chairman, says a small number of institutions now monopolize most federal research contracts. He contends that outsiders cannot break into "this charmed circle." Wider distribution of contracts will eventually mean new government processes for awarding them.

TECHNICAL DATA VIA STATES—Commerce Dept. is asking the 50 states to designate institutions capable of joining in the new federal program of information dissemination. Under the new Technical Services Act, the government is assuming a positive role in disseminating data to industry, which can be technical reports, abstracts, computer tapes, microfilm, reviews, or reference services.

INTELSAT OKAYS SATELLITE—Plans to launch two second-generation international communications satellites (also to serve the Apollo program) are breaking through international red tape. International Telecommunications Satellite Consortium (Intelsat) has seconded U. S. approvals for Comsat Corp. to buy the satellites from Hughes Aircraft Co. The plan is to orbit one of the 150-lb. satellites over the Pacific, and one over the East Coast of Africa. More sophisticated than the Early Birds, they'll be orbited by NASA at about 22,300 miles high.

MICROWAVE SHARING PROPOSED—FCC proposes a major shift in policies on sharing in safety and special microwave services. The commission has issued a proposed rule to relax present bans on sharing of private microwave facilities so that anyone eligible for the same radio service could share a microwave system. It would also permit cross service sharing by commonly owned companies, public safety agencies, right-of-way companies and companies whose rates are publicly regulated.

R&D SPENDING SLOWED—While increased action in Vietnam is bulging defense supply orders, it is hurting the progress of R&D. While working on military requests for fiscal 1967, budget-makers are having a hard time holding the level of spending for continued development of new weapons systems. No major projects will be cancelled, but the rate of their R&D will be slowed somewhat. The cost of keeping an expected force of 100,000 men in Vietnam would be about $4 billion a year—which will mean some belt-tightening in other defense areas.

TEAR OUT AND SAVE FOR FUTURE REFERENCE

• quick reference guide to RCA memory cores

Whatever your ferrite memory requirements, RCA has the right cores...conventional, wide-temperature-range or special-purpose types

Two new cores, **RCA types 1100M5 and 1101M5,** are specially designed and characterized for the new "2½D" and "3D" schemes for memory system operation. Check the table below for the basic characteristics of these new cores which also feature extra-square hysteresis loops.

RCA WIDE-TEMPERATURE-RANGE CORES
Operate over any 100° C range between the limits of —55° C and +125° C without temperature compensation, air conditioning, or special cooling.

CORES FOR SPECIAL APPLICATIONS
For custom-formulated cores designed to meet your special or unusual requirements, ask for a quotation.

FOR MORE INFORMATION and extra copies of our Quick Reference Guide, write, wire or phone your local RCA Sales Office, or: RCA Electronic Components and Devices, Memory Products Operation, 64 "A" Street, Needham Heights, Mass. Telephone: (617) 444-7200.

YOUR SYSTEM CYCLE-TIME	RECOMMENDED RCA CORE TYPE		RECOMMENDED COINCIDENT-CURRENT DRIVE CONDITIONS PULSE CHARACTERISTICS @ 25 C				TYPICAL OUTPUT CHARACTERISTICS @ 25°C				CORE SIZE OD/ID
(Coincident-Current)	Conventional	Wide-Temp Range	I_m in Ma	I_{pw} in Ma	t_r in μsec	t_d in μsec	dV_1 in mv	dV_2 in mv	t_p in μsec	t_s in μsec	(in mils)
<1 μsec	NEW! 1100M5	0181M5	875	437.5	0.05	0.2	35	5	0.10	0.18	20/12
			875	437.5	0.05	0.2	40	5	0.10	0.18	23/15
1 to 2 μsec	0183M5		550	275	0.1	0.5	55	7	0.21	0.41	30/18
	0172M5		700	350	0.1	0.4	60	5	0.18	0.36	30/18
	0175M5		700	350	0.05	0.3	40	5	0.13	0.25	23/15
		270M1	800	400	0.1	0.5	65	6	0.21	0.41	30/18
		0187M5	820	410	0.05	0.25	35	5	0.11	0.22	20/12
		NEW! 1101M5	850	425	0.05	0.25	38	4	0.12	0.24	23/15
2 to 4 μsec	0173M5		450	225	0.2	0.8	50*	4	0.36	0.60	30/18
		0167M5	625	312.5	0.2	0.8	50	4	0.36	0.58	30/18
4 to 6 μsec	232M1		480	240	0.2	1.5	80*	10	0.45	0.95	50/30
		264M1	630	315	0.2	1.5	80*	12	0.45	0.90	50/30
6 to 8 μsec	226M1		400	200	0.5	1.5	80*	7	0.70	1.25	50/30
		269M1	480	240	0.5	1.75	55	7	0.80	1.50	50/30
over 8 μsec	225M1		250	125	0.5	3.0	35*	3	1.15	2.40	50/30
	222M2		400	200	0.5	3.0	75*	10	1.15	2.30	80/50
		269M1	480	240	0.5	1.75	55	7	0.80	1.50	50/30

RCA ELECTRONIC COMPONENTS AND DEVICES

* μV_1

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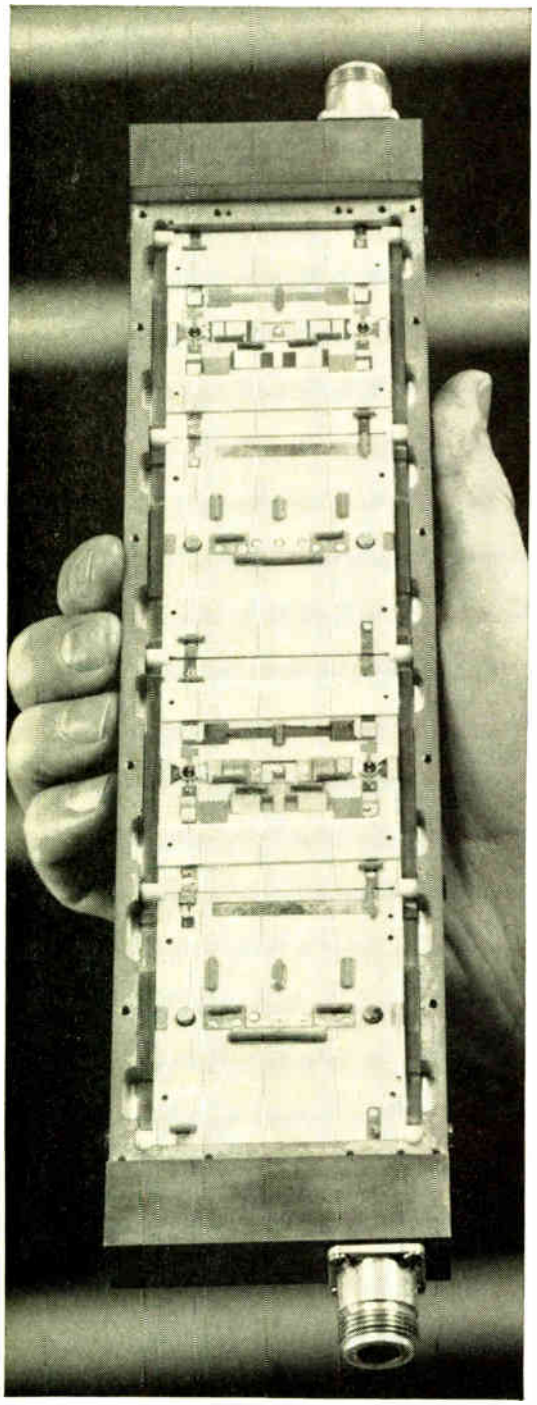
Circle 16 on Inquiry Card

Report from

BELL LABORATORIES

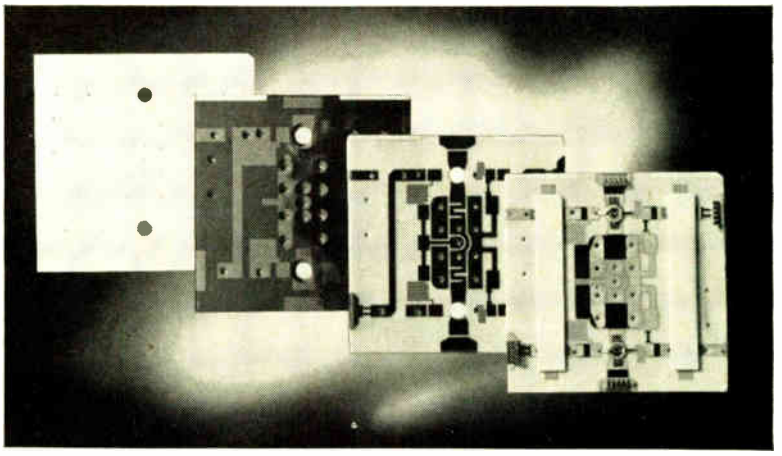
Integrated circuits at microwave frequencies



Laboratory model of a four-stage microwave amplifier which can provide up to 40-db gain and noise figures as low as 3 db in the 1- to 2-gigacycle frequency range. Similar amplifiers have been developed to operate at frequencies from 0.5 to 4 gigacycles with bandwidths of 1000 mc.

Engineers at Bell Telephone Laboratories have developed integrated circuits for use as amplifiers in the microwave range. Thin-film tantalum techniques are used to provide the precise, stable resistors, capacitors and transmission-line components required at microwave frequencies. Improved transistors provide up to 10 db of gain per stage and noise figures as low as 3 db.

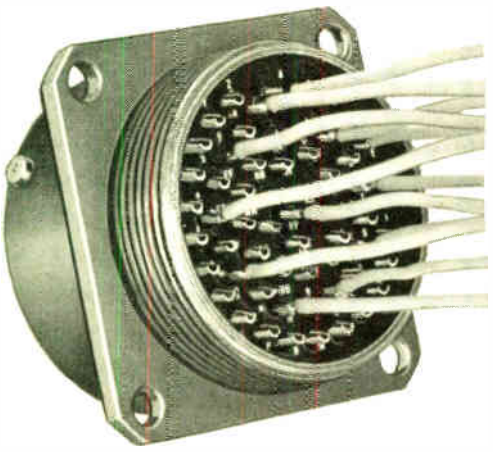
A "balanced" design, using a power-splitting directional coupler, makes possible wideband, stable gain characteristics without the need for tuning adjustments. Up to the highest frequency for which these amplifiers are now usable—4 gigacycles—the electrical performance characteristics are equal or superior to those of low-noise traveling-wave tubes. In addition, they have the other advantages of solid-state circuitry, such as long life and reliability.



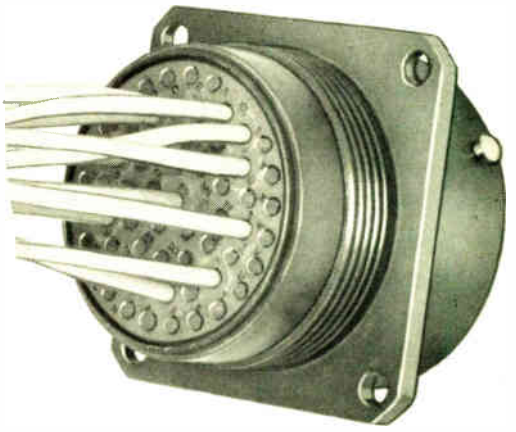
Thin-film techniques are used in the integrated microwave amplifier. Starting from bare ceramic substrates of about 2 x 2 inches (left), partially finished circuits are shown during the multi-step fabrication process. Circuit at right, complete with transistors, comprises one stage of amplifier. "Balanced" design with electrically similar transistors gives precise wideband amplification in the low-microwave-frequency range.

Bell Telephone Laboratories
Research and Development Unit of the Bell System

MS-3110
MS-3112
MS-3114
MS-3116
MS-3118
MS-3120
MS-3122
MS-3124



Solder Terminals



Crimp Terminals

26482 CONNECTORS

Methode "Midgets" are available in all standard shell sizes and insert configurations with solder or crimp type terminals.

Removable and replaceable one piece contact retention clips have been proved reliable in over 10,000 insertions and withdrawals.

Methode's unique contacts provide positive contact sooner upon entry of pin; lower insertion force and higher retention without millivolt drop variation.

Methode can provide complete assembled connectors with solder pot terminals or unassembled connectors or will supply contacts only.

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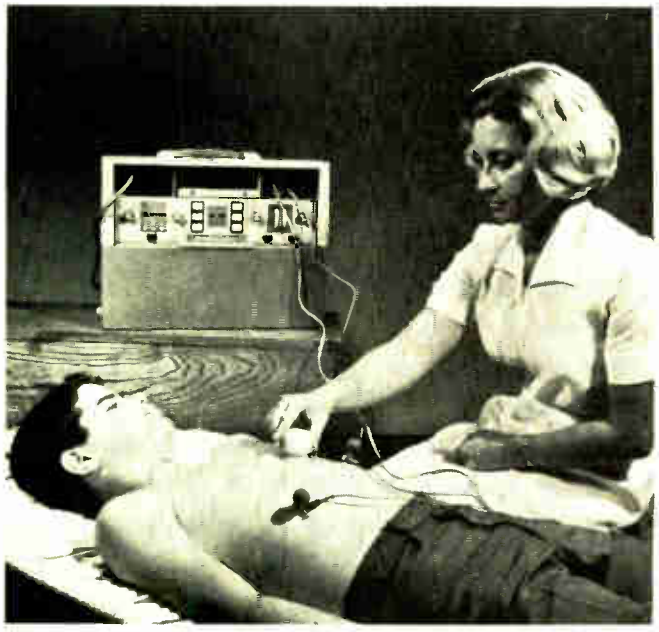


▲ HEART SOUND SCREENING AID

New medical electronic unit, small as an attache case, "listens" to patient's heart and instantly identifies normal and abnormal sounds. Named "PhonoCardioScan," developed by Humetrics, division of Thiokol Chemical Corp., the device is designed for rapid screening of great numbers of people to help physicians locate people with heart disease.

▲ CLOSED CIRCUIT VIDEO RECORDER

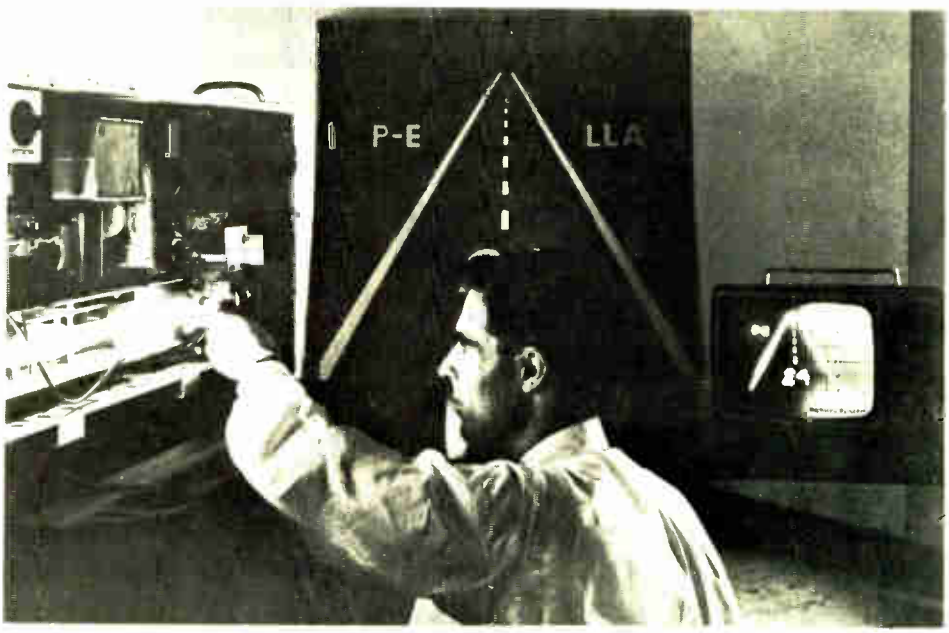
Professional videotape recorder and mobile recording system for closed circuit use in education, medicine and military service, developed by Ampex Corp. Programs produced with the mobile self-contained Videotrainer (VR-7100), according to Ampex, may be played back on any number of conventional TV receivers for any remote viewing.

ELECTRONIC SNAPSHOTS

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

▼ COMPUTER CIRCUIT

Advanced integrated circuits mounted on plug-in element for new UNIVAC 1108 II Multi Processor are examined by J. Frank Forster (right) President of Sperry Rand, and Carl J. Knorr, Vice President UNIVAC Marketing. The 1108 II will provide five times more computing capacity than predecessor 1108, the firm reports.



▲ EXPERIMENTAL LASER TV SYSTEM

Laser television system which needs no studio lights or other external light sources, disclosed by Perkin-Elmer. Scanned by narrow lines of laser light, subjects in complete darkness appear on TV screen as though in broad daylight. Picture clarity is equal to or better than commercial TV, report P-E engineers. Potential uses include commercial TV, all-weather aircraft landing aid (above), law enforcement, studies of animals, and lunar and planetary landing aid for spacecraft.

Helipot's side-adjust Helitrim® cermet trimmer-world's smallest-costs as little as $1.50 in quantity.

Helipot's side-adjust Helitrim® cermet trimmer-world's smallest-costs as little as $1.50 in quantity.

Helipot's side-adjust Helitrim® cermet trimmer-world's smallest-costs as little as $1.50 in quantity.

The Model 62PA side-adjust is a new easy-access cermet trimmer with these quality features: virtually infinite resolution; excellent high frequency characteristics; and standard resistance from 10 ohms to 1 megohm. Its rugged cermet resistance element gives you long, trouble-free life and freedom from sudden failure. Inside its plastic case is a sealed metal housing identical to the popular ¼" top-adjust Model 62P.

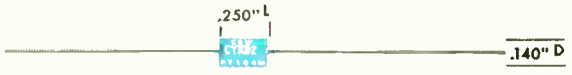
Focus in on delivery advantages, too... immediate stock availability. Call your Helipot sales rep for full specs.

Beckman® INSTRUMENTS, INC.
HELIPOT DIVISION
FULLERTON, CALIFORNIA • 92634

INTERNATIONAL SUBSIDIARIES: GENEVA; MUNICH; GLENROTHES, SCOTLAND; TOKYO; PARIS; CAPETOWN; LONDON

GLA

Now .1 mfd in this case size



New CORNING® GLASS-K Capacitor with CORNING® glass capacitor dependability

SS-K

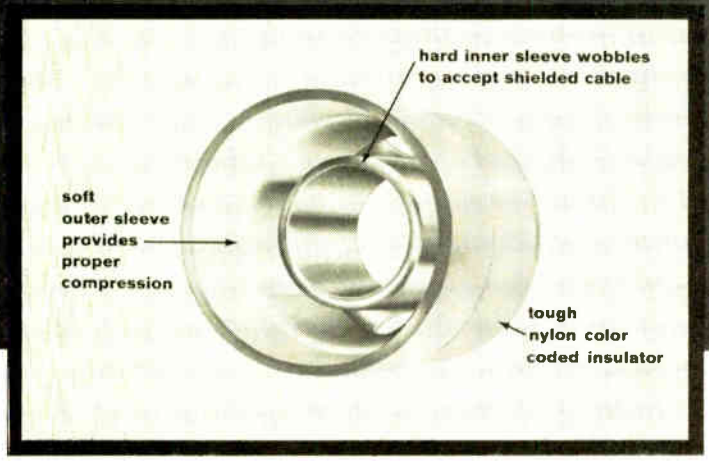
CYK02—100,000 pf in just .250" L x .140" D.
CYK01— 51,000 pf in just .250" L x .100" D.
SMALLER SIZE BY FAR THAN CONVENTIONAL CK CERAMIC TYPES.
Ideal for cordwood packaging and machine insertion applications.
Stability: Remarkable! And predictable. 3 families for optimum stability, capacitance and size.
Voltage Rating: 50 VDC.
Tolerances: 10% and 20%.
Temperature Range: −55°C to +125°C.
Insulation Resistance: 10,000 megohms min.
Power Factor: 2.5% maximum.
Price: Competitive.
Let us tell you more.

Corning Glass Works, Electronics Drive, Raleigh, North Carolina
Please send complete data on the CORNING® GLASS-K Capacitor

Name _____ Title _____
Company _____
Address _____
City _____ State _____ ZIP _____

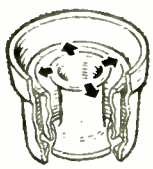
CORNING
ELECTRONICS

NEW WOBBLE-ACTION CONNECTOR



Patent Pending

NEW ONE-PIECE Shielded Cable Connector Employs T&B Shure-Stake™ Compression for Noise-Free Reliability – Meets Performance Requirements of MIL-F-21608B – connector size selection is easy too – nine color-coded sizes cover the conductor insulation range from .030 to .202 dielectric diameter.

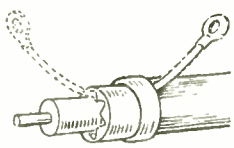


Shield-Kon™ Connectors Provide Quick, Easy Insertion

Floating inner sleeve wobbles as braid is inserted . . . no chance of braid bunching or separating strands. Braid is distributed uniformly between "floating" inner sleeve and outer compression sleeve.

Shield-Kon™ Connectors Allow Absolute Visual Inspection

Two large inspection holes permit clear view of braid. The edge of the transparent nylon insulator is scalloped to permit viewing.



Shield-Kon™ Connectors Ground From Front or Back

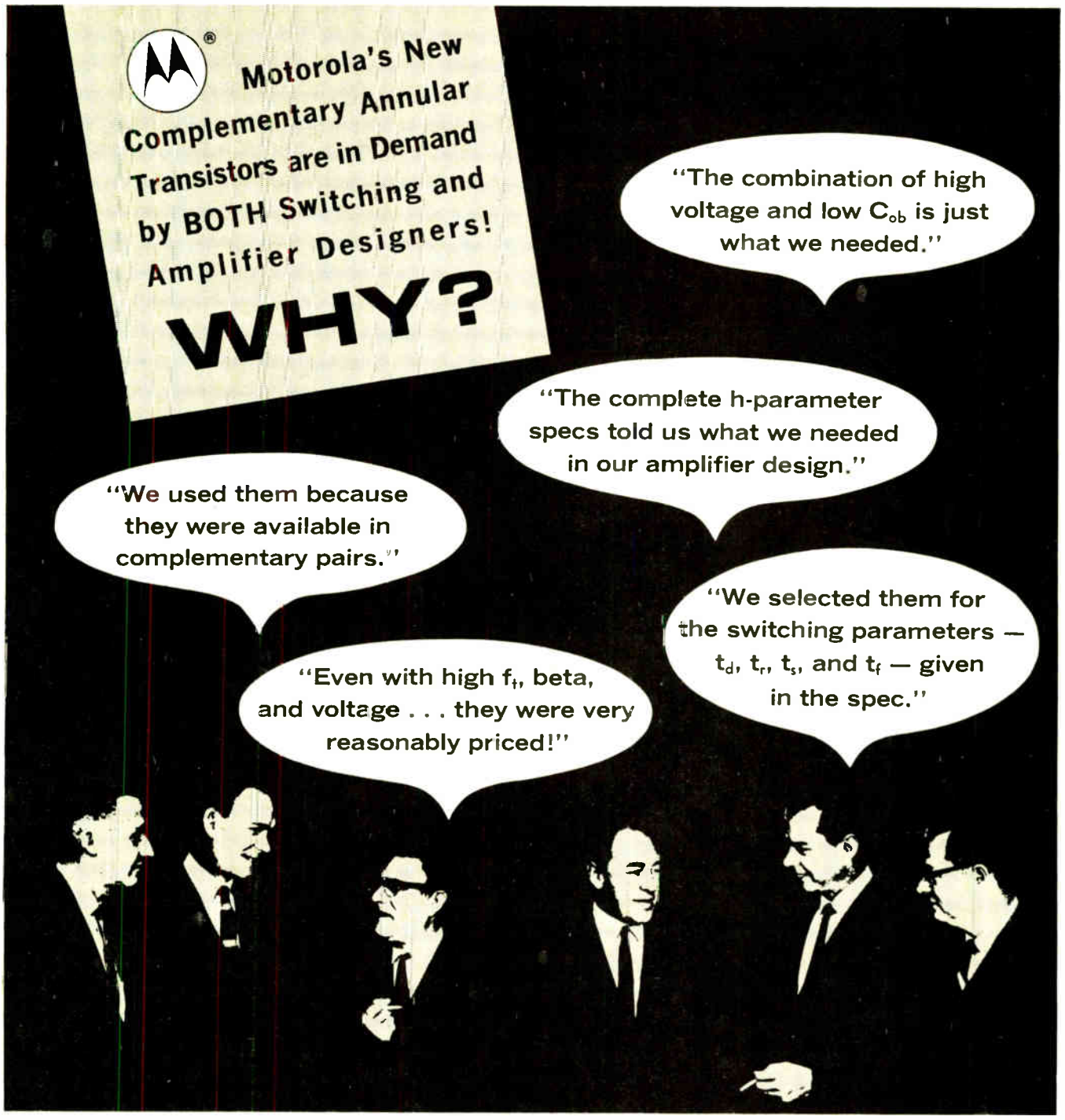
All connectors accommodate either one or two #20 or #22 stranded ground wire from back or through front inspection hole. Can be instal'ed by Class I, MS-25312 tooling or T&B hand and air powered Shure-Stake tools.

The Thomas & Betts Co., Incorporated • Elizabeth 1, New Jersey

In Canada, Thomas & Betts Ltd. • Montreal

T&B ENGINEERED

THOMAS & BETTS



Because these key Motorola transistors (PNP type 2N3250/51 and NPN 2N3946/47) are more completely specified for *both* switching *and* amplifier performance than any other types!

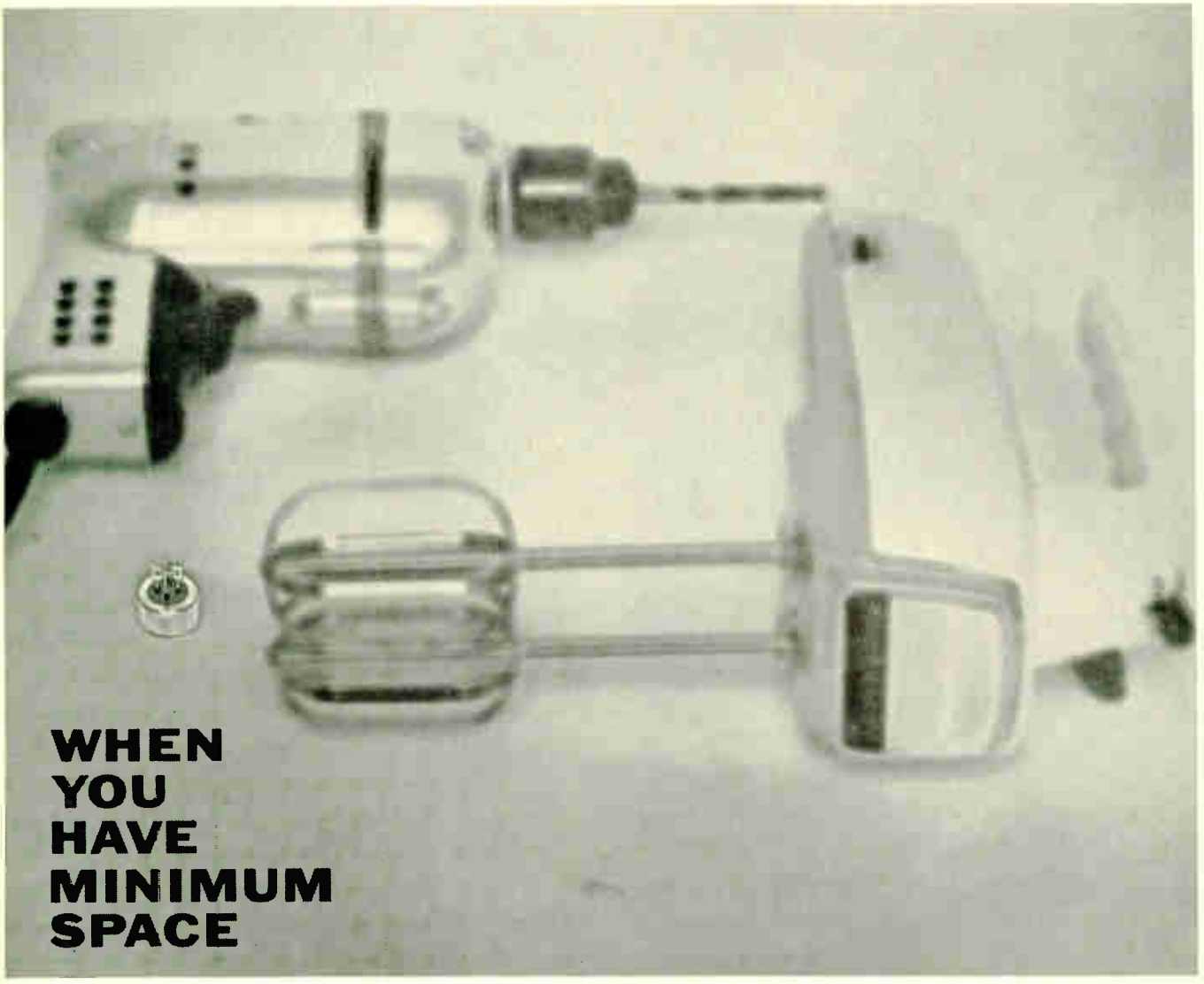
For example, if you're working with amplifiers, the complete h-parameter specs (h_{fe}, h_{re}, h_{ie}, h_{oe}), the 40-volt (V_{CEO}) breakdown voltage, the 250 MHz (min) frequency response, the noise figure spec, and low capacitance values – would be just the measurements you needed for calculating circuit performance.

Or, if you're working with switching designs, the complete switching time specs (t_r, t_d, t_s, t_f), low saturation voltage ($V_{CE(SAT)}$ = 0.25 volts max.), low $r'_b C_c$ value, and low input and output capacitances would be ideal design values to know.

In short, we think you'll find these well-specified Motorola PNP and NPN silicon annular transistors are the "most usable" complementary devices for general purpose switching and amplifier applications available anywhere!

They are available *now* from your local franchised Motorola semiconductor distributor in quantities to 999 or in production lots from your Motorola field representative. Call your Motorola man. He'll be happy to give you samples for evaluation. For complete technical details on PNP types 2N3250-51 or NPN types 2N3946-47, write the Technical Information Center, Motorola Semiconductor Products Inc., Box 955, Phoenix, Arizona 85001.

MOTOROLA
Semiconductors



WHEN YOU HAVE MINIMUM SPACE

and need maximum power-

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SILICON AVALANCHE
INTEGRATED BRIDGE RECTIFIERS

When your design must deliver maximum performance, and you have tight space requirements, Varo's IBR® devices can be a low-cost solution to your rectifier problems.

The IBR® is a **full-wave bridge in one small package** with SAR® (silicon avalanche) characteristics to control transient overvoltages. All devices feature 2000 V minimum circuit-to-case insulation. They are available with 3 versatile mounting methods: press-fit; single-stud; and TO-3 mounts.

For full-wave bridge applications: the 1N4436 (250 V min BV_R), 1N4437 (450 V min BV_R), and 1N4438 (650 V min BV_R). Output current is 10 amps at 100°C (T_C). Three-phase, half, and full-wave rectifiers, full wave center tap rectifiers, and voltage doublers are also available in the IBR® line.

Write today for complete information and a better solution to all your rectification problems.

VARO INC

SPECIAL PRODUCTS DIVISION 2201 WALNUT ST., GARLAND, TEXAS 75041, (AREA CODE 214) 276-6141 TWX 214-276-8577

DPDT TRIMPOT® Relay: 160 mw Sensitivity, Microminiature Size

This new DPDT is more than just small—it's reliable! Subject it to 150 G shock or 40 G, 3000 cps vibration, and you still get the performance that's on the published data sheet. Model 3101 has single-coil design, rotary balanced armature, hermetically sealed case, and self-cleaning contacts. It's designed to meet or exceed all environmental requirements of MIL-R-5757D.

Every relay goes through a 5000-operation run-in and 100% final inspection, including mass-spectrometer leak testing, for all important characteristics. In addition, monthly samples undergo the punishment of the Bourns Reliability Assurance Program. This program, originally developed for TRIMPOT potentiometers, is one of the most extensive series of electrical and environmental tests in the electronics industry. It underscores the trustworthiness of the name TRIMPOT in relays, too.

Model 3101 relays and their SPDT companion, Model 3100, are available immediately from the factory in a full range of coil-resistances and with voltage or current adjustment. Three terminal types, two mounting-bracket styles. Write for complete technical data.

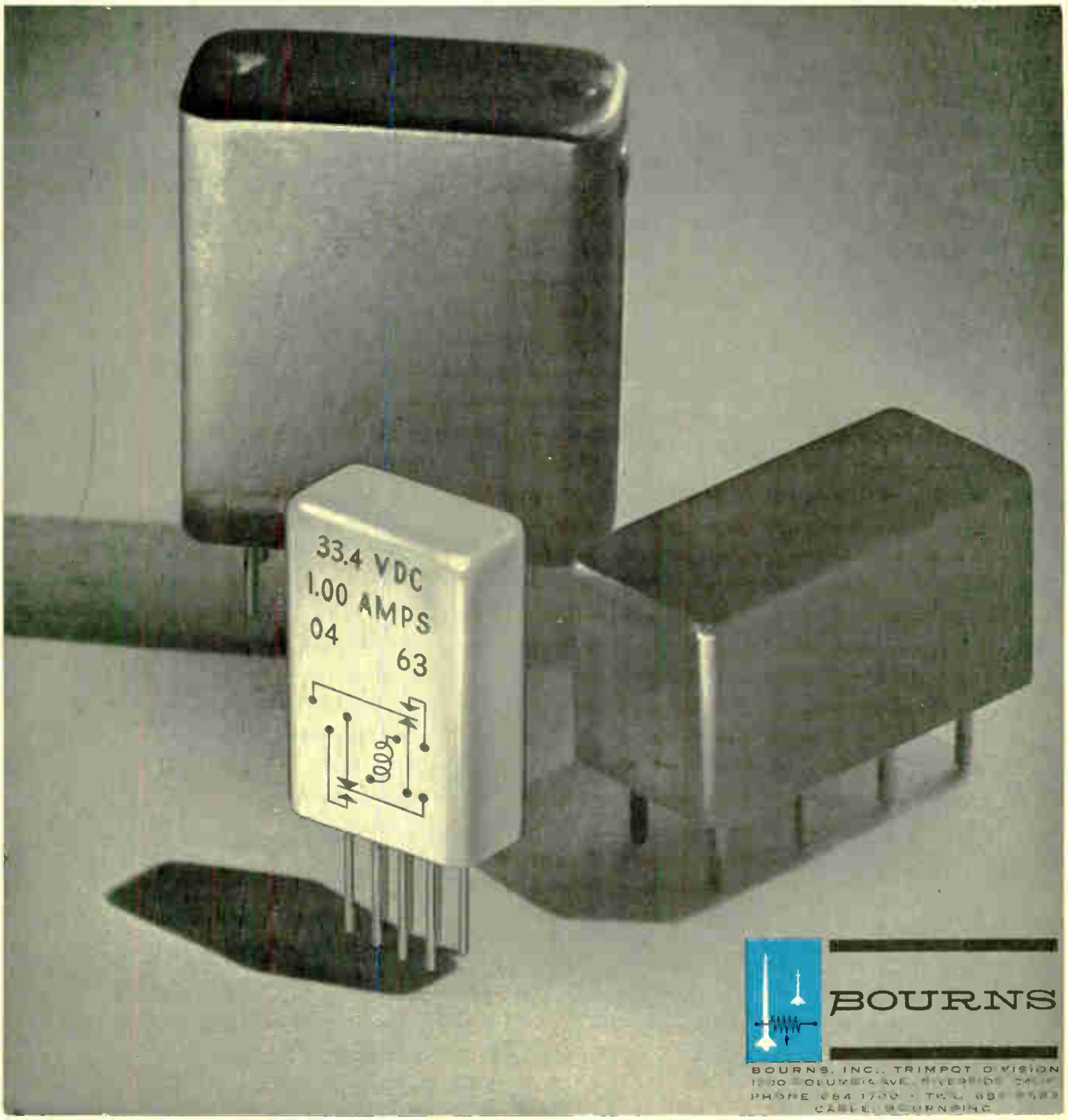
Size: .2" x .4" x .6"
Maximum operating temperature: 125°C
Contacts: DPDT; Rating: 1.0 amp resistive, 26.5 VDC
Coil resistances: 65Ω to 2000Ω
Pick-up sensitivity: 160 milliwatts
Vibration: 40G, 5-3000 cps
Shock: 150 G

ACTUAL SIZE

If it's TRIMPOT, it's BOURNS

Compare its space requirements with those of the usual crystal-can or half-crystal-can types.

TRIMPOT is a registered trademark of Bourns, Inc.



BOURNS

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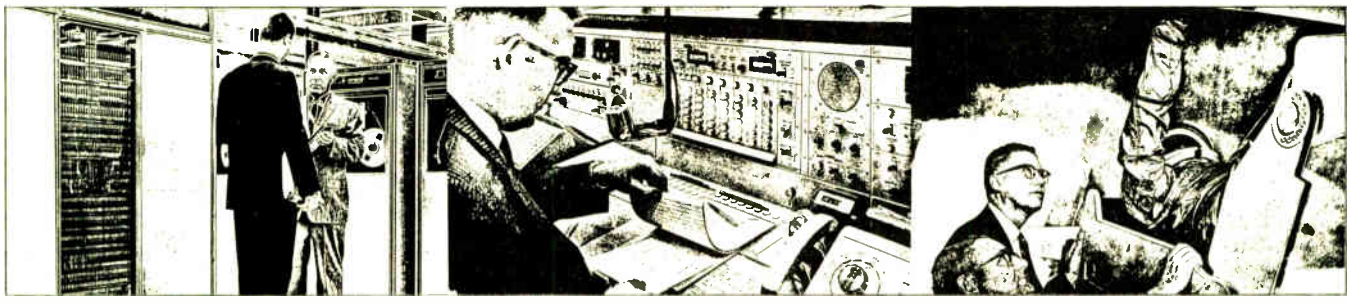
Manufacturer: Trimpot® & Precision Potentiometers, Relays; Transducers for Pressure, Position, Acceleration. Plants: Riverside, California; Ames, Iowa; Toronto, Canada

HERE'S AN OPPORTUNITY



TO IMPROVE YOUR FUTURE

. . . Both professionally and personally. Every project at Collins is the most demanding in its area of industry, and we need professionals to continue the growth this level of quality has created. Living and working conditions — and compensation — are commensurate with these standards. These listings are current.

SEND RESUME FOR PROMPT INFORMATION

MICROWAVE SYSTEMS ENGINEERS — Electrical engineers with experience in microwave communication systems, design, or wire line carrier design. B.S.E.E. preferred. Must be willing to travel. (Dallas)

INDUSTRIAL ENGINEERING — These men will have a wide range of industrial engineering experience. They will be involved in standard data application, cost estimating, utilization studies, layout facilities planning, work measurement and cost reduction. (Cedar Rapids and Newport Beach)

INDUSTRIAL ENGINEERING, MECHANICAL ENGINEERING OR INDUSTRIAL MANAGEMENT GRADUATES — Experience in any of the following areas: manufacturing planning and methods, facilities planning, work measurement, cost reduction and control systems and procedures, tool and equipment design, computerized manufacturing techniques, quality engineering. (Dallas and Newport Beach)

FIELD SUPPORT ENGINEERS — Openings for field engineers with installation and check-out experience in one or more of the following: high density microwave systems, toll terminal equipments, cable and open wire multiplex monopulse tracking techniques, phase locked loop receivers, parametric amplifiers, Cassegrain feeds, tropospheric scatter systems, solid state data systems. Most openings are single status with minimum of one year at location. (Dallas)

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

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

PRODUCTION ENGINEERS — These men should have a background in flight director systems, gyroscopic devices or general electronics manufacturing. This area involves final development, tooling up and development of processes required for manufacture of newly designed avionics products. (Cedar Rapids and Newport Beach)

ELECTRICAL ENGINEER (Test Equipment) — This supervisory position involves the application of advanced techniques in product testing. Background should include utilization of programmed tape control and real time computer control technology and automatic test stations. (Cedar Rapids and Newport Beach)

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

COMMUNICATION / COMPUTATION / CONTROL

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LETTERS

to the Editor

You Missed Us!

Editor, ELECTRONIC INDUSTRIES:

We are somewhat distressed at being omitted from your "1965 Survey of Microwave Semiconductors," which appeared in your Thirteenth Annual Microwave Issue.

It is possible that the questionnaire which you sent did not arrive here, or if it did, it was misplaced. It would be appreciated if you could take steps to insure that we are not omitted from the next issue, since we are manufacturers of microwave varactor diodes and have recently developed some microwave oscillator diodes. Thank you.

A. Lederman
President

MSI Electronics, Inc.
116-06 Myrtle Ave.
Richmond Hill 18, N. Y.

Send Them Books . . .

Editor, ELECTRONIC INDUSTRIES:

I note the letter from Dr. Keats Pullen, Jr., in the October ELECTRONICS INDUSTRIES concerning the educational needs in Okinawa.

The University of the Ryukyus was established in Naha, Okinawa, about 1950 and has since that time been advised by teams from Michigan State University. Currently, the team includes one engineering professor as well as specialists in other areas.

Dr. Pullen is quite correct that additions to their library facilities would be welcomed. Anyone wishing to aid in this way should write Professor Frank S. Roop, MSU Advisory Group, USCAR Department of Education, Naha, Okinawa, for further information and shipping instructions.

All such aid would be much appreciated there.

J. D. Ryder
Dean

Michigan State Univ.
East Lansing, Mich.

Technical Obsolescence

Editor, ELECTRONIC INDUSTRIES:

As Education Chairman of the Richland Section, IEEE, I found your recent article on "How to Avoid Technical Obsolescence" very interesting. I feel that distribution of this article to our membership may stimulate renewed interest in Continuing Education programs in our area. Therefore, would you please let me know if reprints of this article are available and, if so, the cost of 200 copies.

M. L. Faught

2011 West Falls
Kennewick, Wash. 99336

Ed. Note: You have our permission to reproduce 200 copies for your use.

Engineering Obsolescence

Editor, ELECTRONIC INDUSTRIES:

The proper way "How To Avoid Engineering Obsolescence" is to quit talking and (worse yet) writing about it because, in fact, it does not exist. It is simply a myth conjured up by the educationists who did such a poor job during the post-World War II boom and nourished by near-sighted businesses who have a financial stake in keeping salaries as low as possible.

The reason the engineering "profession" is not really a profession is because the naive saps who populate it agree (without thinking) with such nonsense and thereby refuse to *act* like those who the public already regard as professionals.

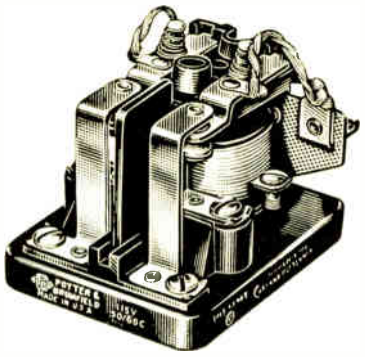
Despite all of the advances in medicine, for example, have you ever heard a medical doctor admit to being obsolete? Or do you see public pronouncements and surveys on medical obsolescence? Of course not. The *professional* thing to do is to do the best you can, keep your yap shut, and properly police your own profession to keep the grossly incompetent ones under control.

With the hundreds of new laws and new interpretations of existing laws, have you ever heard a lawyer admit that he was obsolete? Of course not. The legal profession also conducts themselves as do the medical doctors.

A professional man is a man of reasonable ability who does the best he can, knows when to call in consultants, carries himself with *quiet* dignity and does not undermine himself or his profession by shouting his shortcomings from the housetops.

Incidentally, even in your business, is it the nightschool students who really get the promotions? Or are they regarded as the ones who lack confidence in themselves?

Ed. Note: It is not our policy to publish unsigned letters. In this case the writer asked us not to divulge his name. However, we thought his comments were worth reading, so we are complying with the writer's request.

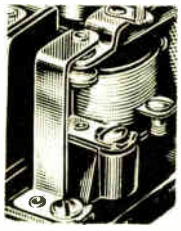


Here's why engineers have specified this heavy duty 25 amp relay by P&B for over 30 years

This is the granddaddy of all P&B relays. Our very first design. Many millions are in use throughout the world . . . starting motors, controlling elevators, switching high current and voltage loads, doing a multitude of heavy duty jobs, reliably. Year after year, the PR Series remains high on our best-seller list. Here are some reasons why.

EXCELLENT CONTACT WIPE ACHIEVED WITH FLOATING CONTACT CARRIER

PR relays are designed with a full floating carrier for the movable contacts. Beside providing sufficient contact pressures, the floating carrier builds-in an abundance of wipe to keep the contacts scrubbed on every operation. Large, 5/16" diameter contacts switch 25 ampere non-inductive loads or 1 HP at 115/230 VAC, single phase. A phenolic barrier between the contacts of multipole relays prevent flash-over between contacts.

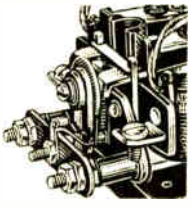


SELECT FROM A VARIETY OF CONTACT ARRANGEMENTS

PR reliability is available in relays having the following contact arrangements: SPST-NO, SPST-NC, SPST-NO-DB, SPST-NC-DB, SPDT, DPST-NO, DPST-NC, and DPDT. Coil voltages range from 6 to 440 volts A.C., and 6 to 110 volts D.C. A vast number of special variations of these standard parameters have been engineered over the years.

AUXILIARY CONTACTS ADD TO VERSATILITY OF PR RELAYS

A single set of auxiliary contacts (Form A, B or C) can be supplied when the application demands. They are rated at 5 amperes at 115 VAC, 60 cycle resistive. Standard models of PR relays with auxiliary contacts are available from leading electronic parts distributors.

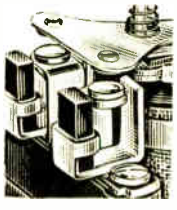


MANY STANDARD RELAYS ARE LISTED BY U/L AND CSA

A wide range of standard PR relays is listed by Underwriters' Laboratories (File E22575) and Canadian Standards Association (File 15734). CSA listing covers AC relays only. These listings can often save you time and extra expense when obtaining UL or CSA qualification for your products.

MAGNETIC ARC-QUENCHERS FURNISHED ON SOME MODELS

For DC loads over 28 VDC, PR relays with normally open contacts can be furnished with permanent magnets to quench arcs. These magnets increase the DC voltage rating to 220 volts resistive . . . and often increase the life of contacts handling DC inductive loads.



PR SERIES SPECIFICATIONS

GENERAL:

Mechanical Life: Single-pole, 1,000,000 (cycles); double-pole 10,000,000 (cycles).

Contacts: 100,000 cycles at rated load. Contact life increases at smaller loads or with appropriate arc suppression.

Breakdown Voltage: 1,500 volts rms minimum between all elements and ground.

Ambient Temperature Range:
DC: −55 to +80° C.
AC: −55 to +45° C.

Weight: Approximately 10 ozs.

Pull-In
DC: 75% of nominal voltage (approx.)
AC: 78% of nominal voltage (approx.)

Terminals: Heavy-duty screw type terminals are standard for coil and contacts. Available with printed circuit, plug-in, ¼" quick connect and terminals for rear panel wiring.

Enclosure: PR dust cover.

CONTACTS:

Arrangements: Up to 2 Form C (DPDT.)

Material: ⅜" dia. silver standard. Other materials available for special applications.

Load: 25 amps non-inductive or 1 HP @ 115/230 volts AC, single phase. Special version—30 amp. non-inductive at 115/230 VAC; single phase available. (Consult factory)

COIL:

Voltage: AC: 6 to 440 volts.
DC: 6 to 110 volts.

Power: DC: 2.0 watts nominal.
AC: 9.8 volt-amps.

Resistance: 63,800 ohms maximum.

Duty: Continuous, AC or DC (DC coils will withstand 8 watts @ +25° C.

Mounting: Two ⅜" diameter holes on 1⅞" centers.

LEADING ELECTRONIC PARTS DISTRIBUTORS STOCK 44 DIFFERENT PR RELAYS

Immediate delivery at factory prices.

Ask your distributor for a copy of Stock Catalog 100

POTTER & BRUMFIELD

Division of American Machine & Foundry Company, Princeton, Indiana
Export: AMF International, 261 Madison Avenue, New York, N.Y.

IRC PRECISION POTENTIOMETERS

Choose from 375 models . . . for every application or price

INFINITE RESOLUTION METAL GLAZE TRIMMERS

Sealed, shockproof rectangular type 450. ½ watt @ 70°C, 100 ohms to 1 meg. 10 and 20% tolerances. 2 pin arrangements, or leads.

½" square type 251 has anti-backlash drive. ¾ watt @ 70°C, 100 ohms to 1 meg. 5, 10 and 20% tolerances. Available in 144 models.

Economical ½" round unit offers speedy adjustment. ¾ watt @ 70°C, 100 ohms to 1 meg. 5, 10 and 20% tolerances. Type 150 in 24 different models.

5/16" cube trimmer saves space. .30 watt @ 70°C, 50 ohms to 0.5 meg. 10 and 20% tolerances. Top and side adjustment or panel mount. Type 350.

WIREWOUND PRECISION TRIMMERS

½" square type in MIL-R-27208 or commercial styles. Shock-resistant. 1 watt @ 60°C, 10 ohms to 50K, 5% tolerance. Type 201 in 144 models.

Popular ½" round trimmer with positive stops for fast response. 1 watt @ 50°C, 10 ohms to 50K, 5% tolerance. Type 100 in 24 termination and adjustment variations.

Microminiature 5/16" cube trimmer, TO-5 size, is ideal for miniaturization. .60 watt @ 60°C, 50 ohms to 20K. Top and side adjustment or panel mount. Type 300.

Precision rotary trimmers in ½", ¾" and 1½" dia., 2 to 3½ watts @ 40°C. 10 ohms to 100K, ±5% tolerance. Meets environmental requirements of MIL-R-27208A.

PRECISION MULTI-TURN POTENTIOMETERS

HERMETICALLY SEALED TYPE

¾" dia., 5 and 10 turns. Dry nitrogen filled. 2 and 3 watts @ 40°C, 25 ohms to 250K. 5% tolerance, 0.5% linearity. Series HS-750.

METAL CASE TYPES

½" dia., 5 and 10 turns. Shock and moisture-resistant. 1 and 1.5 watts @ 40°C, 15 ohms to 150K. 0.1% stability. Series 5000.

¾" dia., 5 and 10 turn models. 2 and 3 watts @ 40°C, 25 ohms to 250K. 5% tolerance, 0.5% linearity. Series 7500.

1" dia., 5 and 10 turns. From 1.5 to 4 watts @ 40°C, 50 ohms to 500K. 5% tolerance, 0.5% linearity. Series 1000.

1" dia., 15 and 20 turns. 4 and 5 watts @ 40°C, 750 ohms to 600K. 5% tolerance, 0.2% linearity. Series 1220.

MOISTURE SEALED TYPES

¾" and 1" dia., 5 and 10 turns. 2 to 4 watts @ 40°C, 25 ohms to 500K. 5% tolerance, 0.5% linearity. Also with O-ring panel seal. Series H-750MS.

PLASTIC CASE TYPES

Popular ⅞" dia., 10-turn unit is ruggedly built. 3 watts @ 40°C, 25 ohms to 250K. 3% tolerance, 0.2% linearity. ¼" or ⅛" dia., shaft. Series 8000.

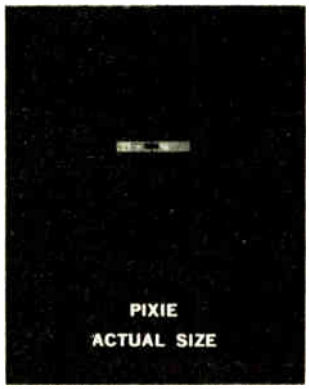
1½" dia., 3, 5 and 10 turns. Designed for heavy-duty industrial use. 500 ohms to 600K. 3% tolerance, 0.25% or 0.1% linearity. Series HD-150.

LOW COST COMMERCIAL TYPE

¾" dia., 10-turn unit also saves space. Rated at 2 watts @ 40°C, 100 ohms to 100k, 5% tolerance. Screwdriver slotted shaft. Series 7300.

All IRC precision potentiometers are application-proved in the field over years of rugged use. They are continually tested for compliance to specifications. Current, documented test data is available on request. For complete technical specifications, prices and samples, write: IRC, Inc., 401 North Broad St., Phila., Pa. 19108.

IRC®



this tiny ENDEVCO device could change your career.

Pixie already is revolutionizing the audio engineer's world, and it's beginning to transform other fields, as well. Pixie is a tiny, semiconductor transducer. It changes its resistive characteristics with force—linearly. A 10-gram force produces a 15% change in resistance. Frequency response is from DC to 50,000 cps. It is powerful enough to drive meters and other readout devices *without additional electronics.* It is an ideal source of proportional feedback. And its price tag—lower than most transistors—makes it ideal for large-volume and expendable applications.

Pixie is looking for new fields to conquer. It is being tested now for such applications as vibration, shock, pressure and motion sensing.

Will you be the man to start the revolution in your field? If you will describe your potential application on your company letterhead, we'll be glad to send you two free Pixies for your experimentation. Write: Mr. B. B. Shoor, Product Manager.

ENDEVCO CORPORATION Σ

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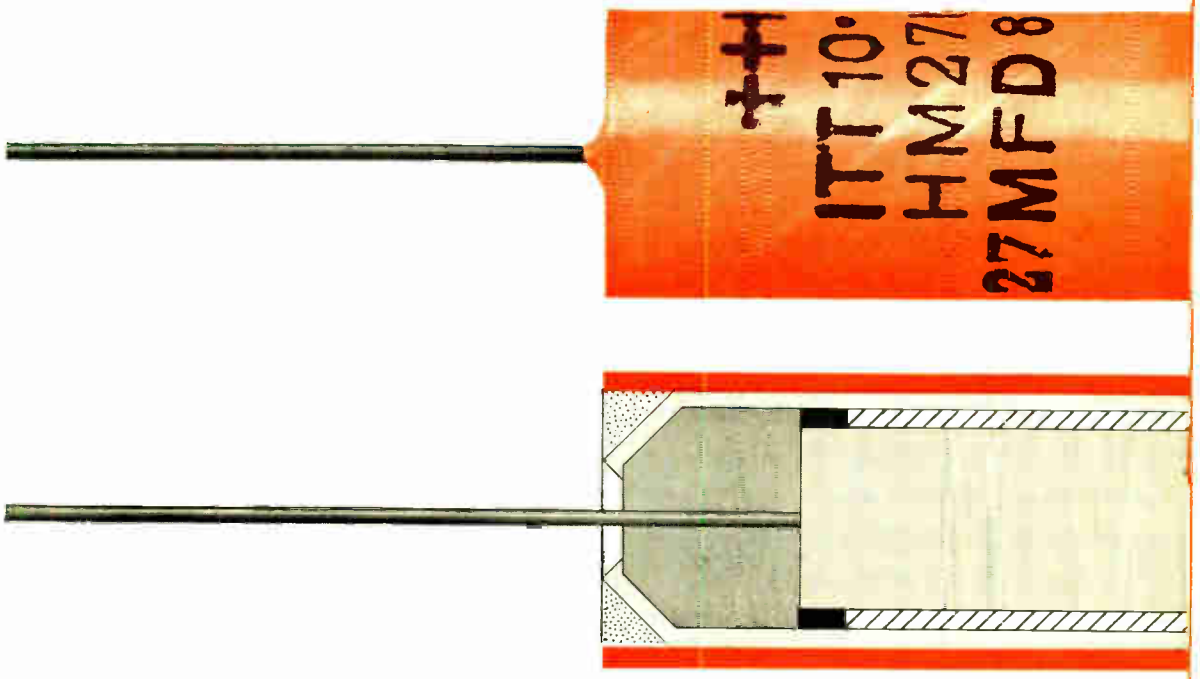


Why ITT wet tantalum capacitors can't leak

Every ITT Red Cap® wet tantalum capacitor gets a "total stress" seal that, unlike the ordinary single-crimp seal, positively prevents electrolyte leakage. To accomplish this, ITT inserts a teflon end seal, then spins down the open end of the can until end seal, anode and insulating washer are under a predetermined compressive force.

Seal integrity is further insured by the addition of an epoxy end fill. Since the epoxy's expansion coefficient is less than that of the can, temperature cycling cannot relax the spun seal.

If you're tired of electrolyte leaks and the problems that go with them, here's an easy solution. Order the ones that can't leak — the Red Caps® — from your ITT Capacitor distributor or from ITT Semiconductors, 3301 Electronics Way, West Palm Beach, Florida.

ITT

ELECTRONIC INDUSTRIES

1966 REVIEW and FORECAST for the ELECTRONIC INDUSTRIES

By ROBERT J. BRAMLETT
Assistant Editor

and EDWARD G. SHAUD, Jr.
Marketing Manager
ELECTRONIC INDUSTRIES

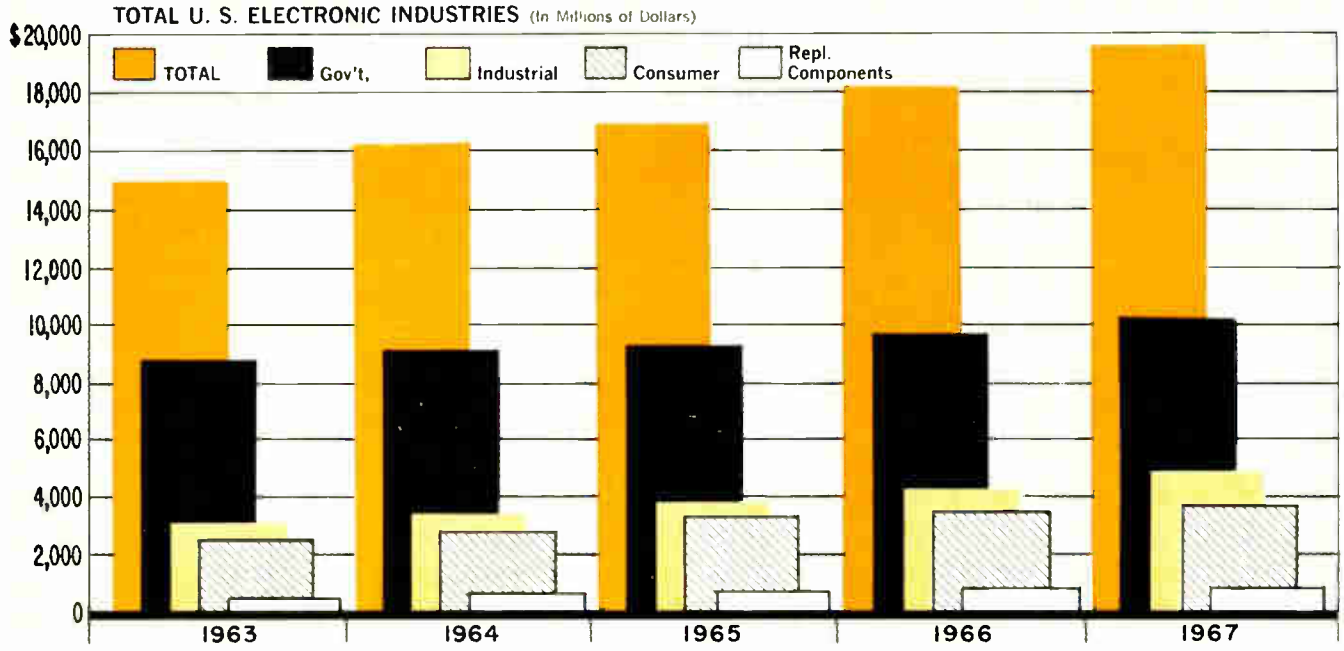
THE U. S. ELECTRONIC INDUSTRIES reached a record sales level in 1965 of over 17 billion dollars.

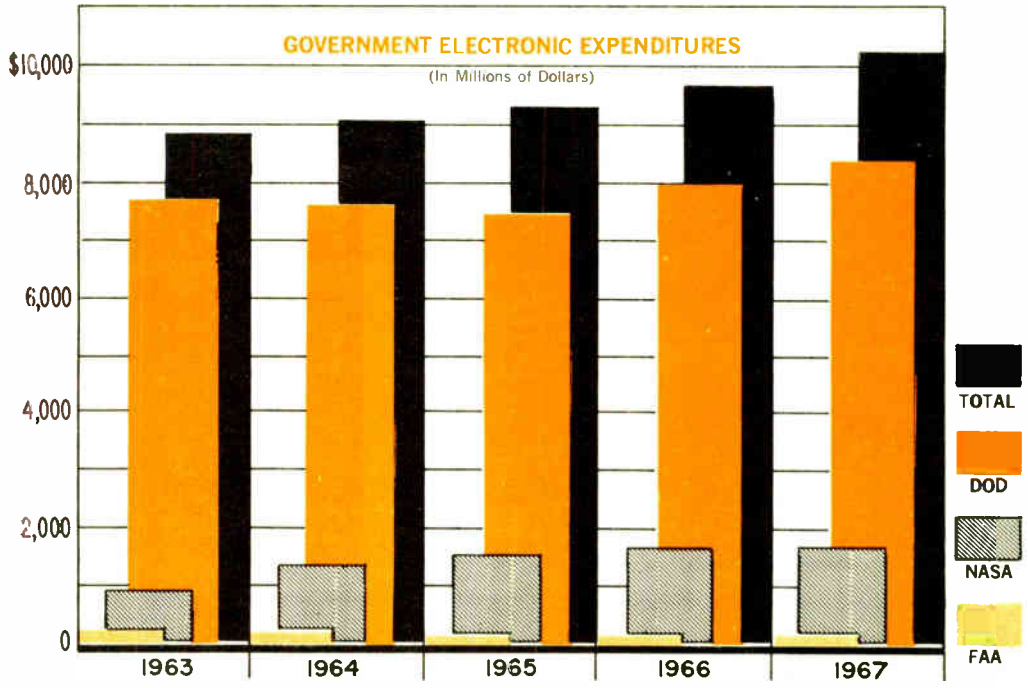
The estimated volume of $17,030,000,000 for all U. S. electronic products sold at home and abroad is almost $900 million ahead of 1964 and represents an increase of 5.5%. All major segments of the electronic industries contributed to the gain.

Total sales for 1966 are projected to about $18.3 billion. The federal government, still the largest customer for electronic equipment and systems, may increase its purchases by as much as 6% to $9.7 billion if current military commitments and space programs continue at their present pace. Industrial equipment sales, a major share of which will be in computers and electronic data processing systems, are expected to top $4 billion—a 12% increase over 1965. The consumer market, lead again by television sales, will prob-

ELECTRONIC INDUSTRIES
(In Millions of Dollars)

	1963	1964	1965	1966	1967
TOTAL	$15,143	$16,135	$17,030	$18,286	$19,527
Government	8,841	9,095	9,185	9,735	10,270
Industrial	3,115	3,465	3,865	4,345	4,820
Consumer	2,597	2,955	3,350	3,556	3,762
Replacement Components	590	620	630	650	675





ably reach nearly $3.6 billion for an increase of 6%.

The projection of total U. S. electronic sales including exports, in 1967 is for $19.5 billion. Looking farther ahead, the market may reach over $23 billion in sales by 1970. To help support and expand the market in general, the electronic industries are directing more attention to industrial and consumer products and foreign markets, including licensing agreements and overseas production by foreign-based U. S. firms as well as direct exports.

Annual sales of U. S. electronic products now account for approximately 2.6% of the U. S. gross national product, which in 1965 is estimated at $665 billion.

GOVERNMENT

Total government expenditures for electronic hardware in 1965 are estimated at $9.2 billion. This is expected to rise to $9.7 billion in 1966 in view of current military commitments and space programs. The year 1967 may see federal expenditures over $10 billion.

The Department of Defense has been and still is the single largest buyer of electronic hardware. Although down slightly from previous years, DOD still bought almost $7.6 billion in electronic goods and services in 1965. The figure for 1966 is forecast at $8 billion.

The major share of DOD funding in 1965—$3.9 billion—was for procurement of tracking, control, telemetry, communications and EDP systems used in aircraft, missiles, ships and field communications. However, the largest single item in the budget—$2.1 billion—went for RDT&E (research, development, test and evaluation). Detached equipment and communications gear not included as built-in parts of military aircraft, missiles, ships and vehicles cost DOD more than $1 billion in 1965.

NASA is expected to purchase more than $1.6 billion in electronic products in 1966, topping the $1.5 billion for 1965. The FAA, while small in comparison, still is an attractive market for certain hardware and systems. In 1965, the FAA bought electronic goods valued at $110 million.

The federal government will continue to be the biggest customer for U. S. electronic equipment for the coming decade, but the growth rate will not approach the dramatic increases of the early 1960's.

GOVERNMENT ELECTRONIC EXPENDITURES
(In Millions of Dollars)

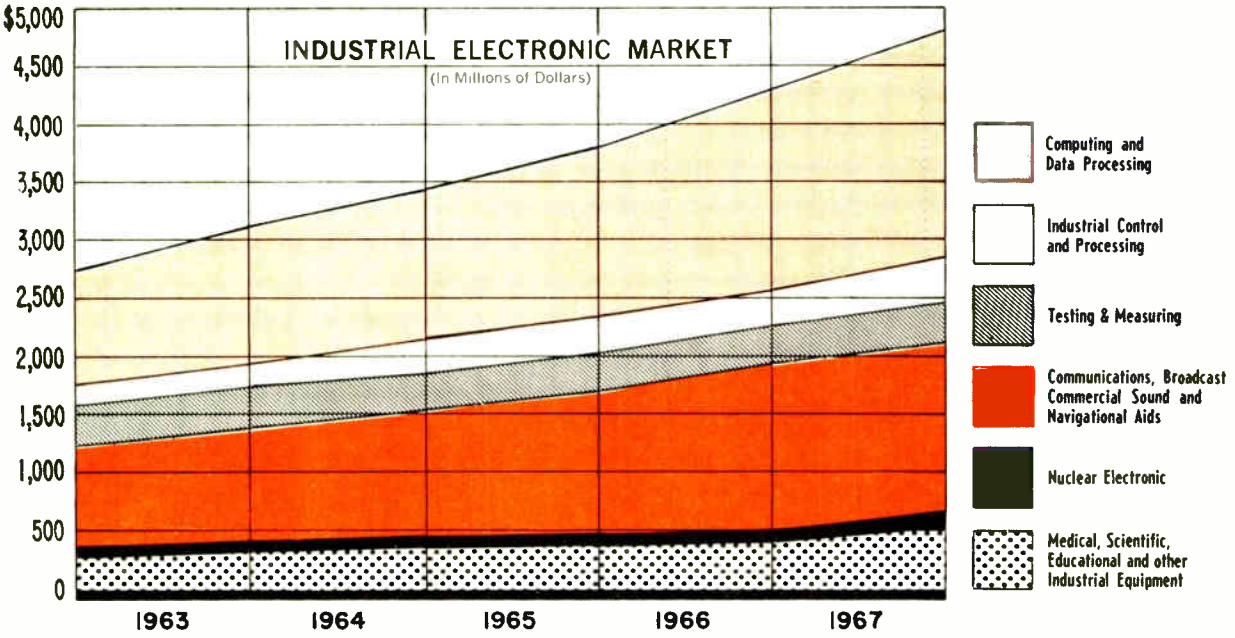
	1963	1964	1965	1966	1967
TOTAL	$8,841	$9,095	$9,185	$9,735	$10,270
DOD	7,735	7,660	7,550	8,000	8,450
NASA	956	1,310	1,525	1,620	1,700
FAA	150	125	110	115	120

DEPARTMENT OF DEFENSE ELECTRONIC EXPENDITURES
(In Millions of Dollars)

	1965	1966	1967
TOTAL	$7,550	$8,000	$8,450
Procurement	3,875	4,080	4,320
Aircraft	1,366	1,575	1,750
Missiles	1,062	970	925
Ships	422	470	499
Ordnance, Vehicles, etc.	91	116	125
Electronics & Communications	913	925	995
Other	21	24	26
Operation & Maintenance	1,450	1,578	1,665
R. D. T. & E.	2,100	2,210	2,325
Military Construction	50	52	55
Other	75	80	65

ELECTRONIC INDUSTRIES SALES AS PERCENTAGE OF GROSS NATIONAL PRODUCT
(In Millions of Dollars)

	1963	1964	1965	1966	1967
GNP	$584,000	$625,000	$665,000	$700,000	$730,000
ELECTRONIC INDUSTRIES	15,143	16,135	17,030	18,286	19,527
Percent	2.59%	2.58%	2.56%	2.61%	2.67%



INDUSTRIAL ELECTRONIC MARKET
(In Millions of Dollars)

	1963	1964	1965	1966	1967
TOTAL	$3,115	$3,465	$3,865	$4,345	$4,820
Computing & Data Processing	1,240	1,375	1,545	1,790	1,985
Industrial Control & Processing	244	270	305	335	370
Test & Measuring	280	300	325	340	375
Communications, Broadcast, Commercial Sound & Navigation Aids	990	1,100	1,225	1,330	1,480
Nuclear Electronic	47	55	60	69	76
Medical, Scientific, Educational & Other Industrial Equip.	314	365	405	481	534

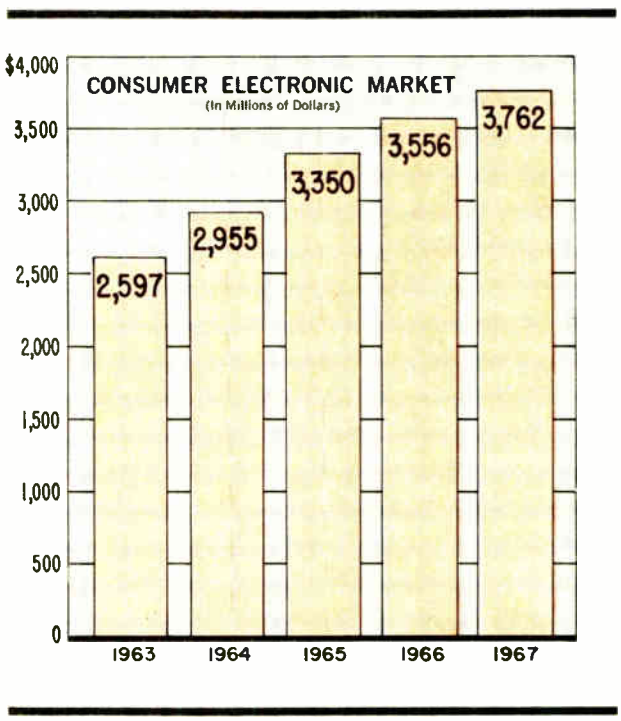
INDUSTRIAL

It has become more evident in the past several years that the future growth of the electronic industries will be directly related to the industrial and consumer electronic markets. There can be little doubt of this when we observe the outstanding growth rate by both markets from 1964 to 1965.

Industrial electronic sales experienced a growth of about 11.5% from approximately $3.5 billion in 1964 to some $3.9 billion in 1965. The rise in government spending, in contrast, for the same period is estimated at 1%. Continued growth is predicted for this all-important segment of the total electronic market. The forecast for 1966 is for $4.3 billion, an increase of over 12%; and 1967 industrial electronic sales should approach $4.8 billion.

The largest category of electronic products purchased by U. S. industry in 1965 included computers and electronic data processing equipment with shipments valued at more than $1.5 billion. Communications equipment for broadcast, commercial sound, navigation aids and common carriers accounted for sales of $1.2 billion in 1965. The estimated forecast for 1966 is $1.8 billion for computers and EDP equipment and $1.3 billion plus for communications equipment.

Considered by many as a promising area in the industrial market, industrial control and processing equipment sales totaled $305 million in 1965. The 1966 forecast is $335 million. This market will surely accelerate as more industrial companies install electronic process control systems for their manufacturing operations.



CONSUMER ELECTRONIC MARKET

(In Millions of Dollars)

	1963	1964	1965	1966	1967
TOTAL	$2,597	$2,955	$3,350	$3,556	$3,762
Television	1,086	1,366	1,620	1,780	1,930
Monochrome	828	878	835	750	690
Color	258	488	785	1,030	1,240
Radio	385	384	445	450	455
Home	179	179	218	222	225
Auto	206	205	227	228	230
Phonographs	421	440	460	470	482
Hi-Fi Components	48	50	53	54	56
Tape Recorders	52	60	70	75	80
Electronic Organs	94	105	117	125	133
Kits	34	37	41	42	44
Records & Magnetic Tape	286	305	321	330	340
Other Consumer Products	191	208	223	230	242

CONSUMER

The U. S. consumer purchased about $3.3 billion in electronic home entertainment products and conveniences in 1965 as compared with $2.9 billion in 1964. This is more than a 13% rise in sales.

The leader in this unusual growth rate was color television sales. In addition, all other consumer electronic products registered gains in total sales—including radios, phonographs, tape recorders and electronic organs.

Estimated volume for television receivers in 1965 is $1.6 billion, including $835 million for monochrome and $785 million for color. 1966 sales are forecasted at $1.8 billion. This includes $750 million for black and white sets and over $1 billion for color!

A market of about $3.6 billion for consumer electronic products is predicted for 1966. Despite the dramatic rise in color television sales, the growth rate will decline slightly as monochrome sales volume declines and other consumer products level off for the present.

RESEARCH AND DEVELOPMENT

Expenditures for research and development are rising throughout U. S. government and industry. More than an estimated $22 billion was spent for all research and development activities in the U. S. during 1965. The greatest share was for development, followed by applied research and then basic research. Expenditures by the federal government, private industry and non-profit organizations should continue to increase for the foreseeable future.

Of the $22 billion spent for all U. S. R & D in 1965, some $14.6 billion was funded by the federal government. Industry allocated $6.8 billion of its own money for R & D, while non-profit organizations spent $610 million. In 1966 the forecast estimate for total expenditures for all R & D is $23 billion. By 1970 the annual research bill for the nation may approach $30 billion.

Current estimates for electronic research and development expenditures are about $3.7 billion for 1965. The forecast for 1966, as R & D costs and allocations continue to rise, is near $4.2 billion. The funding for 1970 could reach $5 billion.

Dispersal of funds for electronic R & D is estimated at 64% for development (design and production) and 24% for applied research (research knowledge applied to the design of products and solutions to industrial scientific and engineering problems). There is a growing new emphasis on basic research, that is, pure science and theory. Present estimates show that about 12% of expenditures are devoted to this activty. This percentage will surely increase in the future as industry and government further recognize the need for more basic scientific information.

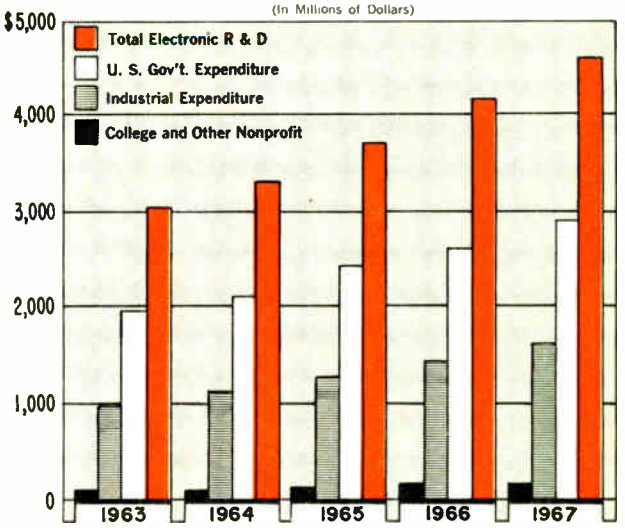
SOURCES OF FUNDS FOR ALL R & D

(In Millions of Dollars)

	1963	1964	1965	1966	1967
TOTAL	$17,460	$20,040	$22,010	$23,170	$24,530
Federal	11,400	13,200	14,600	15,200	16,000
Industrial	5,600	6,300	6,800	7,300	7,800
Non-Profit	460	540	610	670	730

ELECTRONIC RESEARCH & DEVELOPMENT EXPENDITURES

(In Millions of Dollars)



Electronic Research & Development Expenditures

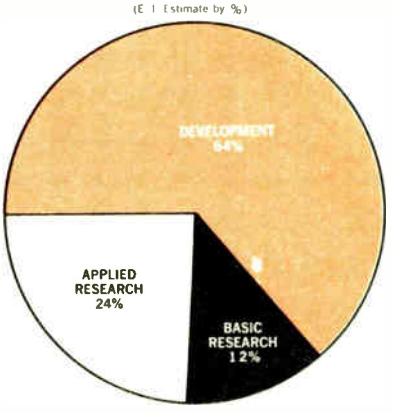
(In Millions of Dollars)

	1963	1964	1965	1966	1967
TOTAL	$3,026	$3,340	$3,705	$4,170	$4,690
Government	1,950	2,100	2,300	2,600	2,900
Industrial	980	1,130	1,280	1,430	1,630
College and Other Non-Profit	96	110	125	140	160

ELECTRONIC R & D FUNDS

Dispersal for 1965-'66

(E I Estimate by %)



DEVELOPMENT — design and production of new products.

APPLIED RESEARCH —for product development and design.

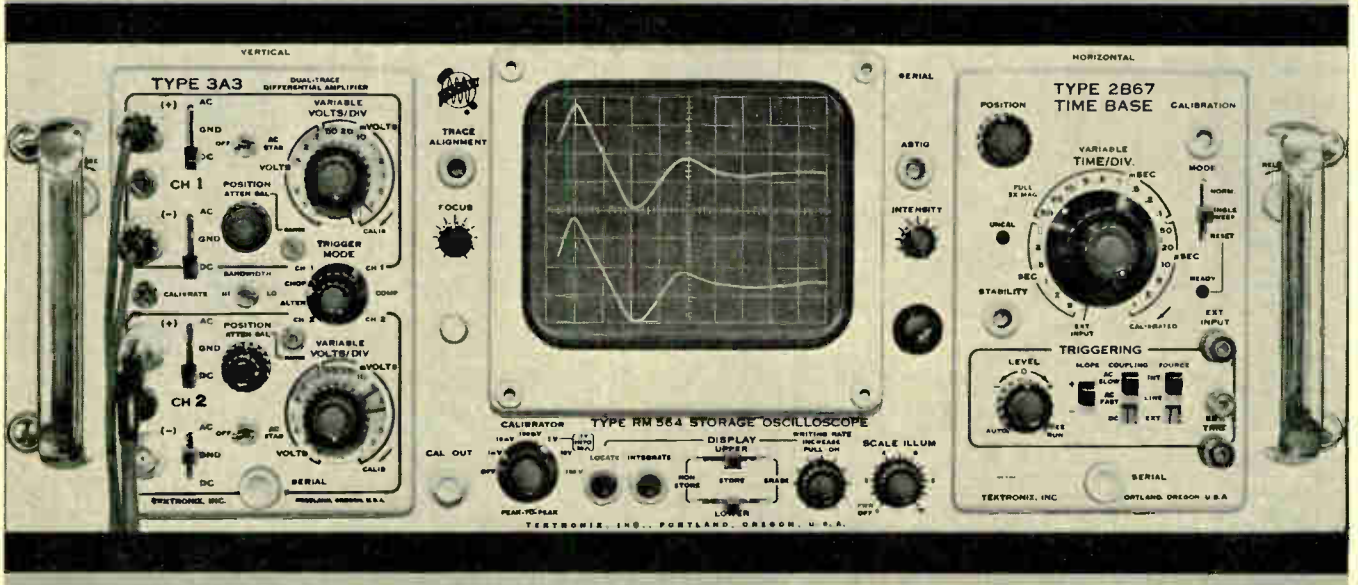
BASIC RESEARCH— pure science and theory.

Type RM564 TEKTRONIX general-purpose oscilloscope

with added feature of

STORAGE

SPLIT-SCREEN / permits simultaneous operation as a storage oscilloscope and as a conventional oscilloscope



■ **presents stored or conventional displays**—The Type RM564 presents full-screen stored displays or full-screen conventional displays. Or—with the split-screen—stored displays can be presented on either the upper or lower half of the crt with conventional displays on the other half.

■ **saves film**—The Type RM564 permits detailed waveform analysis and simplified waveform comparisons, in many instances, without resorting to photography. Just store and analyze—for periods up to one hour, with quick erase in less than one-fourth second.

■ **trace photography is easier and can cost less**—Stored displays can be recorded at one's convenience, without the need for high-speed lens or film.

■ **accepts combinations of 20 plug-in units**—The Type RM564 adapts easily to such applications as multi-trace, low level differential, sampling, spectrum analysis, others—including matched X-Y displays using the same type amplifier units in both the amplifier and time-base channels.
Plug-in units offer capabilities from 100μV/cm sensitivity (3A3) and 10MHz passband (3A1, 3A6), to 0.5 μsec/cm sweep rate (3B1, 3B3) and sweep-delay applications (3B1, 3B2, 3B3).

■ **saves space**—The Type RM564 occupies **only 7 inches** of standard **rack height**, yet has a full 8-cm by 10-cm display area.

■ **operates simply and reliably**—Although capable of many sophisticated measurements, the Type RM564 retains the operating convenience of a conventional oscilloscope.

Display shows ability of the Type RM564 to store single-shot events. Waveforms represent displacement of leaf springs due to imparted shocks given them during test. Split-Screen Facility—with independent storage and erase of upper and lower half of the crt—permits easy comparison of test waveforms to a reference display.

Type RM564 Oscilloscope	$1035
Type 3A3 Dual-Trace Differential Amplifier Unit	790
Type 2B67 Time-Base Unit	210

18 other plug-in units available.

Type 564 Cabinet Model also available with same performance specifications	950

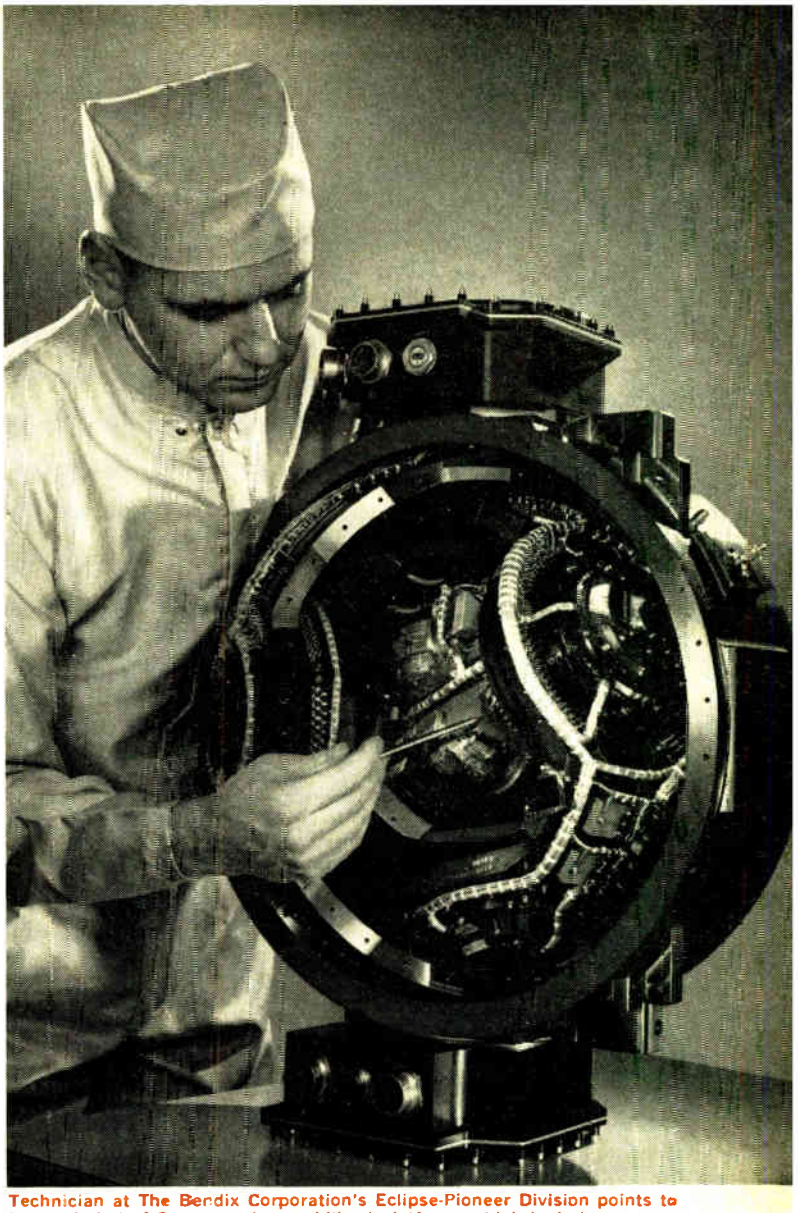
U.S. Sales Prices f.o.b. Beaverton, Oregon

Oscilloscope prices without plug-in units

Tektronix, Inc.

FOR A DEMONSTRATION, PLEASE CALL YOUR TEKTRONIX FIELD ENGINEER

Why Eclipse-Pioneer precision-cleans Saturn rocket assemblies with GENESOLV®-D



Technician at The Bendix Corporation's Eclipse-Pioneer Division points to inner gimbal of Saturn rocket stabilized platform, which includes components cleaned by Genesolv-D.

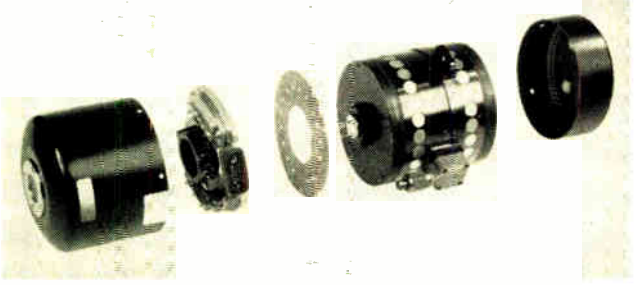
The reliability of critical aerospace assemblies depends on scrupulous cleanliness as well as on precision tolerances and finishes. That's why Eclipse-Pioneer uses Allied Chemical's Genesolv-D Electronic Grade Solvent for this critical cleaning assignment.

All parts in six components of each stabilized platform are cleaned in Genesolv-D during assembly.

Eclipse-Pioneer, a division of The Bendix Corporation, uses Genesolv-D for these important reasons:

1. It's 99.99% pure (less than 1 ppm residues).
2. Has low surface tension/high density; penetrates smallest spaces for fast, easy cleaning.
3. It's nonflammable, nonexplosive, relatively nontoxic.
4. Selectively cleans metals, plastics, elastomer and paint or varnish surfaces, with little or no solvent action on base materials.
5. Excellent electrical properties – resistivity over $200{,}000 \times 10^6$ (megohm cm). Low dielectric constant.
6. Stability and economy – Genesolv-D won't decompose at temperatures up to 300°F; can be distilled and reused since it contains no additives.

Genesolv-D is processed and packed under class 100 clean-room conditions to assure you a contaminant-free solvent; shipped in non-returnable drums with special moisture-proof covers, and in tank truck quantities. Each shipment bears inspector's analysis of purity. Write for full details.



These gyros are used in each stabilized platform, which includes components cleaned by Genesolv-D.

Allied Chemical

GENERAL CHEMICAL DIVISION
P.O. Box 353, Morristown, N.J.

Circle 28 on Inquiry Card

1964 U. S. BALANCE of TRADE for ELECTRONIC PRODUCTS by SELECTED COUNTRIES

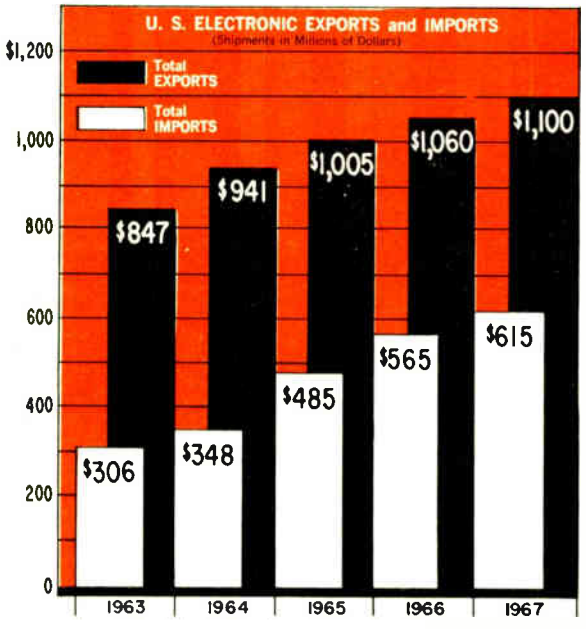
(In Millions of Dollars)

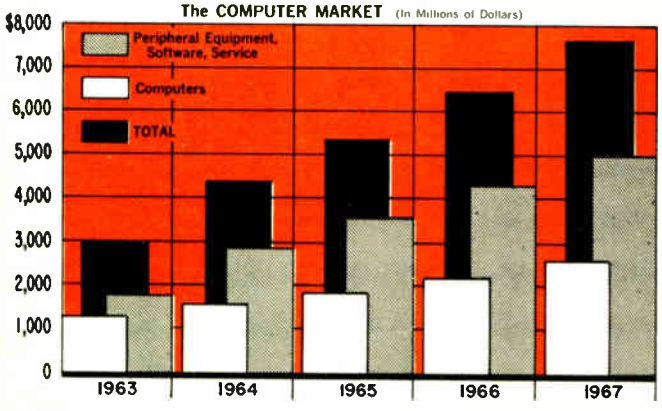
Country	TOTAL		MILITARY & INDUSTRIAL PRODUCTS		CONSUMER PRODUCTS		ELECTRONIC TUBES & COMPONENTS	
	U. S. Exports To	U. S. Imports From	U. S. Exports To	U. S. Imports From	U. S. Exports To	U. S. Imports From	U. S. Exports To	U. S. Imports From
TOTAL	$941	$348	$724	$47	$69	$219	$148	$82
European Economic Community	173	40	113	4	13	17	47	19
West Germany	50	20	33	2	5	13	12	5
France	68	3	48	—	1	—	19	3
Italy	23	4	15	2	2	—	6	2
Netherlands	17	13	12	—	—	4	5	9
Belgium & Luxembourg	15	—	5	—	5	—	5	—
United Kingdom	92	32	78	7	3	18	11	7
Canada	108	36	75	25	10	5	23	6
Japan	63	213	57	8	2	166	4	39
Other Countries	208	27	129	3	41	13	38	11
Not Specified By Country	297	—	272	—	—	—	25	—

ESTIMATED WORLD ELECTRONIC OUTPUT

(In Millions of Dollars)

	1963	1964	1965	1966	1967
TOTAL	$23,843	$25,335	$26,930	$28,786	$30,727
United States	15,143	16,135	17,030	18,286	19,527
Japan	1,700	1,800	1,800	1,900	2,000
United Kingdom	1,300	1,400	1,500	1,600	1,700
European Economic Community	4,300	4,500	5,000	5,400	5,800
Canada and all other Nations	1,400	1,500	1,600	1,600	1,700





INTERNATIONAL MARKETS

Exports of U. S. electronic products in 1965 are estimated at $1 billion, up only $60 million from 1964's $941 million. Detailed figures for 1965 exports and imports are not yet available, but of 1964's export total Canada received the largest volume of shipments —$108 million. The second largest buyer was the United Kingdom at $92 million. The European Economic Community as a whole purchased $173 million of U. S. electronic equipment. Within the EEC, French imports totaled $68 million with West Germany next at $50 million.

The principal exporter of electronic products to the U. S. continues to be Japan. Total shipments in 1964 were valued at $213 million, up from 1963's total of $162 million. Since total U. S. imports for 1964 were only $348 million, this means Japan holds 61% of the U. S. import market. Japan's share of the import market is expected to increase for the next few years.

Canada is a distant second as a single exporter with $36 million in electronic products sent into the U. S. in 1964. The EEC shipped $40 million in 1964 with West Germany accounting for $20 million of the total.

The U. S. currently manufactures over 63% of the total world output of electronic products. The European Economic Community nations comprise the next largest producing entity. Japan and the United Kingdom rank third and fourth respectively.

The present annual rate of growth of the U. S. Electronic Industries is 5.5%. Total sales volume in electronic products for the rest of the world is considerably below the output of the U. S. However, the aggregate rate of growth in output by all other nations, when taken as a group, is about 7%.

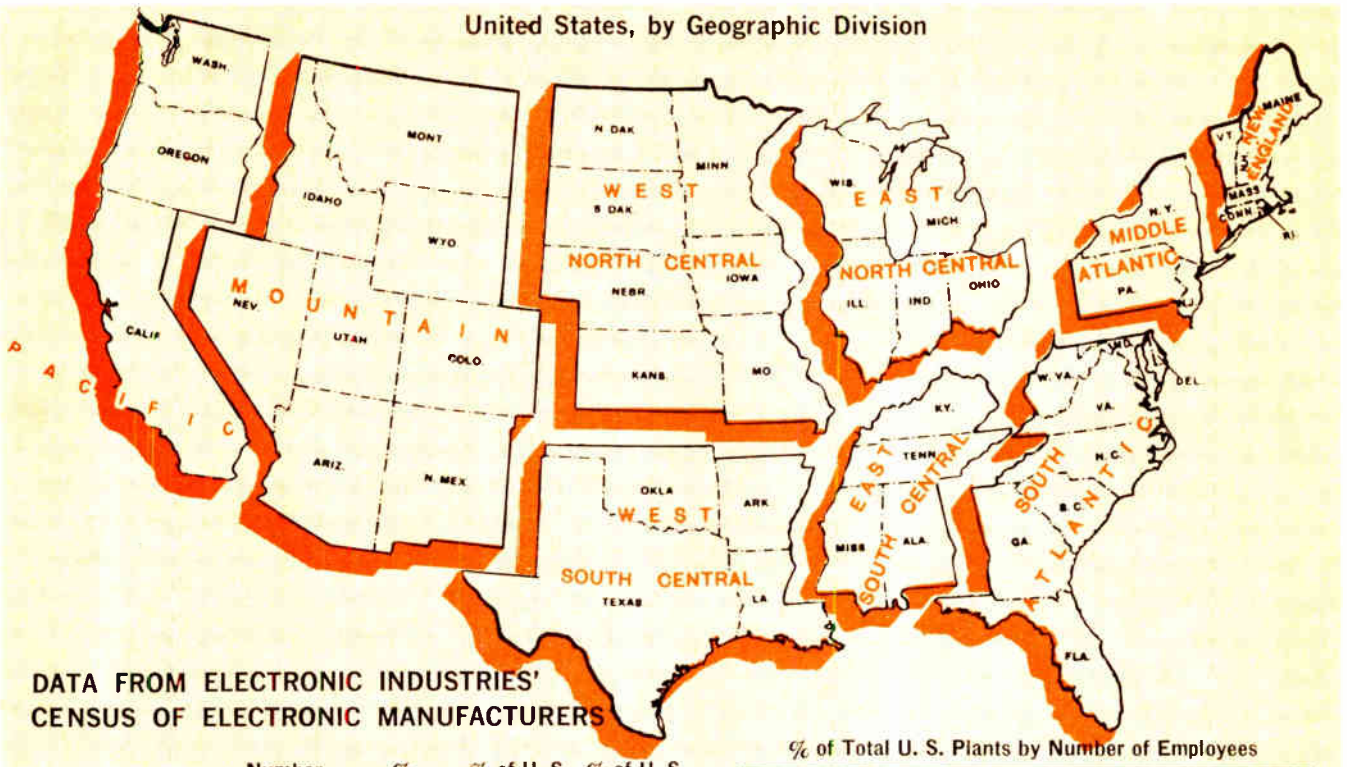
COMPUTERS AND ELECTRONIC DATA PROCESSING EQUIPMENT

In 1965 sales of computers reached an estimated $1.8 billion. The total for 1964 was $1.5 billion, and the forecast for 1966 shows a market of $2.2 billion.

Including hardware, peripheral equipment, software and service, the complete electronic data processing market for 1965 is estimated at $5.3 billion. Projections through 1970 suggest $2.6 billion for computers and $7.6 billion for the entire computer market. At the end of 1965, there were more than 17,000 EDP systems and equipment installations (valued at $7 billion) in operation in the U. S. This total may reach 20,000 by the end of 1966.

The above figures include sales to U. S. industry, the federal government and private institutions as well as to similar groups in other countries. In 1965 the bulk of computing equipment, about $1.5 billion, was sold directly to U. S. and foreign industry.

Many experts suggest that Europe is the fastest growing market for computer systems in the world today. The continent is currently rated five years behind the U. S. with about 6,000 computers installed and in use. The prediction for the next five years is that some 8,000 more computers will be sold in Europe.



DATA FROM ELECTRONIC INDUSTRIES' CENSUS OF ELECTRONIC MANUFACTURERS

	Number of U. S. Plants	% of U. S. Plants	% of U. S. Electronic Engineers	% of U. S. Electronic Output	% of Total U. S. Plants by Number of Employees: Less Than 50	50-249	250-999	1,000-4,999	Over 5,000
New England	875	14.61	10.56	10.65	5.39	5.71	2.63	.78	.10
Middle Atlantic	1,953	32.62	25.36	36.60	13.09	13.06	4.40	1.74	.33
South Atlantic	307	5.13	9.94	5.30	1.91	1.97	.84	.34	.07
East North Central	1,220	20.38	14.20	23.15	6.65	7.40	4.44	1.57	.32
East South Central	56	.93	.42	.50	.24	.35	.20	.14	—
West North Central	215	3.60	4.91	2.60	1.09	1.62	.59	.17	.13
West South Central	100	1.67	5.04	2.20	.84	.44	.27	.09	.03
Mountain	83	1.38	2.57	2.50	.58	.57	.13	.09	.01
Pacific	1,179	19.68	27.00	16.50	10.00	6.94	1.88	.71	.15
TOTAL	5,988	100.00%	100.00%	100.00%	39.79%	38.06%	15.38%	5.63%	1.14%

COMPONENTS

Shipments of electronic components reached a new high of $4.3 billion in 1965. The largest dollar volume was accounted for by semiconductors ($720 million) and television picture tubes ($388 million). Substantial gains over 1964 were also registered by capacitors at $360 million and resistors at $356 million. Receiving tube sales have reached a plateau for the present, showing only a slight decrease from 1964's $270 million to $268 million in 1965. Power and special purpose tube shipments have also leveled off somewhat, remaining around $250 million.

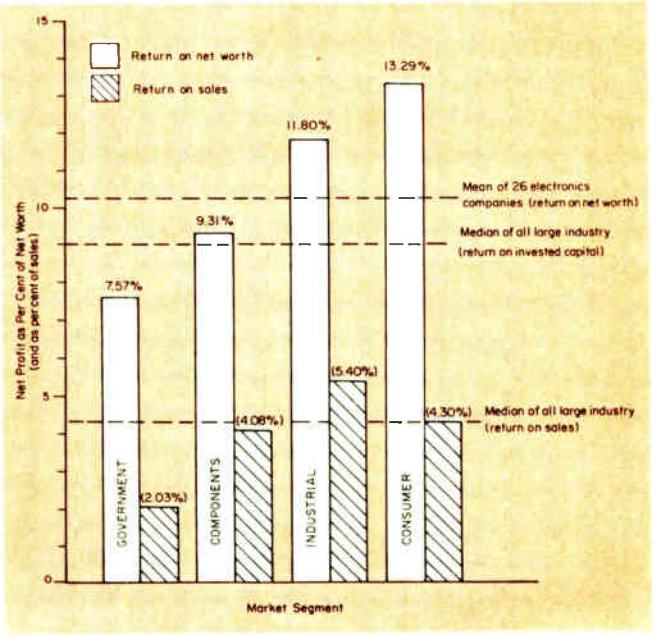
The largest percentage increase in components during 1965 was by integral circuit packages, which showed a rise of more than 22% in sales. Dollar volume for 1964 was $225 million and should reach $275 million when 1965's figures are complete. The next largest gain was registered by television picture tubes at 16%.

The forecast is for the components market to expand by approximately 28% from $4.3 billion now to $5.5 billion by 1970. In the more immediate future, important gains are expected for 1966 in integral circuit packages to $350 million; semiconductors to $770 million; television picture tubes to $450 million; and capacitors and resistors to $380 million and $372 million respectively. In addition, most other component categories are expected to contribute gains to the 1966 component sales forecast of $4.6 billion.

Strong replacement demands for standard receiving tubes will probably continue well into the 1970's. The recent decline in sales appears to have slowed down somewhat. The buying surge in color television sets coupled with still strong demands for monochrome television is part of the answer.

The feeling now among many executives in the electronic industries is that the receiving tube market will not die out as quickly as some forecasters had indicated.

AVERAGE NET PROFIT LEVELS FOR FOUR GROUPS OF ELECTRONIC COMPANIES



SOURCE: Battelle Memorial Institute

FACTORY SALES OF SELECTED ELECTRONIC COMPONENTS

(In Millions of Dollars)

	1964	1965	1966
CAPACITORS	$339	$360	$380
Paper Dielectric	52	55	57
Film Dielectric	30	33	34
Combination (Dual) Dielectric	6	7	8
Metallized Paper or Film Dielectric	29	31	33
Electrolytic	122	127	134
Aluminum	72	76	82
Tantalum	50	51	52
Mica, Glass and Vitreous Enamel Dielectric, Fixed	29	31	33
Ceramic Dielectric, Fixed	47	51	54
Variable	24	25	27
CONNECTORS	$238	$246	$254
Coaxial	35	37	39
Cylindrical	88	90	92
Multiple Contact (Rack and Panel, Including MIL-C-26518 and Similar Types)	52	53	55
Fusion Sealed (Except Coaxial)	6	6	6
Printed Circuit	27	30	32
Miscellaneous (Special Purpose Connectors)	30	30	30
INTEGRAL CIRCUIT PACKAGES	$225	$275	$350
Filters	51	55	65
RCL Modules	17	20	25
Functional Assemblies	104	112	123
Microelectronic Circuits	53	88	137
Thin Film	12	18	25
Semiconductor	41	70	112
MICROWAVE COMPONENTS	$87	$105	$125
POWER & SPECIAL PURPOSE TUBES	$251	$251	$250
High Vacuum Tubes	59	57	55
Gas & Vapor Tubes	22	21	20
Klystrons	40	40	40
Magnetrons	30	31	31
Forward & Backward Wave Tubes	36	37	37
Light Sensing Tubes	24	25	25
Light Emitting Tubes	11	11	11
Storage & Special Purpose Display Tubes	11	11	11
Miscellaneous Special Purpose	18	18	20
QUARTZ CRYSTALS	$44	$46	$49
Hermetically Sealed, Glass or Metal Case	43	45	48
Clip Mounted-Plated	24	25	27
Less than 2 MC	3	3	3
2 MC thru 12 MC	7	7	8
Over 12 MC	14	15	16
Pressure & Wire Mounted	19	20	21
Unsealed, Plastic Case	1	1	1
RECEIVING TUBES	$270	$268	$245
Subminiature G. & V.	9	8	6
Military Reliable	7	5	4
All Other Types	2	3	2
Miniature	187	190	176
Military Reliable	11	9	6
All Other Types	176	181	170
Standard Glass (G & GT)	64	60	54
Military Reliable	3	3	2
All Other Types	61	57	52
Other (Metal, Ceramic, Lock-In, Etc.)	10	10	9

	1964	1965	1966
RELAYS (For Electronic Applications)	$199	$217	$225
Clapper, Rotary, Plunger or Solenoid (Except Telephone Types)	88	91	92
Telephone Types	26	29	29
Crystal Can Types	20	22	23
Stepping Switches	12	13	13
Thermal	4	4	4
Dry Reed	14	21	26
Other (Including Coaxial, Mercury Wetted & Motor Driven Relays)	35	37	38
RESISTORS	$334	$356	$372
Fixed Composition	66	66	65
Fixed, Deposited Carbon & Borocarbon	20	21	22
Fixed, Metal Film	29	33	36
Fixed, Wire Wound	52	57	61
Variable, Non-Wire Wound	62	67	71
Variable, Wire Wound	77	83	87
Attenuators, Voltmeter Multipliers, Etc.	5	5	5
Other (Including Varistors, Thermistors, and Thermistor/Bolometers)	23	24	25
SEMICONDUCTOR DEVICES	$647	$720	$770
Diodes & Rectifiers	212	235	250
Germanium	32	34	35
Silicon	162	181	192
Selenium & Copper Oxide, Etc. (Thru 15 Amps)	18	20	23
Special & Light Sensitive Semiconductor Devices	106	113	120
Voltage Regulator Diodes	30	31	32
Voltage Reference Diodes	8	9	10
Multi-Layer Devices (Controlled Rectifiers, PNPN Diodes, and Related Devices)	38	40	42
Microwave Diodes (Mixers & Detectors)	8	9	10
Variable Capacitance Diodes (Including Parametric Diodes, Harmonic Generators, Etc.)	5	6	7
Tunnel Diodes	3	3	3
Solar Cells	4	4	4
Other Special Semiconductor Devices	10	11	12
Transistors	329	372	400
Germanium	157	165	165
Silicon	172	207	235
TRANSFORMERS & REACTORS	$211	$232	$244
Other than Toroidal	180	198	209
Toroidal	31	34	35
TV PICTURE TUBES	$334	$388	$450
Monochrome	165	156	140
Color	169	232	310

For further information on marketing statistics or any other phase of ELECTRONIC INDUSTRIES Marketing Assistance Program (M-A-P) contact:
Edward G. Shaud, Jr., Marketing Manager
ELECTRONIC INDUSTRIES, Chestnut & 56th Streets, Philadelphia, Pa. 19139, Area Code 215, SHerwood 8-2000

SOURCES OF STATISTICAL DATA

ELECTRONIC INDUSTRIES wishes to thank the following for their assistance in providing information that has been used in this Review and Forecast:

Battelle Memorial Institute
Economic Index & Surveys, Inc.
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BIG: Big performance, big economy.

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NEW: New straight and concentric tandems.
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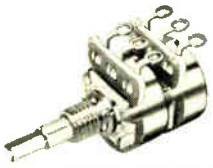
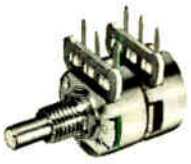
New Constructions

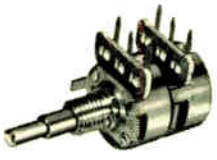
Straight Tandem
Solder Lug Terminals



Concentric Tandem
Solder Lug Terminals



Straight Tandem
P. C. Terminals



Concentric Tandem
P. C. Terminals

Sample constructions showing Series 200 versatility

(Many other combinations available.)

Basic 200 Control
Ear Mounted

Rear Extended Shaft
Bushing Mounted

ND On-Off Switch
Bushing Mounted

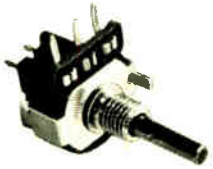
Q On-Off Switch
Ear Mounted

Basic 200 Control
Bushing Mounted

Rear Extended Shaft
Ear Mounted

Mounted with Shaft
Perpendicular to
Panel

ND On-Off Switch
Shaft Perpendicular
to Panel



Q On-Off Switch
Bushing Mounted

Founded 1895

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CALIBRATION SYSTEM

Measurement to Parts in 10^9, 10^{10} or 10^{11}

Motorola Frequency Standard 1, 2 or 3

VLF Receiver

Motorola Frequency Error Expander 4

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Instrument to be calibrated

TRACKING AND GUIDANCE SYSTEM

Motorola Frequency Standard 1, 2 or 3

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1

New . . . low cost standard!

Motorola S1076AR Frequency Standard—Parts in 10^{10} Setability • Less than 1×10^{-9} Aging Per Day • 10 Second short term stability $\pm 5 \times 10^{-10}$ • 100 kc and 1 mc outputs • Proportional controlled oven • Motorola precision 3 mc crystal • Zener regulation • All silicon circuitry • Coarse and fine frequency adjust • Small size—3½" high • Model S1076AR $585.

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3

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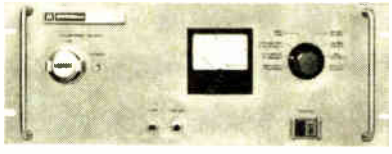

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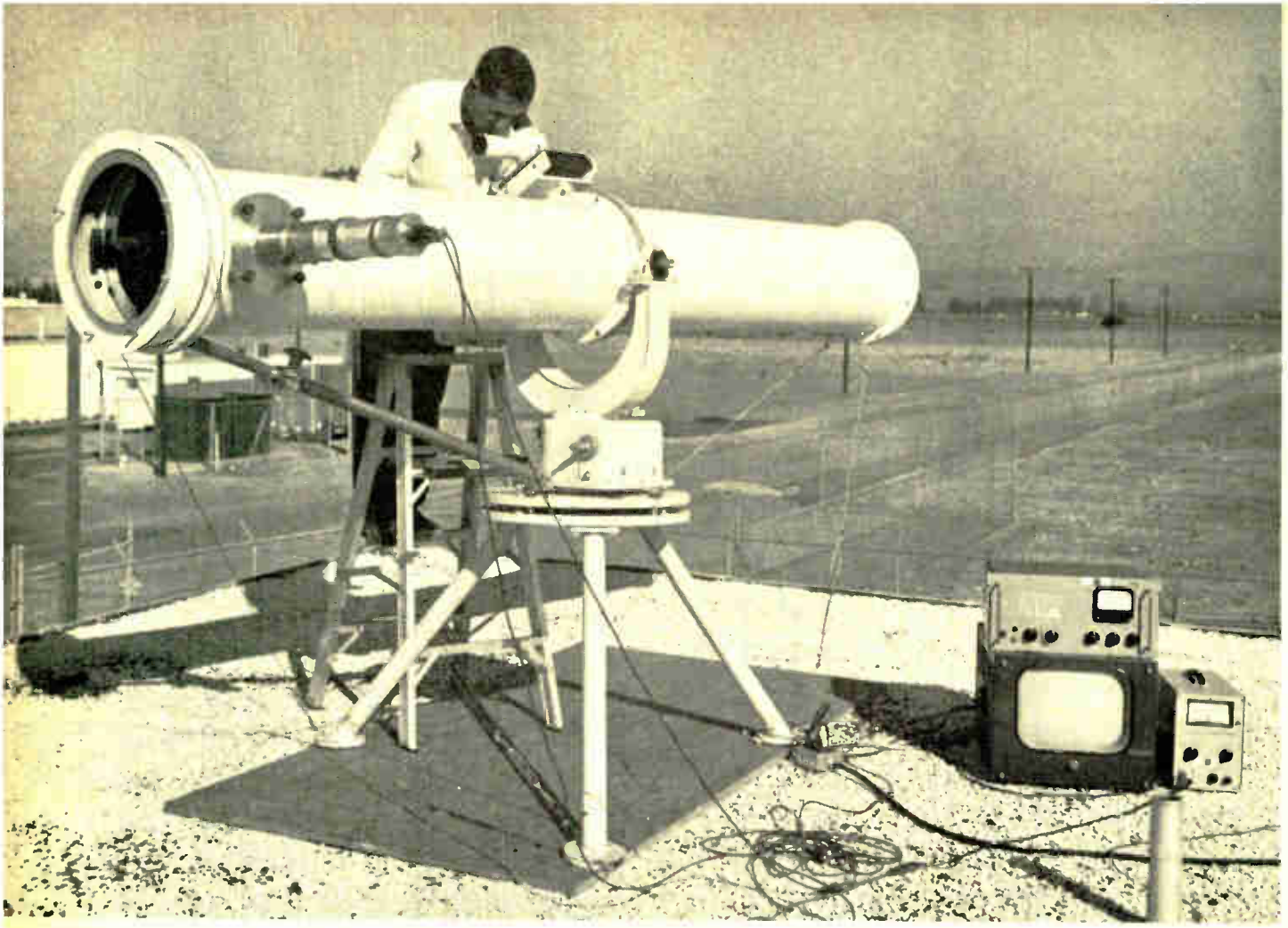


Fig. 1: The optical receiver that is used with the infrared TV system uses a Newtonian telescope with a photomultiplier in place of the eyepiece.

A Practical Infrared TV System

Here is a relatively inexpensive infrared transmission system that is being used for TV and scientific data transmission. The authors describe the design problems encountered and how they solved them. The information can be used to develop other systems.

WE WERE INTERESTED in developing a low-cost telemetry system and TV link that would use available items. The main effort was put into designing an optical transmitter with a bandwidth of 10 MHz and a range of 0.5 to 1 mile. The receiver section also will be described. It is a Newtonian telescope with a photomultiplier for a detector (Fig. 1).

The GaAs diode* was used for the transmitter.[7,8] This is a nonlasing or emission diode, and it has both a fairly high-power and a bandwidth of $\approx$ 20 MHz. Under the conditions chosen, the light power output is about 5 mw. Much higher outputs can be obtained with cooling and increased current drive. The light output has a spectrum of about 200Å width, centered at 0.9 μ (9,000Å). The light is radiated into a 120°

*Texas Instruments Incorporated SNX-110

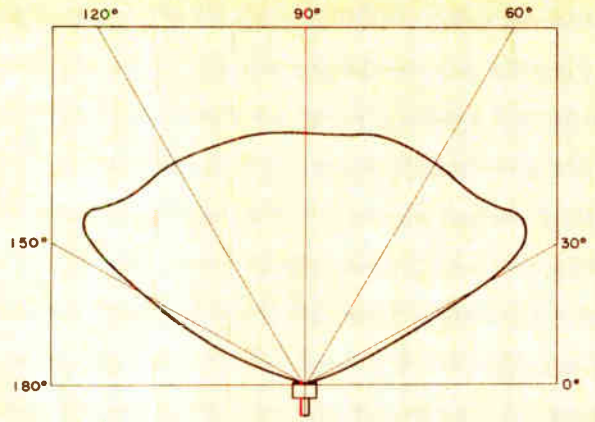


Fig. 2: The polar radiation pattern of a GaAs SNX-110.

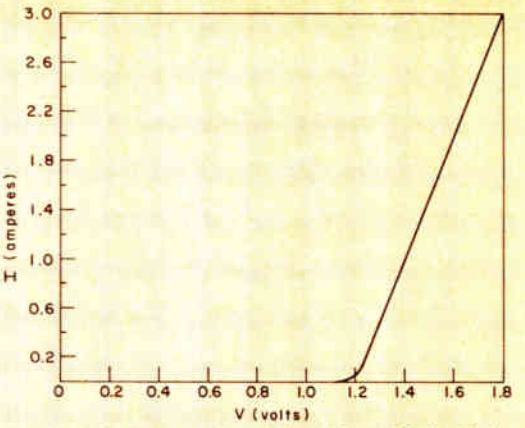
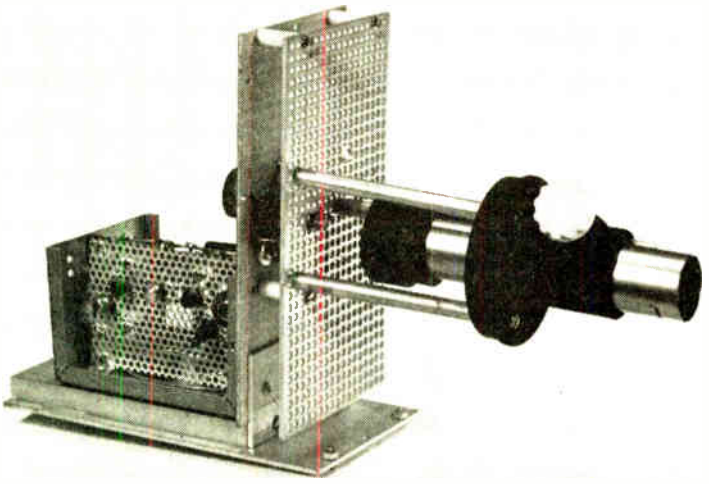
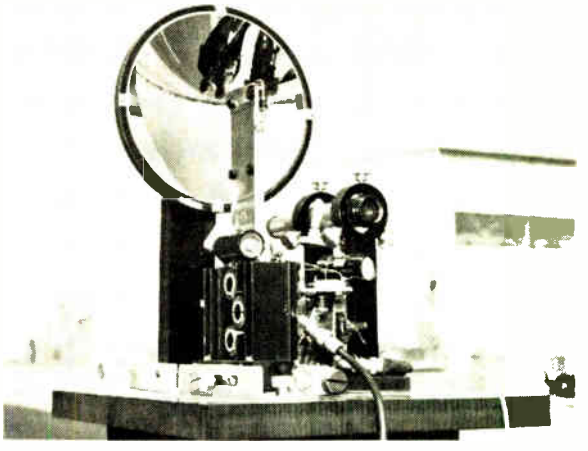


Fig. 3: V-I characteristic of the infrared GaAs diode.



◀ Fig. 4: This was the first model of the optical transmitter. It consisted of a straightforward transistor video amplifier with 4 parallel emitter-follower output stages driving the diode.

▼ Fig. 5: The final model of the optical transmitter. It overcame the problems of the earlier model. In some respects it resembles a microwave antenna setup, using a parabola to collimate the light.



By DAVID BUHL
and LARRY SPINAZZE

Engineering Research Div.
Lawrence Radiation Lab.
University of California
Livermore, Calif.

David Buhl

Larry Spinazze

cone and so must be collimated (Fig. 2). The diode was operated at ambient temperature, and a wavelength shift of about 4Å/°K was not serious enough for temperature control. Because 1.5 watts input to the diode would have to be dissipated, it was decided against cooling to dry ice or LN temperature, even though some increase in the 5 mw optical power output would have been obtained.

Transmitter Design

The basics for designing the transmitter were (1) to obtain a bandwidth of 10 MHz at a required current level of 1 a, (2) to collimate the light output of the diode into a parallel beam, and (3) to properly heat sink the diode for a dissipation of 1.5 watts. The simplest modulation would be class A, AM modulation of the light beam. Any FM system would require the use of a subcarrier and other complications. The V-I of the diode is quite linear after ≈ 1 v in the forward direction (Fig. 3). Its slope is 0.2 Ω in the emission region. To obtain a power output of 5 mw, the diode had to be operated at a current of 1 a. Thus, class A operation would require a maximum drive current of 2 a peak-to-peak and a voltage swing of 0.8 v peak-to-peak. This low impedance operation proved to be the hardest design problem.

Inductance in Drive Circuit

The first transmitter model (Fig. 4) consisted of a straightforward transistor video amplifier with 4 parallel emitter follower output stages driving the diode (a simple lens was used to collimate the light out of the diode). Because the stud of the diode package is also the anode, the heat sink and lens mount were driven

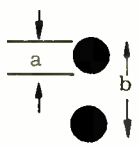
Table 1
Light Gathering Efficiency of a Lens or Parabola with a 120° Light Emitter at its Focus.

Lens				Parabola			
f/	θ	Ω	Efficiency	θ	Ω	Efficiency	f/
2	14°	0.18	6%	14°	0.18	6%	2
1	27°	0.69	22%	28°	0.74	23%	1
0.5	45°	1.84	59%	53°	2.50	80%	0.5
0.4	51°	2.33	74%	64°	3.53	100%	0.4
0.3	59°	3.05	97%	80°	5.19	100%	0.3
0.2	68°	3.93	100%	103°	7.70	100%	0.2

along with the anode connection; the cathode being grounded. The capacitance of driving all this did not prove a problem even at 10 MHz, but the series inductance of the short 1 in. leads connecting the driver transistors to the diode began to cut off at 1 MHz. This is a direct result of the very low impedance (O.2Ω) which the diode presents to the output transistors (thus we have a stray series inductance problem, rather than the usual stray parallel capacitance problem).

An approximation of the inductive effect can be made by considering the inductance per unit length of a two-wire line. This is given as:

$$L = \frac{\mu_0}{\pi} \cosh^{-1} \frac{b}{a} \sim \frac{\mu_0}{\pi} \ln \frac{2b}{a} \qquad (1)$$



Since the log is a slowly varying function, we take b/a to be about 10:

$$L = (\mu_0/\pi) \ln 20 = 3\mu_0/\pi = 1.2 \times 10^{-6} \frac{\text{henrys}}{\text{meter}}$$

$$L = 30 \frac{\text{nanohenrys}}{\text{inch}}$$

$$R = 0.2\Omega \qquad (2)$$

$$f = \frac{R}{2\pi L} = \frac{0.2}{2\pi \times 30 \times 10^{-9}} \sim 1 \text{ MHz}$$

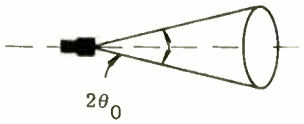
This calculation shows that a 1 in. lead of wire is enough to cause a cutoff at 1 MHz.

Collimating Infrared Beam

A second problem with this transmitter was that the lens system could only collimate 5% of the light (Table 1) because of the wide radiation cone of the diode. Because of the problems, we built a second model, which in some respects resembles a microwave antenna setup (Fig. 5).

The second transmitter used a deep parabola f/0.32 to collimate the light from the diode. This was needed to collect the large cone of light out of the diode. An integration over spherical coordinates shows that

$$\Omega = \frac{A}{R^2} = \frac{1}{R^2} \int_0^{2\pi} \int_0^{\theta_0} R^2 \sin\theta \, d\theta \, d\phi$$

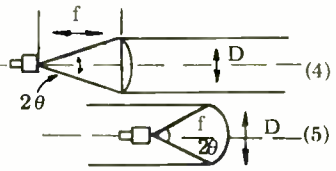


$$\Omega = 2\pi (1 - \cos\theta_0) \qquad (3)$$

Where $2\theta_0$ is the angle of the cone of radiation and Ω is the equivalent solid angle. Also, we give some basic definitions of an optical lens or parabolic mirror for producing a collimated beam:

Lens: $\tan\theta = \frac{D}{2f} = \frac{1}{2f/}$ (4)

Parabola: $\cot\theta = 2f/ - \frac{1}{8f/}$ (5)



We can define a light gathering efficiency for the parabola or lens as the percent of the light collected. This is just the ratio of the solid angle subtended by the parabola to the solid angle of the radiation cone. For the diode used, the radiation cone is about 120°.

$$2\theta_0 = 120°$$

$$\therefore \Omega_0 = 2\pi (1 - \cos\theta_0) = \pi$$

This is the equivalent solid angle. To find the solid angle subtended by a lens or parabola, we first find the angle θ corresponding to the $f/$ using Eq. 4 or 5, and then find the equivalent solid angle. Several values are given in Table 1. The $f/0.32$ parabola used will collect all the light emitted from the diode.

Strip Line Solves Problem

With the diode located at the focus of a 7 in. dia. parabola, fairly long leads were needed to connect

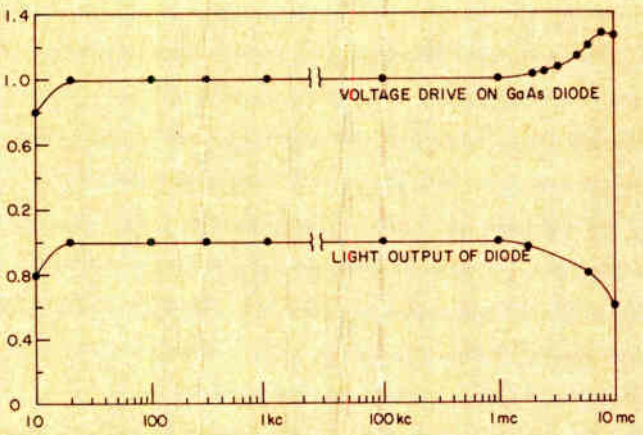


Fig. 6: Driver amplifier and IR diode frequency response.

the driver amplifier to the diode. Also, the diode had to be heat-sinked without a large structure in the parabola, obscuring the beam. We used a strip transmission line of 0.2 Ω that had a fairly heavy center conductor to act as a heat sink. The plane of the strip line was mounted parallel to the axis of the parabola, so it would block very little of the beam. The strip line is a double-sided line and is similar to the standard coax line (Fig. 5). The center conductor is aluminum with a ¼ X 2 in. cross section. The dielectric is a 5 mil Mylar® sheet and the outer conductor consists of two copper strips 2 in. wide. The whole strip line is held together as a "sandwich" by nylon screws. The impedance of the line is

$$Z_0 = \frac{d}{w}\,\frac{377}{\sqrt{\epsilon}} \sim 0.33\ \Omega \qquad (6)$$

It was almost impossible to measure the impedance of this line. The stray inductance of any leads connecting to the line is much larger than the quantity to be measured.

Since any length of wire proved to be a problem, the diode stud was screwed directly into the edge of the strip line, and a large "shroud" was placed over the top of the line connecting the outer conductor to the case of the diode.

At the other end of the 12 in. line, 3 parallel emitter-follower output stages were mounted on the strip line, with their emitter leads connected to the center conductor. Thus, eliminating any inductance problems in the driver transistors. The collector leads (cases) are connected together through the heat sink mounted on the line. The base leads are brought through the line to the other side and connected to the preceding stage. We attempted to make the driver transistors, strip line, and diode all part of one transmission structure. This was done to reduce any inductance effects.

Drive Amplifier

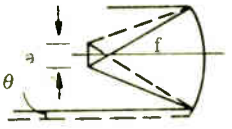
The amplifier used to drive the diode is a cascade of a basic stage, consisting of a common base amplifier driving an emitter follower (Fig. 7). It has a flat response to 10 MHz, and was purposely peaked to compensate for the falloff in the diode. The final output stage is 3 parallel emitter followers forming a voltage drive for the strip line (these are mounted directly on the strip line). There is a dc feedback loop from the collector of the final emitter followers back to the pot which controls the dc current through the diode. Because of the low impedance and some heating in the transistors, this was needed to stabilize the dc current.

The final amplifier and strip line worked well, and any frequency response problems appeared to be in the diode package. This approach of making the amplifier and diode an integral part of the strip line is necessary. It can be applied when diodes with higher frequency response into the GHz region become available.

A final note with regard to the transmitter follows. An ideal parabola with a point source of light at its focus will produce a parallel beam of light to within the diffraction limits of the aperture. In the present case the diode is not a point source and appears to have an emitting area of 1/16 in. This will give a beamwidth of 1.6° (experimentally the beamwidth was measured as ~ 1°).

$$\tan\theta \sim \frac{d}{f} = \frac{1/16''}{2\text{-}1/4''} = \frac{1}{36} \qquad (7)$$

$$\theta = 1.6°$$



The 7 in. parabola we used had a 2¼ in. focal length. The only way of reducing the beamwidth is with a parabola having a longer focal length. This also means the parabolas get rather large, unless we can find a diode with a smaller cone of radiation.

Receiving System

The receiving system consists of a 12½ in. Newtonian (reflecting) telescope fitted with a photomultiplier in place of an optical eyepiece. An aperture (pinhole) placed in a rack and pinion mount is adjusted to coincide with the image plane, to restrict the field of view. The photomultiplier is spaced several inches from the pinhole (for maximum cathode use) and detects that portion of exposed field. Twenty-five feet of 50 Ω coax cable conducts video from the rooftop telescope-photomultiplier (Fig. 1) to a video amplifier and monitor in a room underneath.

The telescope is specially weatherproofed. It consists of a heavy metal tube mounted on a tripod. Precision azimuth and elevation controls allow for smooth tracking. The front of the telescope is sealed with a transparent window of Mylar®. This window attenuates the incoming signal only about 10%. An 8-power elbow telescope acts as a finder.

With an optical eyepiece installed in place of the pinhole, the Newtonian telescope becomes an accurate instrument for precise line-of-sight alignment

with the transmitting parabola. By viewing through the optical eyepiece and an infrared image converter, the transmitting parabola may be adjusted with respect to the diode, focused, and aligned with the telescope receiver.

The system is shown in Fig. 7. The pinhole diameter is found from simple trigonometric relationships. In this system, the telescope focal length is 10 ft, located at a distance of 2200 feet from the transmitter. The transmitting parabolic mirror is 11½ in. in diameter which, by triangular relationships, sets the minimum pinhole at about 0.054 in. Theoretically, this size aperture restricts the field to exactly 11½ in. Any smaller aperture would result in signal loss, any larger aperture would result in excess noise.

In such a restricted field condition, telescope stability is of prime importance. In this instance the field of view corresponds to an angle of about 0.027°. A deviation of ¼ of this angle in one direction (either azimuth or elevation) results in a 30% drop in signal strength. A similar deviation in both directions results in a signal decrease of about 45%. Furthermore, if the area outside the source is considered noise, the signal-to-noise ratio drops by a still greater amount. These suggest a tolerance no greater than 0.007°.

Interference filters were tried, but were found not to perform as well either with the pinhole or by themselves. The reason here is that the noise is mainly from two sources—external light and statistical (shot) noise. While a filter reduces external light noise, it also attenuates the signal.

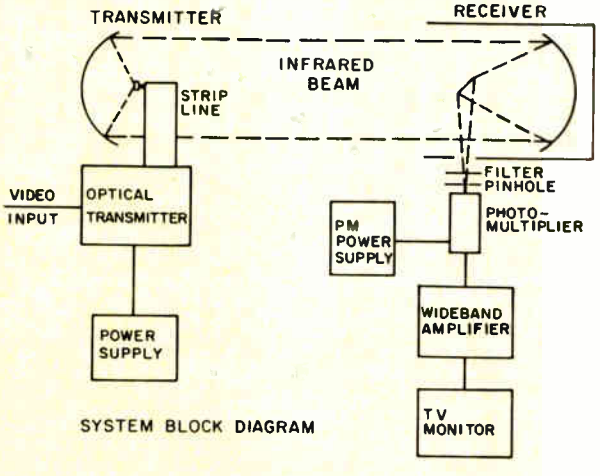
Measurements of alignment, signal strength, and noise were observed from a dc microammeter temporarily connected on the output of the photomultiplier. We noted a maximum signal strength of 900 μa, which corresponds to about 4.5 μw. On a sunny day, background noise (no signal) is about 50 μa; on a cloudy day it drops to about 8μa; and at night only the photomultiplier dark current is present. On a cloudy day during a light rain, with water droplets on the telescope window, picture quality is improved because of the low background. Water droplets on the Mylar window reduce the signal strength to about ½ or ⅓ maximum and increase noise about 1½ or 2.

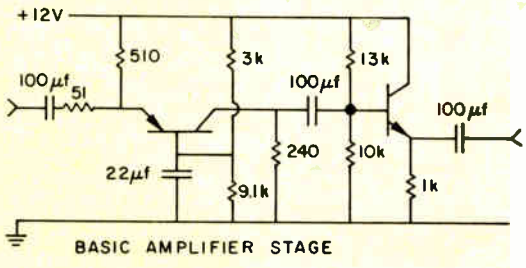
A night time measurement was made to find the lowest usable signal strength for picture presentation. The system was detuned to produce a signal strength of 50 μa (overall noise is less than 0.5 μa), representing about ¼ μw, giving a noisy but acceptable picture.

A high-gain, wide-band amplifier was used in between the photomultiplier and video monitor.** The needed amplification varied between 5 and 20, depending upon signal strength. An improved signal-to-noise ratio could probably be realized if a low pass filter were used with the amplifier to limit the bandwidth to 2 or 3 MHz.

At present, the system is working over a distance of ½ mile between buildings. An 11 in. transmitter parabola and a 12½ in. receiver telescope are being used. The picture quality is good and the system seems to have a potential for much greater range (particularly when higher power diodes become available). Drawings for the entire system are available.

Fig. 7: Top section shows the block diagram for the whole system. Bottom is the basic amplifier stage used.





Acknowledgment

The authors would like to express their thanks to Harry Klapper for help with the design and construction of the system. We also appreciate several interesting and helpful discussions with Bob Horning and Carroll Maninger.

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**Tektronix type 1121

WHAT'S NEW

NEW LINE OF ICs INTRODUCED BY RCA

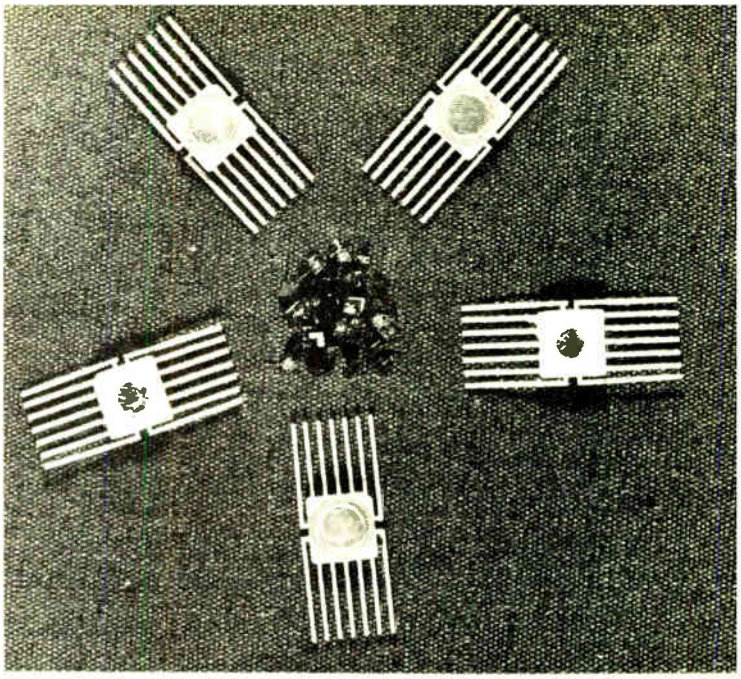
RCA HAS INTRODUCED TO THE INTEGRATED CIRCUIT FIELD a new extensive line of digital and linear circuits. According to John B. Farese, Vice President of the Electronic Components and Devices Division, the ICs will be price competitive with solid-state circuits using conventional active and passive components.

The digital line is highlighted by the Emitter-Coupled Current Steered Logic (ECCSL) devices. These units have an average propagation delay of 3.0nsec. The digital devices start at $1.60/gate in evaluation quantities of 1-24, allowing the design engineer to breadboard his equipment at reasonable prices.

The ultra-high-speed ECCSL is ideally suited for use in "third generation" business computers. Three devices are offered in this family: CD2150, a Dual 4-input positive logic OR/NOR gate; CD2151, a Dual 4-input positive logic OR/NOR gate with "Phantom OR" output capability; and CD2152, a single 8-input positive logic OR/NOR gate with "Phantom OR" output capability. Each of these new circuits features: 3.0nsec. average propagation delay (fan-out = 1 + 10pF); nonsaturated switching; built-in reference voltage supply temp. tracks logic levels; noise immunity of ± 350mv relative to logic swing (800mv); and emitter follower outputs capable of driving 100Ω transmission lines.

A more moderately powered line of ECCSL circuits are available for non-saturated switching speeds. These devices are the CD2100, a Dual 4-input OR/NOR gate, and the CD2101, a Quad 2-input NOR gate. Propagation delay for these circuits is 0nsec.

Three low-power DTL types are available for aerospace computers and counters, airborne computers, battery-operated ground equipment, computer interface and peripheral equipment, and failure detection logic circuits. These include the CD2200, a Dual 4-input positive logic NAND gate; CD2201, a Quad 2-input positive logic NAND gate; and CD2203, a J-K Flip-Flop with set-reset capability.



Each one of these ICs contains the equivalent of 20 transistors, 18 resistors, and 2 capacitors on a silicon chip, which is no larger than the letter "o" on a typewriter.

The new linear circuits, which operate from dc to 100MC, use a basic differential amplifier circuit configuration with a built-in controlled constant-current source. These linear circuits start at $4.40 each in evaluation quantities of 1-24.

Nine types of linear circuits are included:

Model	Function	—3 DB Bandwidth	Gain
CA3000	DC Amplifier	650 Kc	37 db
CA3001	Video Amplifier	16 Mc	19 db
CA3002	IF Amplifier	11 Mc	23 db
CA3004	RF Amplifier	100 Mc	12 db
CA3005	RF Amplifier	100 Mc	16 db
CA3006	RF Amplifier	100 Mc	16 db
CA3007	AF Amplifier	20 Kc	22 db
CA3008	Operational Amplifier	300 Kc	60 db
CA3010	Operational Amplifier	300 Kc	60 db

Further technical information on these integrated circuits is available from Commercial Engineering, RCA Electronic Components and Devices, Harrison, N. J.

Circle 167 on Inquiry Card

COMPARATOR HANDLES 231 COMBINATIONS OF 2 INPUT FREQUENCIES

A MULTIPLE-INPUT FREQUENCY COMPARATOR, which accepts 21 commonly used frequencies, is now available from Parzen Research, Inc., 48 Urban Ave., Westbury, L. I., N. Y. Model 091 handles frequencies between 100KC and 10MC in both input channels. Thus, it compares 231 pairs of frequencies.

The inputs automatically handled are 100, 111.1, 125, 142.9, 166.7, 200, 250, 333.3 and 500KC. Also handled are 1, 1.5, 2, 2.5, and 3, through 10MC. Following error multiplication, the frequency difference can be indicated in terms of parts in 10^{10}, 10^{9}, 10^{8}, 10^{7}, and 10^{6} in 1 second on conventional digital frequency or period counters.

The instrument accepts more than two or three frequencies at every input. No auxiliary equipment, switching, adjustments, or connection changes are required for different frequencies, and two input channels can be used interchangeably.

Circle 168 on Inquiry Card

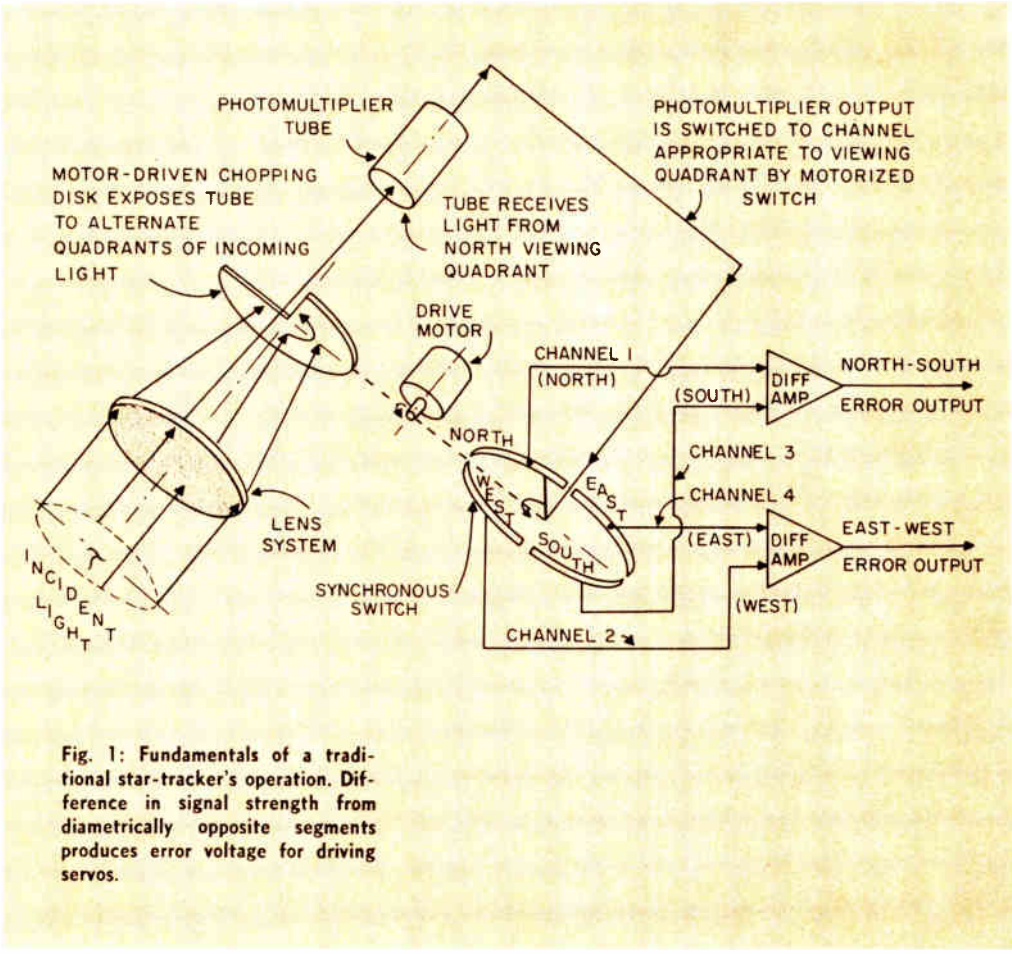


Fig. 1: Fundamentals of a traditional star-tracker's operation. Difference in signal strength from diametrically opposite segments produces error voltage for driving servos.

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High Resolution Star Tracking

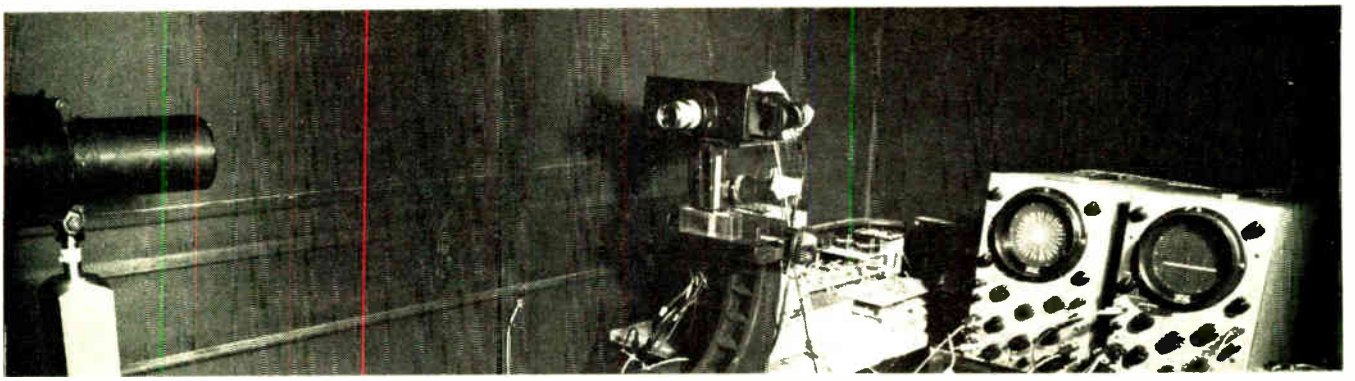
HIGH-ALTITUDE ROCKET PROBES, balloon-borne observation platforms, and some space satellites need a stable platform for their payload of telescopes and terrestrial cameras. This platform must hold these instruments in accurate alignment with predetermined patches of sky. Servo-controlled star-tracking equipment provides one method of doing this. Despite pendulum-like swings of a balloon-borne observatory, the servo system locks onto a chosen star, then holds the optical apparatus on-target throughout a filming or spectrographic mission.

The simplest star-tracker uses a combination of optical and electronic devices whose output signal is an error voltage representing off-target angle. By feeding the error signal into an angle-correcting servo system, alignment of the tracker can be continuously corrected by gimbal rotation. Or, it can even be corrected by firing small stabilizing jets if the observation platform is a satellite. Overall effect of the optical and electronic controls is to hold the target star in the center of the viewing system despite drift imposed by natural or inboard forces acting on the platform.

Prior Mechanical Systems

Traditionally, star-trackers have used multiplier phototubes as the basic optical-electronic transducer. Photomultipliers have a high signal gain (about 10^6), permitting sizeable electrical signals to be developed when viewing weak and remote stars.

Fig. 1 shows the fundamentals of a traditional star-tracker's operation. A motor-driven chopping disk covers three out of four quadrants of the multiplier phototube's viewing area at any given instant. Thus, the phototube's electrical output is proportional to the light intensity seen while that particular quadrant of the photocathode is exposed to the incident light.



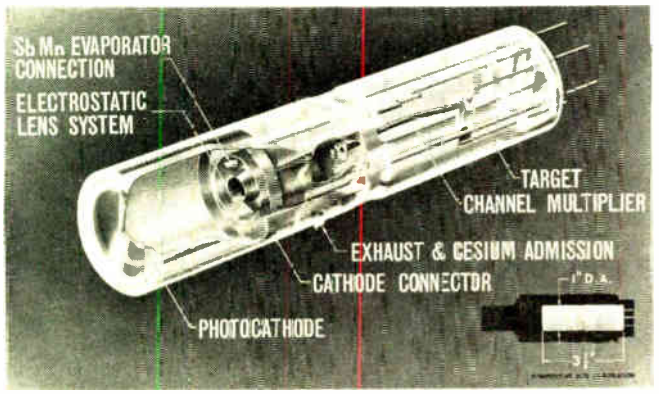


Fig. 2: "Channeltron" image dissector tube is shown above. The channel multiplier section of this tube produces a gain of 10^6.

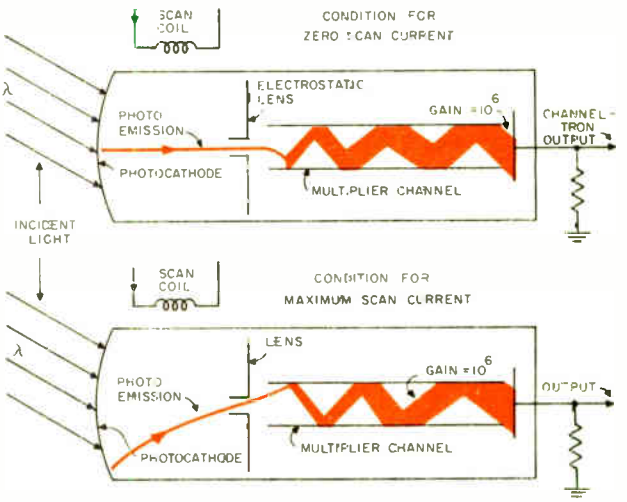


Fig. 3: (a) Electrons emitted from the center of the photocathode enter the lens aperture at zero scan current. In drawing (b) the electrons enter from other regions according to the field patterns which are set up by scan currents in the deflection coils.

Use of a magnetoresistance multiplier as the source of scanning signals in a precision star-tracker paves the way for seconds of-arc tracking resolution. An image-dissector that provides sensitivity equal to the state-of-the-art in multiplier phototubes and the novel scanning pattern are other features discussed.

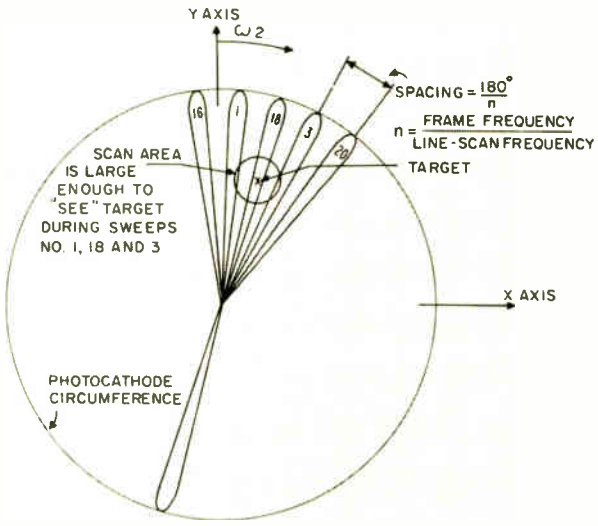
A commutator driven in sync with the chopping disk feeds the photomultiplier's output to a signal channel appropriate to the quadrant of sky being viewed. In Fig. 1, the chopping disk is shown exposing the phototube to light from a star in the upper, or North, quadrant. The signal developed by this star is fed by the commutator to Channel 1, thence to the North/South differential amplifier and control servos.

When the chopper has turned through a further 180°, absence of a star in the South quadrant will cause a reduced output to be developed. This reduces the input via Channel 3 to the North/South differential amplifier. Thus, the differential amplifier receives unbalanced inputs, causing it to develop an error-correcting difference signal. After further amplification, the error signal powers the servo-motors, or control jets, and swings the multiplier phototube so that the star moves into the center of its field of view. This is the null condition that the servo maintains. It holds the star in this position because light input is then equal on all four photocathode quadrants.

Where needed, two sets of star-tracking apparatus can be installed on one viewing platform so that all three axes are held in correct alignment with the target star. Cameras and other research equipment are not necessarily focused on the same target star; instead, the target star merely furnishes a reference point from which the other measurements can be taken.

Non-Mechanical Tracker

Although the traditional star-tracking system using the scanning disk is widely used, many advantages accrue from a solid-state star-tracker developed by The Bendix Corp. This system eliminates all moving parts and provides a very high resolution in the order of arc-



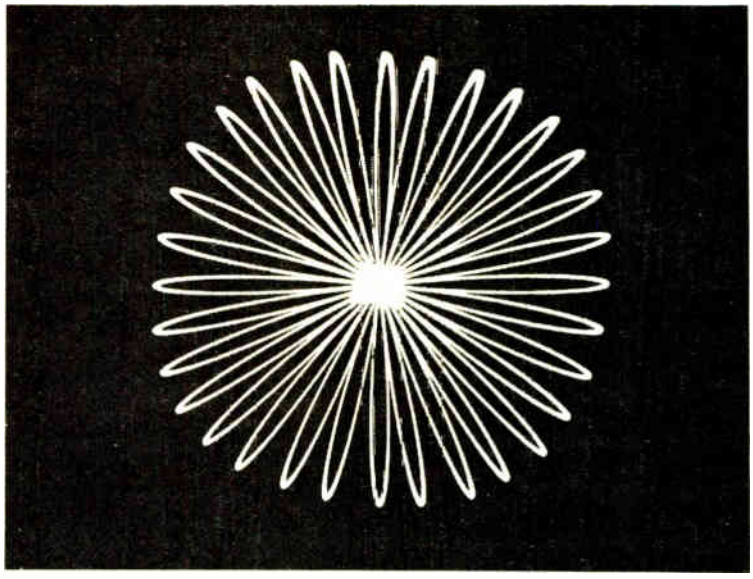


Fig. 4: Odd numbered "petals" are traced out during first half-cycle of the 25 cps modulation signal, even numbered petals during the second. (a) Oscillogram of complete scan shows how magnetoresistance multiplier's freedom from harmonics enables all zero crossings to be coincident (b).

STAR TRACKER (Continued)

seconds. Besides increased reliability stemming from solid-state scanning methods, the absence of rotating parts cuts down on size and weight. Also, vibration and noise are reduced and much less power is drawn from the electrical supply.

Fundamental needs of the solid-state system are the same as for the shutter-scanned star-tracker. That is, to develop an electrical error signal whenever the target star drifts away from the center of the multiplier phototube's field of view. The error signal then turns on servo motors or control jets, which bring the phototube back into alignment as before.

But, absence of a motor-driven shutter requires an alternative method for relating the electrical output signals to the excited regions of multiplier phototube cathode. That is, the star-tracker must be able to produce an electrical output proportional to light intensity in a known viewing direction, regardless of the circuits needed to do it. Furthermore, at null, or on-target, the error signal must remain a drift-free null.

One method of generating an angle-dependent output from an optical-electronic transducer would be to use the image-orthicon tube widely employed in TV cameras. But, since such tubes use a heated filament, reliability is greatly reduced.

Instead, a newly developed multiplier-phototube, classified under the generic title of image dissector, fills the bill. This tube is made by The Bendix Corp. under the trade name Channeltron. Owing to its fresh method of signal amplification, it combines the normal photomultiplier's high sensitivity with the image orthicon's scanning capability.

In Fig. 3a, the Channeltron is shown *instantaneously* viewing the center of the tube's emissive cathode. This particular view occurs when the scanning current through the deflection coils goes momentarily through zero. Fig. 3b shows the tube an instant later in time. Here the scan currents have attained new values, and are guiding electrons from different photocathode regions through the aperture and into the multiplier section.

Besides scanning the whole emissive area of the photocathode and developing an output proportional to light intensity at different regions, the star-tracker must also relate output signals to the viewing angles from where they originate. This coordination of electrical output to star angle is done—in the mechanical system — by the four-quadrant chopper and its synchronized commutator. In the wholly electrical method described here, the deflection signals are also used as inputs to the signal processing circuits which generate error voltages from the Channeltron output signal.

Particular values of deflection field guide electrons from specific photocathode areas through the aperture plate and into the Channeltron multiplier section. Since the deflection signals are accurately known, synchronous demodulators use the deflection information in de-

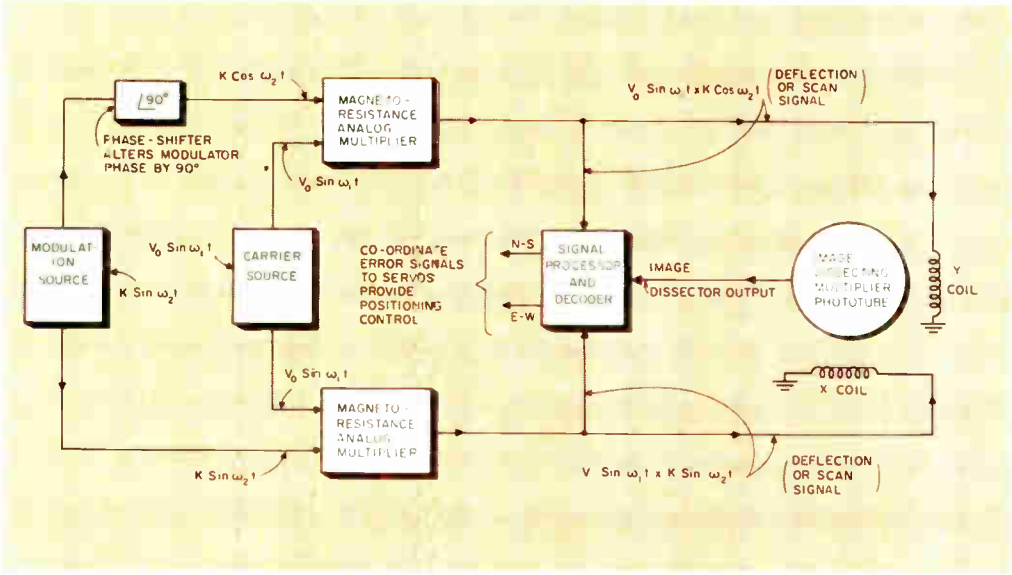


Fig. 5: Magnetoresistance multipliers generate scane signals and furnish coordinate information to signal processing circuits. Scan generator simulates a two-phase resolver excited at 400 cycles/sec. and turned at 25 revolutions/sec.

Fig. 6: (a) Multiplier output developed between points P-Q is simultaneously proportional to coil input and to voltage across R-S, hence is proportional to instantaneous product of the two inputs.

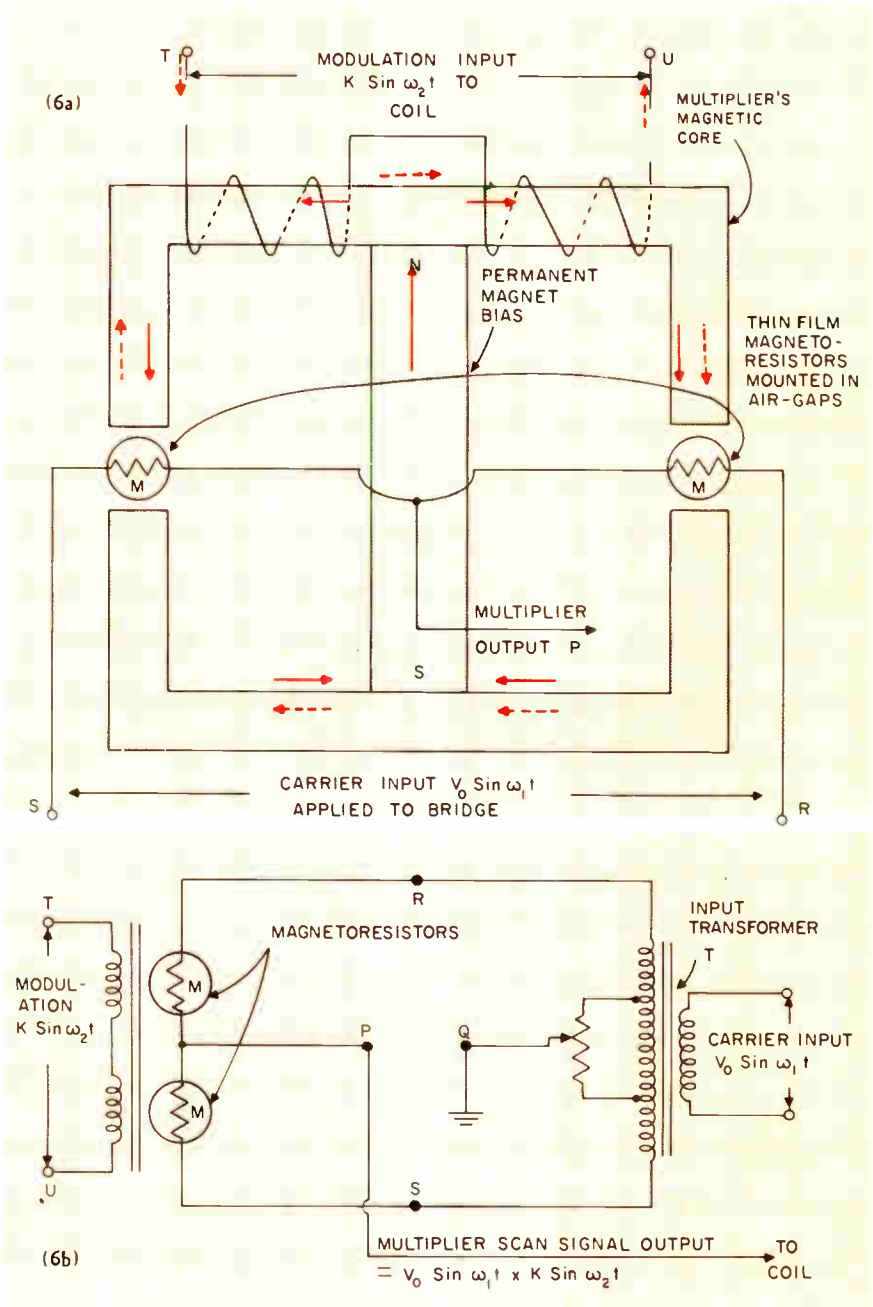
coding the Channeltron output and converting it into X and Y error voltages.

Scanning Patterns

Various scanning patterns can be used in the non-mechanical system. Flexibility of the electronic scanning method can be turned to advantage by the designer, enabling him to tailor the scan pattern exactly to his needs.

The most obvious scanning pattern . . . the raster used in TV scanning . . . provides the initial search capability. But it yields no increased resolution for tracking at the center of the field of view. Spirals and other uniformly distributed patterns also fail to simultaneously satisfy the searching and tracking criteria.

The novel flowerlike scan, Fig. 4, meets both conditions. The flower "petals" cover the whole viewing area for search operation and the many center-crossings produce greatly enhanced information rates when the system is on-target. Also, this scanning pattern may be generated with completely solid-state



STAR TRACKER (Concluded)

circuits, and uses magnetoresistance multipliers, (Figs. 5 and 6) for pattern generation.

Operating Principles

The flower-like scan pattern of Fig. 4a may be initially regarded as being produced by a 400 CPS sinusoidal carrier signal fed into a scanning coil that is physically rotated at 25 revolutions/sec.

The 16:1 ratio between carrier frequency and frequency of rotation of this hypothetical coil gives rise to 32 separate petals. The carrier's positive half-cycle generates one petal and the following negative half-cycle generates the opposite petal. In one half rotation, the complete field is scanned; during the second half rotation the gaps between petals are interlaced as shown.

A second analogy enables the rotating scan coil to be eliminated and normal X and Y scan coils to be substituted. In this case, the appropriate scan pattern could be generated by supplying the two (X and Y) scan coils from the stator windings of an electrical resolver.

If the resolver were excited with the 400 CPS carrier current and its shaft turned at the 25 RPS rate, the scan pattern would be the same as before.

In the new star-tracker no resolver is actually used for scan generation; instead, the resolver action is simulated by solid state circuits. Two magnetoresistance modulators enable the 400 CPS carriers to be modulated with 25 CPS envelopes, just as occurs in the electromechanical resolver.

Solid State Scan Circuit

By analogy with the mechanically rotated resolver, input to the X scan coil of the Channeltron should be a 400 CPS signal modulated with a 25 CPS envelope and represented mathematically by $V_X = V_0 \times \text{Sin } \omega_1 t \times K \text{ Sin } \omega_2 t$; where ω_1 and ω_2 are the # angular velocities corresponding to 400 CPS and 25 CPS respectively. Since the envelope of the Y scan coil input is in quadrature with the X coil input, its equation is given by $V_Y = V_0 \text{ Sin } \omega_1 t \times K \text{ Cos } \omega_2 t$. These two scan signals, generated from separate 400 and 25 CPS inputs, are all that are needed to develop the flowerlike scan pattern.

Since the X and Y scan inputs are shown by the above equations to be proportional to the mathematical product of carrier and modulating frequencies (400 and 25 CPS), the modulators themselves must be true instantaneous multipliers, and be free from higher order harmonic products.

Operation of the scan generator (Fig. 5) follows the method discussed previously, with separate 25 and 400 CPS inputs fed into each magnetoresistance modulator. Output is then the product of these two sets of inputs. The magnetoresistance multiplier is itself a novel device. Its characteristics are very favorable for this use and contribute to the star-trackers high null accuracy.

Two flux-sensitive resistors, magnetoresistors M_1 and M_2, Fig. 6a, are fitted into the air-gap in a closed magnetic core and connected in a circuit analogous to a Wheatstone bridge, Fig. 6b. Application of current to the magnetizing coil sets up a field in the magnetic core that opposes the mmf from the bias magnet in one limb and aids the bias magnet's mmf in the other limb. Thus, one magnetoresistor increases in resistance, while the other one decreases.

Since the two are connected in series, their push-pull change in resistance alters the bridge circuit's balance and develops an output between points P and Q. Actual magnitude of output at bridge unbalance depends simultaneously upon the amount of this unbalance, and also upon the voltage applied at that instant between points R and S.

As shown by Fig. 6b, bridge unbalance is proportional to the modulation signal $K \text{ Sin } \omega_2 t$, and bridge input is equal to $V_0 \text{ Sin } \omega_1 t$. Instantaneous output from the circuit is then the product of the two inputs: namely, $V_0 \text{ Sin } \omega_1 t \times K \text{ Sin } \omega_2 t$, with the proportionality constant set at unity by some appropriate turns ratio on the input transformer, T.

Two of these magnetoresistance multipliers are used, one each for the horizontal and vertical scan coils. The resulting scan currents simulate the action of a resolver turning at 25 RPS and develop the flowerlike scanning pattern for the image dissector tube.

Conclusions

Three important developments share in the star-tracker's success. First, the image dissector simplifies the conversion of star position into electrical signals. This Channeltron tube is smaller than image dissectors previously available and besides taking up less space dispenses with the usual chain of voltage dividing resistors.

Secondly, the fresh ideas in information gathering lead to a new scanning pattern. The star-tracker achieves a broad view of the whole field of vision yet provides an intensive examination of the region of maximum interest.

Finally, the magnetoresistance multipliers used in the scan-generation circuits permit high viewing resolution through low noise and harmonic levels. Circuit simplicity and drift-free operation are further benefits of their use.

. . . Exotic Devices of the Future?

Here are some new developments in the laboratory that may be used in the future for amplifying, switching and memory devices. Right now it is not clear how practical they will be. Information is included about fluid amplifiers.

By RALPH GLASGAL*
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SINCE LEE DEFOREST put a grid between the plate and the cathode of a vacuum tube, there has been a search for new and better active devices. New devices emerge from the laboratories faster than use can be made of them. Many of these devices fade into obscurity — because of fabrication difficulties, scarce capital, lack of publicity or high cost. Others, like the transistor, become the foundation of whole new industries. This article describes some recent devices, some of which show promise of importance and others which are merely intriguing, but now impractical curiosities. All, however, exist and do work in the laboratory.

Opto-Electronic Transistor

A new type of transistor is the opto-electronic transistor (Fig. 1). It has an electroluminescent emitter, a transparent base and a photo-electric collector. A limitation of transistors is that minority carriers must diffuse across the base region from the emitter to the collector. The minority carrier may, if an electron, combine with a hole or be annihilated by nuclear radiation. If the diffusion time is too long, or the base region too wide, high-frequency response will be limited. Photons, however, travel at the speed of light, and using photons to transfer energy from the emitter to the collector would free designers from the material and narrow-base fabrication problems that plague them in the design of h-f transistors. Optical transistors would also afford complete isolation between input and output circuits. These devices, when perfected, may be able to operate at GHz rates. At present, the best units

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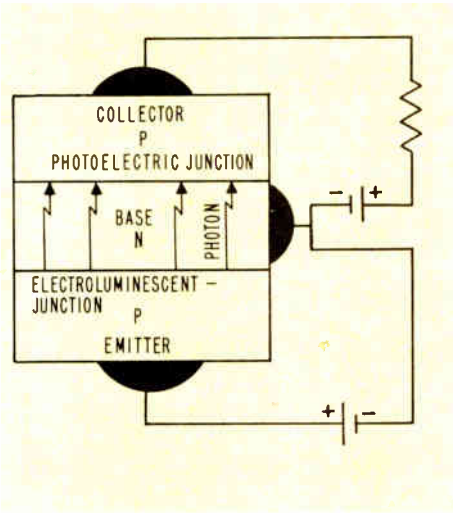


Fig. 1: Sketch illustrates an opto-electronic transistor which shows promise as a device of the future.

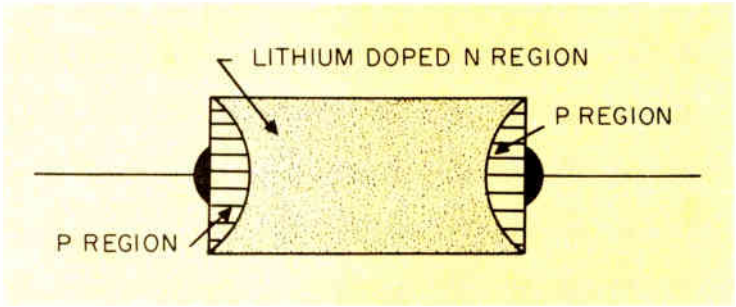


Fig. 2: The flexode is a flexible diode that has a PN junction which may be altered at will from one direction to the other.

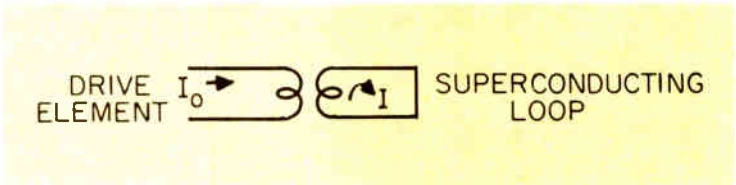


Fig. 3: (bottom): The cryotron resembles a transformer with two one-turn windings, with the secondary winding being shorted.

EXOTIC DEVICES (Continued)

operate at liquid nitrogen temperatures because room temperature current gains are less than unity.

Madistor

A potentially useful plasma device is the madistor. The madistor is a semiconductor device that makes use of the effects of a magnetic field on a plasma current. A magnetic field may be used to deflect a plasma current in a semiconductor in much the same way as an electron beam in a cathode ray tube. At least four types of madistors have been studied. One type is a magnetic diode. The strength of a magnetic field determines the conductivity of the madistor material. A small change in the magnetic field produces a larger change in madistor current. Amplifiers, switching circuits, and oscillators operating at up to 450 KHz have been built.

In a second type of madistor the magnetic field is used to switch the current of it with two collector or output terminals from one output to the other. The magnetic field can be removed, but the current will remain at the output to which it was last steered. Switching times of 2 to 3 μsec. have been measured for these bistable flip-flops.

A third type includes devices with a multiplicity of output contacts. The plasma current may be magnetically switched in sequence from one output to the next, thus it is a solid-state beam switching tube.

In a fourth type, a magnetic field acts to vary the emitter current of a transistor structure and control its gain. A field of 10 gauss is enough to operate all of these devices.

Flexode

The flexode is the first of what promises to be a long line of adaptive semiconductor devices. As its name implies, it is a flexible diode. Normal diodes contain a PN junction that is hopefully stable and whose characteristics do not vary with time. The flexode, on the other hand, contains a junction that may be altered at will from a PN junction in one direction, to no junction at all, to a PN junction in the opposite direction. Thus the direction of easy current flow may be reversed without reversing the leads to the diode, and the resistance of the diode may be continuously varied from the back resistance value to the forward resistance value. It may be set to behave as a simple resistor with the same value for both directions of current flow.

In a normal diode the N and P type impurities that form the diode junction are firmly bound to their positions in the germanium crystal lattice at room temperature. One type of flexode (see Fig. 2) has a central N region containing lithium doped germanium, with an excess of lithium. Both ends of the diode are made of P type germanium. Lithium is a very light metal. Lithium ions have a very small nucleus and cross-sectional area. Therefore, when it is used as the N type impurity in germanium, it is easy for the lithium atoms to move about. They have a high drift mobility, even at room temperature. A strong electric field will cause the mobile lithium N doping ions to congregate at one end of the central flexode region forming metallic filaments in the junction; which end depends on the direction of the applied field. When enough lithium

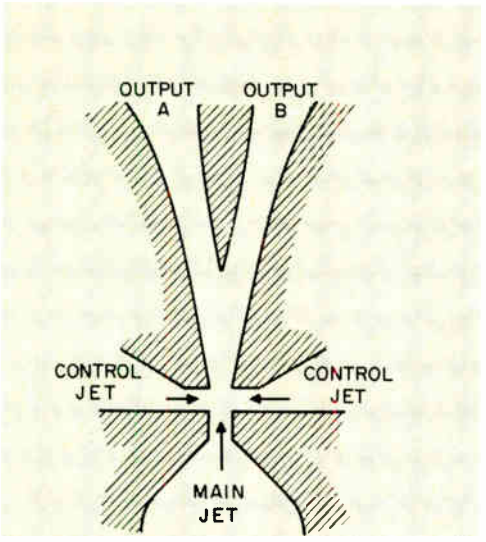


Fig. 4 (left): The bistable flip-flop is shown set to the B output.

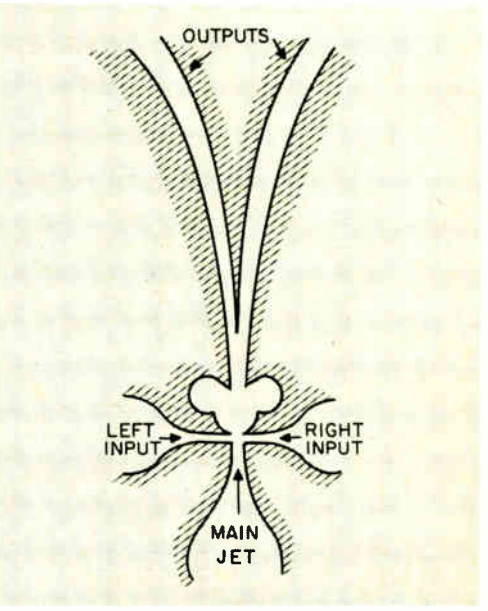


Fig. 5: This is a proportional differential fluid amplifier.

atoms have migrated to the border of the P type end, the junction is shorted out. At the same time lithium metal filaments leave the other junction, so that it is no longer shorted. This junction will either be a PN junction or an NP junction, depending on the direction of the applied field.

A flexode diode can be reversed from one polarity to the other by a current of 200 to 300 ma applied for about half an hour. The diode characteristics remain stable over a period of several weeks under no-current conditions. Small currents in the 8 ma range do not affect the state of the flexode appreciably.

The flexode is the first and so far the only semiconductor adaptive device. It is expected that the flexode will find wide use in the fields of neural logic, bionics, machines that learn, etc. The small size of the flexode and its suitability for integrated circuit methods seems to point to a bright future for this device. It does have some disadvantages. Both the current required and the time to switch the diode characteristics are too high for many practical computer uses. Also, the ratio of front-to-back resistance is only about 100 to 1. Back resistance is reduced by high temperatures, and even at room temperature some deterioration is noted after several weeks. With further development many of these disadvantages will undoubtedly be eliminated. Illumination of the N area with light greatly speeds the transitions between states of the flexode. This should result in greater possibilities for it.

Nickel Oxide Film Diode

A new kind of solid-state diode which does not use semiconductor materials has been discovered. It is made of nickel oxide film. One side of a small plate of nickel is oxidized and leads are attached. A nickel oxide film may be switched from a low to a high impedance state. It has an OFF state in which the impedance is very high (about 10 megohms). It has an ON state in which the impedance is quite low (about 100 ohms). It may be switched from OFF to ON by applying a 300 volt, low-current pulse for 10 μsec. It may be switched from ON to OFF by applying a 30 volt, high-current pulse for 10 μsec. Neither the ON nor OFF state can be destroyed by applying pulses of 5 volts or less. In effect it works as a diode flip-flop. The application of high voltage causes conducting filaments to form within the normally nonconducting nickel oxide film. The subsequent passage of high current through these filaments dissolves the filaments and returns the oxide to its insulating state.

The nickel oxide film diode offers possibilities as a computer memory element with a large signal nondestructive read-out capability. It may also have use in switching networks, telephone system crosspoints and logic circuits.

Cryotrons

The discovery of superconductivity has led to many new devices. At temperatures close to absolute zero some elements become superconducting and show zero resistance properties. Each element has its own threshold temperature at which it becomes superconducting. Superconductivity is also current dependent. A superconducting element may lose its superconductivity

(*Continued on page* 101)

1966 Survey of Potentiometer Specifications | Part 3: Trimmer Potentiometers

Trimmer Potentiometers	Type No. or Series	Trimmer(T); Precision Trimmer(P)	Wirewound (W); Metal Glaze (G)	Carbon (C); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg.(S); Bush.Mtg.(B); Screw(SC)	P–C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Height (in.)	Width (in.)	Length (in.)	Dia. (in.)
Aero Electronics Corp. 1745 W. 134th St. Gardena, Calif.	625 725	T	W			R		20	125	10	to 0.1		190	5		X	SC	X	L	0.5	0.4	1.2	
	627 727	T	W			R		20	125	10	to 0.1		190	5		X	SC	X	P	0.5	0.4	1.2	
	825 925	T	W			R		20	100	10	to 0.1		190	3		X	SC	X	L	0.2	0.3	1.2	
	827 927	T	W			R		20	100	10			190	3		X	SC	X	P	0.2	0.3	1.2	
	1127	T	W			R			100	10				1		X	SC	X	P				
	800 900	T	W			R											B						
Allen-Bradley Co. Milwaukee, Wisc.	F	T		CO		C	1	100	5K	20	N		120	0.2	X		B	X	T			0.6	1
	O	T		CO		C	1	100	5K	20	N		150	0.4	X		B	X	T			0.5	0.5
	R	T		CO		R	25	100	3K	20	N		125	0.2		X	B	X	P	0.3	0.2	1	
	N	T		CO		R	25	100	3K	20	N		100	0.3	X			X	T P	0.3	0.2	1	
	T	T		CO		C	1						120	0.5	X			X	P				0.8
Amphenol Controls Div. 120 S. Main St. Jonesville, Wisc.	992 4	T	W			R		10	50	10			105	1		X	SC	X	X	0.3	0.3	1.2	
	993 5	T		C		R		20	1K	20	N		105			X	SC	X	X	0.3	0.3	1.2	
	2880	T	W			R	25	10	100	5	to 0.1		125	1		X	SC	X	X	0.3	0.3	1.2	
	2600 10	T	W			R	20	100	20	10			125	1		X		X	T	0.3	0.2	0.7	
	2700	T	W			R		100	30	5				1		X	SC	X	L	0.3	0.2	1	
	2750	T	W			R		100	100	5			175	1		X	SC	X	X	0.3	0.2	1.2	
	2850	T	W			R	25	10	100	5			175	1		X	SC	X	X	0.3	0.3	1.2	
	2860	T	W			R	25	10	100	5			175	1		X	SC	X	X	0.3	0.3	1.2	
	2900	T	W			S		10	50	5				1		X	SC	X	X	0.5	0.2	0.5	
	2901	T			F	S	25	500	20	10	N		175	1		X	SC	X	X	0.5	0.2	0.5	
	2870	T	W			R		10	100	5			125	1		X	SC	X	X	0.3	0.3	1.2	
Atohm Electronics 3030 Empire Ave. Burbank, Calif. 91504	ART10	T	W			R	18	10	100		to 0.2		200	1		X	SC	X	X	0.3	0.2	1	
	270	T	W			R	18	10	100		to 0.2		175	1	X		SC B	X	X	0.3	0.2	1	
	ART11	T	W			R	25	10	150		to 0.1		200	1		X	SC B	X	X	0.3	0.3	1.2	
	T11	T	W			R	25	10	150		to 0.1		175	1	X		SC B	X	X	0.3	0.3	1.2	
	120	P	W			R		10	150		to 0.1		200	2		X	SC		P	0.3	0.2	1	
	870	T	W			R		10	100		to 0.1		115	0.5	X		SC	X	X	0.3	0.3	1.2	
	—	T	W			R		20K	1K				85	0.2	X		SC	X	X	0.3	0.3	1.2	
Beckman Instruments Helipot Div. 2500 Harbor Blvd. Fullerton, Calif. 92634	50 54	T	G			R	35	10	2K	10	N		200	1.5	X				X	0.3	0.3	1.2	
	55	T	G			R	27	10	2K	10	N		175	1	X			X	X	0.3	0.3	1.2	
	56 58	T	G			R	35	10	2K	10	N		175	1	X		SC		X	0.3	0.2	1.2	
	75	T	G			R	25	10	2K	20	N		150	0.5	X			X	X	0.3	0.3	1.2	
	61	T	G			C	1	10	1K	20	N		150	0.5	X			X	P				0.25
	62	T	G			C	1	10	1K	20	N		125	0.5	X			X	P				0.25
	70 71	T	W			S		10	20	5	to 0.1		150	1	X			X	P/L	0.5	0.2	0.5	
Bourns, Inc. Trimpot Div. Riverside, Calif. 92507	200	T				R		10	100	10			105	0.5	X		SC	X	X	0.3	0.2	1.2	
	215	T				R		5K	5K	20			125	0.2	X		SC	X	X	0.3	0.2	1.2	
	260	T				R		10	100	10			175	1	X		SC	X	X	0.3	0.2	1.2	
	207	T	W			R	25	100	200	10	to 0.2		175		X		B/SC		L	0.8	0.3	1.2	
	209*	T	W			R	25	10	50	10	to 0.2		135		X		SC		L	0.5	0.3	1.2	
	215	T		C		R	22	1K	5K	20			125		X		B SC	X	X	0.3	0.3	1.2	
	220	T	W			R	15	10	30	5	to 0.2		175	1		X	B SC	X	X	0.3	0.2	1.2	
	224	T	W			R	22	10	100	5			175	1		X	B SC	X	X	0.3	0.2	1.2	
	235	T		C		R	22	5K	5K	20			125	0.2		X	B SC		X	0.4	0.3	1.3	
	236	T	W			R	25	10	100	10	to 0.2		135	0.8		X	B SC		X	0.4	0.3	1.3	
	260	T	W			R	25	10	100	10	to 0.2		175	1	X		B SC		X	0.3	0.2	1.2	
	271-5	T	W			R		50	20	10			105	0.5	X		B SC		X	0.3	0.2	1.2	
	272-6	T		C		R		5K	1K				105	0.2	X		B SC		X	0.3	0.2	1.2	
	3000	T	W			R	15	50	20	10	to 0.3		175	0.5		X		X	P	0.3	0.2	0.7	
	3001	T		C		R	15	5K	5K	20			150			X		X	P	0.3	0.2	0.7	
	3010	T	W			R	25	10	100	5	to 0.2		175	1		X	B SC	X	X	0.3	0.3	1.2	
	3011	T		C		R	22	5K	5K	20			150	0.2		X	B SC	X	X	0.3	0.3	1.2	
	3012	T				R	25	2K	1K	10	N		175	1		X	B SC	X	X	0.3	0.3	1.2	
	3020	T	W			R	25	100	50	5	to 0.2		200	5		X	B SC		L	0.2	0.3	1.2	
	3030	T	W			R	25	10	10	10	to 0.6		265	15	X		SC		L	0.9	1	1.3	
	3040	T	W			R	17	500	20	10	to 1		350	5	X		SC		L	0.4	0.3	1.2	
	3051	T		C		R	22	5K	5K	20			150	0.25		X	B SC	X	X	0.3	0.2	1.2	
	3052	T				R	25	2K	1K		N		175	1		X	B SC	X	X	0.3	0.2	1.2	
	3053	T				R	25	2	0.2		N		175	0.5		X	B SC	X	X	0.3	0.2	1.2	
	3067	T	W			R	15	50	20	10	to 0.3		85	0.5	X		SC	X	L/T	0.4	0.3	1	
	3068	T		C		R	15	20K	1K	20			85	0.2	X		SC	X	L T	0.4	0.3	1	
	3070	T	W			R		100	50	5	to 0.1		175	1.5		X	B SC	X	X	0.4	0.1	1	
	3250	T	W			S	25	10	50	5	to 0.1		175	1		X	SC	X	X	0.5	0.2	0.5	
	3251	T		C		S	25	5K	5K	20			150	0.5		X	SC	X	X	0.5	0.2	0.5	
	3280	T	W			S	25	10	50	5	to 0.1		175	1		X	SC	X	X	0.3	0.2	0.3	

(Continued)

* Dual element

Third in a series of special reports by EI editors identifying manufacturers with their trimmer potentiometer types and characteristics

Electronic Industries' POTENTIOMETER SPECIFYING GUIDE (Part 3) covers general purpose and precision trimmer potentiometers used in military, commercial and industrial applications for all classes of service from dc to high frequency.

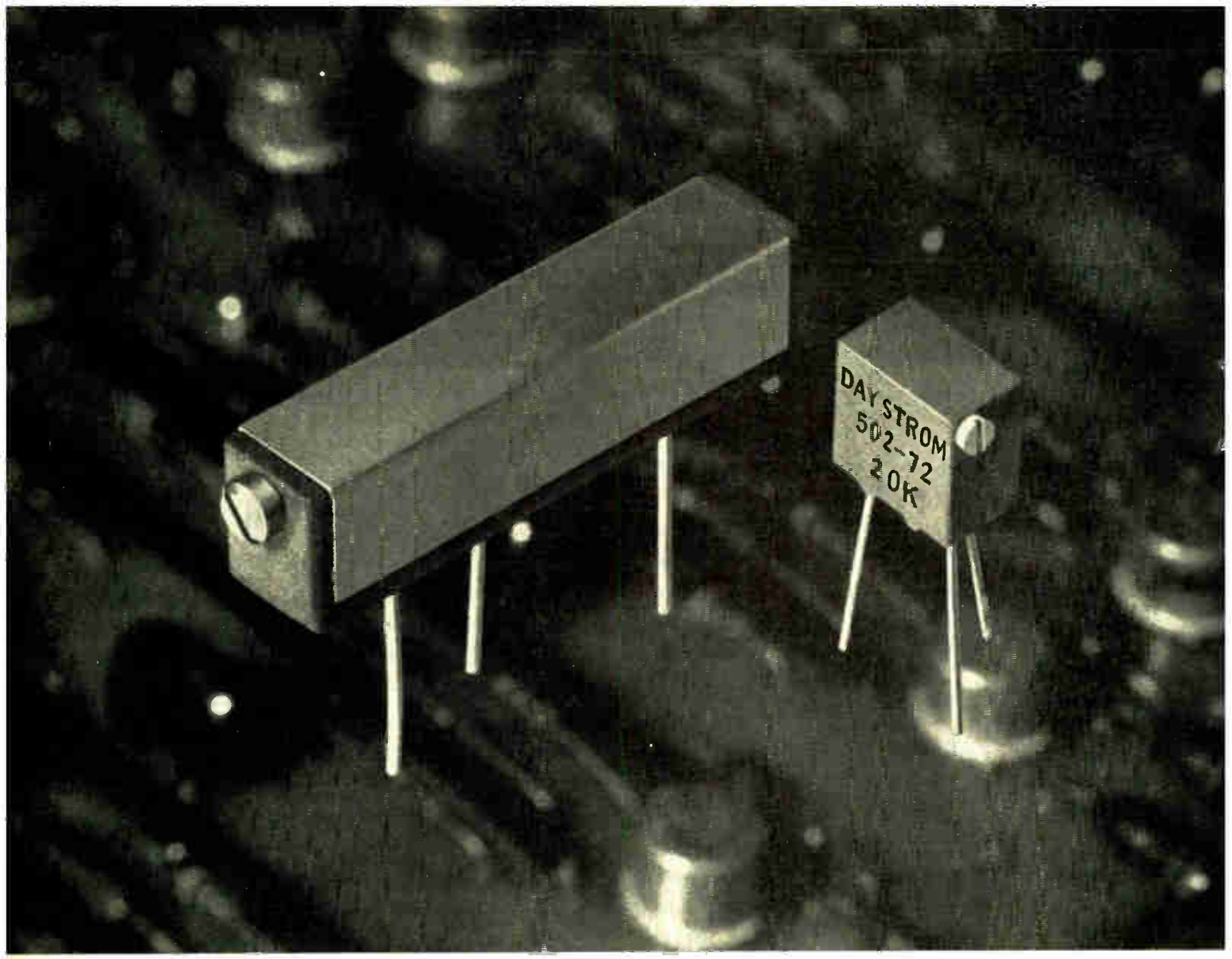
The charts indicate the types of trimmers, their construction, performance characteristics, power ratings, mounting configurations and size.

POTENTIOMETER SURVEY

Part 1 appeared in the October EI Issue
Part 2 appeared in the November EI Issue
Part 4: General Purpose Potentiometers will appear in the March EI Issue

Trimmer Potentiometers	Type No. or Series	Trimmer (T); Precision Trimmer (P)	Wirewound (W); Metal Glaze (G)	Carbon (C); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg.(S); Bush.Mtg.(B); Screw(SC)	P.C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Height (in.)	Width (in.)	Length (in.)	Dia. (in.)
Bourns, Inc.	3281	T		C		S	25	20	1K	20			150	0.5		X	SC	X	X	0.3	0.2	0.3	
(Continued)	3257	T	W			S		10	20	10			105	0.2	X		SC	X	L	0.5		0.5	
	3300	T	W			C	1	10	20	5	to 0.2		175	0.5	X		B	X	L P				0.3
	3301	T		C		C	1	10K	1K	20			150	0.2		X	B	X	X				0.3
	3307	T	W			C	1	50	20	5			150	0.5	X			X	P				0.3
	3367	T	W			C	1	100	50	5	to 0.1		105	0.5	X		B	X	P T			0.2	0.5
	3368	T		C		C	1	20K	1K	20			105	0.2	X		B	X	P T			0.2	0.5
Carter Mfg. Corp.	107A	T			CP	R	20	100	10		N		150	1		X	B SC		L	0.3	0.2	1	
23 Washington St.	107	T	W			R	25	10	50	5	to 0.1		150	1		X	B SC		L	0.3	0.2	1	
Hudson, Mass.	04A	T	W			C		100	10	5		1		0.5		X		X	L			0.3	0.2
	120H	T	W			C		100	50							X	S		L			0.5	0.5
	101	T				C	1	47	15	10				0.2		X			P L			0.6	0.2
	118C-E	T	W			C		100	25	5		1		1		X	B		T			0.5	0.9
	12H	P	W			C	to 10	50	100		to 1	to 0.5	150									1	0.5
Clarostat Mfg. Co., Inc.	76	P	W				M	100	20	5	to 0.03				X			X	P			1.2	
Dover, N. H.	56	P	W				25	100	20	10	to 0.2	2		0.8	X		SC		L	0.3	0.25	1.2	
Conelco Components	015	–	W			C	22	10	50	5			180	0.7		X	B		T L			0.7	0.2
465 W. Fifth St.	025	T	W			C	22	10	125	5			180	1		X	B		T L			1.1	0.2
San Bernardino, Calif. 92401	031	T	W			R	22	10	50	5			180	0.7		X	SC		T L	0.4	0.2	0.7	
	037	–	W			R	22	10	125	5			180	1		X	SC		T L	0.2	0.4	1.2	
	040	T	W			R	22	10	125	5			180	0.7		X	SC	X	P	0.4	0.3	1.3	
	062*	T	W			R	22	10	125	5			180	0.7		X	SC		T L	0.2	0.6	1.2	
	039	T	W			R	40	0.5	0.017				155	0.1		X			L	0.2	0.4	1.2	
	090	T	W			R	45	10	125				105	0.5		X	SC	X	P	0.4	0.3	1.3	
	071-4	–	W			S	31	10	50				180	1		X	SC	X	X	0.5		0.5	
	051-6	T	W			S	22	10	50				180	0.7		X	SC	X	X	0.4		0.4	
	028 '128	T	G		F	C	45	5	2K	0.7	N		180			X	B		P T			1.1	0.2
* Dual element																							
Consolidated Resistance Co.	10	P	W			R		1	800			to 0.02		3		X		X	X	0.4	0.3	1	
44 Prospect St.																							
Yonkers, N. Y.																							
CTS Corp.	110	T	W			C		0.5	10	20				2					T			0.4	0.7
Elkhart, Ind. 46514	115	T	W			C		0.5	10	20				2	X			X	T			0.4	0.7
	201	T		CO		C		100	5K	30				0.2					T			0.2	0.6
	220	T		CO		R		250	2.5K	20				0.1					T	0.5	0.3	0.4	
	IRW	T	W			R	60	400	2	10	N			0.5		X			L	0.3	0.3	1.3	
	140	T		C		R		100	1K	20				0.2	X			X	P L	0.3	0.3	1.2	
	160	T	W			R	15	100	2	10				0.7	X				P L	0.3	0.2	1	
	330	T				C		100	2.5K	20				0.4	X				T P			0.4	0.5
	350	T	W			C		50	20	5			125	1	X				P			0.2	0.5
	385	T	G			C		100	500	20				0.4	X				P			0.2	0.4
	630	T	G			C	1	20	2.5K	20				0.5	X			X	P T			0.4	0.5
* Carbon ceramic																							
CTS of Asheville, Inc.	350	T	W			C		50	20	5	to 0.2		125	1		X		X	P			0.2	0.5
Skyland, N. C.																							
Dale Electronics, Inc.	5050-107	P	W					10	50	5			175	1	X				L	1	0.7	0.7	
1356 28th Ave.	5080 91	T	W			S		100	50	5			175	1	X			X	P L	0.5		0.5	
P.O. Box 609	600	P	W			R	15	10	50	5			175	1		X		X	X	0.2	0.3	1	
Columbus, Nebr.	1200	P	W			R	25	10	100	5			175	1		X		X	X	0.3	0.3	1.2	
	1600	P	W			R	22	10	100	5			175	1		X		X	X	0.2	0.3	1.2	
	5000	P	W			S	23	10	50	5			175	1		X		X	X	0.2	0.5	0.5	
	200	T	W			R	25	10	50	10			105	0.5	X			X	T L	0.2	0.3	1.2	
	300	T	W			R	25	100	200	15			85		X			X	T	0.2	0.3	1.2	
	2100	T	W			R	25	10	100	10			125	1	X			X	X	0.3	0.3	1.2	
	2200	T	W			R	15	10	50	10			125	1	X			X	X	0.2	0.3	1	
	100	T	W			R	25	10	50	5			135	0.8	X			X	X	0.2	0.3	1.2	
	1100	T	W			R	25	10	100	5			175	1	X			X	X	0.3	0.3	1.2	
	1500	P	W			R	25	10	100				175	1		X		X	X	0.2	0.3	1.2	
Electro-Techniques	1L W PC	T	W			R	35	10	100	5	to 0.1		175	2			SC	X	L P	0.3	0.4	1.2	
11301 Ocean Ave.																							
La Habra, Calif.																							

Listings continue on page 108



And the small one does a better job

New 5/16″ Daystrom Commercial 501 & 502 Squaretrim® Potentiometers Take About 1/6 Space At No Extra Cost

Notice how much space you save: 0.0185 inch cubic volume releases five-sixths of the space formerly required by conventional rectilinears—and you save that space at no increase in price. Nor do you pay extra for:

Soldered Terminations—for better protection against vibration, shock and humidity—no pressure taps.

Better Tolerance— ±5% (100% better than many rectilinears).

Superior Resolution—0.125% or less.

Adjustability—15 mechanical turns.

Slip Clutch—eliminates wiper damage, cuts production delays.

Convenience—3 different configurations to choose from: with adjusting screw on top, side or end.

Wide Range—10 to 20K ohms.

High Power—0.6 watt in still air at 70 C.

Wide Temperature Range— —55 C to +150 C.

Low Temperature Coefficient— ±70 ppm max.

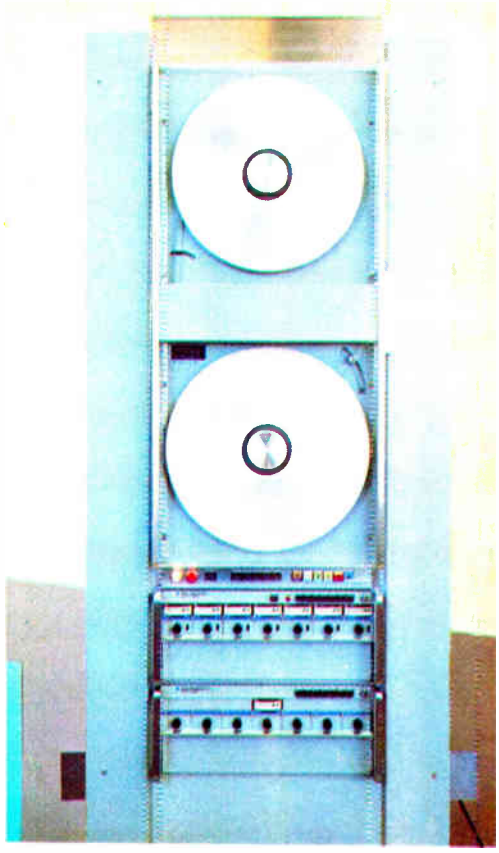
Low Noise—100 ohms max ENR.

Add it up and you can see why so many large users already have turned to the New Weston-Daystrom Models 501 & 502 Squaretrim® Potentiometers. Get the facts and you will too. **Weston Instruments, Inc. • Archbald Division • Archbald, Pa. 18403**

WESTON® *prime source for precision . . . since 1888*

Circle 101 on Inquiry Card

RECORDERS OFFER HIGH PERFORMANCE AT LOW COST



Low-cost recorders come in 7 and 14 channel, 15-in. reel models. Many factory preset adjustments, and ball bearings which require no lubrication cuts maintenance.

LOW-COST INSTRUMENTATION TAPE RECORDERS, which have quality features and almost no maintenance, have been introduced by Hewlett Packard, 1501 Page Mill Rd., Palo Alto, Calif. These magnetic-tape units, called the 3950 Series, are available with either 7 or 14 channels in standard IRIG configurations.

The recorders operate at 1.5MC. They offer 15 in. reels, pushbutton selection of tape velocity, tape transport operation, playback equalization, full metering of all recording functions, and pushbutton channel-by-channel front-panel system checkthrough.

Typical flutter, measuring all components from dc to 1500 CPS, is under 0.2% peak-to-peak. This level of motional stability is attained in an easy-to-thread, open-loop drive, without the use of tachometer servos. To lock replay speed exactly to recording speed, the buyer may add an optional Tapespeed Servo. It records an IRIG-standard 17KC carrier control track, and uses it during replay to govern reproducing tape velocity.

The overall signal-to-noise ratio depends on the magnetic tape. Distortion from electronic sources is more than 50db below peak level. The all solid-state record/reproduce plug-in amplifiers retain this characteristic even when interchanged at random. The signal-to-noise ratio specification is more than 26db in the band 400 CPS to 1.5MC; typical performance is 33db. Square-wave risetime is less than 0.4μsec.

Electrical and electronic controls are pushbutton throughout. Tape transport functions (stop, play, reverse, fast forward, and record) are remotable for centralized or automatic control. Any of six tape velocities may be pushbutton-selected, without belt or gear changes. Reproduce equalization is selected by press-bar controls. Each of these is, itself, integral with its equalizer electronics; each press-bar/equalizer is a plug-in, interchangeable and readily replaceable.

Complete system adjustment may be accomplished, channel by channel, entirely from the front panel. Built into each system, as standard equipment, is a row of pushbuttons, one/channel for recording and reproduce. Using these, test equipment may be plugged directly into the front panel, and a complete system checkthrough may be performed with no need for access to rear connections.

Prices given are less than $16,000 for the 15 in. reel 7-channel Model 3956A, and less than $20,000 for the 14-channel Model 3957A. Circle 169 on Inquiry Card

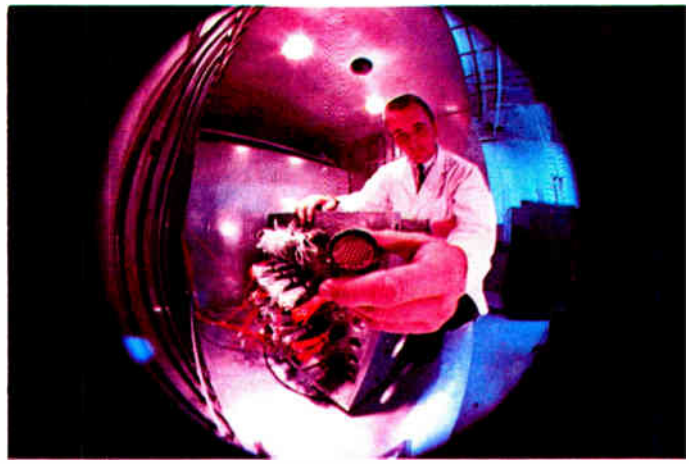
RELIABILITY TEST SYSTEM

A RELIABILITY TESTING CENTER for electrical connectors, based on Electronic Industries Association Guidelines on Connector Reliability, is in operation at Amphenol Corporation's Connector Division, Chicago, Ill. It is designed specifically to test at one time 112 connectors of varying sizes within an environmental chamber. Amphenol's Type 48 series connectors are being tested first with this equipment, but other connectors can be tested as well.

The test facility is composed of an environmental test chamber, data logging equipment, associated power supplies and refrigeration equipment. Test space within the chamber is a four-foot cube. Weighing about four tons, the chamber is programmed by the control console to produce 98% humidity, a temperature reduction from 44°C to −65°C in 30 minutes, and a temperature increase from −65° to 200°C in 30 minutes by use of electric metal sheath heaters. The vacuum pump can provide vacuum conditions equivalent

(Continued on page 67)

Special 180° view from inside the environmental test chamber.



Designing Circuits with CERMET* Passive Elements

Designers attracted by 10 to 300,000 ohms per square sheet resistance range and proven reliability record.

Economies realized from CTS mass production techniques and low tooling costs.

CTS CERMET resistance elements are produced by screening formulations of conductive, resistive, and insulating materials onto ceramic substrates. After firing above 650°C, a semiconducting matrix is formed which is permanently bonded onto the dielectric substrate.

Since the middle '50's, the CERMET resistance element has been designed successfully into many types of resistor-capacitor modules and microcircuits. Apollo, Tiros, Minute Man, Talos and numerous other high performance military and industrial applications use CERMET resistors.

Wide resistance range simplifies design, improves performance, saves space and provides design flexibility.

The designer is offered an unusually wide range of sheet resistance from 10 to 300,000 ohms per square. Short straight resistance paths, in a range from 10 ohms to 10 megohms, simplify design, reduce size and improve frequency capabilities. For example, at 100 ohms, resistance is constant to at least 250 mc. Other resistance values have limited predictable change through several hundred megacycles.

192,400,000 hours of unmatched reliability

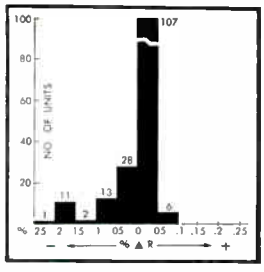
See Table I for the story of unmatched reliability of the CERMET resistance element.

Tests are run continuously on sample quantities from current production.

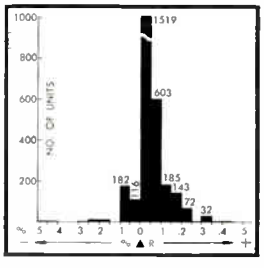
Typical CERMET resistor module test data

CERMET resistors from 50 ohms to 100K ohms were applied to both sides of a .310" x .310" x .010" ceramic dielectric substrate.

1) Temperature Cycling—168 resistors tested: Substrates were subjected to 5 cycles from −65°C to +125°C. Each temperature noted was held for 30 minutes.

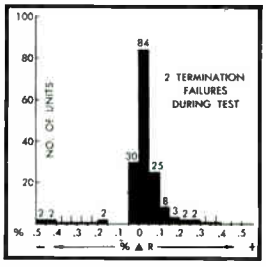


2) Short Time Overload—2876 resistors tested: Resistors were subjected to 6¼ times rated wattage for 5 seconds per MIL-R-10509B.



*Trademark of CTS Corporation

3) Moisture Resistance—168 resistors tested: Substrates were tested per Method 106A, MIL-STD-202B, ⅛ watt per resistor, 93% to 95% RH, 10 cycles.



Economy

Low tooling and start-up costs effect significant economies for CERMET circuitry over integrated circuits. Cost savings are also substantial over discrete components, including elimination of interconnections, much smaller physical size, and the elimination of costs incurred in purchasing, stocking, handling and inserting various components. Additional economy is effected by efficient CTS proprietary mass production techniques.

Other design parameters

In addition to wide sheet resistance, unequalled reliability and economy, CERMET resistors and capacitors offer the designer these additional characteristics:

1) Stability at end of life: ±2% for resistors, ±3% for capacitors.

2) Low temperature coefficient over a wide temperature range: For resistors; ±200 PPM/°C (T.C. on individual substrates can be matched to ±25 PPM/°C.)
For capacitors: −300 to −700 PPM/°C.

3) Low current noise: −30db at 100 ohms per square.
−10 db at 10K ohms per square.
+20db at 300K ohms per square.

4) Initial tolerances as low as ±0.10% for resistors, ±2% for capacitors.

5) Moisture resistance: less than ±1% change under ordinary humidities. For extreme humidity conditions, encapsulation or cover coat is recommended to maintain ±1% max.

6) Vibration, shock and abrasion resistant because all CERMET passive circuit elements and conductors are fused to the substrate and to each other.

7) High overload capacity due to superior heat sink capability.

8) Relatively low capacitance losses—dissipation factor less than .002 ("Q" greater than 500) @ 1 Meg C—before and after processing and throughout life.

9) Very low (0.5pf max.) parasitic capacitance introduced by CERMET crossover and parallel conductors.

Unaffected by severe environments

The CERMET resistance element is virtually indestructible. It remains unaffected by the most severe environmental conditions

TABLE 1 RELIABILITY DATA	RELIABILITY 95% Confidence Level ±3% Failure Criterion	FAILURE RATE 95% Confidence Level ±3% Failure Criterion	RESISTANCE RANGE	POWER DENSITY Watts/sq. inch of resistor area	POWER DENSITY Watts/sq. inch of substrate area
A. 12.4 million resistor hours documental 10,000 hours with ½ watt per substrate; 97° C ambient resulting in a 125° C hot spot temp.; encapsulated, 1236 resistors; ⅛ watt applied to each resistor; 1½ hours ON, ½ hour OFF.	99.962% per 1,000 hours	0.038% per 1,000 hours	47 ohms to 100K ohms	9 to 55	5
B. 94 million resistor hours documented 10,000 hours with 1.2 watts per substrate; 25° C ambient resulting in a 116° C hot spot temp.; unprotected resistors; 9420 resistors; 0.1 watt applied to each resistor.	99.990% per 1,000 hours	0.010% per 1,000 hours	50,000 ohms	11.4	3.2
C. 86 million resistor hours documented 10,000 hours with 1 watt per substrate; 25° C ambient resulting in a 99° C hot spot temp.; unprotected resistors; 12,000 resistors; 0.1 watt applied to each resistor.	99.9946% per 1,000 hours	0.0054% per 1,000 hours	1K to 55K ohms	8.6	2.6

and oxidizing atmospheres up to 500°C. Designers are using CTS CERMET resistance elements successfully under such adverse conditions as nuclear radiation, solvents and cesium atmospheres.

Packaging techniques

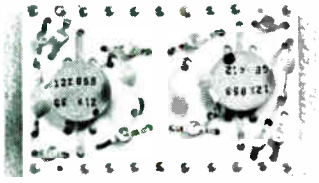
An infinite array of package designs to fit every designer's need is possible with CERMET circuitry. TO-5 headers, flatpacks, or various sizes and shapes of molded housings can be used. Round or flat leads can be attached in any configuration parallel or perpendicular to the substrate. Leads can be bonded to pads, swaged into the substrate or anchored through holes in the substrate.

Three classes of CERMET elements available to designers

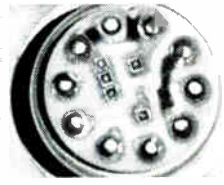
1) Element groupings: Resistor modules, capacitor modules, and resistor/capacitor modules. All are available with or without assembled active devices such as dice, flip chips, and pico, micro or conventional leaded types.

2) Interconnections: In addition to the fired conductive network, pads can be provided for soldering, welding, alloying, die bonding, thermocompression, ultrasonic and wedge bonding, beam lead bonding, and flip chip bonding.

3) Auxiliary elements: Edge-around conductor, plated-through-hole conductor, lead crossover, insulative cover, and reconnect conductor.

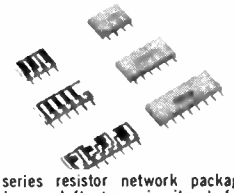


Top view of CTS hybrid integrated circuit showing attached discrete components and terminal pins soldered through holes in substrate.

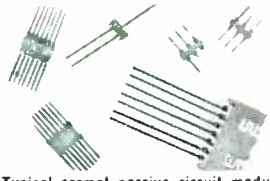


TO5 header showing cermet resistors and transistor dice.

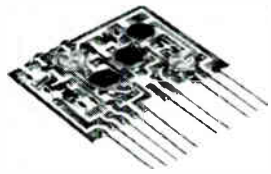
Enlarged view of flip chip assembly to ceramic substrate with platinum gold conductors.



750 series resistor network package. Modules on left show circuitry before coat ng.



Typical cermet passive circuit modules with leads attached.



CTS hybrid integrated circuit showing attached discrete components soldered to terminating pads.

Delivery

4-5 weeks for prototypes. 5-6 weeks in production quantities. Several hundred thousand CERMET microcircuits are being shipped by CTS weekly.

Latest data available to designers

Many of the nation's leading designers have already been attracted by the unique properties and design flexibility of CTS CERMET elements. Great strides have been made every year by CTS engineers in the art of microcircuitry. Send for the latest technical data or forward your circuit. CTS engineers will analyze your requirements and recommend a CERMET microcircuit design to your exact specification. Just contact your nearest CTS office or rep.

Sales offices and representatives conveniently located throughout the world.

founded 1896

CTS® **CTS CORPORATION** Elkhart, Indiana

Circle 31 on Inquiry Card

WHAT'S NEW

(Continued from page 65)

to 110,000 ft. altitude. The fixture that holds the connectors is bolted to a shaker table which provides necessary vibration at varying cyclical rates. A heat exchanger circulates water through the shaker for cooling. This permits shaker constriction with substantially reduced acoustic output.

The data logger makes parameter read-outs automatically as programmed, from two minutes to 1½ hour intervals. Readout is handled on two electric typewriters which will list the data for 100 connectors in 100 columns. Limit values for parameters, such as insulation resistance, can be preset, and out of limit values will print out in red. The data logger also contains power supplies to supply current to connectors on test during certain conditions. Potentiometers are used for adjustment of current to each individual connector to produce maximum design temperature of 238°C at the contacts during the 200°C ambient temperature exposure.

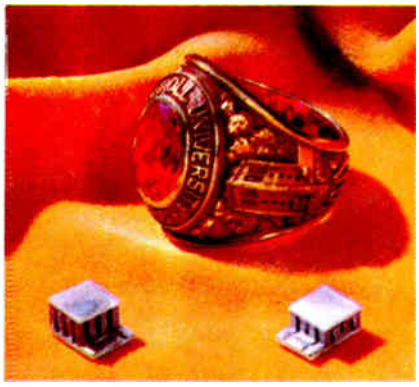
The EIA Guidelines for connector reliability instructs the qualifying agency for any specification to establish a unique environmental and mechanical stress sequence which represents what a connector built to that specification might experience in the field. The Amphenol reliability test center accomplishes this by putting the connectors through a life stress created from the environmental and mechanical stresses defined within MIL-C-38300. This life stress is repeatedly applied in accordance with the concepts of MIL-STD-690 in order to establish and maintain a reliability figure of merit of 1%/thousand hours failure rate.

This life or test cycle consists of six separate sections or test conditions. Test condition No. 1 is 1½ hrs. long. Relative humidity is held at 98%, temperature at 44°C, pressure at atmospheric and connectors are vibrated continuously. Under test condition No. 2, the pressure is decreased to simulate 110,000 ft. altitude with relative humidity uncontrolled. In test condition No. 3, connectors are exposed to 110,000 ft. altitude (−65°C) for approximately 1½ hrs. Under test condition No. 4, pressure is returned to atmospheric, held there with humidity uncontrolled, and then reduced again to simulate 110,000 ft. During this condition, temperature is raised from −65° to 200°C. In test condition No. 5, also lasting 1½ hrs., connectors are exposed to 200°C ambient. Since connectors are carrying current, actual operating temperature is 238°C. Under test No. 6, relative humidity is raised to 98%, temperature is reduced to 44°C, and pressure is reduced to atmospheric.

A complete record of each test discipline is obtained as applied to each individual connector among the 100 units under test.

Circle 166 on Inquiry Card

New products

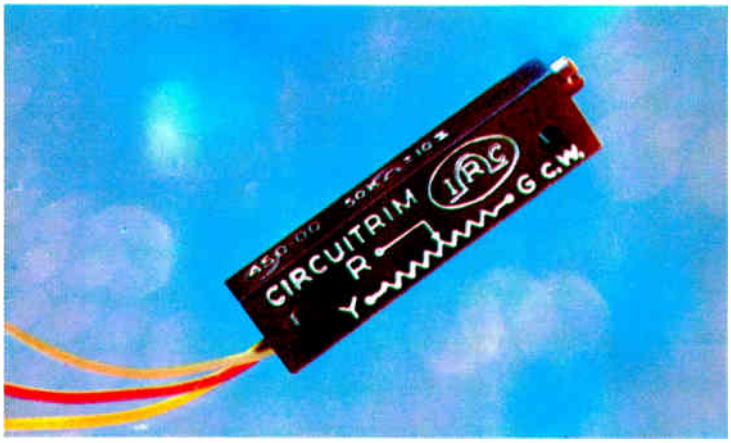


THERMOELECTRIC MODULES

For use with power sources supplying as low as 1.75a. @ 0.8v.

Ideal for integrated circuit cooling, these miniature modules operate with a heat sink capable of handling as low as 1.5w. Max. operating temp. is 100°C. At 27°C hot-junction temp., model 837 pumps 875 mv in air. Model 838 uses 2.75a. @ 0.8vdc and pumps 1.3w. in air. Borg-Warner Thermoelectrics, Dept. of Borg-Warner Corp., Wolf & Algonquin Rds., Des Plaines, Ill. 60018.

Circle 124 on Inquiry Card

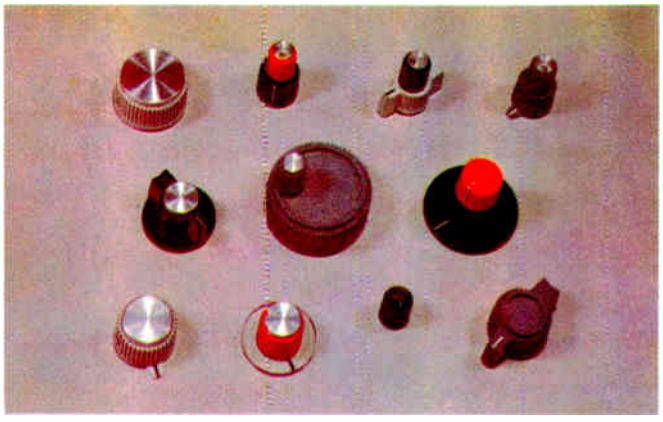


INFINITE RESOLUTION TRIMMER

Resistance values to 1 meg. Power rating: ½w. @ 70°C.

The Type 450 infinite resolution rectangular trimmer matches or exceeds the requirements of Mil-R-22097B. The effective electrical resolution is 22 turns (±5 turns); mechanical rotation is 24 turns with stops and slip clutch. Max. working (ac or dc) is 300v. Also available in the series is the type 450-10, which has leads that plug into printed-circuit boards. International Resistance Co., 401 N. Broad St., Phila., Pa. 19108. Phone Richard Stranix, 215-WA2-8900.

Circle 125 on Inquiry Card



INSTRUMENT KNOBS

The Prestige, Standard, and SSN series instrument knobs feature single-round, pointer, skirted, concentrics, bar, bar concentric, and spinner knobs. Prestige knobs have spun anodized aluminum caps. Standard series offer all-plastic outer design with top plastic indicator. The new SSN series knobs have SS knob design without top plastic indicator. These are used with special dial skirts and in other applications where an indicator is not desired. Buckeye Stamping Co., 555 Marlon Rd., Columbus, Ohio. 614-443-9458.

Circle 126 on Inquiry Card

PHOTOMULTIPLIER

Ceramic construction eliminates use of glass. Withstands shock.

RCA has developed a photomultiplier tube which detects and measures harmful radiation at long distances—such as the Moon and Mars. The tube is 4 in. long and weighs 7 oz. It comes in two versions: RCA-C-70144 and RCA-C-31009. Both have an aluminum-oxide window with transmission characteristics down to 1800Å. Index of refractive is 1.78. Phototube Div., RCA, Lancaster, Pa.

Circle 127 on Inquiry Card

SHIELDED CABINETS

RFI shielded aluminum cabinets offer great weight savings.

This line of welded aluminum slope-front electronic consoles are designed to NASA specs. Called the Space Series, the slope-front line offers standard 19 and 24 in. panel openings, with a 19° slope to the front. Design features are said to allow installation of 10% more cabinets in a given area. Depths offered are 25½ in. and 30½ in.; overall height is 53 in. Writing surface (shown) is optional. Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif. 91503. Phone Doug Griffith, 213-849-5521. Circle 128 on Inquiry Card

SKEWMETER

Verifies tape transport accuracy to assure interchange of tapes.

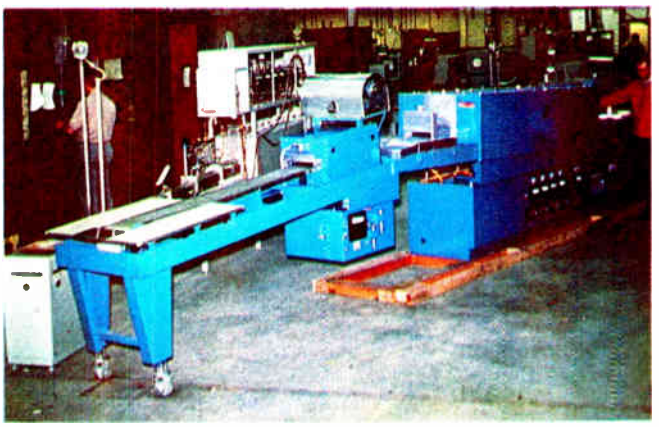
The Skewmeter establishes accurate reference standards of performance for magnetic tape transports. Its major function is to eliminate data losses due to skew error. It provides a simple and quick means for detecting skew errors in transports before their magnitude reaches the point of causing data losses. As a reference standard, the Skewmeter can verify the accuracy of any transport to allow interchangeability of magnetically recorded data between transports regardless of transport speed differentials. Dartex, Inc., 1222 E. Pamona St., Santa Ana, Calif. Contact Robert Kleist 714-542-1196.

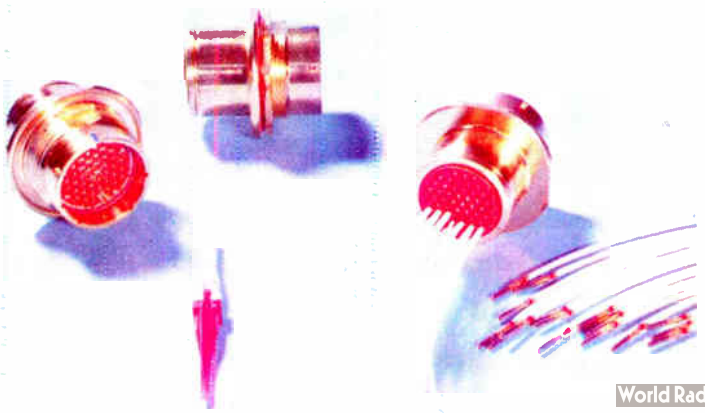
Circle 129 on Inquiry Card

INTEGRATED CIRCUIT FURNACE

Insures automatic laminar flow of the muffle atmosphere.

Manufacturers of integrated circuits will value this furnace for resistive and conductive ink firing as well as glassing processes. It features a guaranteed temp. flat along the muffle; guaranteed temp. flat across the belt; thermosensitive hearth; and identical profiles from no load to full load condition. A radiant dryer may be added to the conveyor system, ahead of the main furnace, for rapid drying of resistive ink without causing the pattern to flow. BTU Engineering Corp., Bear Hill, Waltham, Mass. 02154. Phone Mrs. G. Beck-617-894-6050. Circle 130 on Inquiry Card



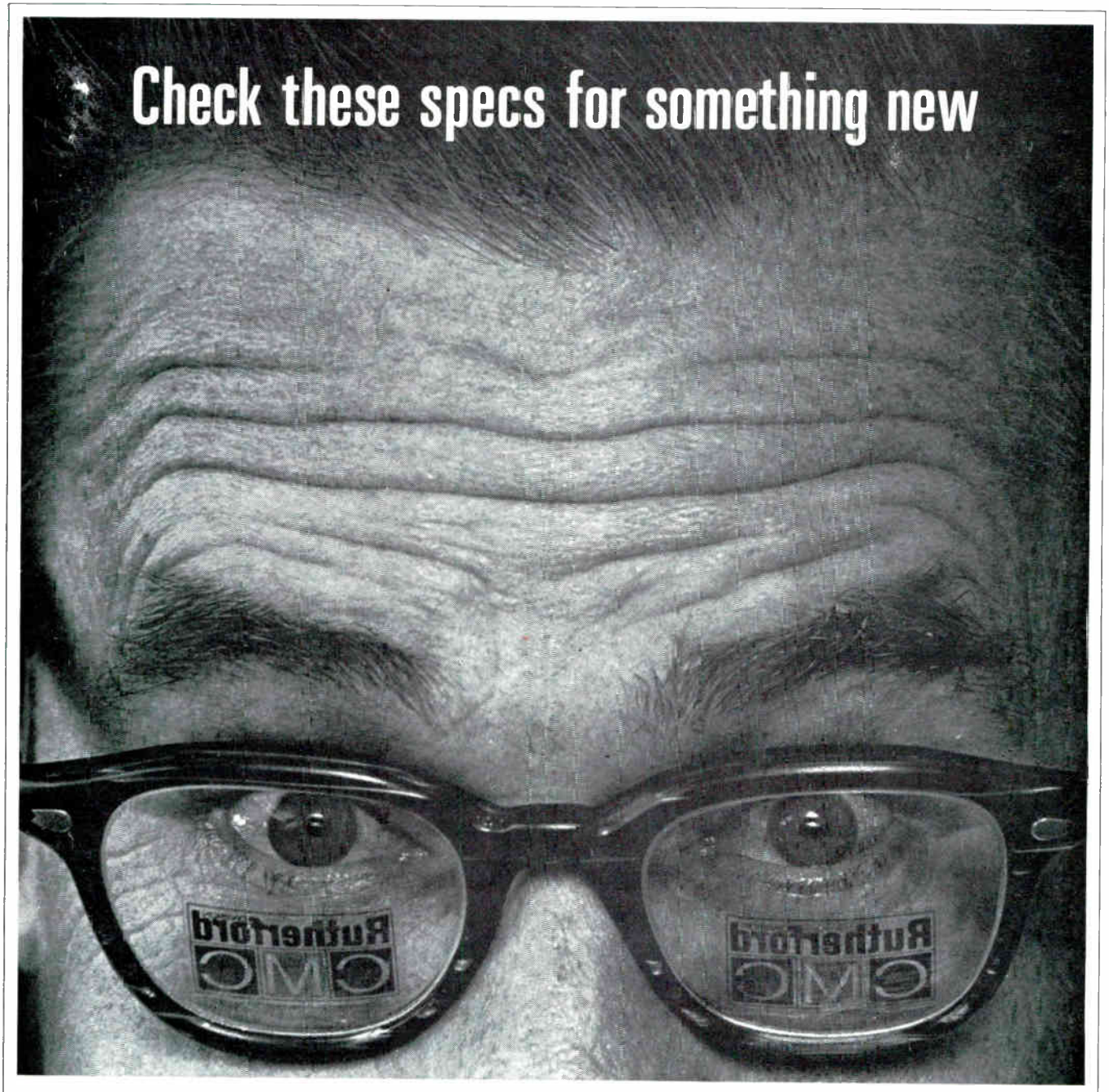


MINIATURE CONNECTOR

Hermetic receptacle units eliminate all solder terminations.

Connectors shown are mateable with all bayonet coupling MS 3126 (Mil-C-26482) or advanced NAS 1599 plug types. They have insertable/removable rear-release crimp contacts. Also, hermetic designs are available in through-bulkhead styles which eliminate all mating plug halves. The rear-release hermetic receptacles withstand 1 x 10^{-8} cc/sec.; thermal shock −120° to +300°F, 900v. RMS at 110,000 ft. Size 20 contacts are rated at 7.5a.; size 16 at 25a. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif. Contact Henry Comeau, 714-849-6701.

Circle 131 on Inquiry Card



See it? We've got a new battlefield ally. Rutherford Electronics . . . the nation's number one name in pulse and time delay instrumentation . . . has joined our crusade as a division of CMC. What a way to finesse big, bad Beckman. (Poor guys, they don't even make a line of pulse generators or time delay generators.) And how about that for keeping our promise to compete with high-powered H-P right up and down their full line!

OK, so this is sort of a sneaky way to outdo those guys. But we warned everybody that we were "hot", and on a crusade to shake up our competition in the instrument business. Now, with Rutherford at our side, we'll be creating some great new instrument improvements for you. Just wait and see what happens when we apply our combined digital and pulse circuitry know-how.

Rutherford DIVISION

So, Crusading Engineers, look sharp! Look twice! Now we double-dare you to "check the specs". Check the specs of CMC counters and digital printers . . . AND check the specs of our Rutherford division's great line of pulse generators, time delay generators, and the new dynamic range simulator. We honestly believe that spec-for-spec, you won't be able to beat CMC/Rutherford instruments for the money anywhere.

Write us! You'll double your pleasure, and earn a glorious Crusading Engineer medal, too.

12976 Bradley · San Fernando, California · Phone (213) 772-6321 · TWX 213-647-5170

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

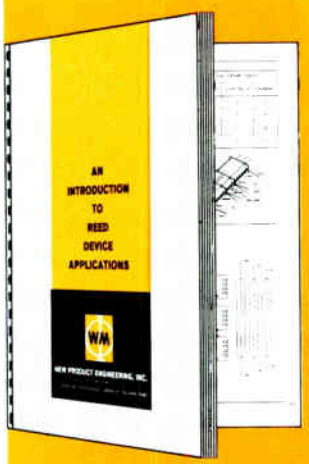
A REED RELAY ENGINEERING DESIGN KIT

15 pages of clearly written and illustrated information and a complete selection of parts to bread-board prototypes of, for instance:

ELECTROMAGNETIC RELAYS
Std. and min. size SPST—NO
Multiple contact relay: SPST, DPST, 3PST—NO and NC
Electrical latching relay
Magnetic latching relay SPST—NO
Permanent magnet biased relay SPST—NC

COMPUTER LOGIC ELEMENTS
AND, OR, and EXOR circuits
Single mode matrix element
Crosspoint memory matrix element

PROXIMITY TRANSDUCERS
For biasing, rotation, switching, shielding, and proximity switching



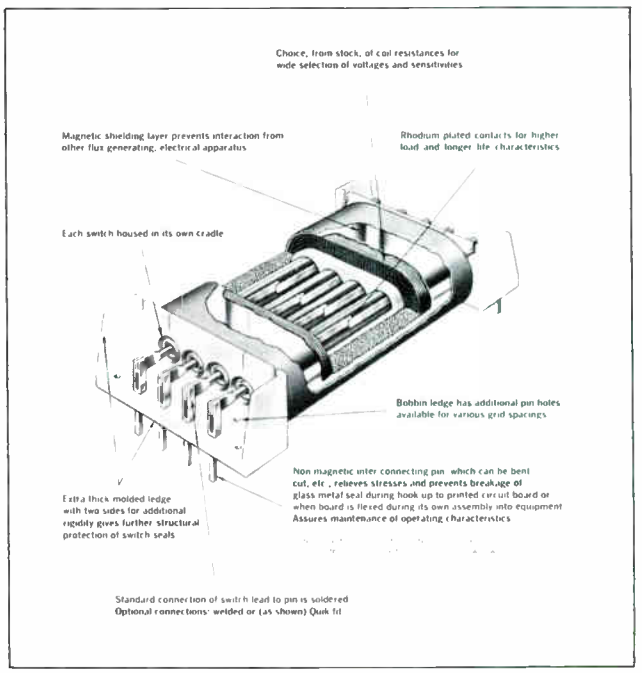
THE PARTS include 9 std. and 6 min. switches in 3 sensitivity ranges . . . std. and min. test coils . . . logic coil, 4 magnets.

THE PRINTED MATTER also covers operation and application considerations that suggest when NOT to use reed switches or reed relays!

THE WHOLE KIT costs $10 and is available from stock. Please order Part No. 67-001.

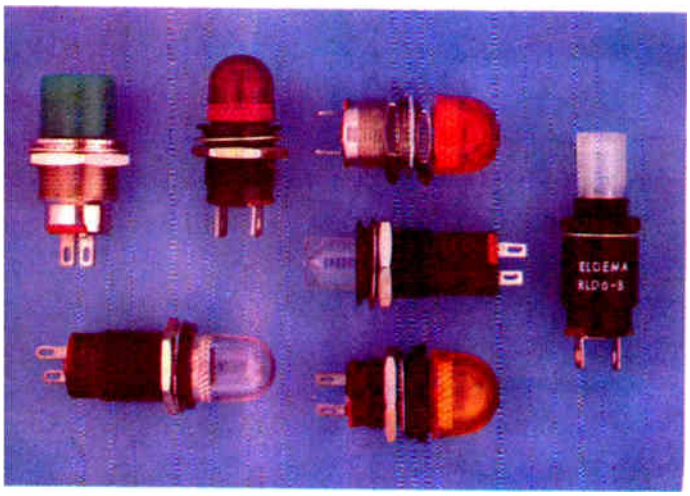
FROM THE COMPANY THAT MAKES THEM LIKE THIS

With the kit, you automatically receive complete specifications of NPE's standard and special reed switches and reed relays. ■ If you want only product literature, without the kit and without charge, write for:
NPE Reed Switch Specifications Bulletin
and/or
NPE Reed Relay Specifications Bulletin
and/or
An Introduction to Reed Device Applications



NEW PRODUCT ENGINEERING, INC.
A Subsidiary of Wabash Magnetics, Inc.
812 Manchester Avenue / Wabash, Indiana 46992

New products



LAMP HOLDERS

These panel indicators are available in a variety of lens colors and shapes, mounting configurations, sizes and finishes. They all offer replaceable flange-based long-life neon or incandescent TI-¾ lamps, and many models accept the new short-based neon lamps. Units are available with or without built-in resistors. Eldema Corp., 18435 Susana Rd., Compton, Calif.

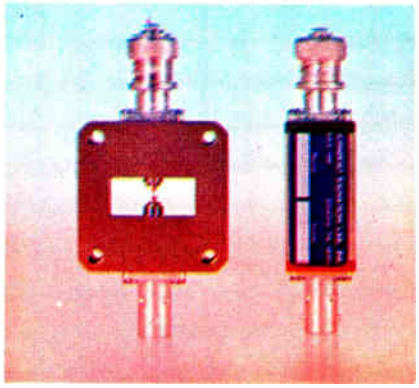
Circle 120 on Inquiry Card

NANOSECOND MICROWAVE SWITCH

Low stored charge permits a turn on and off in less than 0.1nsec.

Model X440 X-band switch uses a single diode whose stored charge is less than 2.0 picocoulombs. This permits a 0.1 nsec. switching time. It has an isolation of over 30db, and an insertion loss of less than 3.0db (1.0db with external tuning) at 9.0Gc. Polarity or straight-through bias drive is available. Either polarity can be selected by attaching a shorting cap to either of the 2 BNC connectors. Somerset Radiation Laboratory, Inc., P.O. Box 201, Edison, Pa., 18919. Phone K. Schomaker 215-348-8883.

Circle 121 on Inquiry Card



PORTABLE WRITING RECORDER

Records 2 channels of analog data on 50 mm wide channels.

The DG 5511 Two-Channel Thermal Writing Recorder has a three-in-one signal conditioning capability. Range is dc to 125 CPS. It can be used with attenuator plug-ins for high-level signals, with pre-amplifier plug-ins for low-level signals, or without plug-ins for high-level signals. It can also be used in laboratories, production areas, or field maintenance. Other features include quick 1-motion front chart loading, and pushbutton selectable chart speeds with an automatic trace density adjustment. Price $1165. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Contact R. B. Harris.

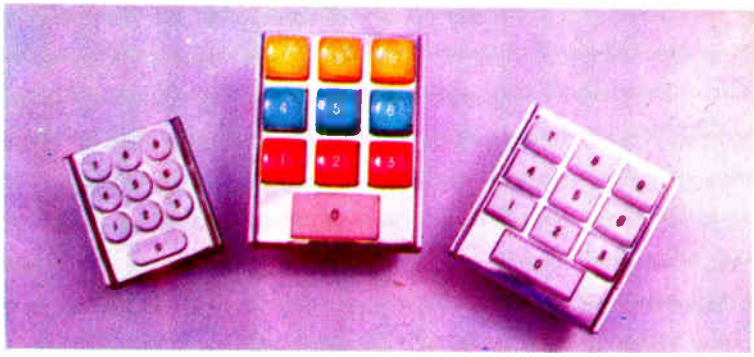
Circle 122 on Inquiry Card

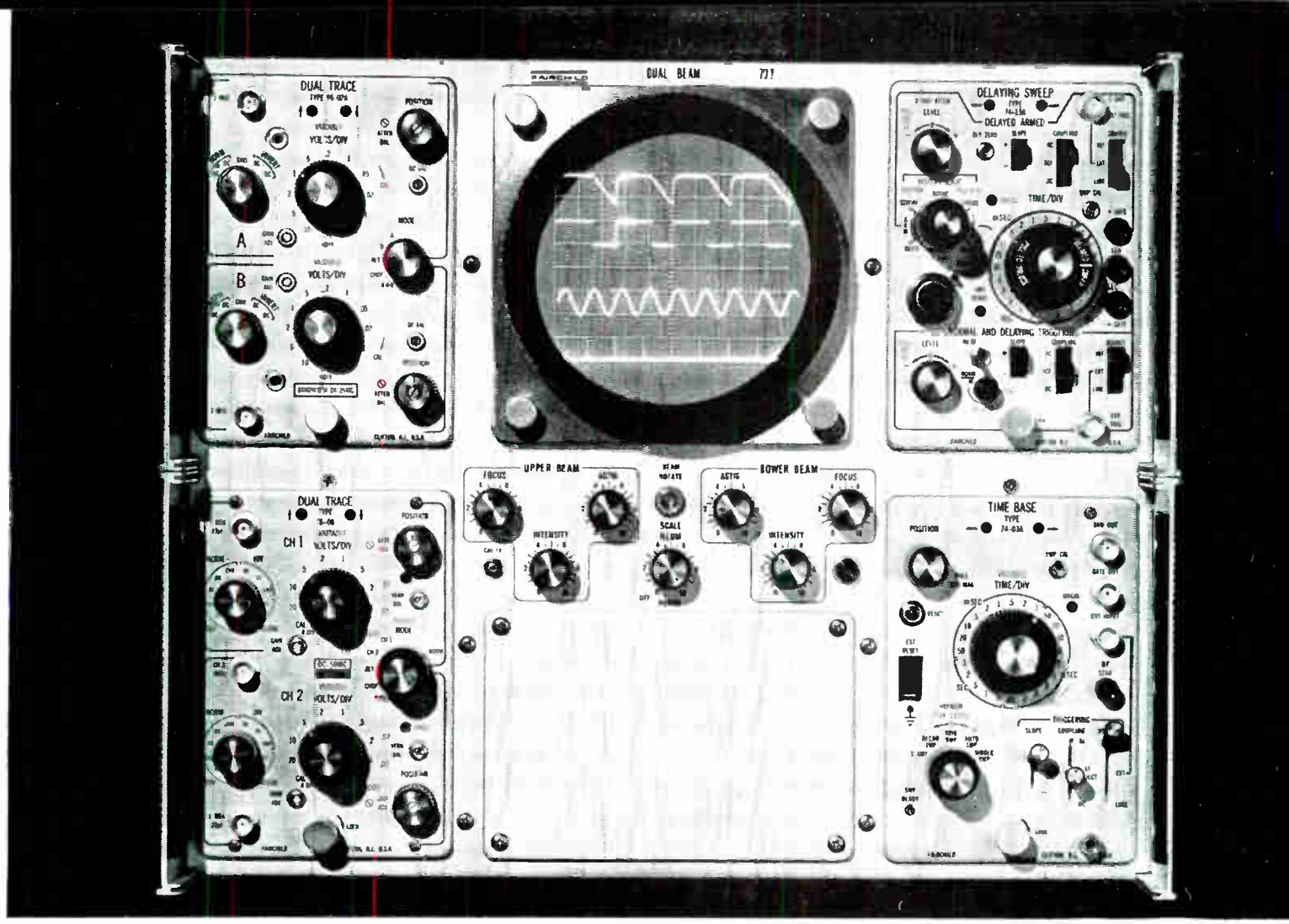
KEYBOARDS

Light operating pressure where fingertip control is desired.

The 10-station keyboard shown here comes in 3 standard sizes: Petite, Ladyette, or Master. A complete unit can be mounted from the front without special tools. They are tested for millions of cycles to assure thousands of hours of maintenance-free service. Meets mil spec. requirements. Custom assemblies available on short notice. Pendar, Inc., P.O. Box 1014, Coeur D'Alene, idaho. Phone Robert Greene, 208-SP3-7311.

Circle 123 on Inquiry Card





HOW MANY SCOPES CAN THIS ONE REPLACE?

A sizable number, depending upon the range of applications. For this is the Fairchild 777—the most versatile of all industrial scopes. The 777 is a dual beam, dual trace scope in which any four of 22 plug-ins are completely interchangeable in both X and Y cavities. These same plug-ins fit all Fairchild 765H Series scopes. They include DC-100 mc bandwidth, spectrum analyzer and raster display capabilities, sensitivity to 500 μv/cm, risetime to 3.5 ns.

Other features of the 777 include 6 x 10 cm display area for each beam with 5 cm overlap between beams for optimum resolution... unique 13 kv CRT with four independent deflection structures... solid state circuitry (with all deflection circuitry in the plug-ins)... light weight (44 lbs.)... environmentalized for rugged applications. Price (main frame): $1,600 f.o.b. Clifton, N.J.

BEAT T.O. WITH FAIRCHILD

The 777 illustrates the Fairchild concept of value through versatility. One scope doing many tasks is only part of it. Future state-of-the-art capability is equally important because it helps you curb the high cost of Technological Obsolescence. And finally, service. Fairchild has more service centers than any other scope manufacturer.

Ask your Fairchild Field Engineer for details on this and other new generation Fairchild scopes. Or write to Fairchild Instrumentation, 750 Bloomfield Ave., Clifton, N.J.

*Technological Obsolescence

FAIRCHILD
INSTRUMENTATION
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

New Bulletin 1492 Style F 300 volt terminal blocks supplement the A-B 600 volt Style C family

ALLEN-BRADLEY BULLETIN 1492 Style F 300 volt terminal blocks of the tubular pressure screw type with pressure plate, and the same in the Style C 600 volt blocks (below).

■ These smaller 300 volt Bulletin 1492 Style F terminal blocks have been designed to offer the same outstanding advantages which have made the larger 600 volt Style C line so popular. They mount on the identical channel, thus making possible the convenience of being able to assemble a terminal strip consisting of a combination of 300 volt and 600 volt blocks.

They're made of attractive, unbreakable white nylon, and available with a variety of terminals for either industrial or electronic applications. Although exceptionally compact, they have ample electrical clearance—additional insulation under the strip is unnecessary.

These new Bulletin 1492 Style F 300 volt terminal blocks are listed in the same timesaving factory assembled 6-foot lengths that's proven so popular in the Style C 600 volt line. Building up terminal strips, block by block, is a waste of time and money. In the modern Allen-Bradley manner, you merely count off the number of blocks required, slide to the end of the gauge used as a packing strip, and snap them off. The metal channel breaks cleanly—no filing or finishing is needed. Sawing is taboo!

Your nearby Allen-Bradley appointed distributor carries the entire line of Bulletin 1492 terminal blocks in stock. Let him demonstrate these new Bulletin 1492 Style F terminal blocks to you. Their superiority in timesaving convenience will become immediately apparent. Or please write for descriptive literature: Allen-Bradley Co., 102 West Greenfield Avenue, Milwaukee, Wisconsin 53204.

Export Office: 630 Third Ave., N.Y., N.Y., U.S.A. 10017.

...and offer identical advantages

LOOK AT THE "EXTRA ADVANTAGES" BUILT INTO ALL ALLEN-BRADLEY 300 AND 600 VOLT BULLETIN 1492 TERMINAL BLOCKS

TERMINAL IDENTIFICATION SURFACE—Pen or pencil can be used. Marking can be easily erased.

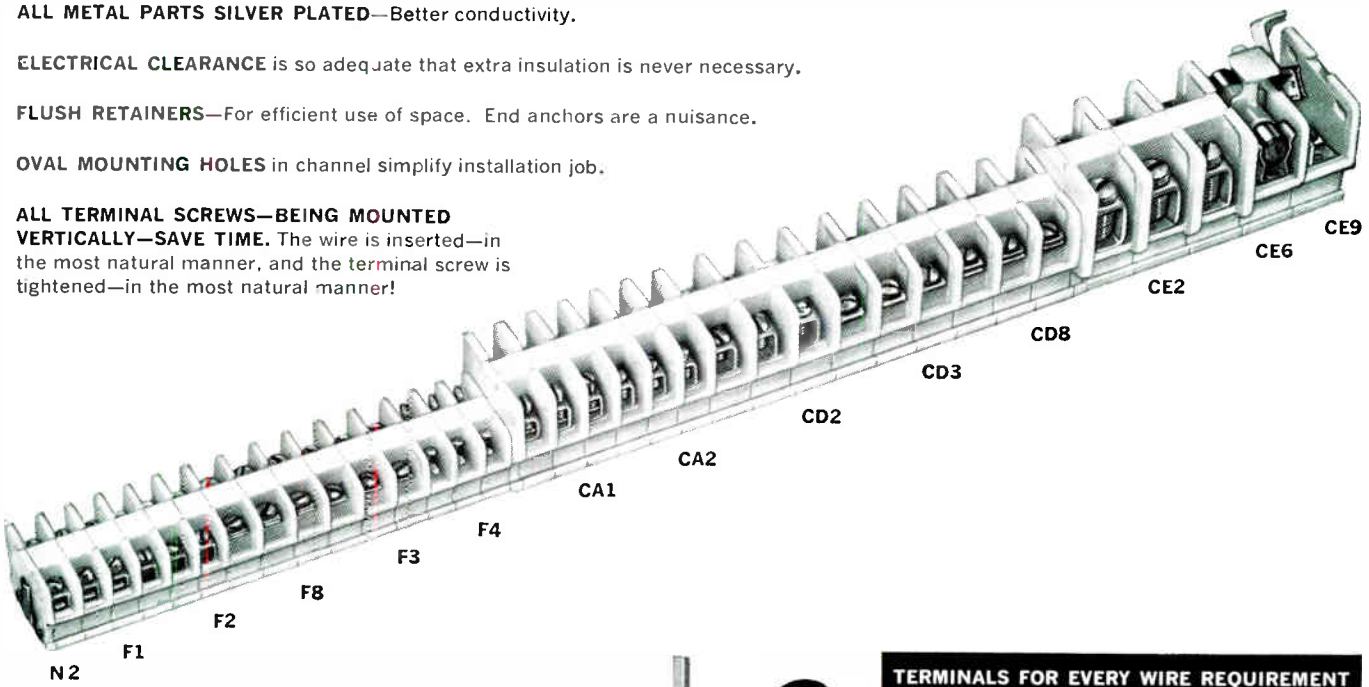
ALL METAL PARTS SILVER PLATED—Better conductivity.

ELECTRICAL CLEARANCE is so adequate that extra insulation is never necessary.

FLUSH RETAINERS—For efficient use of space. End anchors are a nuisance.

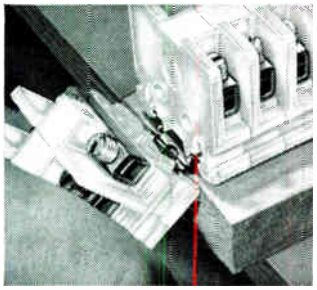
OVAL MOUNTING HOLES in channel simplify installation job.

ALL TERMINAL SCREWS—BEING MOUNTED VERTICALLY—SAVE TIME. The wire is inserted—in the most natural manner, and the terminal screw is tightened—in the most natural manner!

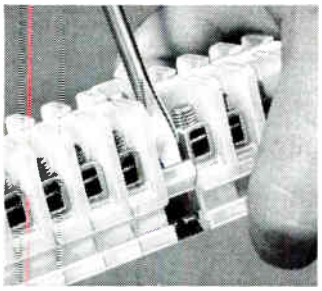


DO YOU WANT TO SAVE SOME MONEY?

Six feet of real economy—available *only* from Allen-Bradley. Ready-to-use factory assembled 6-foot lengths—easily broken off into any lengths required. Makes a neater job in a fraction of the time required by any "block by block" assembly. Available in both the 300 volt Style F line with a maximum of 210 blocks per 6-foot length and the 600 volt Style C with a maximum of 175 blocks per 6-foot length.



HANDY SNAP-OFF MOUNTING CHANNEL. An A-B exclusive. No tools required—cutting and filing unnecessary.



WHITE NYLON. Very strong. Individual blocks are easily removed without disturbing adjacent blocks.

TERMINALS FOR EVERY WIRE REQUIREMENT

Type of Connector	300 Volt Style F Catalog Number	300 Volt Style F Wire Size	600 Volt Style C Catalog Number	600 Volt Style C Wire Size
Tubular Pressure Screw Type with Pressure Plate	1492-F1	22-14	1492-CA1	22-8
Tubular Pressure Screw Type without Pressure Plate	1492-F2	22-14	1492-CA2 1492-CD2 1492-CE2	22-8 14-4 10-1/0
Screw Terminal	1492-F3	22-14	1492-CD3	18-10
Screw Clamp Terminal	1492-F8	22-14	1492-CD8	18-10
End Barrier for CA & CD Blocks	—	—	1492-CA5	—
End Barrier for CE Blocks	—	—	1492-CE5	—
End Barrier for F Blocks	1492-F5	—	—	—
Push-on Terminals	1492-F4	—	—	—
Fuse Clip Screw Clamp Terminal with Fuse Puller	—	—	1492-CE6	18-10
Switch Screw Clamp Terminal	—	—	1492-CE9	18-10
Fuse Puller	—	—	1492-CE10	—
Mounting Channel	1492-N1	—	1492-N1	—
Retaining Clips	1492-N2	—	1492-N2	—

A-B QUALITY

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

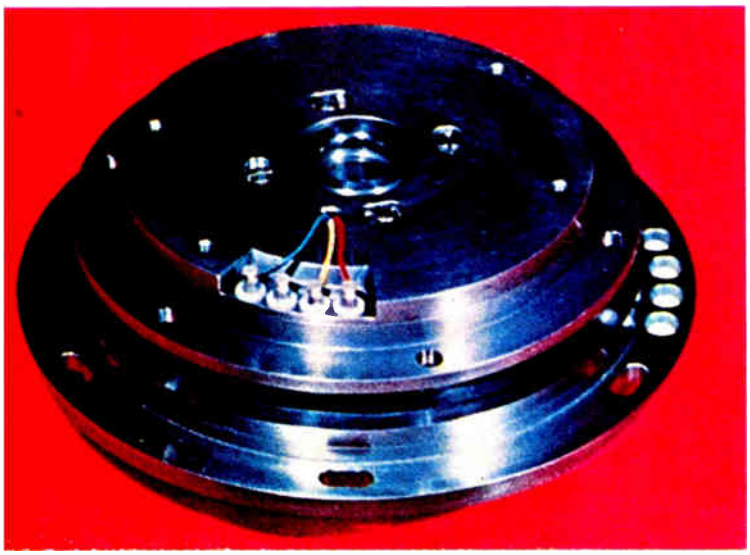
New products

SILICON RECTIFIERS

Peak forward blocking voltage of 600; forward current 70a.

Series 2N1792 through 2N1800 SCR's are used for constant-current supplies, pulse width modulators, thyratons, ignitrons, magnetic amplifiers, power transistors, relays, switches, contactors and circuits. The all-diffused units feature rigid post and clip construction for better performance and reliability. Peak reverse blocking voltage is from 60v., for 2N1792, to 720v., for 2N1800. Silicon Transistor Corp., Garden City, N. Y. Contact S. Iovin.

Circle 134 on Inquiry Card

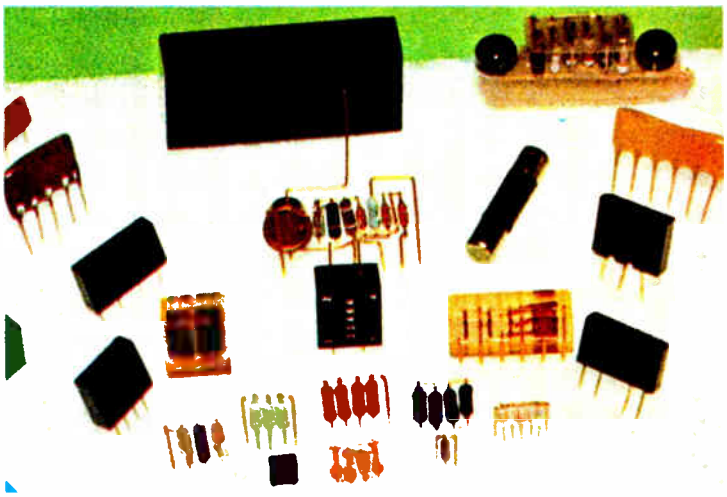


CUSTOM GIMBAL COMPONENTS

Provided in virtually any size with wide characteristics.

Kearfott offers complete facilities for the design and manufacture of custom-engineered gimbal-mounted and gimbal-supporting components for gyros and stable platforms. They consist of synchros, resolvers, dc torquers, multi-speed or fractional-speed synchros and resolvers, and induction potentiometers for gimbal-mounted uses. Units are available either as separate rotor and stator pickoffs with or without housings, or as cartridges containing gimbal-supporting bearings integrally housed with one or more components. Typical multi-speed units include 2-, 3-, 25-, and 36-speed synchro control transmitters; 2-, 25-, and 36-speed synchro control transformers; 15 and 1-speed and 16 and 1-speed resolvers; and 4-, 8-, 25-, and 64-speed resolvers. Kearfott Div., General Precision, Inc., 1150 McBride Ave., Little Falls, N. J. 07424.

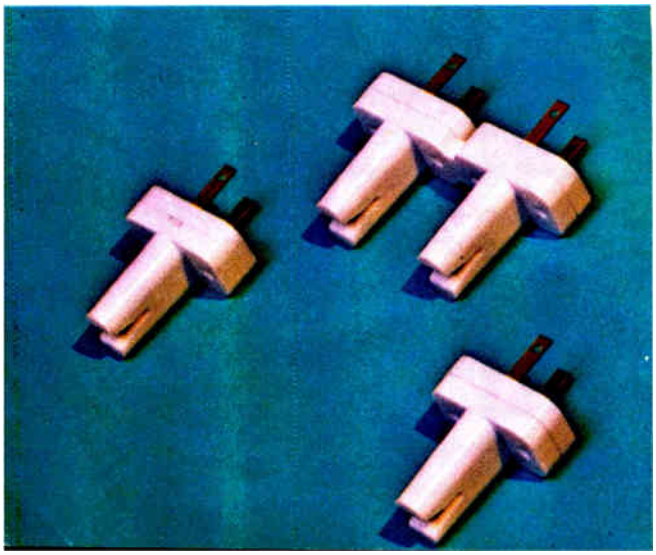
Circle 135 on Inquiry Card



ENCAPSULATED NETWORKS

These solid-state networks, custom packaged to meet the customer's needs, are available as resistor, resistor-capacitor or diode gates and matrixes. The standard resistor-capacitor networks are customized to fit specific circuit needs. Units are encapsulated with silica-filled epoxy for high heat dissipation. External lead wires from 2 to 14 pins can be selected from 0.15 to 0.032 in. dia. El-Tech Mfg. Co., Inc., 416 E. Church Rd., Bridgeport, Pa.

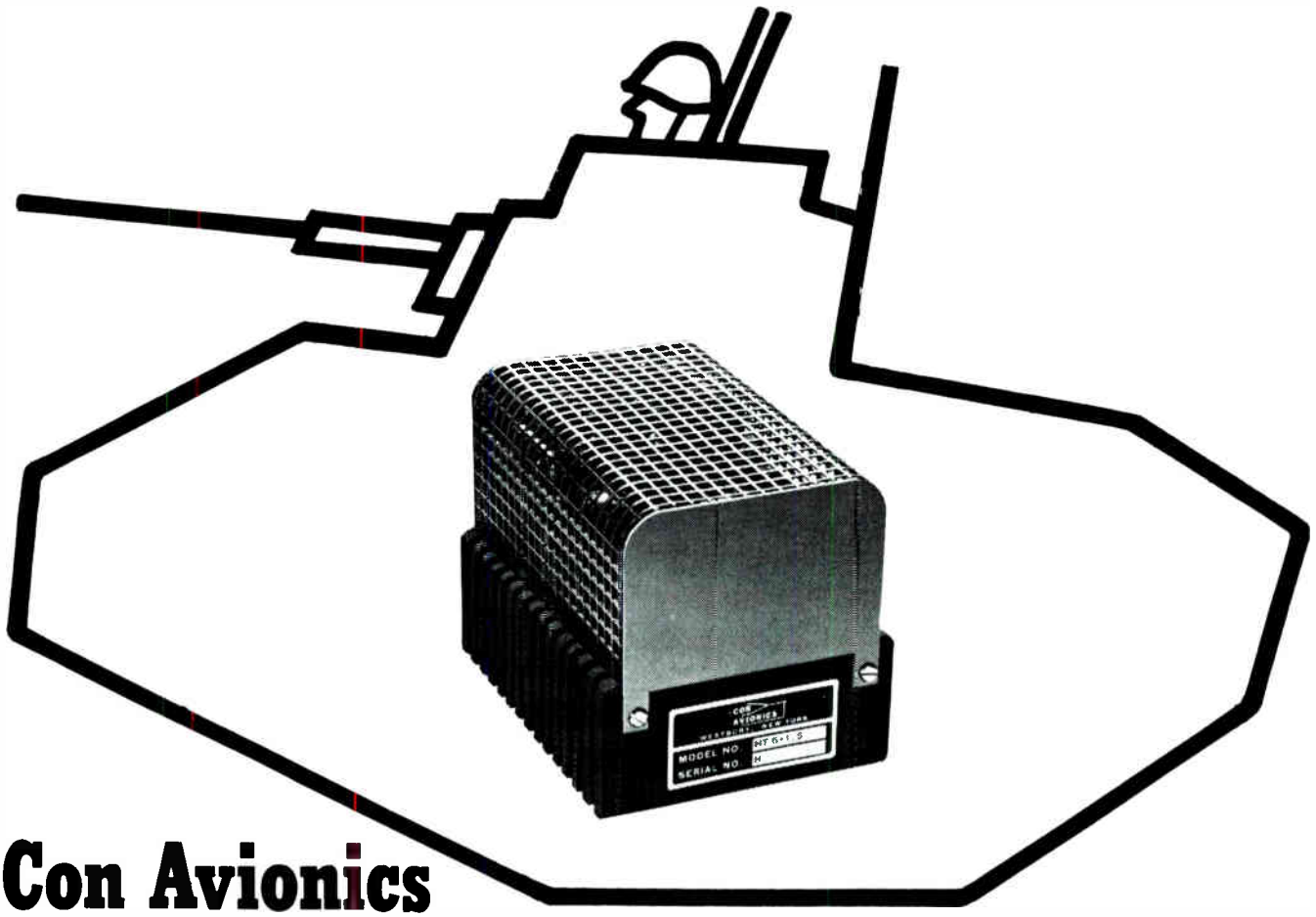
Circle 136 on Inquiry Card



AXIAL LEAD SOCKET

These low profile, Kelvin contact, axial lead sockets accommodate leads up to 0.030 in. diameter and permit great component density. They are available as a fixed or variable contact center distance socket with gold plated, heat treated beryllium-copper contacts. Textool Products, Inc., 1410 Pioneer Dr., Irving, Tex.

Circle 137 on Inquiry Card



Con Avionics $65 power supplies meet military specs

Made With Silicon Transistors, They Are Unconditionally Guaranteed For 5 Years

These dc regulated power supplies are available in nearly 200 different voltage-current combinations. Silicon transistors are used throughout and the units operate in ambients as high as 75°C, with a small external heat sink.

The Mean Time Between Failure of the modules is 100,000 hours, calculated according to Mil Handbook 217. They are certified to meet the environmental tests of Mil-E-5272, and most of the requirements of three other mil specs. In addition, they meet the RFI requirements of Mil-I-6181.

Prices start at $65. Every time you specify one of these supplies, instead of a comparable germanium unit, you save considerable money. If you're using commercial supplies, typical savings-per-unit are about $40. For military supplies it's much more.

The fastest way to get complete technical information and prices is to write, call, TWX or wire Gerry Albers at Con Avionics.

SPECIFICATIONS

	STANDARD MODEL	"A" MODEL
Total Regulation (Line and Load)	±0.5%	±0.05%
Ripple (rms max.)	10 mv	1 mv
Temperature Coefficient	0.07%/°C	0.03%/°C

ALL MODELS

Input	105-125 v ac, 47 to 440 cps
Temperature	75°C ambient max. 90°C base plate max.
Response Time	10 microseconds
Military Specifications	Certified to meet the environmental requirements of MIL-E-5272 and the RFI requirements of MIL-I-6181

CONSOLIDATED AVIONICS *A DIVISION OF* **CONDEC** *CORPORATION*

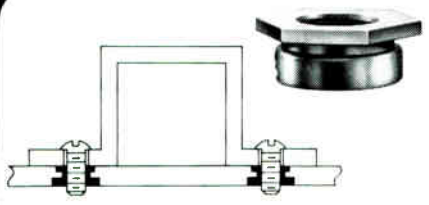
800 SHAMES DRIVE / WESTBURY, L.I., NEW YORK / 516 ED 4-8400

Permanent Threads Resist Pull Out, Push Out, Torque Out!

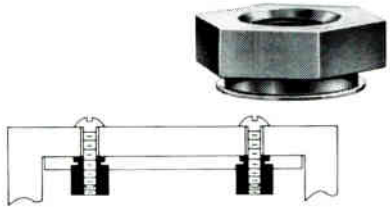
National Captive Hardware can improve designs, simplify assembly, and enhance the appearance of your finished product.

Hex-head design resists torque. Recessed cavity accepts cold-flow of parent material. Result: They never push out, pull out, or torque out of the parent material. They can be installed easily without special tools, even in cramped chassis locations. (Just drill hole, insert hardware, and press in . . . even with an arbor press.) They provide permanent threads for otherwise soft and easily-stripped materials. They are inexpensive.

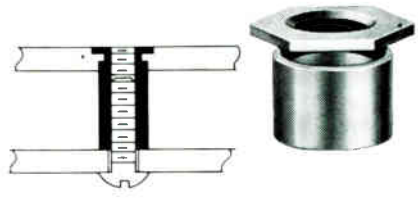
National Captive Hardware is **the** answer to your fastening or assembly problems. Shown below are just nine possible applications for National Captive Hardware, but many others exist. Why don't you investigate the many uses available?



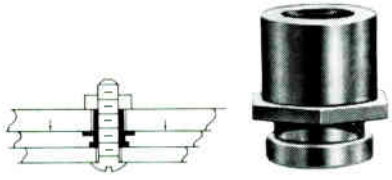
Back of panel inaccessible, no extensions allowable: Type 1 National captive nut fits flush on both sides. Can be used for mounting bracket or component or in cases when top and bottom are closed.



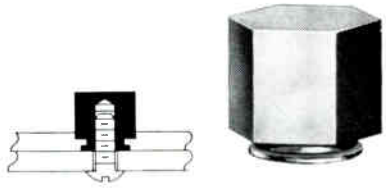
Extra threads required, or possibly to stand off compression load: Type 2 National captive nut extends hex-head above parent material, gives extra holding power for thin materials.



Tensile load spacer needed: National's Type 3 meets several requirements with cylindrical barrel which projects from parent material.

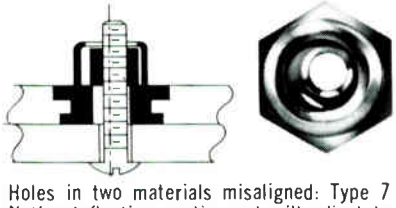


Compression load stand-off required, need orientation guide for second plate: Type 4 National captive nut meets these requirements while it provides extra threads.

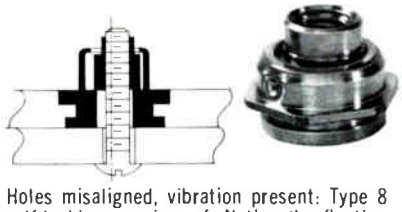


Need water-tight or short-circuit-proof nut: National's Type 5 do not have through taps, but end in a blind hole, preventing water seepage or shorting of chassis components. Can also stand off compression load.

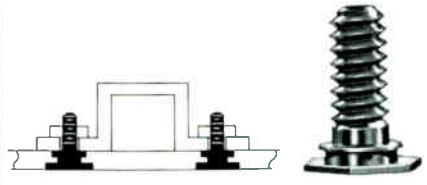
Components subject to vibratory or cyclic motion: Type 6 self-locking National captive nut has an oval-shaped extension that holds, yet is easily installed. Meets MIL-N-25027.



Holes in two materials misaligned: Type 7 National floating captive nut will adjust to correct misalignments of as much as .031". Low profile. Simple installation.



Holes misaligned, vibration present: Type 8 self-locking version of National's floating captive nuts answer both problems, yet offer strong threads in weaker materials. Type 8 **combines** the features of 6 and 7. Locking feature meets MIL-N-25027.



No extensions permitted on panel, but threads required: National's captive stud fits flush with parent material. Wide range of standard sizes and threads, with many others available on special order.

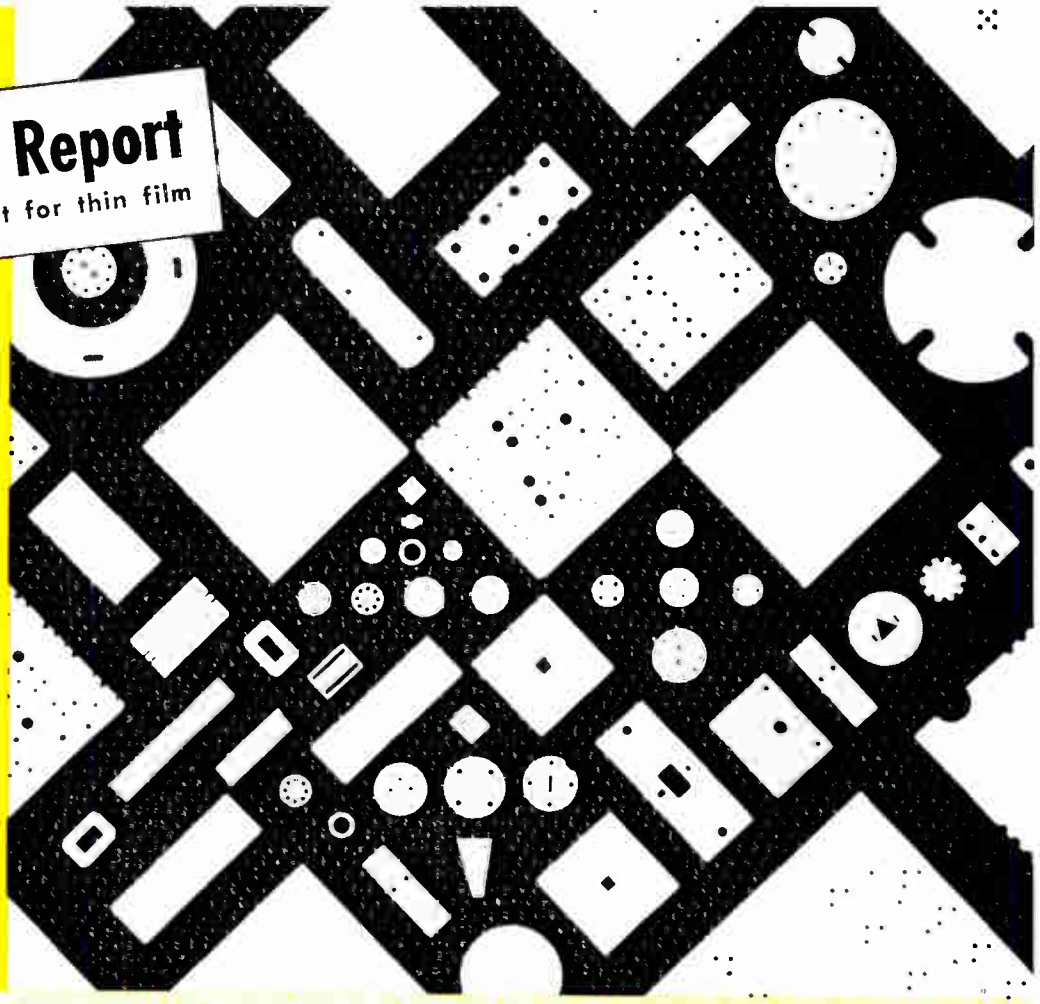
Is your application here?

National Radio Company, Inc.

37 Washington Street, Melrose, Massachusetts 02176 Telephone: 617-665-4800, TWX: 617-665-5032

Progress Report

of special interest for thin film



ALSiBASE®

CERAMIC SUBSTRATES

with "AS FIRED" SURFACE SMOOTHNESS of 6 to 8 Microinches CLA

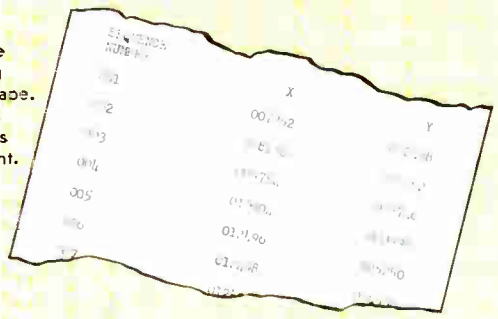
"AS FIRED" SURFACES. An "as fired" working surface as smooth as 6 to 8 microinches CLA is being regularly produced in AlSiBase substrates of AlSiMag 772, a 99½% alumina ceramic composition. The "as fired" surface is suited for many resistive patterns in thin film circuitry.

Surface smoothness is measured on our Talysurf equipment. Above: Tape of AlSiMag 772 with "as fired" surface smoothness of 6 microinches CLA at 10,000 amplifications.

BERYLLIA* CERAMIC SUBSTRATES. Beryllia ceramics are excellent electrical insulators. They conduct heat about as well as aluminum does. These characteristics suit beryllia substrates to applications where heat must be dissipated rapidly. American Lava Corporation has developed and refined a dense 99.5% beryllium oxide material with "as fired" surface of 15 microinches CLA or better on the working side. This material, AlSiMag 754, is finding an increasing number of applications. It requires special precautions in handling and is justified where other materials will not meet design requirements.

MEASUREMENTS OF COORDINATES. An increasing number of ceramic substrates require accurate placement of a number of holes. American Lava has precision equipment which produces a printed tape showing the x-y coordinates of the holes. This equipment is used to inspect set-ups before production and to inspect the final product to assure compliance with exacting specifications.

Typical coordinate measuring machine tape. Decimal is two places to the right.



STOCKED SIZES. Prototypes to your specifications can be supplied. Preferred sizes of substrates are stocked "as fired" in a thickness of .025". In AlSiMag 614 and AlSiMag 772 alumina, present sizes are ½"x¾", 1"x1", 1"x2", 2"x2". In AlSiMag 754 beryllia, 1"x1". AlSiMag 614, a 96% alumina ceramic with AlSiMag 743 glaze can be supplied in a thickness of .030" in sizes ½"x¾", 1"x1", 1"x2", 2"x2".

Let your own practical tests on prototypes or stock items give you the answer.

* It should be noticed that special precautions are necessary to insure safe handling of beryllium oxide ceramics.

American Lava Corporation

A SUBSIDIARY OF 3M COMPANY

PHONE 615 265-3411, CHATTANOOGA, TENN. 37405

64th YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Co. in these cities (see your local telephone directory): Birmingham, Michigan • Boston: Needham Heights, Mass. • Chicago: Bedford Park, Illinois Cleveland, Ohio • Laurens, S. C. • Los Angeles, Calif. • Minneapolis, Minn. • Metropolitan New York: Ridgefield, N. J. Up-State New York: Phelps, N. Y. • Philadelphia, Penn. • Dallas, Texas • Roanoke, Va. • South San Francisco, Calif. **All export except Canada:** Minnesota Mining and Manufacturing Co., International Division, 700 Grand Ave., Ridgefield, N. J.

Circle 33 on Inquiry Card

NEW PRODUCTS

MOTOR-POTS

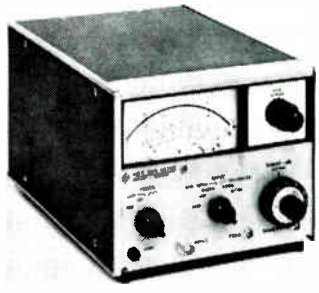
Eighteen standard gear ratios from 1:21 to 1:560 are available on any model.

Models 942, 943 and 948 combine precision potentiometers, a 4.5vdc gear head motor, and slip clutch. Model 942 has a 3-turn pot with resistance values from 5 to 194,700Ω. Linearity tolerance is ±0.10% and power rating is 3w. The 10-turn model 943 has values from 10Ω to 648.1KΩ. Linearity tolerance is ±0.05% and power is 5w. The model 948 is available with resistance values from 15 to 80KΩ. Linearity tolerance is ±0.10% and a power rating is 3.5w. Helipot Div. of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. Phone R. Crittendon 714-871-4848.

Circle 132 on Inquiry Card

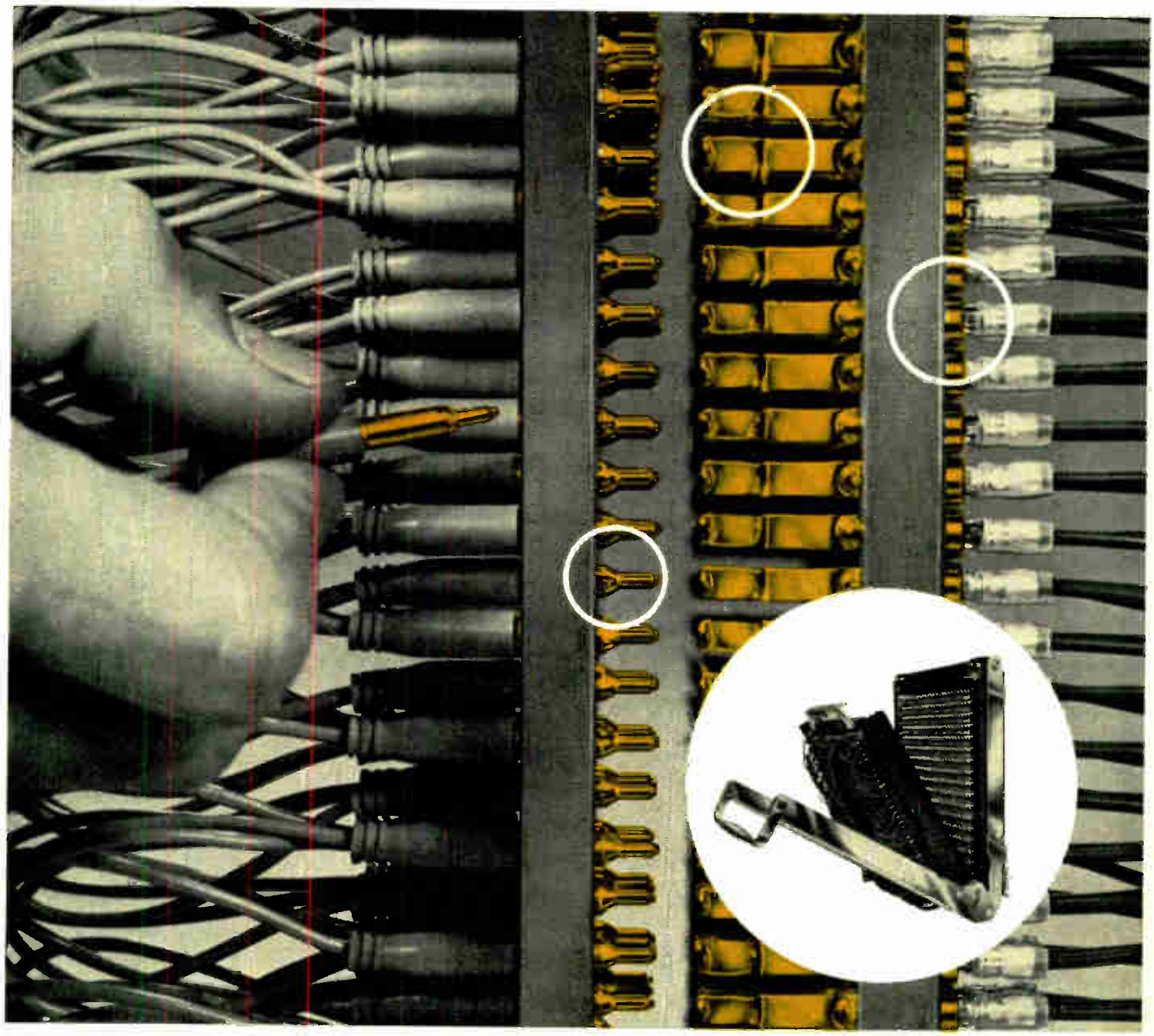
SWR METER

Standing-wave radio meter has a noise-figure spec. of less than 4db.



Model 415E SWR meter is used in r-f and microwave measurement systems. In addition to standing-wave ratio, it measures attenuation, gain, or any other parameter determined by the difference between 2 signal levels. The meter uses low signal levels. This reduces both the necessary drive to the measured array and the modulation index for the detected signal. An expand-offset feature allows any 2db portion of the instrument's 70db range to be expanded to full scale for max. resolution at a specified linearity of ±0.02db. Price is $350. Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. Phone Ross Snyder, 415-326-7000.

Circle 133 on Inquiry Card



Zero in on quality

There's not even the hint of a "miss" in this A-MP★ Patchcord Programming System!

Patchcord Programming Systems are comprised of a series of metallic contact junctions. The electrical performance of these systems is determined by the sum of the mechanical properties of these junctions.

Check ours out . . . feature by feature . . . and one fact is outstanding: it's quality-built at *every point* for overall *reliable* performance.

Ours is a modern, compact, lightweight system designed with fewer moving mechanical parts and is quality-controlled to maintain precision tolerances, resulting in increased reliability.

All contacts are gold-over-nickel plated. This, coupled with our patented double-wiping action that pre-cleans contact springs and patchcord pins, assures positive, reliable connections everytime.

Twin-Detent Patchcords, in manual or semi-permanent types, incorporate a specially designed, wholly contained spring-member that locks the cord to board and prevents program failure by accidental dislodgement. Patchcords can be easily hand-removed to facilitate program changes.

As for rear board wiring, precision crimped LANCELOK★ contacts provide maximum electrical performance and positive retention in the board through a unique locking lance design.

These are just highlights. All of them add up to the quality you look for to assure reliable performance. Get all the details you need by writing today for complete information.

★Trademark of AMP INCORPORATED

AMP INCORPORATED
Harrisburg, Pennsylvania

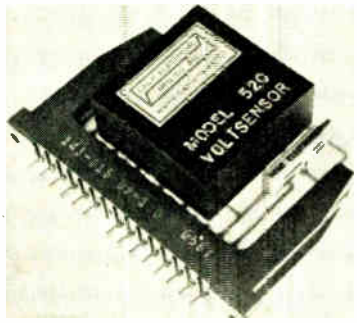
INDUSTRIAL SALES DIVISION

A-MP★ products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

NEW PRODUCTS

RELAY DRIVER

Low cost voltage sensitive relay driver with adjustable trip point.

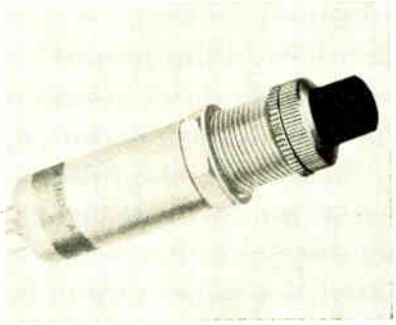


Model 520 Voltsensor uses all silicon planar transistors. It is designed for single or multiple use in industrial controls, alarm systems, production quality control, etc. Features include: input impedance 100KΩ; trip range ±20v; operating time less than 25μsec.; hysteresis less than 50mv. output ±20vdc @ 50ma; trip-point stability better than 0.025%/°C; operating temp. range −40°C to +75°C. Model 520 sells for $38.00. California Electronic Mfg. Co., P.O. Box 355, Alamo, Calif. 94507.

Circle 138 on Inquiry Card

PUSHBUTTON SWITCHES

Service life is a min. of 25,000 operating cycles at rated current load.



Marcoswitch Press-Lite Switches show at a glance exactly which circuits are activated. They come in current ratings of 5a. or 15a. Switches are available in SPDT or DPDT, alternate or momentary action. Incandescent or neon lamps can be accommodated. Snap-action provides high current handling capacity with very low contact bounce. Prices range from $2.50 to $6.00, depending on type and quantity. Marco-Oak Industries, P. O. Box 4011, Anaheim, Calif. 92803. Phone John Cassato, 815-459-5000.

Circle 139 on Inquiry Card

TRANSDUCER-ACTUATOR

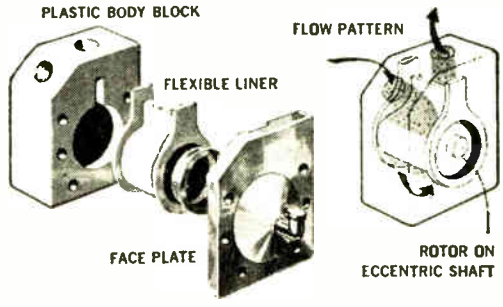
Rotary motion is produced directly and electromagnetically without cams.

This high-speed, high-reliability rotary solenoid can be used for computer peripherals and aerospace applications. The rotary motion is produced directly and electromagnetically without using cams or linear-to-rotary translating mechanisms. The direct electrical input to motion outputs permits speeds up to 4msec. Life tests have exceeded 10^8 cycles. Price is $45.00 in small quantities. IMC Magnetics Corp., Marketing Div., 570 Main St., Westbury, N. Y. 11591. Phone Bob Heslen, 516-334-7070.

Circle 140 on Inquiry Card

PLASTIC SEALLESS PUMP

Standard capacities are from ⅓ to 40 gpm



A rotor, mounted on an eccentric shaft in this plastic pump, rotates within a liner to create a progressive squeezing action on fluid trapped between the liner and the body block. All metal parts and mechanical action takes place inside the liner where fluid never reaches. This completely eliminates the need for stuffing boxes or shaft seals, guaranteeing no leakage.

The pump is self-priming, operates wet or dry and is suitable for extremely corrosive fluids, abrasive slurries or viscous materials. Applications include pumping of acids, alkalies, distilled water, diatomaceous earth slurries, electroplating solutions, ceramic tile glaze as well as shear sensitive emulsions.

Standard capacities are from ⅓ to 40 gpm with discharge pressure up to 50 psi. Materials of construction include Teflon, PVC, linear polyethylene, Buna-N, Bakelite or stainless steel for body blocks and Viton-A, Kel-F elastomer, Hypalon, Neoprene and Buna-N for the liner. These are the only parts in contact with the fluid.

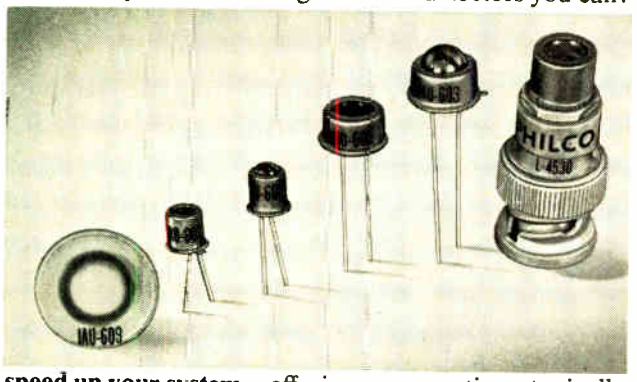
For additional information, write Vanton Pump & Equipment Corporation, Hillside, New Jersey or telephone Area Code 201 Murdock 8-4120.

Circle 41 on Inquiry Card

Solid Status Report 1/66

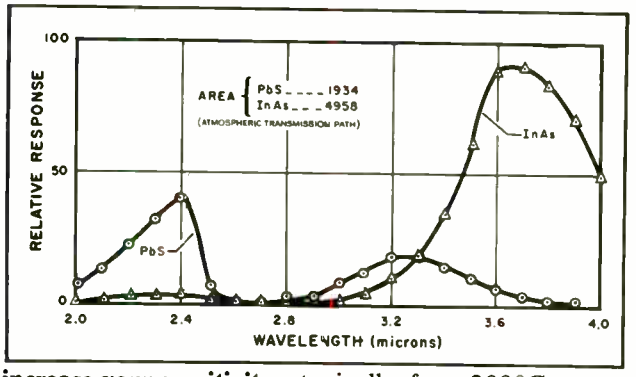
Look what our new InAs Infrared detectors can do better than good old PbS detectors:

We're talking about our new room-temperature single-crystal InAs IR detector series (IAU-600) for industrial and military applications—and we're matching them against conventional thin-film lead-sulfide detectors. Confidently. Because using our InAs detectors you can:



speed up your system—offering response times typically less than 1μsec (custom devices with RC cutoff frequencies beyond 5 Gc)—compared with the millesecond range of typical PbS detectors.

extend your spectral coverage—all the way up to 4 microns, with the highest response occurring in an atmospheric window of minimum background interference from sky radiation.



increase your sensitivity– typically, for a 200°C target, the signal from InAs is 2.5 times the signal from PbS. **provide single-crystal stability and reproducibility**—with glass passivated surfaces. Packaging is in reliable hermetic weld sealed TO-5, TO-18 or flat pack configurations. Areas of application? Temperature monitoring and control, anti-intrusion alarms, laser detection, missile guidance and horizon sensors, to name just a few. We also offer uncooled immersed InAs detectors with greater than twice the sensitivity. For prompt technical information and help, call, write or wire Gordon Baumeister. Or circle the Reader Service Card. (Phone: 215-948-8400.)

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A SUBSIDIARY OF Ford Motor Company
LANSDALE DIVISION • LANSDALE PA
In Canada, Don Mills Road, Don Mills, Ontario, Canada

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SEMICONDUCTOR TESTER

✓ **Cannot damage low or high power semiconductors either in or out of circuit**

✓ **Measures Beta with as low as 50 ohms emitter-base shunt.**

OTHER IMPORTANT FEATURES

- Measures beta in two ranges covering 1 to 1000.
- Measures diodes and rectifiers for opens or shorts, in-circuit with 20 ohms across device terminals.
- Completely safe for semiconductors — resistance measurements are independent of semiconductor loading. Power output limited to 0.25 microwatts.
- Simple to operate by semi-skilled personnel.
- Operates on type "C" flashlight batteries.
- Easy to read — measurements on 6½" taut-band meter.

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suburban Philadelphia

Circle 42 on Inquiry Card

NEW PRODUCTS

LIMITED-SPACE RESISTOR

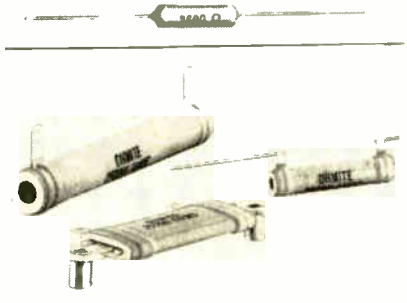
Resistance range is 200Ω through 5.0 megohms (linear taper).

The ¼w. ⅝ in. dia. Series 200 variable resistor is available in tandem construction with straight (Type 2-200) or concentric (Type C2-200) shafts. The 200 comes with rear extended or conventional shafts in 0.125 in. or 0.156 in. dia., ear or bushing mounting, and various associated switches (when desired). It can be mounted with shaft perpendicular or parallel to the panel. Printed circuit terminals and single construction are available. Price in quantities of 3000-9999 is under 20¢ each for bush mounted controls, and approx. 16¢ each for ear mounted controls. CTS Corp., Elkhart, Ind.

Circle 141 on Inquiry Card

AXIAL-LEAD RESISTORS

Temp. coefficient of resistance is 0 ±20 ppm/°C. 20Ω and above.



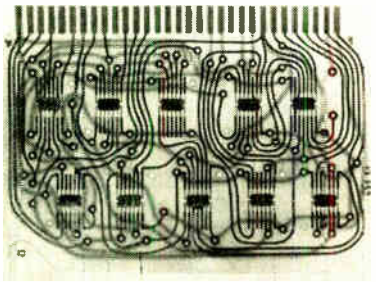
Type 444 axial-lead style wire-wound resistor comes in 4 wattage sizes: 1 to 11. This line of Ohmicone-coated resistors also includes 3 other styles. Type 404, available in 5 sizes, 3 to 20w., are tubular styles with tinned wire leads welded to small lugs. Type 454, furnished in 7 sizes, 10 to 95w., are the oval-core type with lug terminals and integral brackets which permit stacking. The Type 474 is the conventional tubular resistor with lug terminals. A great variety of 37 sizes from 6½ to 1000w. are available. These 3 styles have a TC of 0 ±30 ppm/°C. Ohmite Mfg. Co., 3665 Howard St., Skokie, Ill. 60076.

Circle 142 on Inquiry Card

NEW PRODUCTS

LOGIC MODULES

Operating speed is 5MC with 32nsec. max switching time.

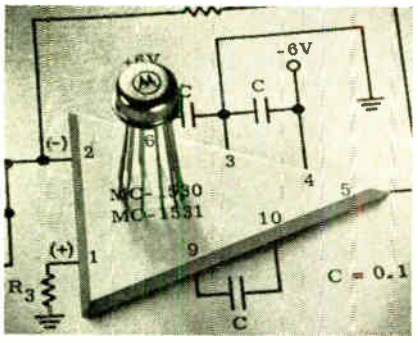


These microcircuit logic modules are available in DTL, NAND, pedestal-gated (RC) flip-flops, decoders, adders, drivers, multivibrators and several combined logic and special circuits. Module size is 4.375 x 2.750 in. (+0.312 in. for the connector). The microcircuits are generally 14-lead flat-packs using silicon-planar-epitaxial and MOS integrated circuits. The temp. range is 0 to 75°C. (−55° to +155°C on Mil spec. version). Noise rejection is greater than 1v. Applied Development Corp., 1131 Monterey Pass Rd., Monterey Park, Calif.

Circle 143 on Inquiry Card

OPERATIONAL AMPLIFIERS

Offers large load driving and large output voltage swing over a broad freq. range.



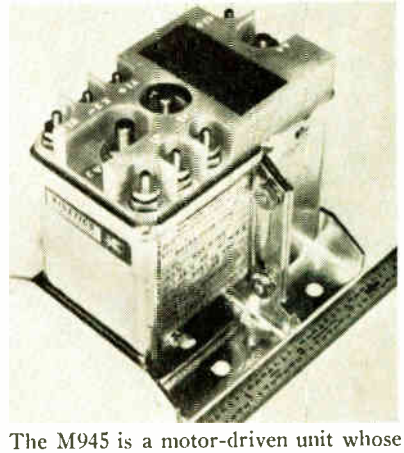
The MC1530 and MC1531 are high-performance integrated-circuit operational amplifiers. The conventional input MC-1530 and the high-impedance Darlington input MC1531 are used as summing amplifiers, integrators, or amplifiers with operating characteristics determined by external feedback components. The output voltage swing of both units is typically ±5v up to 100KC. Both series offer typical output impedances of 25Ω for high load-driving capability. Other features include slew rates typically 4.5v. μsec, operating temp. range is −55 to +125°C. Motorola Semiconductor Products, Inc., Box 955, Phoenix, Ariz. 85001.

Circle 144 on Inquiry Card

NEW PRODUCTS

MOTOR-DRIVEN SWITCH

Makes positive power connection under extreme shock and vibration conditions.



The M945 is a motor-driven unit whose SPST pin-and-socket contacts are rated at 75a. @ 28vdc. Voltage drop is 50mv. Transfer time is 85msec. with minimum guaranteed life of 20K cycles. Of special importance is built-in, solid-state sensor circuitry which breaks the circuit in the event of overload or a reverse current. The switch is designed for critical aerospace uses and is hermetically sealed. Total weight is 2 lbs. Kinetics Corp., 410 So. Cedros Ave., Solana Beach, Calif. Phone A. J. Unetic, 714-855-1181.

Circle 145 on Inquiry Card

MICROWAVE EQUIPMENT

Complete transmitter or receiver, including power supply in 10½ in. rack space.

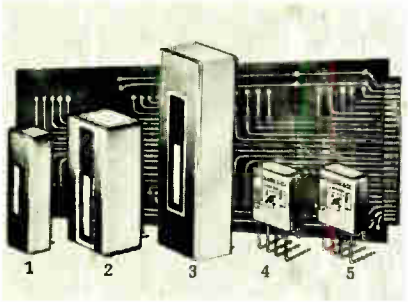
The 440 series are solid-state microwave transmitters and receivers. The receiver uses crystal-controlled oscillator, thus eliminating the klystron and AFC circuitry. Transmitters provide 2w. of r-f output power, allowing smaller antennas to be used. Video units assure optimum color and monochrome performance for broadcast and closed-circuit uses. Other features include: 12MC baseband flat within 0.25db, freq. stability of 0.005%, and individual self-contained power supplies. Jerrold Electronics Corp., 12th & Lehigh Ave., Phila., Pa. 19132.

Circle 146 on Inquiry Card

NEW PRODUCTS

SWITCHING RELAYS

Minimizes noise and thermal voltage problems found in low-level switching circuits.

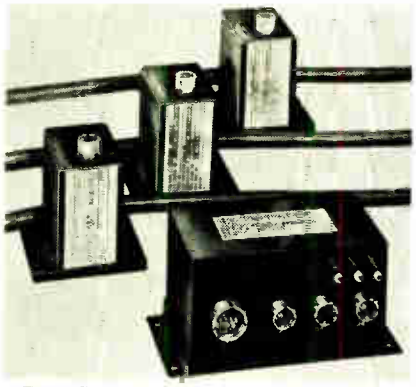


The FT and SFT series crystal-can relays have 2 Form C contact arrangements. They are rated at 10μa, 10mv for low level, and 2a. resistive, 28vdc for power uses. The FT has 4 standard coil resistances ranging from 35 to 2450Ω, with must operate voltages from 3.2 to 24.5vdc. The SFT has 3 standard coil resistances from 340 to 50000Ω with must operate voltages from 4.1 to 15.5 vdc. Operate times are 5msec. for FT and 8msec. for SFT. Release times, at nominal voltage, are 1.75msec. for the FT and 4.5 msec. for the SFT. C.P. Clare & Co., 3101 Pratt Blvd., Chicago, Ill. 60645.

Circle 147 on Inquiry Card

CURRENT SENSORS

Produces directly proportional output signal without breaking vital cables.



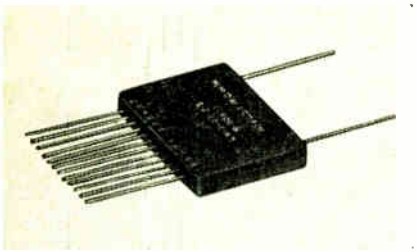
The CRS current sensor produces an output signal directly proportional to the current in a dc current-carrying cable, without breaking the integrity of vital cables. A 0 to 5vdc output signal is provided which is isolated from ground and supply power by over 100 megohms. Internal impedance of the output is less than 1000Ω. Linearity is better than 1%. The output ripple is less than 20mv, although the response time is better than the 10msec. All semiconductors are silicon. Pioneer Magnetics Inc., 1745 Berkeley St., Santa Monica, Calif. 90404. Phone 213 EX 3-0136.

Circle 148 on Inquiry Card

NEW PRODUCTS

FILM LADDER NETWORK

Standardized 1 x 3/16 x 1½ in. ladder network module contains up to 28 resistors.

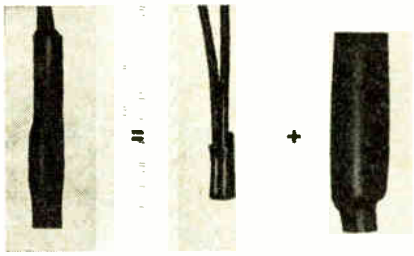


Up to 28 leads, 14 on each side, 22-gauge 0.025 in. gold dumet can be had with this precision film ladder network. The resistor complements may be binary ladders or digital analog conversions with output ratio accuracy to ±0.01% and ±1ppm/°C. A wide range of network impedances are available, and the film resistors feature less than 20nsec. rise time. The same block, or module, can be used for other network configurations. Sample quantities are available in most resistance values. Angstrohm Precision Inc., 7341 Greenbush Ave., North Hollywood, Calif.

Circle 160 on Inquiry Card

INSULATION CAPS

Heat-shrinkable caps completely pot a connection in seconds.

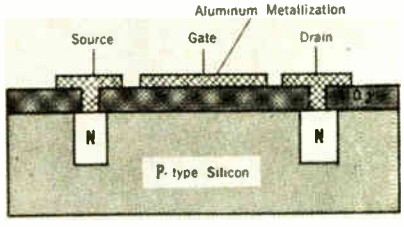


Thermofit PD Caps offer an inexpensive way to encapsulate crimped electrical connections. By applying moderate heat, the irradiated, tough, non-melting outer wall of the cap shrinks to force the meltable inner wall to flow into every area of the crimp. This completely pots the connection and thereby offers protection against moisture while covering sharp burrs on the crimp. Both physical and electrical protection are offered by the tough, non-melting outer wall surrounding the potted crimp. Rayclad Tubes Inc., Redwood City, Calif.

Circle 161 on Inquiry Card

MOS TRANSISTOR

Designed as a UHF amplifier. Can be used in both military and commercial units.



Model K1201 is an insulated-gate field-effect (MOS) transistor. This silicon type uses an N-channel depletion design, features low cross-modulation distortion, and has a high input impedance. Performance measured at 450mc showed a power gain of 12db (typical) and a noise figure of 4db (typical). The transistor is packaged in a TO-18 outline with 4 leads used. The substrate is connected to the case. KMC Semiconductor Corp., Parker Rd., RD 2, Long Valley, N. J. 07853. Phone Samuel Dasham, 201-876-3811.

Circle 162 on Inquiry Card

NEW PRODUCTS

PC CONNECTOR

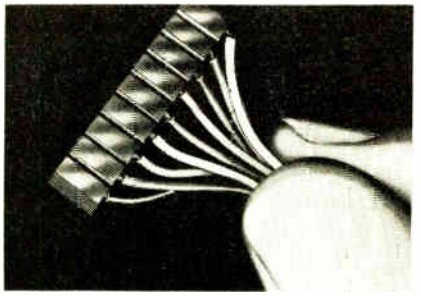
Has 60 molded pin contacts for dip solder printed-board termination.

The plug-half of Model DPMZC-60 contains NAS 1600 type socket contacts, and uses the Little Caesar™ rear release contact retention assembly. In this assembly, crimped socket contacts are inserted, released, and removed from the rear of the insulator with a simple plastic tool. Contacts are laid in 2 staggered rows and are spaced on 0.100 in. centers. ITT Cannon Electric, Advertising Dept., 3208 Humboldt St., Los Angeles, Calif.

Circle 163 on Inquiry Card

READOUT PHOTOCELL

Operates under dc bias conditions which are required by silicon transistors.

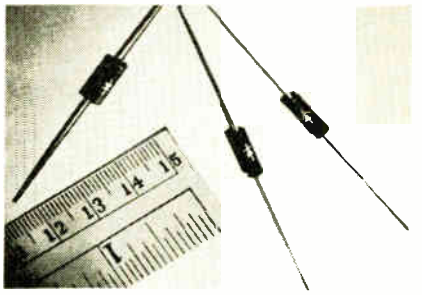


The NSL-701-9A is a 9-element, punched-tape readout, silicon photocell. Typical single segment reverse current at −1.0v. @ 55°C is 1μa. The output of each segment in the array is matched within 10%. Array is mounted on a brass block 0.9 x 0.2 x 0.180 in., with 10 leads each 6 in. long. Samples are immediately available. Prices start at $19.00 each for small quantities. National Semiconductors Ltd., 2150 Ward St., Montreal, Canada.

Circle 164 on Inquiry Card

HIGH VOLTAGE RECTIFIERS

Silicon power rectifiers have peak inverse voltages from 100v to 10Kv.



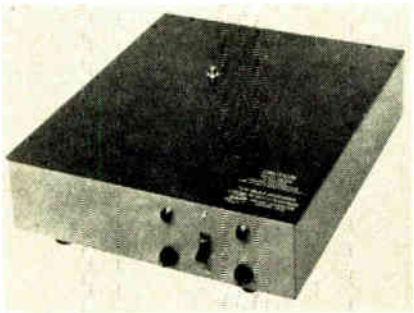
The Sempac series are cylindrical in design and have insulated case and axial leads similar to a computer diode. Hermetically sealed, they have the following characteristics: 100v to 1Kv, 1a @ 55°C (no heat sink), 3a/MIL-STD-750; 1500 to 3Kv, 0.25a @ 55°C (no heat sink). Storage and operating temp. range from −55°C to +175°C. Semtech Corp., 652 Mitchell Rd., Newbury Park, Calif. Phone W. B. Krause, 213-628-5392.

Circle 165 on Inquiry Card

NEW PRODUCTS

DEGAUSSERS

Erase either an entire 17 in. magnetic reel or a small spot on it.

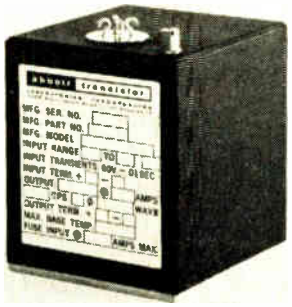


Three degaussers are offered for erasing magnetic tape. The bulk tape eraser, type 9205A, completely erases program and residual noise from magnetic tape or from films with magnetic sound tracks. The large active field area erases a recorded signal to more than 50db below saturation. A smaller model, type 64221, is available for erasing 10½ in. reels of tape. Type 8905 magnetic erasing pencil is recommended for erasing program material, words, complete sentences and individual syllables. Hi-Q Div., Cinema Plant, Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

Circle 149 on Inquiry Card

POWER MODULE

Capable of sustained full load operation at 100°C.



The hi-temp. dc to dc converters, series B51D, convert 28vdc to any required output voltage from 5 to 3650vdc at 50w. Modular design concept results in a compact module 2¾ x 3 x 3¼ in. weighing less than 1.5 lbs. Units feature complete isolation of inputs and outputs, and adjustment range of 12% from the nominal output voltage, and close regulation (0.2%) for input voltage variations of 24 to 30vdc. In addition, these converters are protected against short circuits, input voltage transients, and reverse polarity damage. Abbott Transistor Laboratories, Inc., 3055 Buckingham Rd., Los Angeles 16, Calif.

Circle 150 on Inquiry Card

NEW PRODUCTS

FLIP-FLOP

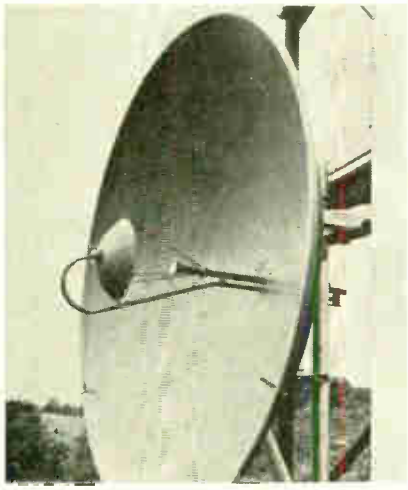
Operates in high noise environment, and costs less than $4.00.

Transients of 5v. peak on the power-supply line, 4v. peak on the circuit output lines, and 1.75v. peak on the input line will not cause the Q 9-420 to malfunction. These characteristics should make it ideal for use where power line transients are a problem. The Q-420 measures 2.0 x 0.5 x 0.725 in. and is totally encapsulated. This series is priced at $3.96 in quantities of 5000 or above. Engineered Electronics Co., 1441 E. Chestnut, Santa Ana, Calif. Phone Paul Taylor 714-547-5651.

Circle 151 on Inquiry Card

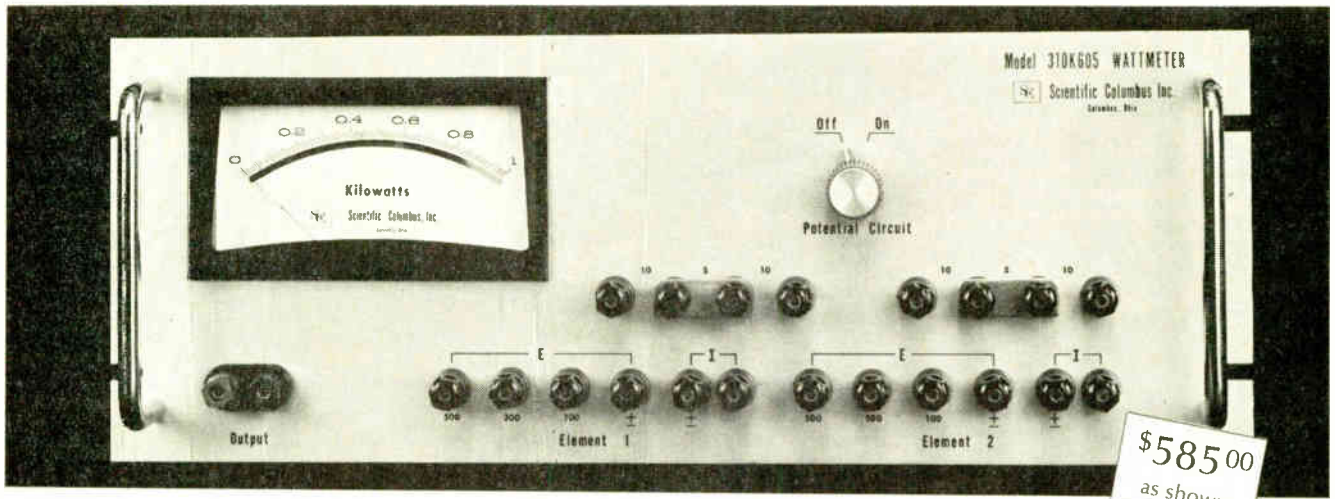
DUAL FREQUENCY ANTENNA

Four port antenna operates in the 5.925-6.425GC and 10.7-11.7GC bands.



This antenna has dual polarized inputs for each freq. band. The concept eliminates the freq. combiner. It uses the principle of superimposing a real physical feed (11GC) coincidental to a virtual feed (6GC) to operate like a space filter and achieve the necessary separation of freqs. The 6GC inputs are WR159 waveguide, while the 11GC inputs are WR90 waveguide. The antenna has a gain of 42 dbi at 6.125GC and a gain of 47.2 dbi at 11.2GC. Min. isolation between any 2 ports is 30db. Andrew Corp., P. O. Box 807, Chicago, Ill. 60642. Phone 312-FI 9-3300.

Circle 152 on Inquiry Card



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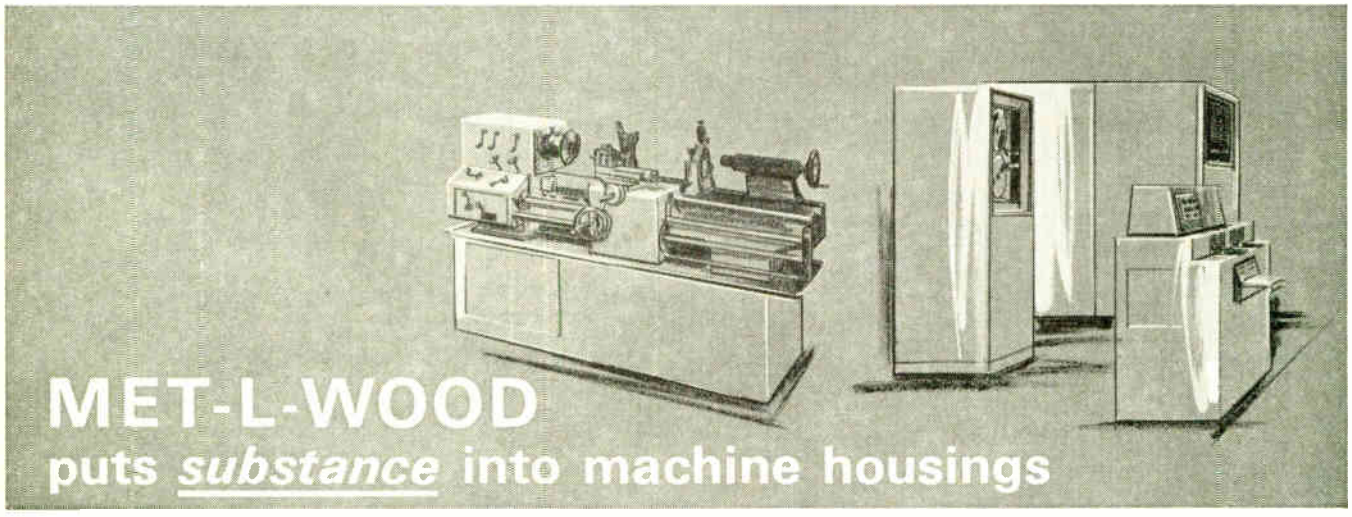
- ± 0.5% overall accuracy (including meter)
- Single phase range — 500 watts to 10 kw in 7 ranges
- Polyphase range — 1 kw to 10kw in 5 ranges
- Potential inputs — 0-100, 200, 500 volts, rms
- Current inputs — 0-5, 10 amperes, rms
- Temperature compensated to maintain accuracy — 0°C to 50°C
- Frequency compensated to maintain accuracy — 50-70 cps (other frequencies available)
- On-off switch for potential circuit
- Current burden — less than 1 va/element

Circle 53 on Inquiry Card



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MET-L-WOOD *Corporation*

NEW PRODUCTS

FILM-THICKNESS MEASURER

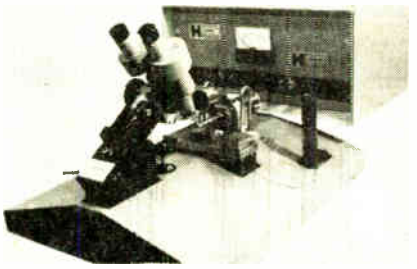
Measures thickness of evaporated thin-films during preparation.

Model 701 quartz-crystal microbalance measures changes in mass deposited on a crystal surface by measuring the corresponding change in resonant freq. of the crystal. Deposits as minute as 10^{-7} gram/sq. cm can be measured routinely, even by an unskilled operator. The instrument has a high-temp. crystal holder capable of operating at 400°C. For further data about the high-temp. crystal holder or the complete Model 701 quartz crystal microbalance, write to R. G. Settelmaier, Westinghouse Scientific Equipment Dept., P. O. Box 8606, Pittsburgh, Pa. 15230.

Circle 153 on Inquiry Card

ULTRASONIC BONDER

For mounting chip glass amb. devices onto substrates.



Model 2901 ultrasonically welds glass amb. devices—diodes, transistors, or complete circuits—directly to thin or thick circuit pads, eliminating the thermal compression bonding method formerly used. All connections are made simultaneously. The bonder operates at 60kc. Devices mounted by the new machine have passed shear tests in excess of 50 grams (equivalent to 25,000Gs). Devices can be welded to aluminum or glass substrates metallized with standard interconnect depositions. Hughes Aircraft Co., Microelectronics Div., Newport Beach, Calif.

Circle 154 on Inquiry Card

DIGITAL VOLTMETER

Has a dc response time of 10msec. while maintaining ±0.005% accuracy.

Model EI-85 is a fast encoding, differential digital multimeter. It has a full 5 digit display. The unit gives accurate measurements without sacrificing overall system speed. 100 readings/sec. are obtainable. Basic dc ranges are 1, 10, 100 and 1000v. full scale. This provides 10μv resolution (on the 1v. range), which is sufficient for most low-level uses without the need for a preamp. With its differential input, the EI-85 provides 120db of CMR and 60db of superimposed noise rejection. Electro Instruments, Inc., 8911 Balboa Ave., San Diego 12, Calif.

Circle 155 on Inquiry Card

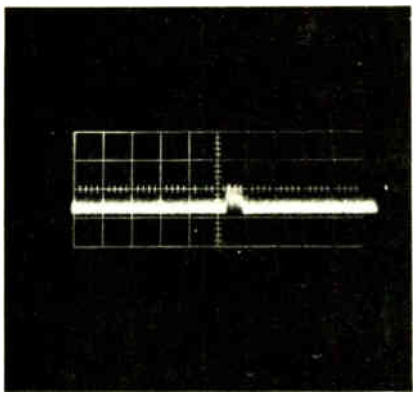


Fig. 1: Example of minimum discernible signal check. Note that signal barely appears above noise.

Measuring Radar System

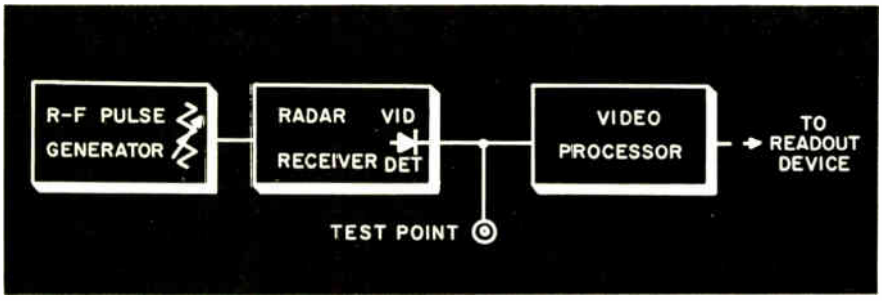


Fig. 2: Conventional set-up for observing minimum discernible signal strength of a pulsed radar receiver.

Two methods are presented for measuring sensitivity of radar receiving equipment having quantized output video—(1) the usual analog method; (2) unique time selection scheme employing a gating circuit and electronic counter for precision readout and automatic monitoring.

METHODS TO DETERMINE SIGNAL SENSITIVITY of radar systems depend upon accuracy desired. The usual method employed is the "First Method" described. It yields somewhat less accuracy than the "Second Method," which is more sophisticated but repeatable to a high order of accuracy.

First Method

A current, widely-used method of determining minimum discernible signal strength of a pulsed radar receiver consists of decreasing the amplitude of an r-f test pulse until it is just visible in the receiver noise, Fig. 1. The point of observation is usually directly at the output of the video detector, Fig. 2. The calibrated attenuator on the pulse generator is then read to obtain the sensitivity value.

Results when using this procedure can vary widely owing to the interpretation by the individual making the measurement. In addition, this approach is sometimes ineffective, or inapplicable, in systems where the output video has been regenerated and the residual noise is no longer visible.

A considerable loss in over-all system sensitivity can take place in the video processing circuitry. This is evidenced by the requirement for an r-f signal of higher amplitude to produce a usable output pulse, Fig. 3. In the dual trace oscillogram at (a), a pulse which is easily discernible at the detector output is not enough to provide an output from the video processing equipment. Increased amplitude is needed as shown at (b), to produce a useful output signal. Thus, the measurement accuracy is limited.

Second Method

The second method for making sensitivity measurements has given results which are repeatable to within 0.2 db. To understand the concepts involved, first examine one segment of time in the pulse-repetition-frequency (PRF) period, just long enough to encompass the width of a standard signal pulse, Fig. 4.

This period of interest is the acceptance gate, T_G, and can be positioned to the point in range at which the r-f signal generator pulse has been positioned. With an AND gate configuration, Fig. 5, all video pulses are inhibited except the one which occurs at the time of gate T_G. If an electronic decade counter is used to observe the frequency of the pulses present at the AND gate output, the maximum count possible is:

$$f_{max} = (N)\ (\text{PRF}),$$

where N = number of pulses which occur within acceptance gate T_G. But since the pulse at T_G is a single discrete one, with a value of either 1 or 0, and width equal to T_G, the maximum count becomes simply:

$$f_{max} = (1)\ (\text{PRF}) = \text{PRF}.$$

This maximum count can occur only if the pulse is present on every peri-

Sensitivity

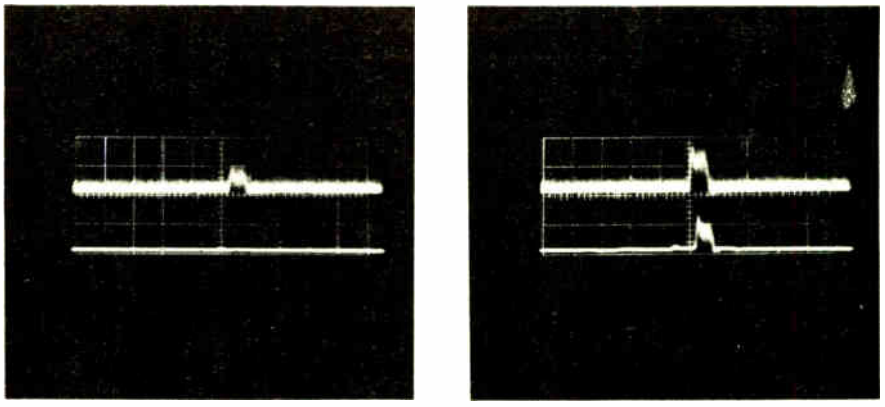


Fig. 3: At left, detector output pulse (upper trace) is not recognized at output video processor (upper trace). At right, increased signal-to-noise ratio (upper trace), is necessary to produce a usable output from the processor (lower trace).

By GEORGE F. ANDREWS,
Professional Engineer
Chief, Radar Engineering Section
Federal Aviation Agency, SMDO-2, Miami, Fla.

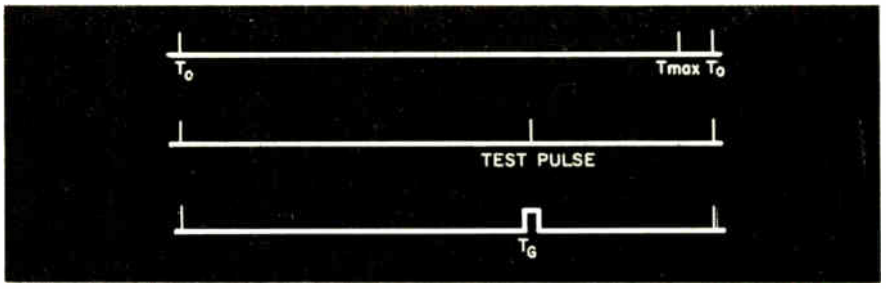


Fig. 4: Acceptance gate T_O can be positioned to the point in range at which the r-f signal generator pulse has been positioned.

od. The minimum count is, therefore:

$$f_{min} = (0)\ (\text{PRF}) = 0,$$

when no pulses are present during the acceptance gate time.

As the r-f signal generator output is decreased to the point at which pulses begin to drop out on successive periods, the counter reading decreases accordingly.

If some ratio is established such that

$$\frac{X}{\text{PRF}} \leq 1,$$

where X is the minimum number of pulses needed for satisfactory operation of succeeding system components or subsystems, it is only necessary to decrease the signal generator output to the point at which this value of X appears on the counter readout. This determines the minimum usable signal strength for a system using quantized video. A desirable lower limit to the minimum usable ratio $\frac{X}{\text{PRF}}$, might be $\frac{1}{2}$. Although this is arbitrary to a point, it is based on the reasoning that if a pulse is available to subsequent circuitry 50% of the time (every other period), further processing of these signals (decoding, integration, etc.) could still be accomplished satisfactorily.

Because the use of this method results in a unity ratio of data samples to total events (during the sampling interval), it may be desirable to smooth readings which can vary due to random instabilities in the equipment or test instruments. To do this, one can make use of the following relationships to determine the mean value of X. When the desired pulses are present 50% of the time, the new PRF of the measured events is given by:

$$F_X = \text{PRF} = \frac{X}{2};$$

and, thus the new period is:

$$T_X = \frac{1}{F_X}.$$

Most decimal decade counters have the capability to solve directly for the mean of this elapsed time function; i.e., since

$$\text{Average} = \bar{x} = \frac{\sum_{i=1}^{N} x_i}{N},$$

it follows that, in this case the mean period ($T_{\bar{x}}$) of the measured pulses (x) is

$$T_{\bar{x}} = \frac{\sum_{1}^{10} T_x}{10}.$$

The counter performs this calculation by counting its internal time base between two stop-start events (successive pulses), and repeats this measurement 10 times as controlled by one of the decades. The number of cycles thus obtained is fed through another decade to divide by 10, and the resulting time measurement is the quantity appearing in the read-

(*Text continues on page 97*)

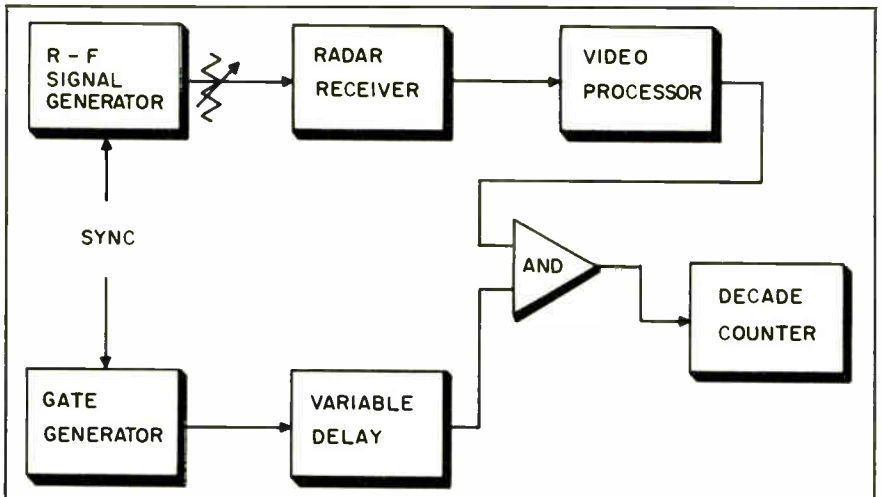


Fig. 5: With an AND gate setup all video pulses are inhibited except the one which occurs at the time of gate T_G.

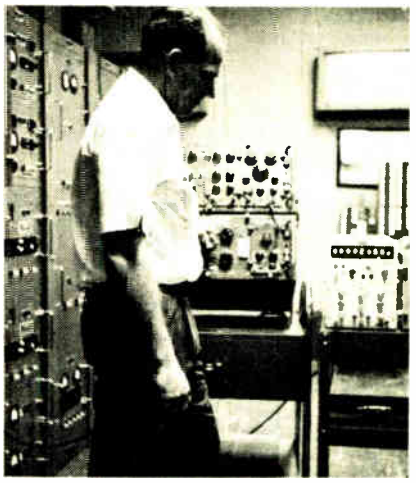
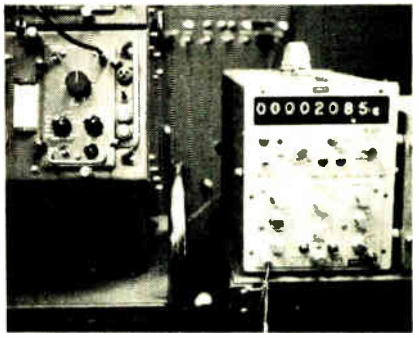


Fig. 6: Above, technician makes sensitivity check using counter as indicating device. At right is a close-up of the counter readout.



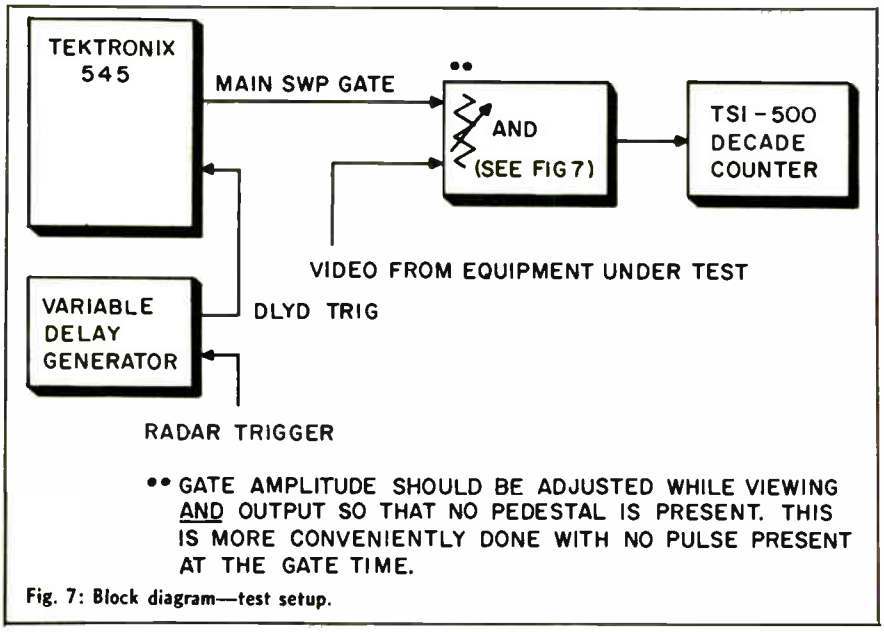
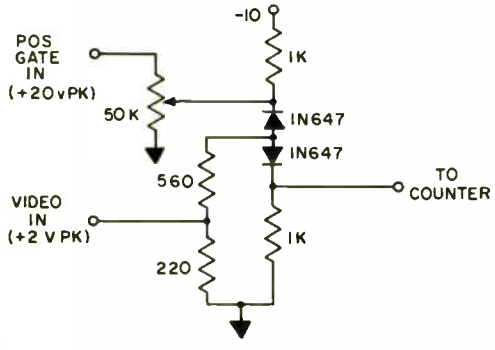


Fig. 7: Block diagram—test setup.

Fig. 8: AND gate circuitry.



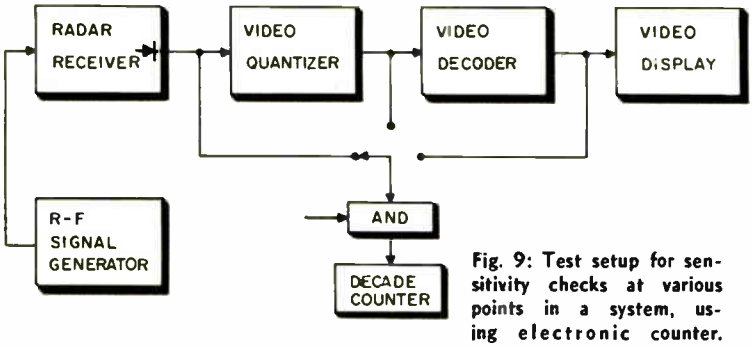


Fig. 9: Test setup for sensitivity checks at various points in a system, using electronic counter.

out. This operation is usually labeled *10 period average* on the counter control panel.

The mean value of T_x has been measured (over 10 periods) from which can now be obtained the value of $F_{\bar{x}}$ as follows:

$$F_{\bar{x}} = \frac{1}{T_{\bar{x}}} = X .$$

For the case just discussed, this value for X would be one-half of the basic radar PRF, and the value for $T_{\bar{x}}$ when using the average method would be twice the radar period.

The measurement method described removes the subjectiveness from sensitivity measurements. One has only a simple number to observe on the counter. Actual sensitivity value is then read directly on the dial of the calibrated r-f attenuator. Actual test setup is shown in Fig. 6. Block diagram of the test set-up is given in Fig. 7. The AND gate schematic is shown in Fig. 8.

Other avenues of usefulness are also suggested by this concept. Since the form of the information is digital rather than analog, it should be relatively easy to use this data to automatically monitor changes in system parameters. For example, any drift above a certain value could produce an alarm.

It should be noted that subsequent video circuitry, which receives as its input these quantized signals, also has a detection level loss in sensitivity. The end result is further degraded system performance. This degradation increases with the number of series-connected subsystem components, each contributing a loss in system sensitivity, plus the possible use of time sharing in the final video display.

It is advantageous, therefore, both for routine maintenance and for system analysis, to be able to measure sensitivity at any point in the chain as can be done with the set-up shown in Fig. 9.

T® Transitron News

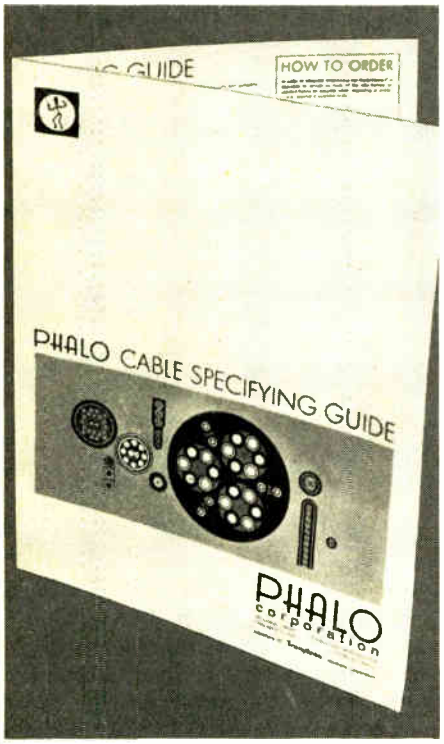
Wherever there's electronics there's Transitron

TRANSITRON ELECTRONIC CORPORATION — WAKEFIELD, MASSACHUSETTS VOL. 1 NO. 9

PHALO CABLE VITAL LINK IN COMPUTER PERFORMANCE

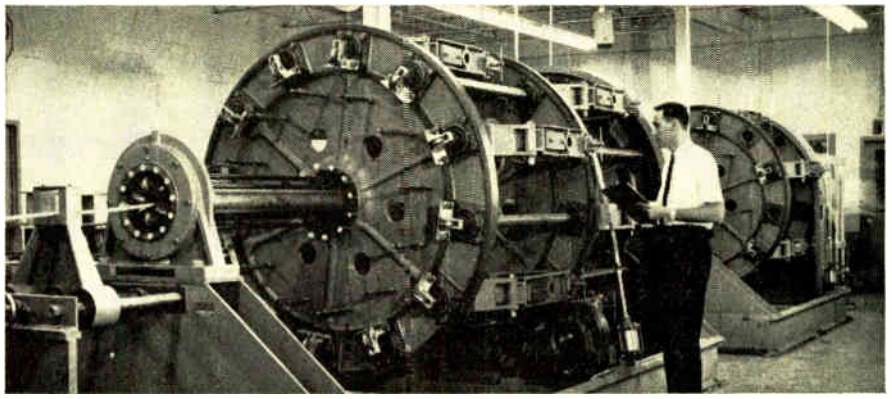
New specification guide simplifies cable purchasing

An illustrated guide to selecting and specifying special electronic and communications cables has been published by Phalo Corporation, a subsidiary of Transitron Electronic Corporation.



The new booklet includes drawings of typical standard and special cable types, together with construction details and materials options. An outline specifying the information required for quotation is also included.

Copies of the new Specification Guide may be obtained without charge by writing to: Transitron Electronic Corporation, Wakefield, Massachusetts.



Hundreds of miles of sophisticated electronic cable, produced to exacting tolerances, are turned out each year by this automatic cable machine.

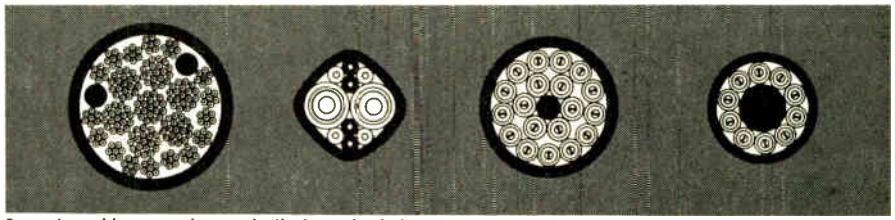
The complex control and signal cables which link peripheral equipment and the main frame are key components in any large, late-generation computer system.

So critical have some specifications become for this ultra-sophisticated "hook-up wire" that there are only two or three manufacturers in the country who can turn it out in quantity with the required uniformity and stability of electrical characteristics.

"In fact," says a Phalo Corporation spokesman, "the unique requirements of the computer industry are causing a mild revolution in the state-of-the-art of cable production. Today, for example, we are building cable to specifications which were thought impossible only a year ago."

Phalo Corporation, a subsidiary of Transitron Electronic Corp., with a large, modern plant on the Boston Turnpike in Shrewsbury, Mass., is one of the country's largest specialists in the design and manufacture of electronic wire and cable. Its products range from cord sets and Mil-spec hook-up wire to audio and communications cable and the specialized, high-performance computer cable mentioned above. The latter, which must meet a battery of exotic requirements such as extremely high capacitance stability throughout broad temperature cycling, requires an unusual degree of engineering competence, as well as a considerable diversity of manufacturing skills and equipment.

Because Phalo maintains a large engineering staff, as well as a completely equipped engineering reliability laboratory, it is called on to handle many of the toughest, most complex cable jobs, both military and commercial, that the electronics industry can dream up.

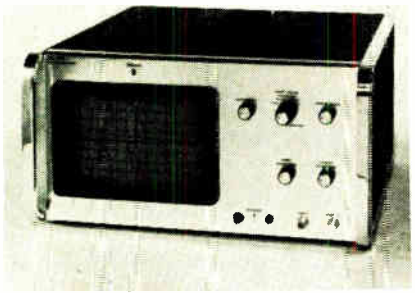


Computer cables range in complexity from simple bundles of several hundred wires encased in a plastic jacket, to complex combinations of coaxial lines, color-coded single conductors, shielded conductors, drain wires, fillers, etc.

NEW PRODUCTS

X-Y DISPLAY

For production testing system using sweep generator techniques.

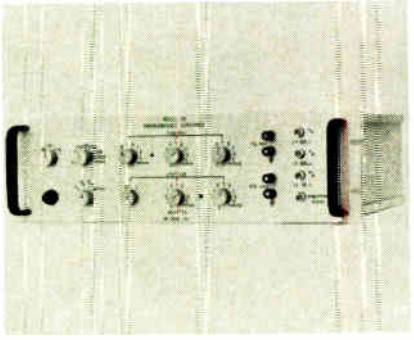


The basic Model DU-88 gives a large screen display of detected band-pass response without using superfluous sweep circuitry. The unit can be used to display birdy markers. The vertical amplifier has a sensitivity of 1mv/div. to satisfy stringent uses. A special marker feature converts pulse or birdy type markers into a pinball marker presentation. This version of the DU-88 allows it to handle most X-Y oscilloscope uses. Price is $675.00. Texscan Corp., 51 S. Koweba Lane, Indianapolis, Ind., 46207. Phone Bob Shevlot, 317-632-7351.

Circle 156 on Inquiry Card

FUNCTION GENERATOR

Allows automatic digital programming of freq., function and amplitude.



The Model 155 has both remote and manual controls. It produces virtually any combination of sine, triangular, or sq. waveforms, eliminating the normal requirement of a separate generator for each stimulus in an automatic system. Freq., function and amplitude can be programmed by tape reader or punched cards. Freq. range is 0.01 CPS to 1MC in 8 ranges; amplitude range is 10mv to 10v. peak-to-peak in 3 ranges; resolution is 3 digits, freq. and amplitude; and response time is less than 2msec. Wavetek, 8133 Engineer Rd., San Diego, Calif. 92111. Phone W. L. Zongker, 714-279-2200.

Circle 157 on Inquiry Card

TIME-MARK GENERATOR

Crystal-controlled, wide-range, time-mark generator has 500 MHz output.

Type 184 provides 16 marker intervals, 5 sine-wave freqs., and 7 trigger-pulse intervals. Positive-going markers are provided from 100 nsec. to 5 sec. in 1-5-10 sequence, 1-volt min. amplitude into 50 ohms. Sine-wave outputs include 2, 5, 10, 20, and 50 nsec. signals. Trigger output provides positive-going pulses with 7 intervals of 1 μsec. to 1 sec. Triggers are time-coincident with the corresponding markers. Price is $675. Tektronix, Inc., P. O. Box 500, Beaverton, Ore. 97005. Phone Alan Jerrick, Area Code 503-MI4-0161.

Circle 158 on Inquiry Card

POLY-PATTERN GENERATOR

Said to reduce electron-beam welding time by up to 50% or more.

The Poly-Pattern Generator is an electron-beam controller which generates various welding patterns such as circles, triangles, squares, rectangles, hexagons, and optional special patterns. These range in size from a dot to a size limited only by the model of the electron-beam welder used. The welding beam is positioned and driven by controlling the X and Y deflection coils of the welder. Since only the beam is moved, inertia and backlash are essentially zero. Difficult-to-weld materials such as Inconel or titanium can be welded. General Electric Co., P. O. Box 15202, Cincinnati, Ohio 45215.

Circle 159 on Inquiry Card

To Our Prospective Contributors

ELECTRONIC INDUSTRIES

Dear Reader;

Most of the articles appearing in EI are solicited, but we also receive and publish many manuscripts submitted to us directly by engineers. On these, we sometimes run into difficulties, and it is not necessary. Because the difficulties can usually be avoided by following these simple rules:

1. Send only manuscripts that have been cleared by your company. Otherwise, you may innocently give away company secrets, or make a statement that reflects on your firm.

2. Send only material that is legitimately new; material that is of interest or use to electronic engineers.

3. Send only typewritten manuscripts. Handwriting is acceptable for equations and graphs, if they can be easily read. Manuscripts should be double-spaced, typewritten on one side of a sheet.

4. Never send your article to several magazines simultaneously—only to one magazine at a time.

5. Send your article to the editor as soon as it is written. Don't wait. Timeliness is important.

6. Send only the article and illustrations. Brochures, catalogs, and proof of what you are presenting are not normally needed.

7. Include best quality photographs. If they are poor to begin with, reproducing them in a magazine will make them worse.

8. Use only standard abbreviations and terms.

9. Comply quickly with an editor's request to shorten an article, expand a point, supply artwork, or any other material or information. If you delay, another article may take its place.

Sincerely,
The Editors

EXOTIC DEVICES (Concluded)

. . . *from page* 61

if the magnitude of the super current becomes too high. Another property is that it is a perfect magnetic shield. A superconductor allows no change in magnetic fields to occur within it. With an external field, an induced current circulates inside the superconductor in such a pattern that a counter field is set up to exactly cancel the new field and keep the field pattern as it was before the external field was applied.

The basic cryogenic device is generally called a cryotron, Fig. 3). Its form resembles that of a transformer with two one-turn windings, the secondary of which is shorted. Let us assume that a superconductive current, I flows in the secondary loop. A large enough drive current I_D will induce an increase in this current until the critical value of current is reached and the loop becomes a normal conductor with a finite resistance. This resistance generates heat and causes the magnitude of the current to decay. If the drive current is maintained at a constant level, the secondary current will decay toward zero. The secondary cannot become superconducting again until it dissipates all the heat it has generated during its normal conducting period. At the moment that the loop becomes superconducting again, the drive current is removed. The collapsing magnetic field induces a superconductive current in the secondary loop in the opposite direction from that which it had originally. Thus the cryotron loop may be switched from one stable state to another, and this is all that is needed to construct logic and memory systems from them.

Ryotron

One of the most promising inductive superconductive devices is the ryotron. The ryotron is really an inductive switch with an inductance variation of better than 3 orders of magnitude. Imagine an inductor wound with wire coated by a superconducting sheath. As long as the sheath remained superconducting, each turn of the inductance would be magnetically shielded from all other turns and the inductance would remain very low. If the superconducting sheath were suddenly to become normally conducting the shielding effect would be gone, the windings of the coil would act normal. In the case of the ryotron a simpler structure of strip lines and ground planes is used rather than actual coils, but the principle is the same. Ryotron switching is nearly a hundred times faster than cryotron switching and uses less power. It is therefore quite likely that the ryotron will be widely used in high speed computer systems of large capacity in a few years.

Fluid Amplifier

Perhaps the most exotic device of all, the fluid amplifier (either gas or liquid), isn't even electronic. Fluid devices, that contain no moving parts, can perform almost all computer and amplifying functions. Fig. 4 shows a bistable fluid flip-flop. A main or power jet chamber emits a high velocity stream of fluid into the channel. Fluid from the right or left control jets hits the main jet and deflects it toward one wall. If the walls are shaped properly and are close to the interaction region, the stream will attach itself to the wall toward which it has been deflected. This wall affinity phenomenon causes the fluid stream to shift completely from one output orifice to the other. The stream will remain attached to the same wall, even after the control jet flow has ceased, thus this cell has all the main properties of a binary memory cell.

Fig. 5 shows a linear amplifier. In this case the control jets deflect the main stream so that more or less fluid reaches the output parts. In this case the channel walls are curved away from the interaction region, so that attachment to a channel wall cannot occur. Oscillators and multivibrators from 0 to 100 KHz may be constructed by putting a feedback tube from the output orifice to a control jet. The frequency of oscillation is set by the length of the feedback channel.

Passive parts, i.e., resistors, inductances and capacitors, also have their counterparts in fluid structures. Thus resistance is an orifice or porous plug, inductance is just a length of tubing, and capacitance is a tank or area that stores fluid.

These fluid elements can be interconnected and built with high packing densities. About 2000 to 4000 bistable cells per cubic inch can be made. A complete medium sized general purpose computer could be packaged in a volume of less than 10 cubic inches. These small structures are made from photographs using optical fabrication and glass or plastic etching methods.

The capability of a pure fluid system for high temperature use goes far beyond that of any other known device, since operation depends only upon the shape of a solid and the flow properties of a fluid. A properly designed unit could operate at white heat if a refractory material were used for the body and a stable non-corrosive gas were used as the fluid. The resistance of fluid devices to nuclear radiation is also phenomenal and only dependent upon the nature of the fluid and the channels through which it flows. The combination of high environmental resistance, small size, and high reliability make the fluid components a choice for space systems in rockets, nuclear test zones or jet aircraft.

One of the most exciting uses of fluid circuits has been in a portable heart pump which requires no electrical power, weighs less than 10 pounds and contains logic elements that adjust the rate of flow and the number of beats to the needs of the individual.

All of the devices described here exist, at least in the form of laboratory models. Whether they will prove to be practical or of commercial value remains to be seen. The fluid amplifier is commercially available. At this writing, the others are still confined to the laboratory—exotic devices.

COMMUNICATIONS— PAST, PRESENT & FUTURE

A State-Of-The-Art Report By Industry Leaders

Presented on these pages are statements concerning various aspects of technological developments as viewed by some of the key personages in the industry. The purpose is primarily to acquaint engineers with advances in technological areas outside their particular specialties. Trends revealed point the direction to new devices, equipment and systems made possible by advancing state-of-the-art.

Microwave Communications Systems

By E. William Bush
Program Manager
Cubic Corporation
San Diego, Calif.

REAL-TIME RECONNAISSANCE — a dream in World War II—is a reality now. It has been made possible through an airborne data-link system that solves the line-of-sight (LOS) problem in transmittal of needed tactical information from "sensor" aircraft over enemy territory to a ground station behind the lines. The complete transfer of data spans hundreds of miles . . . in seconds.

A data-link system is used in the Air Force Project SeeFast, a reconnaissance data system employing wideband frequency modulation (WBFM) techniques to transmit video data from reconnaissance aircraft to a ground terminal station. Data transmission is achieved over distances exceeding line-of-sight (LOS) distance using a second aircraft to relay data between the low-level aircraft and ground stations. The data-link subsystem provides three video data channels with carrier frequencies between 4.5 and 5 GC. FM transmitters accept the video signals from side-looking radar (SLR), visible and infrared photo scanners, and television sensor equipment. Reconnaissance sensors and data-link are integrated in three RB66 aircraft, and referred to by SLR aircraft, carrying side-looking radar and FM transmitters; multi-sensor aircraft, carrying visible and infra-red cameras, film processors, and scanners, and FM transmitters; and relay aircraft, carrying a sensor tracking flush mounted antenna, FM receivers and transmitters.

The SeeFast ground station consists of a parabolic tracking antenna (12-ft in diameter), FM receiver equipment, and data processing equipment matching each airborne sensor.

Solid-State Microwave Systems

By Alan F. Culbertson
Vice President—Engineering,
Lenkurt Electric Co., Inc.,
a subsidiary of
General Telephone & Electronics Corp.

MOST RECENT MOVES TOWARD SOLID STATE have been the result of advances in the state-of-the-art of new devices, coupled with an improvement in our understanding of how these devices may be used. It is always difficult to interpret the value of new techniques.

Generally, this decision is based upon the use of new devices at higher and higher frequencies. The 4 GC band would seem to be the next logical one to yield to an all-solid-state approach. The 6 GC band, with its common carrier industrial and military applications, is much more interesting, and it is in this band that attempts are being made to achieve a fully solid-state high-performance microwave system.

Lasers, tunnel-diode amplifiers, parametric amplifiers, solid-state microwave generators, and many such technological innovations first have to be understood in the light of technical and economic feasibility. Because these things are technologically exciting to us and our customers (and especially to some of our suppliers), we have to make a special effort to be honest with ourselves when we judge their suitability for product applications.

However, when they do pass the test of being reasonably competitive and producible and seem likely to give users a worthwhile value, then we try to use them in product designs.

Within the next five years a completely solid-state, high-performance microwave communications system will probably become a reality.

Trends in Space Communications

By Louis Pollack
Director, Space Communication and Tracking Systems Laboratory
ITT Federal Laboratories,
a division of ITT Corp., Nutley, N.J.

TECHNOLOGY REQUIRED TO IMPLEMENT a time division multiple access system using burst transmission techniques has been studied. By dividing a unit period of time into a number of time blocks and assigning a time block to each station, it is possible to arrange for many ground stations to access the satellite in time sequence.

At specific intervals, such as once every ten thousandths of a second, information that has been stored will be transmitted very rapidly to the satellite, retransmitted to the corresponding ground station and there stored for later transmission at a normal rate. This process is repeated very rapidly about once every 1/100/sec.

Important characteristics of this technique are ultimate low-cost, over 98% efficiency, flexibility in traffic apportionment, no careful balancing of earth terminal power, and compatibility with terrestrial network.

In such a satellite system employing time division multiple access, an earth station, or an airborne or seaborne station, not only receives from the satellite from another station, but also measures the range to the satellite to determine the time slot that will be used for transmission. This range data can be used to determine the vehicle's location. Necessary calculations which use known orbital parameters of the satellite and measured range to calculate the station location can be computed and read out.

Optical communications promise low power and extremely wideband transmission, which may be particularly useful in satellite-to-satellite communication and in satellite-to-space vehicle communication.

Semiconductors In Communications

By Q. T. Wiles
Vice President and General Manager
TRW Semiconductors

IT IS AMPLY APPARENT THAT TRANSISTORS of higher and higher power at higher and higher frequencies have now blanketed a large area of communications applications. This is to say, the range is from 40 w at 17 MC (at 28v with 70% efficiency) to 10 w at 500 MC (at 28v with 50% efficiency).

Our challenge today is to draw on this wealth of technology to develop efficient transistors for real needs. Opportunities are limited only by the practical considerations of people and economics.

With needed characteristics established, development programs draw heavily from accumulated technology. In communications transistors in particular, creative and imaginative approaches pay large dividends. This applies to such areas as die geometry and pattern layout and, in a very special sense, to elements of construction affecting thermal efficiency.

The use of multiple transistor elements and their paralleling represents an adaptation of microelectronic technology to a discrete component. An example is the six-cell PT5692 transistor delivering 20 w of rf power at 150 MC at 28v.

New packaging technologies have extended the economically practical power-at-frequency range. Flat, radial-lead, beryllium - and - metal packages provide excellent performance in hf circuits without the serious parasitic effect of earlier packages.

In addition, more recent materials technology has made possible silicone-molded packages providing a highly economical answer to industrial and military requirements at temperatures of 175° C.

Modulation Systems

By W. S. Litchman
ITT Federal Laboratories,
a division of ITT Corp., Nutley, N.J.

THE AMOUNT OF INFORMATION conveyed by speech and video waveforms is somewhat less than the data capacity of the channels to transmit these waveforms. High quality vocoders (voice coders) which offer 3:1 reductions in bandwidth, and video scanners offering similar reductions, are finding military, space and commercial application.

Since early 1960's digital transmission has assumed a top role in communications research, planning and testing. Models which describe the error proclivity of transmission systems have been developed. The pareto distribution (due to Mandelbrot) and Markov models (due to Gilbert and Elliott) describe error bunching distribution.

To circumvent error bunching (long bursts of error), several important digital message coding techniques have been employed. Of particular interest are the long constraint length codes (due to Zieler), threshold decoding (due to Massey and Kohlenberg), time spreading, and sequential coding (due to Lincoln Laboratories). The latter (providing a 7500 bit/sec. data rate over a telephone channel with low error) depends equally upon extensive equalization of the channel.

Based upon this an automatic equalization system has been developed to overcome the dispersive effects of the channel. An interesting modulation system (modified duobinary, due to Lender) has been developed which achieves 2:1 bandwidth compression over binary systems and which allows detection by either noncoherent FM or differentially coherent phase detection.

Data Communications

By E. Wayne Copeland
Data Communications
Bendix-Pacific Division

THE GREAT INCREASE IN THE VOLUME of data required by DOD and NASA missions is forcing a revolution in the data communications field. Increasing demands for more data of greater accuracy from systems of reduced size, weight and power use, have exerted great pressures on equipment designers.

The problems of accuracy, bandwidth conservation and simpler processing of data are being resolved through more advanced digital systems and techniques. Accuracy in digital systems becomes a function of detecting the presence or absence of a signal rather than measuring signal amplitude (phase displacement etc.). In addition, use of narrow bandwidths made possible by digital methods increases transmission power effectiveness. The fact that data can also be processed directly by computers without need for conversion equipment is of great value.

In compression, high data transmission can be achieved by using circuitry which select only key data. Up to 95% of data sensed in many telemeter and other systems either repeat, or is useless, therefore, large savings in data bandwidth as well as data processing, computation and recording time are achieved. By careful use of the data compression system, data not received also has useful meaning.

Capabilities of data systems are now being extended by use of circuitry which switches continuous data channels back and forth among two (2) or more data sources according to a preset program, or set of data condition limits, or both. These adaptive techniques used with data compression can, in effect, multiply the capability of a data transmission system by several times.

Satellite Communications

By Dr. Daniel E. Noble
Group Executive V. P.
Motorola, Inc.

THE SUCCESS OF THE SYNCOM communications satellite, the Early Bird, represents a revolutionary, step-function change in communications, and particularly in the microwave field. When one considers that the Early Bird satellite, which links North America to the European continent, provides a bandwidth substantially greater than the hf bandwidth available night or day through all other systems in operation, the radical nature of the change becomes clear.

Roughly speaking, we have been using the first five kilomegacycles for all of our communications needs, with most systems crowded into the first five hundred megacycles. Now, suddenly, the Early Bird system offers the possibility of opening up the balance of the spectrum from five to thirty kilomegacycles, or in other words, it provides the potential effective utilization of a spectrum five times that now in use. We can foresee a thousand Early Birds providing worldwide facsimile, TV, voice and picture communication. Worldwide point-to-point and mass transmission of informational processing patterns is not far off.

While it is difficult to project the future impact of the Early Bird satellite concept upon surface microwave relay systems, we may be sure that there will be an impact which will modify, extend and develop the effectiveness of all microwave systems in use.

The Early Bird system will also have an impact upon mobile telephone service and mobile voice communication service in general. In addition, the critical need for additional channels to handle the present volume of mobile traffic may also extend the mobile radio operating spectrum into microwaves.

Communication Systems

By Stanley Zebrowitz
Manager Communications Systems Engineering,
Communications & Electronics Division,
Philco Corp., Philadelphia, Pa.

MODERN COMMUNICATION SYSTEMS provide more and more links for digital data transfer in addition to analog services. Demands for local and long distance links of improved reliability and increased capacity have mushroomed.

Communication satellites, bandwidth capabilities of undersea cables, and reliable long distance and wide bandwidth tropo scatter circuits, plus improvements in other transmission modes, are leading to a truly global integrated system. For special uses, new modes of transmitting data via optical and millimeter waves are being introduced.

The first generation of solid-state communication equipment is becoming obsolescent—soon to be replaced by more reliable equipment employing integrated circuits. Quantum electronic devices are providing severe competition to the older methods of producing and amplifying microwave energy through such devices as the varactor diode harmonic generator, the tunnel-diode low-noise amplifier, the diode microwave oscillator and the maser. Electromechanical switches and relays are being superseded by solid-state equivalents which hold promise of comparable costs with a higher order of reliability.

The use of information theory in communication systems is resulting in equipments for error detection and correction. Also, spread spectrum and other coded waveform systems are being introduced which allow highly reliable and secure information transfer over marginal links.

Finally, the coming of an overwhelming volume of digital communications is spurring techniques which convert analog signals to digital form, without requiring increased transmission bandwidth.

Telemetry Antenna Advances

By Ronald Johnson and John Bolen

Director of Sales, Telemetry Systems
Section Chief, Antennas
Electronic Specialty Co.
Los Angeles, Calif.

OVER THE LAST THREE YEARS, advances have been made in three basic areas of telemetry antenna technology: (1) broadband feeds; (2) polarization diversity; and (3) circularly polarized antennas for airborne applications.

Broadband feeds now available cover bands as broad as 215 to 2300 MC. This coverage—greater than 10:1—means that ranges can use the present vhf frequencies and still be compatible with the S-band requirements now on the way in. The transition is therefore greatly simplified. The techniques which have made this possible are frequency independent antennas, and multiple narrow-band elements.

Polarization diversity refers to antennas which can receive right-hand circular, left-hand circular, horizontal and vertical modes. The linearly polarized signal from a tumbling satellite may look circular, or worse, to the receiving antenna. And a signal which is right-hand circular when the satellite is approaching is left-hand circular when the satellite is going away. Polarization diversity is achieved by putting more feeds at the focal point of the dish.

Circularly polarized airborne antennas were available previously for ground applications, but they were too large to be used on aircraft or satellites. Linearly polarized antennas on the satellites resulted in at least a 3 db loss. With distances rapidly increasing, this problem became acute. The problem now has been overcome through the use of dielectric loading, and loading of other types. Thus, circularly polarized omni-directional antennas small and light enough for space applications are currently available.

Telemetry Error Elimination

By Gerald O. Reinen
Telemetry Product Line Manager
Systems Div., Beckman Instruments, Inc.

SEVERAL FACTORS ARE OPERATING to make it harder to extract accurate data from space probes. Distances are increasing. The amount of power available for telemetry transmission is grudgingly given. At the same time, the volume of data that must be transmitted is growing, which means that telemetry engineers can no longer enjoy the luxury of a slow bit rate to counteract the effect of the worsening signal-to-noise ratio.

For all these reasons, we take the position that the key place to spend development dollars and hours is in the front-end of telemetry processing systems. The quality of the processed data can be no better than the accuracy of the initial signal detection.

With this emphasis, there have been developed PCM bit synchronizers that are capable of maintaining a 10^{-6} bit error probability (one error in a million bits) in a 9.8 db signal-to-rms noise environment. Moreover, the equipment can maintain this accuracy at transmission rates up to 1,000,000 bit/sec.

One secret to this performance is the lengthy use of adaptive circuits which adjust the system to varying signal amplitude and baseline wow. These circuits are adapted to automatic computer control. Detecting techniques are used to recover PCM pulses, the choice depending on type of signal and noise or filter conditions. These choices include: a point sampler detector for optimum recovery of heavily-filtered NRZ code formats; single integrator detector for optimum recovery of NRZ code formats heavily degraded by hf noise; differential integrator detectors of two types, one for split-phase code formats and the other to recover signals containing significant low-frequency noise (baseline wow).

Railroad Communications

By Robert C. Karvwatt
Director of Communications and Signals,
New York Central System

20TH CENTURY ELECTRONICS in railroading is completely transforming the industry. America's railroads have revolutionized their communications with radio, tv, microwaves, radar, electronic computers and data processing, and at cost-cutting efficiency.

Each day the New York Central, for instance, operates about 800 freight trains and has 110,000 freight cars on line. System-wide data must be collected, communicated and processed as quickly as possible.

In planning its new communications system, the Central re-defined its entire communications problem. The ideal system had to interpret a variety of inputs, provide a common source of information, transmit data back to a requesting station, be compatible with other equipment, and perform code and format translations. In addition, the system had to have high-speed and accuracy, around-the-clock reliability, and be fully automatic. The system must pay for itself on the basis of the function it was going to perform. The Central in 1961 prepared a specification for an electronic switching and processing center to meet these requirements.

Collins Radio Company engineers, working with the Central, built the "Data Central," a redundant switching system that consists basically of an automatic message switching and processing center for telegraph networks. The center, located in New York, serves as a classification and distribution point for all messages and data. More than 57,000 miles of circuits are connected to the center and more than 250 points transmit and receive data over these circuits through Data Central.

Digital Communications

By Dr. M. C. Andrews
Communications Systems Manager,
Federal Systems Div.,
International Business Machines Corp.

THE AVERAGE BIT OF INFORMATION, in time, will spend a smaller part of its life in an analog form.

This seems to be a reasonably long-range extrapolation of changes now in process; there are fundamental demand and supply reasons. First is the momentum of the information age in which scientific, engineering, business, and social problems demand more and more data with automatic digital aids. The second is the momentum of digital methods with flexibility and rapidly declining costs. Over the past decade the average cost of digital components has been about halving every three years, compared to a five year half-cost period for analog parts.

Until recently, practical needs could not justify the cost of coding/decoding hardware to do more than detect errors, and correct them by retransmission. In 1961, all known error-correcting codes for correcting burst errors of frequently observed lengths were thought impractical. But, as high-speed data sending needs have become more pronounced, and lower cost digital electronics have become available, the problems have been getting more attention. A recent report discusses a method of correcting errors occurring in data transmission at 9600 bits-per-second over a voice-grade telephone circuit. (This is about ½ the theoretical capacity; 2400 bit/sec. is common practice.) The method (experimental) used forward error correction with detection and retransmission. By adding 25 redundancy bits to 175 information bits, the system corrected up to three errors in the 200-bit blocks; hence, reducing the data throughout to ⅞ of the transmission rate

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brought a much lower error rate than could have been obtained by transmitting uncoded data at 8400 bit/sec.

Still more complex error-control systems now are considered practical for demanding channels subject to long error bursts. One system uses 8 redundancy bits for 8 data bits and interlaces the result into 3200-bit superblocks. This system will correct bursts as long as 2800 bits, with an average error-free time to recover of 1800 bits. Furthermore, if the decoder does not detect long error bursts, it switches to a random error correcting mode in which it will correct 1 error in 8 bits.

Continued pressure to use existing channels more efficiently and to achieve computer tolerable error rates $<10^{-8}$ should continue to set a rapid pace in error control.

A fact of life is that bandwidth is cheaper in large pieces. This automatically makes efficient multiplexing an important problem. On the "well established" end we find pulse-code-modulation with time-division multiplexing represented by the latest interexchange telephone trunks. These systems, built within the last five years, will carry 24 voice channels over a single cable pair. Low cost comes from a high percentage of common equipment at the terminals—digital electronics is flexible.

Among less established but very active developments, we find code-division-multiplexing for common frequency band, multiple-access systems. Here channel separation is achieved by superimposing a digital code sequence on a transmission. The code is set up in the intended receiver and some form of correlation detection used to discriminate the transmission from all others (or from noise). A convenient method of generating the codes uses digital pseudo-random sequence generators. Such techniques have found many special uses such as deep space ranging and data transmission systems; they appear to be strong candidates for wider application.

The state-of-the-art is one of rapid change toward digital use of communications functions, new and old.

Continued from page 63

Trimmer Potentiometers	Type No. or Series	Trimmer (T); Precision Trimmer (P)	Wirewound (W); Metal Glaze (G)	Carbon (C); Comp. (CO)	Met. Film (F); Cond. Plastic (CP)	Square(S); Rect.(R); Circ.(C); Cube(CU)	No. of Turns; Multiturn (M)	Resistance Min. (Ohms)	Resistance Max. (Kilohms)	Resistance Tolerance (±%)	Resolution (±%); Infinite (N)	Linearity (±%)	Oper. Temp. Max. (°C)	Power Rating (W)	Enclosed	Sealed	Servo Mtg.(S); Bush.Mtg.(B); Screw(SC)	P–C Mtg.	Wire Leads (L); Pins (P); Terms. (T)	Height (in.)	Width (in.)	Length (in.)	Dia. (in.)
Fairchild Controls 225 Park Ave. Hicksville, L. I., N. Y.	TF12	P				S		10	50	5				0.7	X			X	P/L	0.5		0.5	0.1
	TF38	P				S		10	25	5				0.7	X			X	P/L	0.4		0.4	0.1
	RTF114	P				R		10	50	5				0.7	X			X	P/L	0.3	0.2	1	
	RTF11	P				R		10	50	5				0.7	X			X	P/L	0.3	0.3	1	
	768	P			F	R		50	25		N	5	175	1		X	SC		L	0.3	0.2	1	
	769	P			F	R		50	25		N	5	175	1		X	SC		L	0.4	0.3	1	
	927	P							50		3		85	1	X		B		T		0.5	0.5	
General Scientific Corp. 1535 First St. San Fernando, Calif.	VSL	T				S		100	50	10		5	150	1			SC		L	0.5	0.2	0.5	
	LVSL	T				S		100	150	10		5	150	1.5			SC		L	0.7	0.3	0.7	
	VSB/S	T				S		10	50	10		5	150	1		X	SC	X	P	0.5	0.2	0.5	
	VRB/KTR	T				C		100	50	10		5	150	2			B	X	T/P			0.5	0.5
	MS1	P				C		100	30	5		5					B/S		P			0.5	0.5
International Resistance Co. 401 N. Broad St. Philadelphia, Pa. 19108	450	P	G			R	24	100	1K	10	N		125	0.5		X	SC	X	L/P	0.3	0.2	1.2	
	250	P	G			S		100	1K	5	N		150	0.7		X	SC	X	P	0.5	0.2	0.5	
	150	P	G			C		100	1K	5	N		150	0.7		X	SC	X	P				0.5
	251	P	G			S	26	100	1K	10	N			0.7	X			X	L				0.5
	350	P	G			CU		50	0.5K	10	N			0.3	X			X	P	0.2	0.3	0.3	
	370	P	G			CU		50	0.5K	10	N			0.3	X		B	X	T	0.4	0.3	0.4	
	CT203	T	W			S		10	50	5			150	1	X		SC/B	X	X	0.5	0.2	0.5	
	200	P	W			S	26	10	50	5			150	1	X			X	L/P	0.5		0.5	
	100	P	W			C	1	10	50	5			150	1	X			X	L/P				0.5
	300	T	W			CU		50	20	10				0.6	X				P	0.3	0.3	0.3	
	5001	P				C		10	50	5	to 0.1	5	150	2	X		B		T				0.5
	7501	P				C		15	75	5	to 0.1	1	150	2.2	X		B		T				0.7
	151	P				C		15	100	5	to 0.03	0.5	125	3.5	X		B		T				1.5
	310	T	W			CU		50	20	10				0.6	X				P	0.3	0.3	0.3	
	320	T	W			CU		50	20	10				0.6	X		B		P	0.3	0.3	0.3	
Logan Electronic Corp. 44 Breed St. E. Boston 28, Mass.	B5SXT	T	W			C		10	50			5	125	1	X		B	X	P			0.3	0.5
	5SXT	T	W			C		10	50	5		5		1	X			X	P			0.3	0.5
	5ST	T	W			C		10	100	10		5	125	2	X		B		T			0.3	0.5
	B5LT	T	W			C		2	250	5		3	125	2	X		B		T			0.6	0.5
	5SRT	T	W			C		2	250	5		3	125	2	X		S		T			0.7	0.5
Maurey Instrument Corp. 4555 W. 60th St. Chicago, Ill. 60629	37-M11/13	P	W			C		50	10	5	to 0.1	5	135	0.5	X			X	P			0.2	0.4
	37-M12/14	P	W			C		50	10	5	to 0.1	5	150	1	X		B		T			0.3	0.4
	50-M123	P	W			C		50	100	5	to 0.1	3	135	1.5	X		B		T			0.5	0.5
Minelco 600 South St. Holbrook, Mass.	HR	T				C	1	20	15	10	0.2		150	0.2		X	B	X	X				0.2
	HR	T				S	1	20	15	10	0.2		150	0.2		X	S	X	X	0.2		0.2	
	MF2	T			F	C		10	100		N					X		X	P			0.2	0.2
	MS37	T				C		20	25	10	to 0.1		150			X	B	X	T			0.3	0.4
	MP5	T	W			R		20	15	10			125	0.2		X		X	P	0.2	0.2	0.3	
Nucleonic Products Co., Inc. 3133 E. 12th St. Los Angeles, Calif. 90023	PA10	T		C				100	10K		N		70	0.1	X			X	T/P	0.2	0.4	0.4	
	PA15	T		C				100	10K		N		70	0.1	X			X	T/P	0.2	0.6	0.7	
	PA25	T		C				100	10K		N		70	0.1	X			X	T/P	0.2	0.7	0.8	
Somarius, Inc. 300 Seymour Ave. Derby, Conn.	RP-126/27	T	W			R	25		to 100					1.2	X		SC	X	X	0.2	0.2	1.2	
Servomechanisms, Inc. 1200 Prospect Ave. Westbury, L. I., N. Y.	HT500	T			F	S		500	25		N			0.5		X	SC	X	P/L	0.5	0.2	0.5	
	HT250	T			F	C	1	100	7.5		N			0.4		X		X	P			0.2	0.2
Spectrol Electronics Corp. 1704 S. Del Mar Ave. San Gabriel, Calif.	84	T	W			C	1	50	100				175	1.5		X						0.27	0.5
	40	T	W			R	15	50	50	5			175	1		X	SC	X	X	0.3	0.2	1	
	42/44	T	W			R		10	100	5			175	1	X		SC	X	L/P	0.3	0.2	1.2	
	46	T	W			R	15	10	50	5			175	1	X		SC	X	L/P	0.3	0.2	1	
	50	T	W			S		10	50		to 0.1			1	X		SC	X	L/P	0.4	0.2	0.4	
	55	T	W			S		10	50		to 0.1		150	1.5		X	B SC	X	L/P	0.5	0.2	0.5	
	60	T	W			S		10	50		to 0.1			1.5	X		SC		L	0.5	0.2	0.5	
	74	T	W			R		10	100		to 0.1		175	1	X		SC	X	L/P	0.3	0.3	1.2	
	80	T	W			C		10	50		to 0.1		150	1	X			X	P		0.2		0.3
	82	T	W			C		50	10		to 0.1			0.5	X			X	P		0.2		0.3
	84/85	T	W			C		50	100		to 0.1		175	1.5		X	B	X	P/T		0.3		0.5
	94	T	W			R		50	20		to 0.2		105	0.5	X			X	L/P	0.3	0.3	1.2	
Techno-Components Corp. 7803 Lemona Ave. Van Nuys, Calif. 91405	10	T	W			S		100	25	5	to 0.16		175	0.5		X		X	L/P	X	0.2	0.2	0.1
	100	T	W			S		10	50	5	to 0.1		175	1		X		X	L/P	X	0.4	0.4	0.2
	12/14	T	W			S		100	25	5			175	0.5		X		X	L	X	0.2	0.2	
	30	T	W			S		100	20	10							B		L		0.4	0.3	0.4
	15	T				S	M	100	25				175	0.5		X		X	P		0.2	0.2	0.2
TIC of California 850 Lawrence Dr. Newbury Park, Calif.	TR2	T				R	15	50	20	5	0.2		175	1			SC		P/L	0.3	0.2	1	
	RV1/2	T	W			C		50	50	10			150	1.5			B		T			0.5	0.5
	RV7/8	T	W			C		100	100	10			150	2			B		T			0.4	1
Vogue Instrument Corp. 129-11 18th Ave. College Point 56, N. Y.	SM-1	P	W			C	1	50	15	10		5	100	2	X		B		T			0.8	0.5
Waters Mfg., Inc. Wayland, Mass.	RM11	P			F	R		500	50	20	N			0.2	X		SC		P/L	0.3	0.3	1	
	RW11	P	W					50	10	10	to 0.1			0.2	X		SC		P/L	0.3	0.3	1	
Weston Instruments, Inc. Archbald, Pa. 18403	200/01	T	W			S		10	50		to 0.1		150		X		SC	X	L/P	0.4	0.1	0.4	
	210	T	W			S		10	50		to 0.1		175		X		SC		L	0.4	0.1	0.4	
	215/18/55	T	W			S		10	50		to 0.1		175		X		SC		L/P	0.4	0.1	0.4	
	300/01/12	T	W			S		10	50				150	1	X		SC		L/P	0.5	0.2	0.5	
	313/18	T	W			S		10	50				200	1.5	X		SC		L/P	0.5	0.2	0.5	
	302	T	W			S		10	50				150	1	X		SC		P	0.5	0.3	0.5	
	310	T	W			S		10	20				175	2	X		SC		L	0.5	0.2	0.5	
	355/56	T	W			S		10	50				200	1	X		SC		L P	0.5	0.2	0.5	
	368	T	W			S		10	6				175	2	X		SC		P	0.5		0.5	
	311/60	T		C		S		5K	5K	20			85	0.5	X		SC		L P	0.5	0.2	0.5	
	303	T	W			S		10	150					1.5					L	0.7	0.3	0.7	
	510	T	W			C							175	1		X		X	P		0.3		0.4
	515	T	W			C		10	50				150	1					P				0.5
	333	T	W			R		50	10	10			80	0.2					T	0.5	0.2	0.5	
	501/2	P	W			S		10	30	5	to 0.1												

INTERNATIONAL NEWS

London—Cossor Electronics Ltd. has formed a Marine Div. with headquarters here to market various marine products within the Raytheon group such as radar, loran and VHF gear.

London—A Myriad computer (English-Electric-Leo-Marconi) will be used by Central Electricity Generating Board for experiment in automatic control of power generation and distribution.

London—More Marconi 60 series transistorized communications and navigation aids have been ordered for R.A.F.'s American Lockheed C-130 Hercules long range transport aircraft.

Portsmouth — Ministry of Defense has ordered a high-speed computer for Navy "war games" from Solartron Electronic Groups. The digital simulator Surface Tactical and Blind Pilotage Trainer—will go aboard HMS DRYAD.

Burgess Hill, Sussex—Electronic Associates Ltd., will supply a solid-state EAI 8800 Scientific Computing System to British Aircraft Corp. for use in systems design for guided missile projects.

Harlow, Essex—Radar Division of Cossor Electronics Ltd. has received an order for primary radar and associated display and communications systems from the Ministry of Aviation.

Montreux — The fifth International Television Symposium and its technical exhibition will be held Monday, May 22, to Friday, May 26, 1967 in the rebuilt Montreux theater with many new facilities.

Torino—Fiat S.p.A. has given General Electric an order to supply aircraft generating systems for Italian Fiat G91Y fighter prototypes.

Paris—Westinghouse Electric International will supply a billion-watt output giant-pulse ruby laser to the Directorate of Research and Testing Facilities, French Ministry of Defense.

The Hague—A computerized checking system (IBM) has achieved savings of over $3½ million per year and has considerably reduced paper work, reports Netherlands Postal Cheque & Transfer Service.

Basel—The 2nd International Exhibition of Industrial Electronics (INEL '65) held recently in the Swiss Industries Fair was hailed as an outstanding success, "by far surpassing the first INEL in 1963."

Stockholm — Scandinavian Airline System (SAS) has awarded the Link Group of General Precision, Inc., a contract for a DC-8 flight simulator to train pilots for SAS's ultra-long-range DC-8 Mark 62 jetliners.

Munich—A wholly-owned European-based sales company, DEI Elektronische Gerate, GmbH, (DEI Electronic Industries), has been established in this city by Defense Electronics, Inc., Rockville, Md.

Marl, West Germany — Chemische Werke Huels has purchased the first Foxboro Co. digital computer systems sold in Europe. Contracts totalled well over $500,000 for two large systems.

Madrid—Spain's largest commercial broadcasting network, Cadena Azul de Radiodifusion has begun conversion into "the most modern network system in Europe," having chosen Singer Products' SINTRONIC FM broadcast transmitters.

Tehran—The government of Iran has given Philco Corp. a $5.5 million contract for an aircraft control and warning system under the U. S. Military Assistance Program.

Rio de Janeiro—Main feature of the Marconi stand at the recent international exhibition in Rio de Janeiro was the Mark IV TV camera, 85% of which have been exported to date, particularly to the U. S.

Tokyo—Nippon Electric Co., Ltd. (NEC) disclosed that it has a contract with Bharat Electronics Ltd., India, to export production know-how of transmitting tubes used in medium-wave radio transmitters.

Seoul—Typical of Korea's industrial expansion into labor-intensive, skilled manufacturing is its Oriental Precision Co., which produced 10,000 automatic telephone switchboards in 1965.

Sydney—A major export order worth about $1,122,500 (Australian rate) for Marconi Doppler Navigation systems and airborne computer, to be fitted in Qantas Airways fleet of Boeing 707 aircraft.

Kobe—TOA Electric Co., Ltd., has appointed Shigoto Industries, Ltd., New York City, as an exclusive marketing agent for TOA public address equipment in the U. S.

BOOKS

Quantum Radio Frequency Physics

By Lev Dmitriyevich Stepin. Published originally by the A. M. Gor'kiy State Univ. of Khar'kov, 1963 under the title Lectures in Quantitive Radiophysics. Published 1965 by The M.I.T. Press, Cambridge, Mass. 02142. Price $6.00. 227 pages.

Book presents the physical foundations of quantum radiophysics. It concerns itself with quantum effects occurring on interaction of EM waves with matter and accompanied either by absorption of energy (microwave spectroscopy) or by emission and amplification of EM waves (quantum generators and amplifiers). Much attention is devoted to the experimental observation of these effects.

Fields and Waves in Communication Electronics

By Simon Ramo, John R. Whinnery and Theodore VanDuzer. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York 16, N.Y. Price $13.50. 754 pages.

This is an updating of Ramo and Whinnery's *Fields and Waves in Modern Radio.* It has been modernized and updated by continuing use in a course at the senior level at the University of California on "Electromagnetic Fields and Waves." The book combines the essential theoretical analysis with the practical viewpoint of engineering applications.

Sourcebook on the Space Sciences

By Samuel Glasstone. Published 1965 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., in cooperation with NASA. Price $7.95. 937 pages.

This account of the principles and uses of space science provides a broad background of the existing sciences—astronomy, biology, geodesy, and the physics and chemistry of the Earth and its environment and of the celestial bodies—which can be advanced by studies using space vehicles. It describes in appropriate context the progress that has already been made by such studies, and indicates the lines along which further investigations are being planned.

Handbook for Electronic Engineers and Technicians

By Harry E. Thomas. Published 1965 by Prentice-Hall, Inc., Englewood Cliffs, N.J. Price $15.00 427 pages.

Book contains basic information covering all phases of commercial and military electronic hardware. It deals specifically with the details of electronic hardware drafting, sheet metal fabrication, and equipment testing, including radar and microwave measurements. Book follows the progressive steps that electronic engineers and technicians encounter in producing a piece of hardware. This arrangement saves time in looking up details of materials, metalworking, components, specifications, circuitry construction, manufacturing, and testing.

(*Continued on page* 117)

BOOKS

Principles of Communication Engineering

By John M. Wozencraft and Irwin Mark Jacobs. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $17.00. 720 pages.

Book stresses the probabilistic nature of communication. Mathematical and physical insight are developed progressively through systematic analysis of signal design and detection, modulation and coding, demodulation and decording, and the compromises of engineering design.

Batteries 2: Research and Development in Non-Mechanical Electrical Power Sources

Edited by D. H. Collins. Published 1965 by Pergamon Press Inc., 44-01 21st St., Long Island City, New York 11101. Price $25.00. 543 pages.

Proceedings of the 4th International Symposium held at Brighton, Sept., 1964. Sponsored by the Inter-Departmental Committee on Batteries.

Biomedical Electronic Instrumentation 1965

Published 1965 by Noyes Development Corp., 118 Mill Rd., Park Ridge, N.J. 07656. Price $10.00. 108 pages, paperback.

Book contains the papers presented at a Life Science Symposium held at the Colgate-Palmolive Research Center during June 1965. Topics include both instrument selection and in-use application.

Transmission-line Theory

By Ronald W. P. King. Published 1965 by Dover Publications, Inc., 180 Varick St., New York 14, N.Y. Price $2.75. 513 pages, paperback.

This Dover edition is an unabridged and corrected republication of the work first published by the McGraw-Hill Book Co., Inc., in 1955, to which has been added a new Index of Symbols.

Books Received

Problems for Computer Solution

By Fred Gruenberger and George Jaffray. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $4.50 401 pages, paperback.

Basic Electronics: "Autotext"— A Programmed Course in Circuits

By RCA Institutes, Inc. Edited by J. W. Friedman, H. G. Rice and G. McGinty. Published 1965 by Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632. Price $13.00. 534 pages.

Elementary Calculus

By P. R. Masani, R. C. Patel and D. J. Patil. Published 1964 by Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y. Price $7.50. 335 pages.

Radio Operating Questions & Answers, 13th Ed.

By J. L. Hornung and A. A. McKenzie. Published 1964 by McGraw-Hill Book Co, 330 West 42nd St., New York, N.Y. 10036. Price $8.25. 598 pages.

MICROELECTRONIC DEVELOPMENTS . . .

A dual differential voltage comparator which features high accuracy and fast response times is now available from Fairchild Semiconductor. Designated the μA711, the new Planar epitaxial microcircuit is intended primarily for core memory sense amplifier applications, and can also be used as a window discriminator in pulse height detectors. The μA711 offers a resolution of 2 mv; response time: 50 nsec.

Sperry Rand Corp. is building 39 digital microcircuited computers for Republic Aviation, Hicksville, L. I. The computers, Mark XIV, will be a key element in the U. S. Coast Guard's meteorological modification program, for which Republic is prime contractor. Mark XIV uses monolithic microcircuits and occupies less than ¾ cu. ft. of space. It is a parallel computer capable of performing 55,000 arithmetic operations/sec. with a 21-word bit length.

A molecular PCM system for Apollo flight systems has been delivered to NASA-MSC by Radiation Inc. The 98-channel high level multiplexer and encoder incorporated many design innovations to obtain a minimum power, high performance system. The package design contains planer assemblies for integrated circuits and 3-D hybrid modules for mixtures of integrated circuits and discrete components.

Electronic Industries Association has launched a program for registration of devices in the expanding microelectronics field according to type. The program has begun with the release of a new format for registration of semiconductor integrated logic gating circuits, the result of more than two years of study by EIA Engineering Department. The registration system is designed primarily to help non-technical persons buy and distribute microelectronic devices.

A new line of high-speed integrated circuit logic modules, SDS T Series, is presented by Scientific Data Systems. The T Series features monolithic integrated circuits as flip flops, buffers and inverters. Some characteristics include: for buffered AND/OR or NAND/NOR 18nsec (typical) and 30nsec (worst case), flip flop—40nsec, typical) and 70nsec (worst case). The Series have a fan-out of 14, logical levels of have a fan-out of 14, levels of Ov for logical zero and +4v for logical one.

EDITOR'S NOTEBOOK

TWO-WAY RADIOS may soon be standard equipment for London "Bobbies." As a trial, the British Home Office has purchased 300 walkie-talkies from Cossor Communications Co., a subsidiary of Raytheon. Eventually all 30,000 patrolmen in Britain could have direct communications with fellow officers and headquarters.

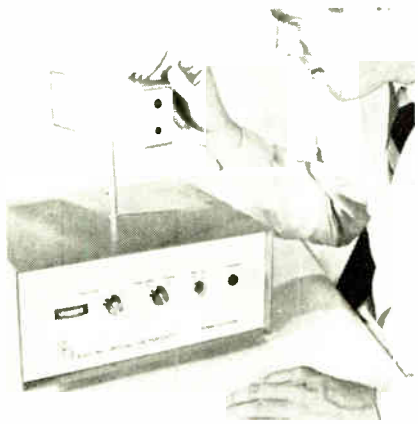
COMPUTERIZED video system that reports sales and inventory data collected from all markets in the U. S. has been installed by Schenley Industries, Inc. The system, developed by Schenley and The Bunker-Ramo Corp. (using B-R's Model 212 TV-like display stations) is reportedly able to accept and answer queries within milliseconds concerning consumer products.

TV DISC RECORDER and instant replay "came of age" during the professional football season when an MVR Corp. portable disc recorder was used to record and play back action highlights of a Baltimore Colts intra-squad game broadcast by CBS. The recorder used, Model VDR-210CF Videodisc, designed especially for sports, is 40 pounds and provides both motion and "freeze action."

ELECTRONIC BETTING got off to a modest start when New York Racing Assoc. recently tested the forerunner of a completely automated pari-mutuel betting system. Tests were confined to daily double wagering only. The system consists of high-speed ticket-issuing machines linked directly to a Honeywell duplex computer system. It was used to keep instantaneous records of every daily double wager made, and compute daily double payoffs each day for the Saratoga meet. If the system is approved, it will handle all types of pari-mutuel betting at NYRA race tracks in 1966.

VAGRANT RADIATION brought FCC to the aid of FAA in the Los Angeles district to clear interference from around Los Alamitos airfield. Trouble was traced to a nearby housing tract and pinpointed to a garage door opener, which the owner volunteered to stop using. But, FCC men found that the development builder had installed openers with each house, and the manufacturer was then out of business. So, FCC had to take 41 of the devices off the air.

RUBY LASER KIT



Scientist adjusts detachable head of pulsed ruby laser by Electro-Optical Systems, Inc. In kit form for general lab, high school and college aid, the 25-lb. unit has a peak power output near 1 joule in a pulse of 600 to 800 μsec duration. Rod supplied provides visible radiation at 6943 A; total bank energy storage is approximately 375 Joules.

RUGGED TUBE TO WITHSTAND ROCKET-SPACE ACTIVITY

A new type of electron tube with ruggedness to withstand rigors of rocket blastoffs and space vehicle landings in interplanetary operations has been disclosed by RCA.

The tube, of ceramic and metal, will enable space scientists to detect and measure the extent and nature of any harmful radiation on the Moon or distant planets, according to C. E. Burnett, Vice President, RCA Industrial Tube and Semiconductor Division.

Mr. Burnett said the tube (C70144) is a photomultiplier, four inches long, two inches wide and weighing seven ounces. It is a 10-stage, venetian blind head-on type with a two-inch aluminum oxide window and an RCA bialkali photocathode.

It uses stacked ceramic-metal construction and has use in applications requiring minimum radioactive content, low dark current, and detection of the ultra-violet region.

NEW DIGITAL CONTROLS

Theta Instrument Corp. has gone into the field of digital display and control systems for industrial use. Reason for the move, according to Edgar Rice, President, was recent development of a low-cost shaft encoder fully compatible with simple, solid-state logic circuits. Mr. Rice said that systems are being produced which display and record process variables, and also provide high-level digital signals for motor control, sequencing, and alarming.

MOBILE TRIAL EDP SYSTEM DOES 3 SATELLITE JOBS

Unlike the harrassed housewife who says, "Can't you see I've only got two hands?" a Univac 1218 computer quietly and deftly does three jobs at once in a new experimental communications terminal, reports Univac Defense Systems Division.

Univac 1218 is part of the Lincoln Experimental Terminal (LET), an air-transportable ground terminal. LET was built by M.I.T. Lincoln Laboratory in an Air Force program to develop devices and techniques for satellite communications.

The system computes antenna pointing instructions that keep the antenna beam zeroed on target. Then, computing distance to the satellite, its speed and direction, the 1218 delivers range and doppler data to timing circuits that allow synchronized operation of transmitting and receiving terminals. Concurrently, it is also used to multiplex and demultiplex digitized voice and teletype messages or digital data up to 9600 bits/sec.

DEBUT SET FOR RECTANGULAR, 22" COLOR TV TUBE

Electronic tube division of Sylvania Electric Products Inc. has announced that it will introduce a 22-inch, 90°, rectangular, "rare earth," color TV picture tube next spring.

Merle W. Kremer, a Senior Vice President in charge of electronic components, said that sample quantities of the tube will be sent to color TV manufacturers in May or June. All of Sylvania's color picture tubes use the red "rare earth" europium phosphor pioneered and introduced by the firm in June, 1964. The new tube will be six inches shorter, and will provide 228-square-inches of viewing area.

DR. SHEPHERD ELECTED PRESIDENT OF IEEE

Dr. William G. Shepherd, Vice-President, Academic Administration, University of Minnesota, has been named President of the Institute of Electrical and Electronics Engineers for 1966.

Dr. Shepherd succeeds Dr. Bernard M. Oliver, Vice-President, R&D, Hewlett-Packard Co. As President, Dr. Shepherd will head the world's largest engineering society, which now has an international membership of more than 146,000.

NEW TECH DATA

Potentiometer Catalog

A revised 16-page Linear Motion Potentiometer Catalog, #IMP263A, presents the comprehensive range of the latest C.I.C. precision film potentiometers, including new Model 110 with stroke to 60 in. Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.

Circle 170 on Inquiry Card

Questions on Soldering

An illustrated technical bulletin—"The Most Often Asked Questions on Soldering" — is an attempt to overcome the misunderstandings underlying trouble in soldering practice and to bring users up-to-date with innovations in the field. Questions and answers compiled represent those asked most frequently and are arranged in logical sequence. Alpha Metals, Inc., 56 Water St., Jersey City, N. J. 07304.

Circle 171 on Inquiry Card

Switch Catalog

A 58-page general switch catalog #G-103 describes a broad line of basic illuminated and environment-free switches with illustrations, engineering drawings and ordering data. Included are sections on a water-sealed 4-light, a snap-in 1-light and a sub-subminiature, type 18, rated at 8a. LICON Div., Illinois Tool Works, Inc., 6615 W. Irving Park Rd., Chicago, Ill. 60634.

Circle 172 on Inquiry Card

Matrix System

New 9000 series video switching matrix system is described in a new technical data sheet 6-382. Information includes typical outputs to inputs and specs. Cohu Electronics, Inc., Kintel Div., Box 623, San Diego, Calif. 92112.

Circle 173 on Inquiry Card

Oscillator Guide

A 24-page, 2-color brochure covering oscillators in the range of 1 cycle to 20MC illustrates many oscillator circuits and covers design data on all types of crystal, tuning fork, RC, and LC oscillators. In addition to circuit data, the brochure covers in depth the parameters in specifying oscillators. Accutronics, Inc., 12 South Island, Batavia, Ill.

Circle 174 on Inquiry Card

PC Dry Reed Switches

AE Product News, No. C961-1070-B, devoted to printed circuit dry reeds switches (Correeds), is available. Booklet describes and illustrates complete line of PC Correeds. Dimensional diagrams illustrate 9 basic forms (1A, 2A, 3A, 5A, 1B, 2B, 1A-1B, 2A-2B, and 1A latching), with corresponding tables that list coil resistance and turns, and operate-release-max. dc voltages. Automatic Electric Co., Northlake, Ill. 60164.

Circle 175 on Inquiry Card

NEW TECH DATA

Power Supply Catalog

Single and dual ouput module power supplies are described in a new 40-page catalog. Thousands of all silicon models are available with outputs from 0 to 500v.; output currents to 25a., rated for continuous duty at −20 to +71°C. The modules are short circuit proof, and designed for automatic recovery. Power/Mate Corp., 22 Walter St., Pearl River, N.Y.

Circle 176 on Inquiry Card

Coaxial/Microwave Catalog

A 40-page condensed catalog of precision coaxial devices and microwave instruments features photographs, descriptive literature, and specs. Weinschel Engineering, Gaithersburg, Md.

Circle 177 on Inquiry Card

Analog Booklet

A 12-page booklet, "Practical Approach to Analog Computers," describes basic principles of analog computation. Briefly, it explains how this versatile problem-solving technique can be used to increase engineering efficiency. Several types of computing models are also described and sample problems are given and solved. Electronic Associates, Inc., West Long Branch, N.J.

Circle 178 on Inquiry Card

Antenna Products Catalog

A 44-page fully-illustrated catalog of advanced antennas and associated equipment, describes antennas for airborne microwave systems, missiles, space and general communications. Also included is a section on tracking pedestals. Keltec Industries, Inc., 5901 Edsall Rd., Alexandria, Va.

Circle 179 on Inquiry Card

Zener Diode Manual

This 16-page zener diode catalog manual now being distributed features application data, characteristic curves, diagrams and specs., including the new 1N4649 low leakage 1w. subminiature series, 1N4678 50μa regulator series and many specialty types., TRW Semiconductors, 14520 Aviation Blvd., Lawndale, Calif. 90260.

Circle 180 on Inquiry Card

High Reliability Brochure

This brochure, "Fact III, Fairchild Assured Component Test Program," describes an in-house test program for supplying high reliability transistors, diodes, and integrated microcircuits. It presents standardized factory procedure and outlines minimum cost for high reliability documentation: quick processing and handling of orders: minimum delay in obtaining quality assurance data, and meeting tightest reliability requirements. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif.

Circle 181 on Inquiry Card

NEW TECH DATA

Delay Line Catalog

A new delay line catalog which includes many entirely new series of electromagnetic delay lines also incorporates a delay line selection chart as a specifying aid to engineers. Kappa Networks, Inc., 165 Roosevelt Ave., Carteret, N. J. 07008.

Circle 182 on Inquiry Card

Resistance Catalog

This condensed catalog describes and illustrates the 0.5 PPM v./ratio divider, 4 PPM lead resistance compensator and v./ratio divider combination. Other instruments shown are the Dial-A-Source, Resist-O-Stat and the well known Dial-A-Volt. Also described are 3 categories of precision wire wound resistors and a new series of modular ladder networks. General Resistance, Inc., 430 Southern Blvd., New York, N. Y. 10455.

Circle 183 on Inquiry Card

Miniature Terminal Block

A new brochure outlines benefits and uses of a new miniature terminal block. The brochure features engineering data plus dimensional drawings, product features, accessory pieces and catalog numbers. The miniature block, the 300V, allows 48 circuits/ft. and "ends the need for lugging." Buchanan Electrical Products Corp., 1065 Floral Ave., Union, N. J.

Circle 184 on Inquiry Card

Tunnel Diode Measurements

This new report on tunnel diode measurements describes characteristics of microwave tunnel diodes. It also describes application needs as well as stability conditions and tells how they can be satisfied. The technique of measuring negative resistance is explained. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y. 14209.

Circle 185 on Inquiry Card

AC-DC Blowers

New brochure gives data for designers on how to select blowers as well as showing performance curves and pictures of an extensive line of air moving products. Globe Industries, Inc., 2275 Stanley Ave., Dayton, Ohio. 45404.

Circle 186 on Inquiry Card

Glass Capacitors

A new catalog outlines specs. and gives characteristic curves for military and industrial glass capacitors. Series CY military glass capacitors, as reported in the catalog, find primary use in critical military applications requiring reliability despite high voltage and temperature stress levels. Voltage ratings are 300 and 500v dc. The catalog also contains dimensional data. Westinghouse Electronic Capacitor Dept., Box 130, Irwin, Pa.

Circle 187 on Inquiry Card

NEW TECH DATA

Semiconductor Catalog

Key specs. for more than 500 silicon semiconductors are listed in a new condensed catalog. Included are descriptions of integrated circuits, field effect transistors, silicon planar and Planex® transistors (NPN and PNP), dual and Darlington amplifiers, diodes, and rectifiers. Raytheon Co., Lexington, Mass. 02173.

Circle 188 on Inquiry Card

Axial Porcelain Capacitors

A line of VY® Axial Porcelain Capacitors, "proved reliable for more than 17 years in military and commercial uses," is described in Data Sheet P13. The sheet contains electrical, environmental and mechanical specs., photos, cutaway and dimensional drawings, and typical curves. Vitramon, Inc., P. O. Box 544, Bridgeport, Conn. 06601.

Circle 189 on Inquiry Card

Thin Glaze Trimmer

Data Sheet 66107 describes new Series 58 trimming potentiometers which have plastic housing measuring less than 0.200 in. thick. Standard resistance values are from 10Ω to 2 megohms with essentially infinite resolution. Glaze element has power rating of 1.0a at 85°C, derating to 0 at 175°C and is free from catastrophic failure. Helipot Div. of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif. 92634.

Circle 190 on Inquiry Card

Transducer Brochure

A brochure describing potentiometric linear position transducers is available. The brochure provides linear position transducer theory, advantages, custom variations, and typical uses. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif

Circle 191 on Inquiry Card

Pushbuttons and Indicators

A pushbutton and indicating light selection guide, GED-5289, to help designers specify proper pushbutton or indicating light is now available. Selection tables are based on environmental conditions, type of operation, continuous current, make and break ratings; types of operators, mounting space, and type of enclosure required. General Electric Co., Schenectady, N. Y. 12305.

Circle 192 on Inquiry Card

Motor Catalog

An illustrated catalog, "DC Motors/DC Gear Motors," describes 9 dc motors, each available with a variety of options, which deliver outputs from 0.004 to 0.1 HP, and up to 1000 oz-in. of torque. The catalog is a guide to selecting motors for industrial and military uses. Diehl Div., Singer Co., Finderne Ave., Somerville, N. J. 08876.

Circle 193 on Inquiry Card

ELECTRONIC INDUSTRIES Professional Profile

Please type or print

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

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

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

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

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

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

NEW TECH DATA

Microcircuit Components

A brochure titled, "Performance Characteristics of Corning Microcircuit Resistors and Capacitors" contains 13 charts, a nomograph, a table and 3 photographs. The microcircuit resistors described in the brochure are tin oxide film. The capacitors are alternate layers of screened gold and glass-ceramic compositions, encapsulated by a glaze. Corning Electronic Products Div., Raleigh, N.C. 27602.

Circle 194 on Inquiry Card

Connector Catalog

Catalog RX describes CA-RX series of connectors. These connectors are circular Mil-C-5015 types using the same hardware and contact arrangements as other Mil-C-5015 connectors. They are interchangeable, and have crimp, snap in contacts in a DUAL SHORE® insulator made of integrally molded polychloroprene. ITT Cannon Electric, 3208 Humboldt St., Los Angeles, Calif. 90031.

Circle 195 on Inquiry Card

Resistance Soldering

Because of popular demand, a third reprinting makes this 16-page booklet, "Principles of Resistance Soldering" available once more to production men, purchasing agents, designers wanting information on a versatile method of soldering that's meeting a growing number of industrial needs. Single copies available. Request on company letterhead to Wassco Glow-Melt Div., American Electrical Heater Co., 6110 Cass Ave., Detroit, Mich. 48202.

Circle 196 on Inquiry Card

Power Amplifier

A technical data sheet describes technical characteristics and mechanical design of Model P-51 Power Amplifier. The data sheet lists performance specs of the 100-w cw amplifier, which operates at S-Band frequencies, used for telemetry and other applications. It also includes environmental specs for the module, which uses a metal-ceramic planar triode at 30% plate efficiency. Resdel Engineering Corp., 990 S. Fair Oaks Ave., Pasadena, Calif. 91105

Circle 197 on Inquiry Card

Tantalum Capacitors

Technical bulletin, MR-24, contains data on high capacitance, tantalum foil capacitors, operating values and characteristic curves, and dimensional tables in inches and millimeters. Made in plain and etched foil, polar and non-polar, the capacitors, ranging from 6μfd to 2100μfd, are designed for electronic equipment in aircraft, missiles and space craft. They are useful in commercial and military control, computer and communication equipment. Transistor Electronics, Inc., West Rd., Bennington, Vt.

Circle 198 on Inquiry Card

NEW TECH DATA

Instrument Catalog

A 28-page condensed catalog describes dynamic measurement instrumentation. Included in the catalog, ES-14, are ac voltage-measuring devices, vital for measurement, analysis, and recording of AM and FM signals in acoustics, data analysis, noise control, fatigue and vibration R&D and strain. B&K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 205 on Inquiry Card

Infrared Brochure

This 2-color brochure (IR-402) on infrared equipment for precise thermal analysis describes infrared plotters, infrared scanners, and accessories for use in quality control and reliability evaluation. Full specs. are included. Sierra/Philco, 3885 Bohannon Drive, Menlo Park, Calif. 94025.

Circle 206 on Inquiry Card

Slotted Sections

This data sheet describes waveguide and coaxial slotted sections for precision VSWR and impedance measurements. Complete specs. are included for all units described. PRD Electronics, Inc., subs. of Harris-Intertype Corp., 1200 Prospect Ave., Westbury, N.Y. 11590.

Circle 207 on Inquiry Card

Tapeswitch Catalog

Catalog #C-3 describes a line of tapeswitch ribbon switches, mat switches, footswitches, safety edge switches and chime/mat annunciator kits. Also included are technical and circuit hints as well as applications data for use in controls, alarms, safety and automation. Tapeswitch Corp. of America, 545 Meacham Ave., Elmont, L. I., N. Y.

Circle 208 on Inquiry Card

Digital Interfacing

This engineering bulletin describes in detail how digital display and control systems may be precisely and economically interfaced with most digital computers. Operating theory, applications, and full specs. are discussed in detail and illustrations. Theta Instrument Corp., Saddle Brook, N. J. 07663.

Circle 209 on Inquiry Card

Test Report on Pots

A 27-page comprehensive report of reliability evaluation tests conducted on the ECONOPOT line of standardized conductive plastic precision potentiometers, includes results of tests for mechanical strength, high speed rotational life, and resistance to shock, vibration, humidity, solder heating, and temperature shock. New England Instrument Co., Kendall Lane, Natick, Mass. 01761.

Circle 210 on Inquiry Card

Test Instruments Catalog

Bulletin 10-1.6 details instruments for measuring high voltage breakdown, dielectric strength, insulation resistance, ground resistance and earth resistivity. The 12-page bulletin also presents data on automated test systems, high voltage power supplies and bridges for resistance and capacitance. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill. 60618.

Circle 211 on Inquiry Card

Filters DC to 12GC

A new, 80-page brochure is designed to help engineers or purchasing agents in selecting and specifying filters from dc to 12GC. The brochure permits engineers to characterize precisely a filter to meet needs. Filter Technical Manual, No. M-100, available with request on company letterhead to American Electronic Laboratories, Inc., P. O. Box 552, Lansdale, Pa.

Circle 212 on Inquiry Card

Manual on Regulation

Theory, design and operation of the Solatron line-voltage regulator are fully covered in a new 12-page technical manual. With photographs, charts, tables and wiring diagrams, the 2-color booklet points out how the regulator incorporates features of motor-driven autotransformers and the constant-voltage transformer. Sola Electric Co., 1717 Busse Rd., Elk Grove Village, Ill. 60007.

Circle 213 on Inquiry Card

Miniature Connectors

Capsule Catalog DBA2 for "NASC approved and fully qualified" DBA miniature electrical connectors is now available. Contains all pertinent data and part number cross-references to high-reliability series of NAS 1599/1600 connectors and contacts, listing some 70 shell styles and configurations. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 214 on Inquiry Card

Switches and Drivers

A complete catalog of solid-state switches and drivers describes 21 different models with a complete range of operating characteristics at any freq. from dc to 11GC and in SPST, SPDT and DPDT configurations. It contains a switch-selector chart, plus typical curves, dimension drawings and specs. Sanders Associates, Inc., 95 Canal St., Nashua, N. H.

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Electronic Galvanometer

A new technical data sheet outlines Model 56A dc null detector and electronic galvanometer. It offers a voltage capability from 1μv to 100v., and a current capability from 0.1pa to 10μa. 160db of sensitivity control is provided in 8 ranges. Input impedance is 10 megohms on all ranges. Boonton Electronic Corp., Parsippany, N.J.

Circle 216 on Inquiry Card

Time Code Generator

This technical sheet describes 911 integrated circuit, 11 format, time code generator. The sheet contains detailed product description and specs. Electronic Engineering Co. of Calif., Box 58, Santa Ana, Calif. 92702.

Circle 217 on Inquiry Card

Module Facilities

An illustrated brochure describes welded module facilities and capabilities. Types listed include digital modules, flip-flops, one-shots, AND, OR, NOR, NAND, and inverted gates, A-to-D converts, and video amplifiers. Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif. 90039.

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Seven-Dial Divider

This data sheet describes and illustrates a 7-dial precision potential divider (URS) with resolution and accuracy needed to calibrate 6-dial potentiometers and primary dc standards. Full specs., simplified schematic and list of options and related equipment included. Data Sheet A11.1112, Leeds & Northrup, 4901 Stenton Ave., Philadelphia, Pa. 19144.

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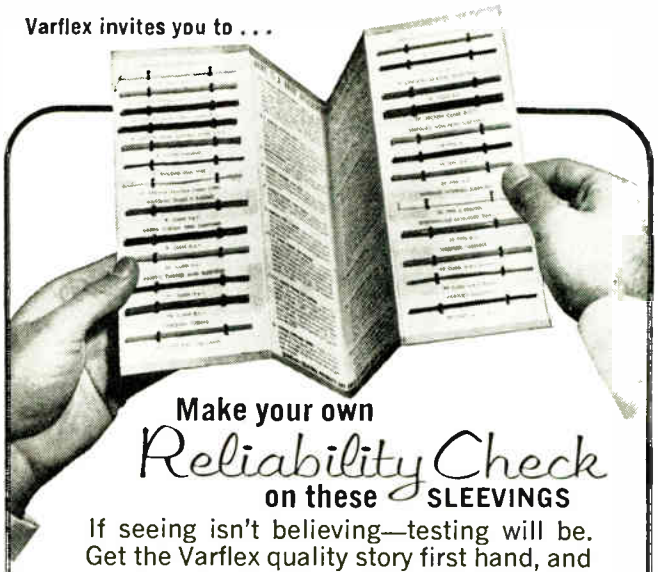

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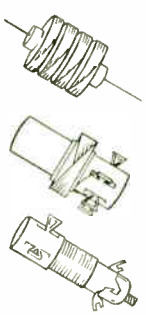

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ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

Who Will Champion The Engineer in 1966?

LOOKING TO THE WELFARE OF OUR PROFESSION in the new year ahead, we see some favorable omens.

Engineering employment is increasing in both defense and industrial fields. In 1965 there was a slow, but steady, upswing in recruiting activities. The climate of continuing demand for professional technical people promises to extend through 1970.

Application of revolutionary new technical electronic developments of recent years seems infinite, particularly in industry, commerce and communications. Electronic Industries Association (EIA) forecasts 40% overall growth in varied government and commercial markets, and 62% growth in industrial electronics, by 1970.

Solid-state devices, particularly, are moving rapidly into industrial and consumer products.

Integrated circuits are also being developed to a point where their cost is low enough to interest manufacturers of commercial and consumer products. The rapid advance in linear integrated circuits is speeding their applications in products ranging from stereo amplifiers and hearing aids to sophisticated defense communications equipment.

Electronic engineers are being sought by various industries, including the office equipment, chemicals, petroleum, atomic energy and automotive fields, and a wide variety of consumer products.

Since electronic engineers will be found working in almost every conceivable industry, they will have to become more interdisciplinary. In such a role, the engineer should achieve greater professional status and greater challenge than ever before.

Electronic engineering is international today. Many of our advanced engineers were educated in foreign countries, and many foreign-born engineers were educated in the U.S. IEEE meetings continue to be held in foreign countries as well as in the U.S. Our engineers will need to understand techniques and thinking of our foreign counterparts and associate with them at highest levels. Engineers will have to become more mobile than ever before, both nationally and internationally. This should broaden engineers' insights and understanding and improve their professional stature.

As electronic manufacturers expand activities, there is great need for engineering managers and managers with engineering background. Most engineers, according to ELECTRONIC INDUSTRIES' Engineering Profile, recognize the need for some education in business. Many engineers are taking courses or advanced degrees in addition to their technical training.

Yet despite these activities, we wonder about the role of the IEEE? We have not seen it championing the electronic engineer as a professional. It took the relatively small membership National Society of Professional Engineers (NSPE) organization to speak up for the engineer. NSPE recently sponsored a conference in New York which considered problems of securing good public relations to further strengthen the public image of engineers. Engineers rank second in professional recognition only to doctors in the public mind, states a recent Gallup Poll sponsored by NSPE and reported in E.I. last October. The engineer's public "image" is good, but it could be improved, and particularly internally, by promoting professionalism among ourselves and our employers.

If there seemed to be a surplus of good electronic engineers because of recent Defense Department cutbacks in contracts, this situation has improved. New recruits to our profession are insufficient to keep pace with increased number of engineers needed to meet expansions and diversifications in the electronic industries. By 1970 the engineer shortage again may be acute, even if colleges recruit greater numbers of engineering students. An improved engineering reputation may help stimulate needed student enrollments.

All told, electronic engineering was never more exciting than it is today. The efforts of electronic engineers are greatly contributing to our increasing standard of living—from consumer electronics to such things as controls for high speed transportation, air and water pollution, crime prevention, and bio-medical electronic systems.

Engineers are important people. We should hold our heads high and prepare ourselves for the greater challenges in the coming year. ELECTRONIC INDUSTRIES will continue to champion you in 1966. Count on us to do so.

Bernard F. Osbahr

For parallel views of events in the electronic business world, please consult our annual "Review and Forecast" on pages 36 to 44 in this issue.

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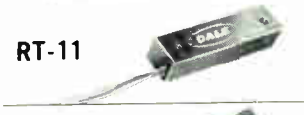
RT-11		Model 1287 P.C. Pin Model 1288 Flex. Leads
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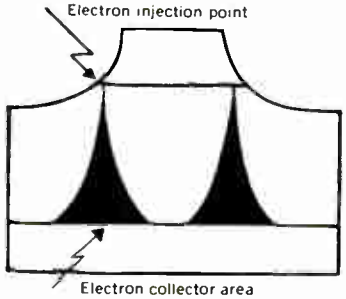
40349 h_{FE} = 25-100 @ I_C = 150 mA V_{CEV} (Max) = 140V	2N3441 h_{FE} = 20-80 @ I_C = 0.5A V_{CEV} (Max) = 160V	2N3442 h_{FE} = 20-70 @ I_C = 3A V_{CEV} (Max) = 160V	2N3773 h_{FE} = 15-60 @ I_C = 8A V_{CEO} (sus) (Min) = 140V



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