

Electronics®

Feedback improves IC performance: page 70

Japan's computer technology: page 93

Standard modules for custom systems: page 102

June 27, 1966

75 cents

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Below: 3-D radar seeks targets
for USS Fox: page 80



C 10

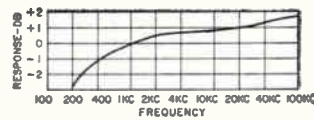
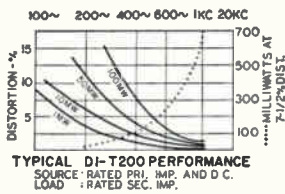
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†DCma shown is for single ended usage (under 5% distortion—100mw—1KC) . . . for push pull, DCma can be any balanced value taken by 5W transistors (under 5% distortion—500mw—1KC)
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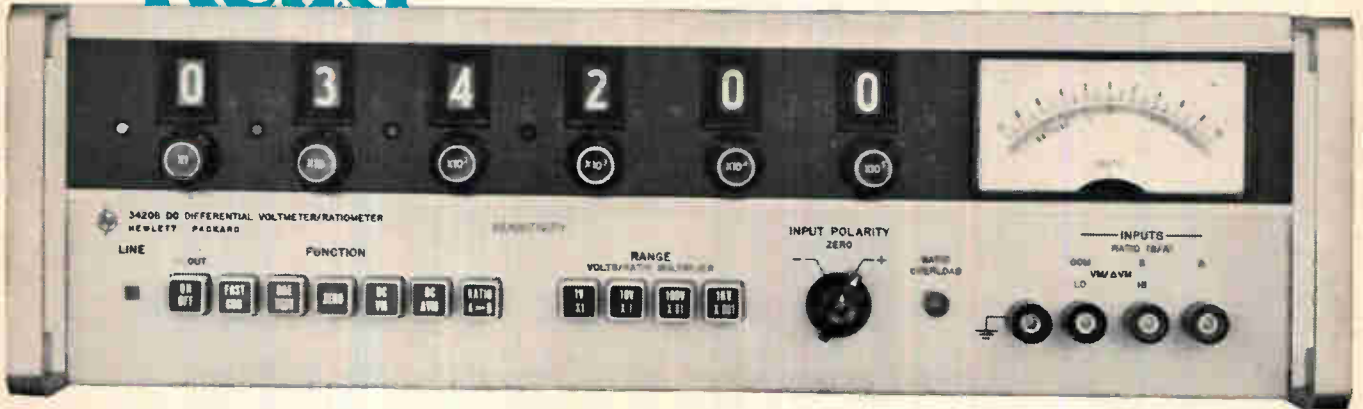
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Electronics

June 27, 1966
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Reprints: Thomas M. Egan

Publisher: Gordon Jones

Electronics: June 27, 1966, Vol. 39, No. 13

Printed at 99 North Broadway, Albany, N.Y., 12207

Second class postage paid at Albany, N.Y.

Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription prices: United States and Possessions and Canada, \$6.00 one year, \$9.00 two years, \$12.00 three years. All other countries \$20.00 one year. Single copies, United States and Possessions and Canada 75¢. Single copies all other countries \$1.50.

Published every other Monday by McGraw-Hill Inc. 330 West 42nd Street, New York, N.Y. 10036. Founder: James H. McGraw, 1860-1948. Corporate officers: Shelton Fisher, President; John J. Cooke, Secretary; John L. McGraw, Treasurer.

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Readers Comment

Software only

To the Editor:

I would like to rectify any misconceptions that your readers may have gotten from your item on the System Development Corp.'s character recognition work [May 16, p.26].

First, ours is strictly a software effort; no hardware development is involved or contemplated. We are currently using standard off-the-shelf equipment: a Rand Graphic Input Tablet, an ITT crt display and a Philco-2000 computer.

Next, and most important, the programs under development are for recognizing single handprinted or handwritten characters. We have not tackled the more general problem of handwriting.

M.I. Bernstein
System Development Corp.
Santa Monica, Calif.

Accurate tachometer?

To the Editor:

I noted with interest J.A. Irvine's tachometer circuit in Designer's casebook [May 2, p.77]. As the originator of the frequency-type tachometer circuit in 1944, we have seen dozens of firms make similar units using transistors and zener diodes, instead of our silver-contacted relay for the accurate transfer of coulombs.

We could be quite interested in Irvine's circuit if its sustained accuracy can be proven to be within 2%. All others we have tested mix the pulse signal with tachometer reading current, resulting in 10% to 30% inaccuracy within a year.

V.L. Westberg
President
Westberg Manufacturing Co.
Sonoma, Calif.

The author replies:

There is no theoretical reason for the accuracy of the instrument to alter under normal conditions. The item which may cause the most variation is the meter movement, which is obviously affected by vibration, dust, or changes in magnetic parameters. After 18 months in development, including acceler-

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Conventional Metal-Film Resistor	1/10	.095" D. .250" L.	0.3 MΩ

Type	Maximum Resistance	Wattage Rating	Size
Extended-Range Filmistor Resistor	1.5 MΩ	1/10	.095" D. .250" L.
Conventional Metal-Film Resistor	1.5 MΩ	1/2	.250" D. .750" L.

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transistor circuits, etc., where space is at a premium. Many designs which previously had to settle for the higher temperature coefficients of carbon-film resistors in order to obtain required resistance values can now utilize the low and controlled temperature coefficients of Filmistor Metal-Film Resistors.

Other key features are $\pm 1\%$ standard resistance tolerance, low inherent noise level, negligible voltage coefficient of resistance, and tough molded case for protection against mechanical damage and humidity.

For complete technical data, write for Engineering Bulletin 7025C to Technical Literature Service, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts 01248.

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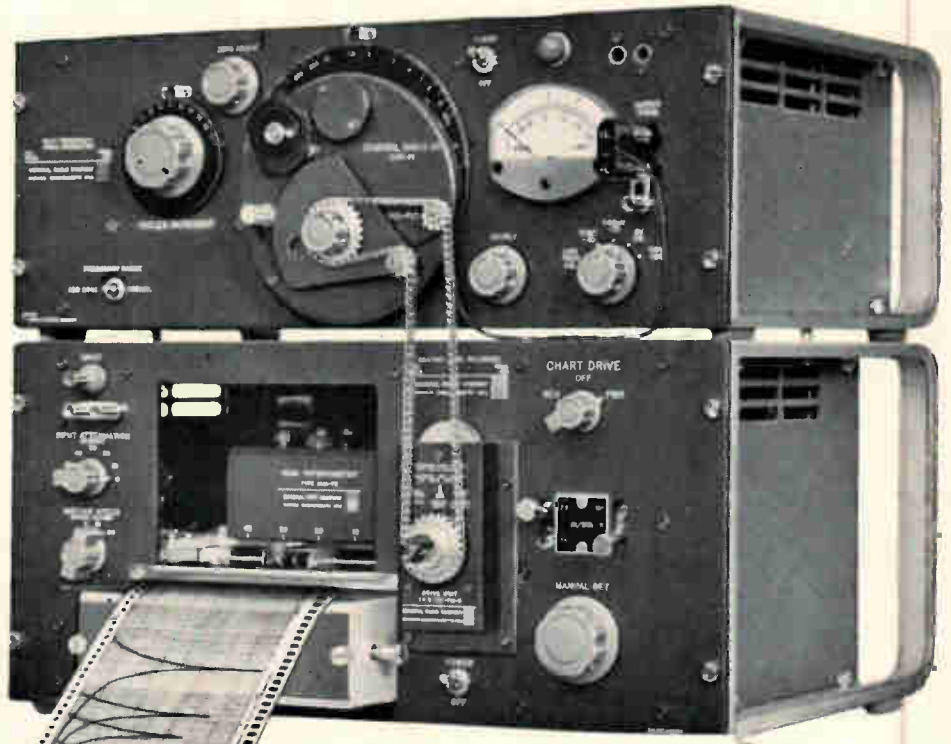


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Call us for a trial demonstration and see for yourself what this recording system can do for you.

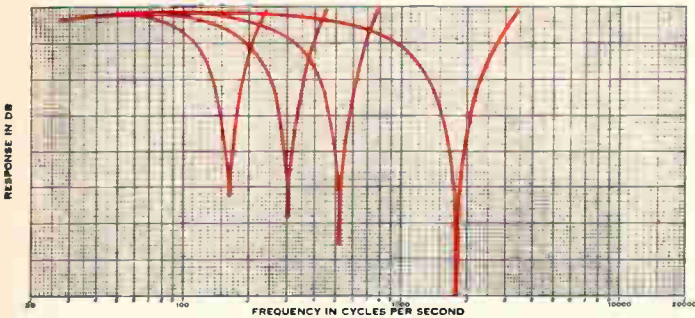


CHART 1350-0487 (top)
General Radio, Inc.

Recording of transmission characteristics of an adjustable notch filter for four different frequency settings. This plot is a permanent ink recording on 4-inch-wide chart paper. Dynamic recording range is 40 dB (20- and 80-dB dynamic ranges also available). Recorder chart speed and pen writing speed can be set over ranges of 2.5 to 75 in/min and 1 to 20 in/s, respectively.

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WEST CONCORD, MASSACHUSETTS

ated life tests, we have been producing tachometers for some 12 months now, and are reasonably certain of their reliability.

Laser scanning

To the Editor:

In your description of the laser scanning system that we are working on there were several errors which made the explanation unclear [May 2, p. 38]. First of all, the He-Ne discharge tube should have been shown between mirrors "A" and "B." In this arm, the beam diameter is necessarily less than 5 mm, the diameter of the bore of the discharge tube. The main reason for the complicated cavity is to expand this narrow beam into a large (several inches) collimated beam for passage through the delay line.

It should also be emphasized that the laser cavity consists of the mirrors "A," "B," "C," and "D." The delay line acoustic modulator is internal to the cavity and therefore does not waste that portion of the circulating light that misses the shear pulse.

Elliott S. Kohn
Vernon J. Fowler

General Telephone & Electronics
Laboratories, Inc.
Bayside, New York

Required reading

To the Editor:

John F. Mason's article "Vietnam: Electronics in the war" [May 16, p.95] is unquestionably one of the most informative and useful articles I have ever read. I have often felt that the feedback from military users to those of us doing military electronics equipment design takes far too long. I am insisting that all my engineers read the

article to gain a better appreciation of the problems faced by military users of our equipment.

I think you are doing the military services, the electronics industry and our entire nation a real service.

V.E. Hills

Radio Corp. of America
Defense Electronic Products
Camden, N.J.

Salute from Saigon

To the Editor:

I must congratulate your correspondent John F. Mason for the thorough research he performed while in Vietnam. When he visited me, I had no idea that he had accumulated the imposing array of facts that were contained in his article [May 16, p. 95]. This to me is significant because although managers, like myself, can generalize on systems concepts and problems, the ultimate success or failure of our communications-electronics systems depends on the effectiveness of the equipment components and the people who operate them. Mason's article certainly provides excellent perspective to this problem.

I have only discovered one noticeable departure from fact. The article states that Colonel Albert Redman is the communications manager in Thailand, when in fact it is Colonel Fred Ritter, Assistant Chief of Staff, J6 (Communications-Electronics). Colonel Redman is the Commanding Officer, Defense Communication Agency, South Asia Mainland, with headquarters in Saigon.

Walter E. Lotz, Jr.
Brigadier General, U.S. Army
Assistant Chief of Staff, J6
Vietnam

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Getting a plug-in for signal conditioning

"Here is my 17-pound multiple channel portable signal conditioner. It's for airborne and ground applications. It accepts output data from various types of transducers and conditions and prepares this data for storage on magnetic tape recorders or what have you— analog instrumentation. It is ideally suited for use with strain gauges and thermocouples."

"Plug-in modules, such as amplifiers and line drivers are available for use with such transducers as 1, 2, 3 and 4-arm strain gauges, thermocouples, accelerometers and other capacitive type pick-up devices. Buy what you need now in either a 7- or 14-channel capacity system, and expand it later to fit your future requirements."

"Nytron calls this brilliant achievement of mine the NY-1200 Portable Signal Conditioner. And here are a few of its specifications (per channel):"

Power Input*	22 to 34 VDC
Zero Stability**	$\pm 0.02\%$ per $^{\circ}\text{F}$
Gain Stability*	$\pm 0.02\%$ per $^{\circ}\text{F}$
Linearity	0.1% deviation from best straight line
Input Impedance	100 K min., differential
Output Impedance	1 Ohm max., isolated
Common Mode Rejection	80 db min. (± 5 VDC Max.)
Gain Setting	100-500 Continuously Variable
Zero Offset	0 to ± 2.5 V Continuously Variable
Output Ripple	25 mV pp max.
Frequency Response	DC to 20 Kc (flat ± 0.1 db)
Output Voltage	10 Volts p-p into 1 K load
Bridge Excitation	Will power 120-1,000 Ohm bridges
Shunt Calibration	Two discrete points of bridge unbalance controlled from front panel
Excitation Voltage	5 Volts Continuously Variable

*30 watts worst case power demand for a 14-channel system.

**Referred to full scale output, including bridge excitation stability.

For greater enlightenment, write me direct at **Nytron**, 795 San Antonio Road, Palo Alto, California (415) 327-0490.



People

Walter L. Wasserman, the man who directed the Philco Corp.'s development of an electronically controlled artificial limb, has joined Hoffman-LaRoche, Inc., the pharmaceutical company that last month announced it was going into the medical electronics business. Providing assistance in Hoffman-LaRoche's new venture is the Radio Corp. of America. The companies have signed an agreement that calls for cooperative development of a wide range of medical electronics products, linking Hoffman-LaRoche's expertise in the medical field with RCA's expertise in electronics.



Other products. Though Wasserman's experience in the development of artificial limbs has been extensive [Electronics, Sept. 20, 1965, p. 42], the venture will not be limited. "Within a year," says Wasserman, "we expect to have a very broad spectrum of medical electronic items." Wasserman will be general manager of the still-to-be-formed Bioelectronics division. To be sure, not all of the products will be developed in-house, Wasserman explains. "We're leaving the door open for 'acquisitions.'"

High on the company's list of priority development projects will be, naturally, artificial limbs. At Philco, Wasserman developed an artificial arm that could be controlled by an amputee simply by his "thinking" into action his shoulder muscles. Tiny electromyographic signals from the shoulder muscles are collected in a complex filtering network; impulses from the network control a small electric motor in the artificial limb. At Hoffman-LaRoche, Wasserman says, "We plan to use this technology for the development of an artificial hand."

Beyond that, the new division will be working on equipment for hospitals' intensive-care sections, on fetal monitoring equipment and on other diagnostic equipment.

The next step. "Currently, most



It isn't that Stan takes nuclear radiation lightly. But his 5-amp silicon transistors do.

With power transistors like these, an applications engineer like Stan can afford to be nonchalant.

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Case types? Six of them. All pictured below.

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3465 and B-3466 RF power amplifiers. (Plus 75 other type numbers specified for your application.) These low-cost epitaxial NPN transistors are already at work in such diversified applications as high-speed, high current core drivers, high-frequency pulse generators, high voltage nonsaturated switching applications, power supplies, relay and solenoid drivers, and power amplifiers and oscillators for HF/VHF communications transceivers.

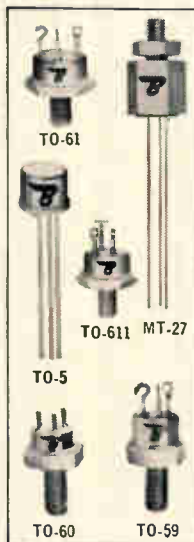
Write or call our nearest sales office soon, won't you? See if Stan can't put his small wonders to work for you.

3 AMP TYPES

VCEO = 40 V to 60 V
VCBO = 80 V to 100 V
Pc = 5 W to 7.5 W
VCE(s) = 0.32 V Typ at IC = 1 A, IB = 100 mA
Switching Types: $t_{on} \leq 35$ ns at IC = 1.5 A, IB = 150 mA
$t_{off} \leq 75$ ns
Amplifier Types: $P_o \geq 4.5$ W at f = 50 MHz, VCC = 28 V, P _{in} = 0.5 W

5 AMP TYPES

VCEO = 40 V to 80 V
VCBO = 50 V to 90 V
Pc = 5 W
VCE(s) = 0.4 V Typ at IC = 3 A, IB = 0.3 A
Switching Types: $t_{on} \leq 40$ ns at IC = 3 A, IB = 0.3 A
$t_{off} \leq 300$ ns
Amplifier Types: $P_o \geq 8$ W at f = 50 MHz, VCC = 30 V, P _{in} = 1 W



10 AMP TYPES

VCEO = 40 V to 80 V
VCBO = 50 V to 90 V
Pc = 25 W
VCE(s) = 0.7 V Typ at IC = 5 A, IB = 0.5 A
Switching Types: $t_{on} \leq 40$ ns at IC = 3 A, IB = 0.3 A
$t_{off} \leq 300$ ns
Amplifier Types: $P_o \geq 25$ W at f = 50 MHz, VCC = 30 V, P _{in} = 5 W

RADIATION TYPES

		Max Radiation Level Exposure = 5×10^{14} NVT						
Symbol	Type	PRE RAD LIMIT			POST RAD LIMIT			UNIT CONDITIONS
		MIN	TYP	MAX	MIN	TYP	MAX	
VCEO	BR100	40	50	—	40	—	—	V IC _{EO} = 50 mA
	BR101	75	—	—	75	—	—	
hFE	BR100	40	100	200	15	25	—	IC = 3 A, VCE = 5 V
	BR101	30	—	150	7	10	—	
VCE(s)	BR100	—	0.5	1.0	—	1.5	2.0	V IC = 3 A, IB = 0.3 A
	BR101	—	0.5	1.0	—	2.0	3.0	

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BV_{CEO}	50V	50V	30V	30V
h_{FE}	@ 10 μ A	80	80	40
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$ V_{BE_1} - V_{BE_2} $	3mV	5mV	3mV	5mV
$\Delta V_{BE_1} - V_{BE_2} $	5 μ V/ $^{\circ}$ C	10 μ V/ $^{\circ}$ C	5 μ V/ $^{\circ}$ C	10 μ V/ $^{\circ}$ C
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People

of our attention is focused on electronic equipment that's used in diagnostic work," says Wasserman. "The next step is to develop gear that can be used to cure. It's in the therapeutic field that electronics will probably make its greatest contribution," he adds. "But right now we know very little about the interaction of electric fields with the body, so a lot of research will have to be conducted before we can contemplate using electronics in this area."

Blue sky. Looking even further into the future, he sees electronics playing a role in preventive medicine. "Certainly it's blue sky thinking," he concedes, "but now's the time to start thinking."

Wasserman, who is 30 years old, entered electronics through an odd route. He attended Queens College in New York and was graduated with a degree in experimental psychology. He went on to graduate study at Syracuse University. "Much of the time I worked with electronic measuring instruments and eventually I became more interested in the tools of my trade than in the trade itself." Subsequently, he studied electrical engineering at the University of Pennsylvania.

His contributions to field of prosthetic equipment were noted last year when he won a medal from the American Congress of Physical Medicine and Rehabilitation.

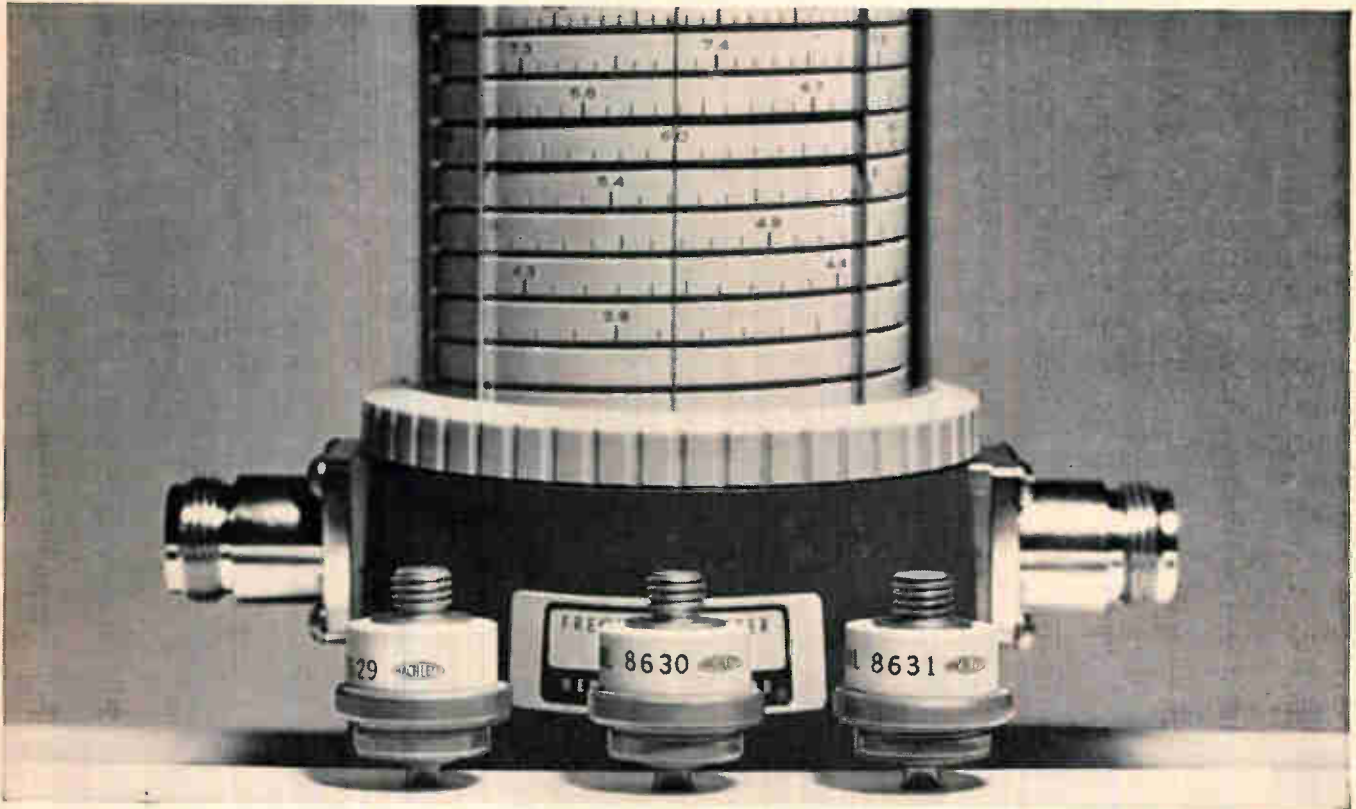
The appointment of **David E. Harris**, 49, as director of HRB-Singer, Inc.'s infrared laboratory at State College, Pa., signals a change in the lab's research effort. So far, the company, a subsidiary of the Singer Co., has concentrated much of



its work on airborne infrared imaging equipment and techniques. Now, under Harris's direction, the lab will widen its scope and turn a significant portion of its research effort to systems that use radar and television.



Highest Power Level for RF operation at C-Band: MACHLETT miniature planar triodes



For comparable size and weight in the C-Band region, and higher, the Machlett miniature planar triode provides the highest plate dissipation capability with correspondingly high duty cycle and rf power output. 1 kW grid pulse operation is currently being achieved at 6 Gc with the ML-8630. From cathode rf heater contact to anode rf surface contact, these new tubes ML-8629, ML-8630 and ML-8631 measure only .565 inches high by .7 inch diameter. These "8600 series" tubes will dissipate 100 watts, or more, with suitable cooling devices. Frequency stable for quick on-frequency performance. Phormat cathode for high voltage stability.

For complete details, write
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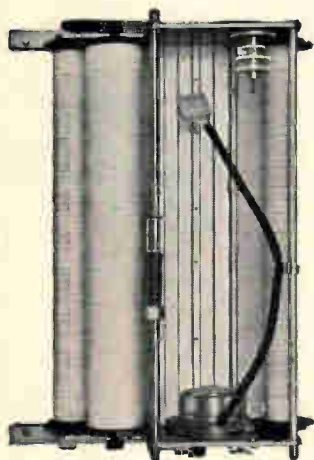
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Meetings

Advance Planning Briefing for Industry on Electronic Systems (classified), Electronic Systems Div., Air Force Systems Command and NSIA; L.G. Hanscom Field, Bedford, Mass., June 28-30.

International Audio-Visual Materials Show, Erian, France, July 1-15.

British Industrial Exhibition; Moscow, July 3.

Institute in Technical and Industrial Communications, Colorado State University; Fort Collins, Colo., July 5-9.

Aerospace Systems Conference, IEEE; Olympic Hotel, Seattle, Wash., July 11-15.

Symposium on Electromagnetic Compatibility, San Francisco Chapter of the IEEE; San Francisco, July 11-13.

Joint Conference on Application of Thin Films in Electronic Engineering, Institute of Electronic and Radio Engineers, Imperial College of Science and Technology, London, England, July 11-14.

Electromagnetic Compatibility Symposium, IEEE, Hilton Hotel, San Francisco, July 11-13.

Conference on Thin Films, Institute of Electronic and Radio Engineers; Imperial College of Science and Technology, London, July 14.

Microelectronics Symposium, IEEE; Colony Inn, St. Louis, Mo., July 18-20.

Microelectronics Symposium, IEEE; Colony Motor Hotel, St. Louis, July 18-20.

Nuclear and Space Radiation Effects Conference, IEEE, Stanford University, Stanford, Calif., July 18-22.

Conference on Data Acquisition and Processing in Biology and Medicine, IEEE; University of Rochester, Rochester, N.Y., July 25-27.

Rochester Conference on Data Acquisition & Processing in Biology & Medicine, IEEE, University of Rochester, Rochester, N.Y., July 25-27.

Medical Equipment Display and Conference (MEDAC), Association of the Advancement of Medical Instrumentation; New War Memorial Auditorium, Boston, July 25-29.

Value Analysis and Engineering Workshop Seminar, Value Analysis, Inc.; La Salle Hotel, La Salle, Chicago, July 25-29.

Research Conference on Instrumentation Science, Instrument Society of America; Hobart and William Smith Colleges, Geneva, N.Y., Aug. 1-5.

U. S. Navy Second Marine Systems and ASW Conference, American Institute of Aeronautics and Astronautics; Lafayette Hotel, Long Beach, Calif., Aug. 8-10.

Guidance and Control Conference, American Institute of Aeronautics and Astronautics; University of Washington, Seattle, Aug. 15-17.

NATO Advanced Study Institute, NATO; University of Keele, Staffordshire, England, Aug. 15-26.

Automatic Control Conference, American Institute of Aeronautics, American Society of Mechanical Engineers; University of Washington, Seattle, Aug. 17-19.

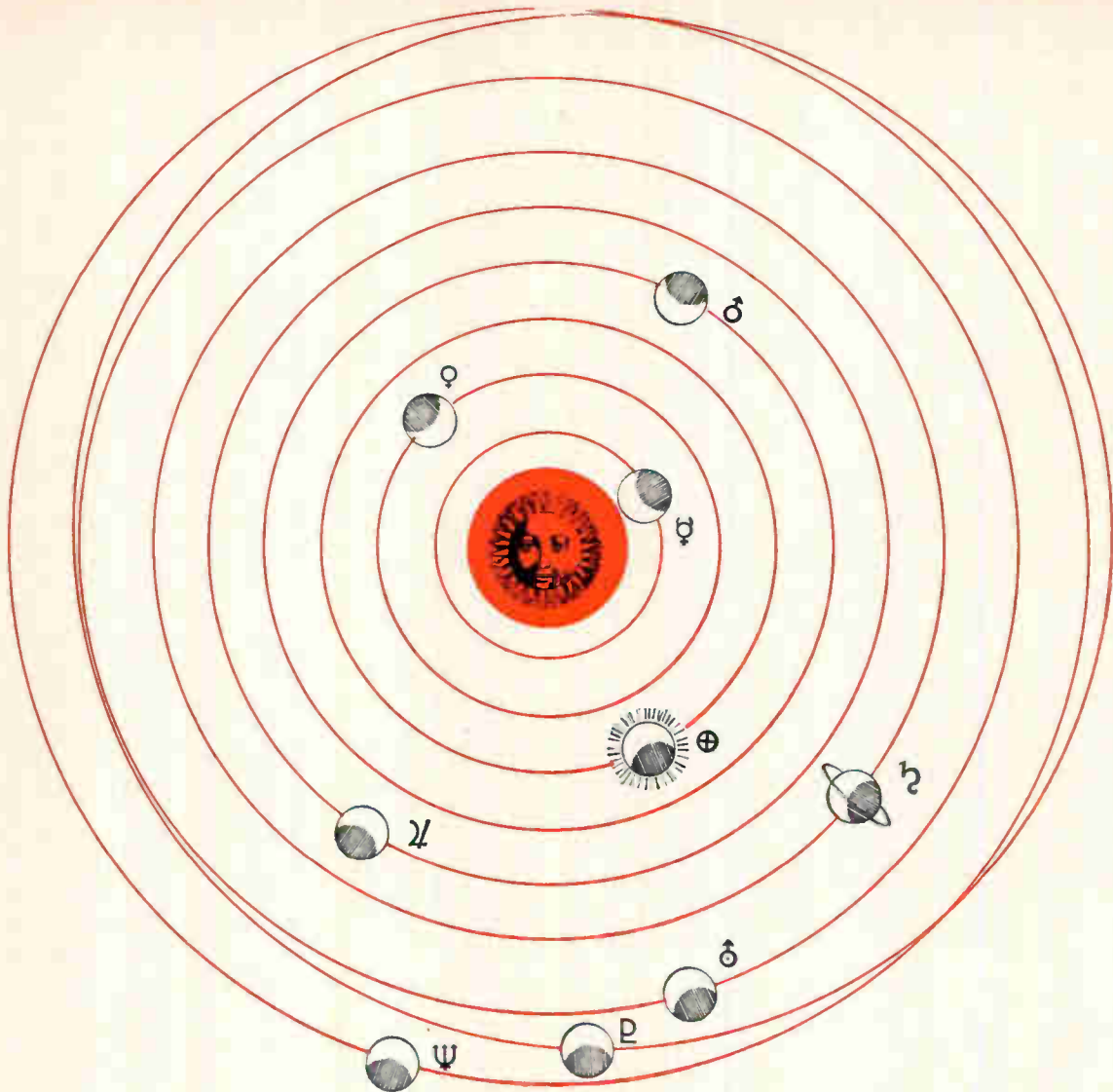
Symposium on Computer and Information Science (COINS), Columbus Laboratories of Battelle Memorial Institute, Office of Naval Research, Ohio State University; Columbus, Ohio, Aug. 22-24.

Western Electronics Show and Convention, IEEE and Western Electronic Manufacturers Association; the Sports Arena and Hollywood Park, Los Angeles, Aug. 23-26.*

Call for papers

Ultrasonics Symposium, IEEE, Cleveland, Ohio, Oct. 12-15. Aug. 1 is deadline for submitting papers to N.S. Shiren, chairman of the technical program committee, IBM Watson Research Center, P.O. Box 218, Yorktown Heights, New York 10598.

* Meeting preview on page 16



Chances are 9999999 to 1 this system's **on the air**

A new target figure for reliable uptime (.9999999) is now being demonstrated with an Astrodata system in one of this nation's key defense communications networks. Unlike other instruments and equipment with high reliability for limited intervals, Astrodata's Model 6600 Timing System is designed to be up and available around the clock.

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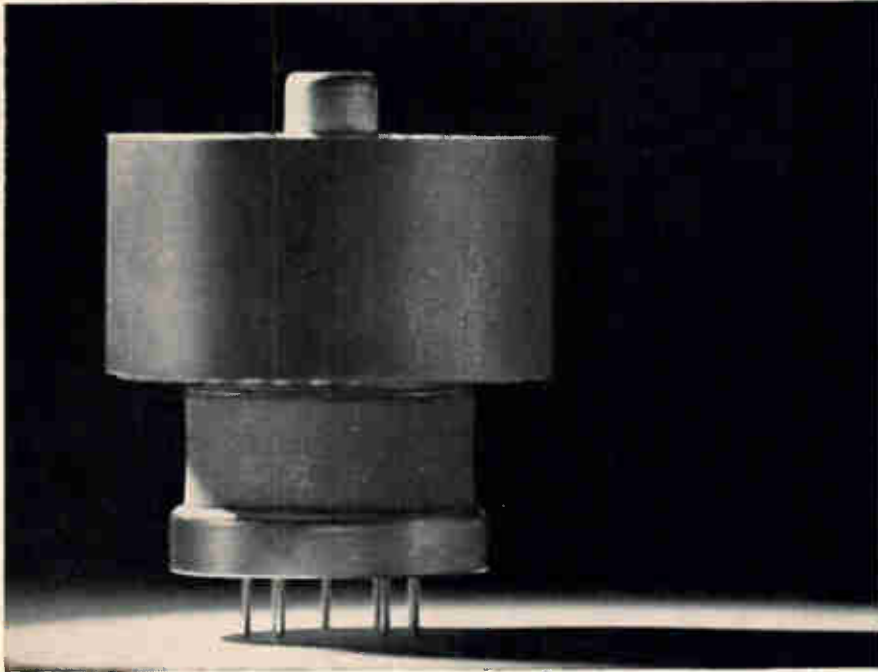


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The new PL-8583/267 Penta beam pentode for 300-400 watt linear amplifier application offers a minimum of -40db 3rd-order intermodulation distortion, without feedback, at 300 watts PEP output. This PL-8583/267 in multiplex service significantly reduces co-channel interference to permit addition of new channels in new equipment or to greatly improve performance in existing equipment. Precision alignment of electrodes contributes to both low distortion figures and low drive requirements.

The PL-8583/267 electrical characteristics:

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Heater current	1.0 amperes

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DC plate voltage	2,000 volts
DC plate current	300 ma
Anode dissipation	350 watts

Size: 2.16" height x 1.75" diameter

For full details, write The Machlett Laboratories, Inc.—Penta Plant, 312 N. Nopal St., Santa Barbara, California 93102

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Meeting preview

Wescon

A review of the technical sessions scheduled at the 1966 Western Electronic Show and Convention, which starts Aug. 23, indicates that the framers of the convention will continue the policy of taking a broad look at technical developments. Extending a technique initiated last year, Wescon sponsors turned to experts in several fields to organize technical sessions. The result: this year many more sessions will bring together top engineers from competing companies.

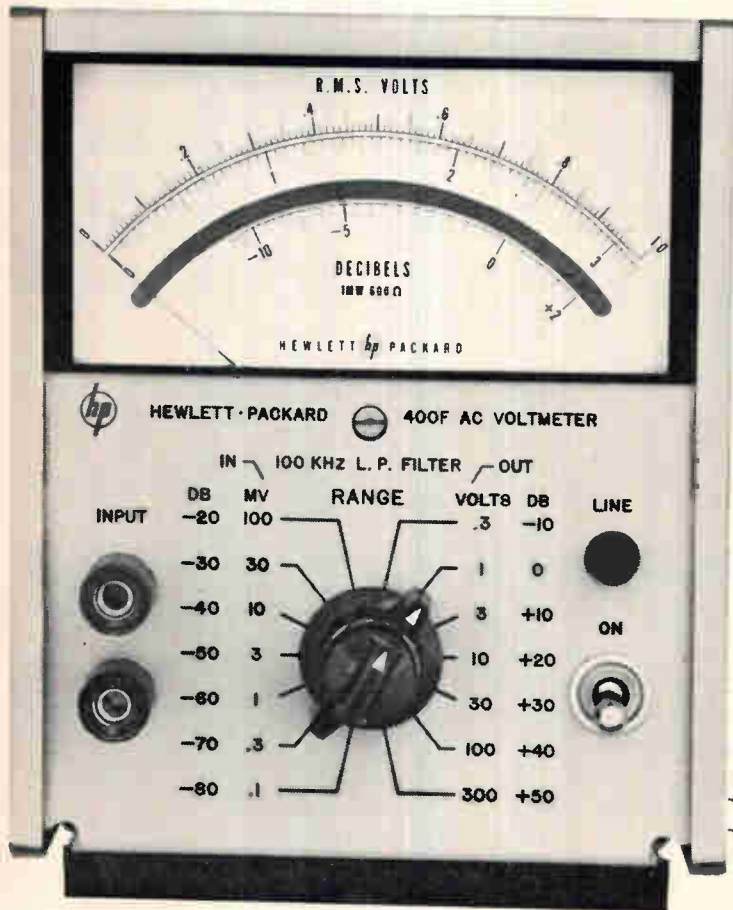
The greatest stress is on solid state electronics. On IC's alone four sessions are planned: Recent Advances in Nondigital Applications and Interconnection Aspects of Integrated Electronics (with papers from the Univac division of the Sperry Rand Corp. and the Arinc Research Corp.); Solid State Devices and Integrated Circuits (speakers represent the Hewlett-Packard Co., Bell Telephone Laboratories, Texas Instruments Incorporated and the Army Electronics Command at Fort Monmouth, N. J.); Large Scale Integration (with papers from the International Business Machines Corp., TI, the Autonetics division of North American Aviation, Inc., and the Fairchild Camera & Instrument Corp.); and Integrated Circuits in the Control Area (with papers by the Westinghouse Electric Corp. and by NASA).

A broad review of the field effect transistor will be presented in one session. The topics will be FET vs. Bipolar Transistor Characteristics, the FET as an Amplifier, the FET as a Switch, Circuit Simplification with FET's and Considerations of the FET in Complex Arrays.

Another featured session, with a broad range of contributors, will consider plastic transistors and their impact on the industry. Engineers from the General Electric Co., TI, Fairchild and the Bendix Corp. will present papers.

More than 45,000 people are expected to attend the four-day conference in Los Angeles. Wescon is sponsored by the Western Electronic Manufacturers Association and the IEEE.

100 μV full-scale sensitivity from this new 20 Hz-4 MHz solid-state ac voltmeter



100 μV sensitivity—for unprecedented low-level ac measurements

Fast response—a reading in less than 2 seconds after turn-on; fast overload recovery, too

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Accuracy $\frac{1}{2}\%$ of reading + $\frac{1}{2}\%$ of full scale

Low-pass filter for controlling bandwidth of noise

10 Meg input impedance for minimum circuit loading (10-25 pf capacity)

Uses all Hewlett-Packard accessories, such as current shunts, voltage dividers

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The highest level of performance available today is yours with the new hp 400F/FL General-Purpose AC Voltmeters. Measure 100 μV to 300 v full scale on an individually calibrated finar meter that lets you measure as low as 10 μV with 1 μV resolution. The 400FL, \$285, offers a linear 12 db log scale with accuracy of 1% of reading. Specified accuracy of the 400F is $\frac{1}{2}\%$ of reading plus $\frac{1}{2}\%$ of full scale. The 400F, Option 01., puts the db scale uppermost for greater db resolution (\$10 extra).

As a low-distortion amplifier, the 400F/FL has a noise spec $< 5 \mu\text{V}$ referred to input, typically 3.5 μV . The instrument can be battery operated through rear-panel terminals. The 1 v ac output is available on all ranges.

The low-pass 100 kHz filter, activated by a front-panel switch, reduces the effect of unwanted high frequencies for low-level audio measurements. The 11074A Voltage Divider Probe (10:1) is available.

The front panel shows the ease of use that's yours with this truly state-of-the-art ac voltmeter. Ideal for low-level audio, servo, communications measurements... one instrument for the widest variety of applications. For complete specifications... or for a demonstration... call your Hewlett-Packard field engineer. Or write Hewlett-Packard, Palo Alto, Calif. 94304, Tel. (415) 326-7000; Europe: 54 Route des Acacias, Geneva.

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- Size 22, yellow
- Size 22, red
- Size 22, green
- Size 20, clear
- Size 20, black
- Size 20, white
- Size 20, yellow
- Size 20, red
- Size 20, green
- Size 19, clear
- Size 19, black
- Size 19, white
- Size 19, yellow
- Size 19, red
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- Size 18, green
- Size 17, clear
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- Size 17, yellow
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- Size 16, red
- Size 16, green
- Size 15, clear
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- Size 15, white
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- Size 15, red
- Size 15, green
- Size 14, clear
- Size 14, black
- Size 14, white
- Size 14, yellow
- Size 14, red
- Size 14, green
- Size 13, clear
- Size 13, black
- Size 13, white
- Size 13, yellow
- Size 13, red
- Size 13, green
- Size 12, clear
- Size 12, black
- Size 12, white
- Size 12, yellow
- Size 12, red
- Size 12, green
- Size 11, clear
- Size 11, black
- Size 11, white
- Size 11, yellow
- Size 11, red
- Size 11, green
- Size 10, clear
- Size 10, black
- Size 10, white
- Size 10, yellow
- Size 10, red
- Size 10, green
- Size 9, clear
- Size 9, black
- Size 9, white
- Size 9, yellow
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- Size 8, clear
- Size 8, black
- Size 8, white
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- Size 8, red
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- Size 7, clear
- Size 7, black
- Size 7, white
- Size 7, yellow
- Size 7, red
- Size 7, green
- Size 6, clear
- Size 6, black
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- Size 6, yellow
- Size 6, red
- Size 6, green
- Size 5, clear
- Size 5, black
- Size 5, white
- Size 5, yellow
- Size 5, red
- Size 5, green
- Size 4, clear
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- Size 4, white
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- Size 4, red
- Size 4, green
- Size 3, clear
- Size 3, black
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- Size 3, yellow
- Size 3, red
- Size 3, green
- Size 2, clear
- Size 2, black
- Size 2, white
- Size 2, yellow
- Size 2, red
- Size 2, green
- Size 1, clear
- Size 1, black
- Size 1, white
- Size 0, clear
- Size 0, black
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- Size 5/16", clear
- Size 5/16", black
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- Size 3/8", clear
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- Size 3/8", white
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- Size 7/16", black
- Size 7/16", white
- Size 1/2", clear
- Size 1/2", black
- Size 1/2", white
- Size 9/16", clear
- Size 9/16", black

- Size 9/16", white
- Size 5/8", clear
- Size 5/8", black
- Size 5/8", white
- Size 3/4", clear
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- Size 3/4", white
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- Size 1", clear
- Size 1", black
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- Size 1 1/8", clear
- Size 1 1/8", black
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- Size 1 3/8", clear
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- Size 1 1/2", clear
- Size 1 1/2", black
- Size 1 3/4", clear
- Size 1 3/4", black
- Size 2", clear
- Size 2", black
- Size 2 1/4", clear
- Size 2 1/4", black
- Size 2 1/2", clear
- Size 2 1/2", black

TEFLON THIN WALL (TFT-200)

- Size 30, natural
- Size 30, yellow
- Size 30, black
- Size 30, red
- Size 28, natural
- Size 28, yellow
- Size 28, black
- Size 28, red
- Size 26, natural
- Size 26, yellow
- Size 26, black
- Size 26, red
- Size 24, natural
- Size 24, yellow
- Size 24, black
- Size 24, red
- Size 22, natural
- Size 22, yellow
- Size 22, black
- Size 22, red
- Size 20, natural
- Size 20, yellow
- Size 20, black
- Size 20, red

- Size 19, natural
- Size 19, yellow
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- Size 18, natural
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- Size 15, natural
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- Size 7, natural
- Size 6, natural
- Size 6, yellow
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- Size 3, red
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- Size 2, black
- Size 2, red
- Size 1, natural
- Size 1, yellow
- Size 1, black
- Size 1, red
- Size 0, natural

TEFLON STANDARD WALL (TFT-250)

- Size 24, natural
- Size 22, natural
- Size 20, natural
- Size 19, natural
- Size 18, natural
- Size 17, natural
- Size 16, natural
- Size 15, natural
- Size 14, natural
- Size 13, natural
- Size 12, natural
- Size 11, natural
- Size 10, natural
- Size 9, natural
- Size 8, natural
- Size 7, natural
- Size 6, natural
- Size 5, natural
- Size 4, natural
- Size 3, natural
- Size 2, natural
- Size 1, natural
- Size 0, natural

ZIPPER TUBING ALL PURPOSE (ZIP-31)

- Size 1/4", clear
- Size 1/4", black
- Size 1/4", yellow
- Size 3/8", clear
- Size 3/8", black
- Size 3/8", yellow
- Size 1/2", clear
- Size 1/2", black
- Size 1/2", yellow
- Size 5/8", clear
- Size 5/8", black
- Size 5/8", yellow
- Size 3/4", clear
- Size 3/4", black
- Size 3/4", yellow
- Size 7/8", clear
- Size 7/8", black
- Size 7/8", yellow
- Size 1", clear
- Size 1", black
- Size 1", yellow
- Size 1 1/8", clear
- Size 1 1/8", black
- Size 1 1/8", yellow
- Size 1 1/4", clear
- Size 1 1/4", black
- Size 1 1/4", yellow
- Size 1 1/2", clear

- Size 1 1/2"; black
- Size 1 1/2"; yellow
- Size 1 3/4"; clear
- Size 1 3/4"; black
- Size 1 3/4"; yellow
- Size 2"; clear
- Size 2"; black
- Size 2"; yellow

ZIPPER—HEAVY DUTY (ZIP-314)

- Size 1/4"; clear
- Size 1/4"; black
- Size 3/8"; clear
- Size 3/8"; black
- Size 1/2"; clear
- Size 1/2"; black
- Size 5/8"; clear
- Size 5/8"; black
- Size 3/4"; clear
- Size 3/4"; black
- Size 7/8"; clear
- Size 7/8"; black
- Size 1"; clear
- Size 1"; black
- Size 1 1/8"; clear
- Size 1 1/8"; black
- Size 1 1/4"; clear
- Size 1 1/4"; black
- Size 1 1/2"; clear
- Size 1 1/2"; black
- Size 1 3/4"; clear
- Size 1 3/4"; black
- Size 2"; clear
- Size 2"; black

ZIPPER—EXTRA FLEXIBLE (ZIP-44)

- Size 1/4"; clear
- Size 1/4"; black
- Size 3/8"; clear
- Size 3/8"; black
- Size 1/2"; clear
- Size 1/2"; black
- Size 5/8"; clear
- Size 5/8"; black
- Size 3/4"; clear
- Size 3/4"; black
- Size 7/8"; clear
- Size 7/8"; black
- Size 1"; clear
- Size 1"; black
- Size 1 1/8"; clear
- Size 1 1/8"; black
- Size 1 1/4"; clear
- Size 1 1/4"; black

- Size 1 1/2"; clear
- Size 1 1/2"; black
- Size 1 3/4"; clear
- Size 1 3/4"; black
- Size 2"; clear
- Size 2"; black

ZIPPER—SHIELDED (ZIP-50)

- Size 1/4"; silver-grey
- Size 3/8"; silver-grey
- Size 1/2"; silver-grey
- Size 5/8"; silver-grey
- Size 3/4"; silver-grey
- Size 7/8"; silver-grey
- Size 1"; silver-grey
- Size 1 1/8"; silver-grey
- Size 1 1/4"; silver-grey
- Size 1 1/2"; silver-grey
- Size 1 3/4"; silver-grey
- Size 2"; silver-grey

PLASTIC IMPREGNATED FIBERGLASS (PIF-130)

- Size 24; black
- Size 24; yellow
- Size 22; black
- Size 22; yellow
- Size 20; black
- Size 20; yellow
- Size 19; black
- Size 19; yellow
- Size 18; black
- Size 18; yellow
- Size 17; black
- Size 17; yellow
- Size 16; black
- Size 16; yellow
- Size 15; black
- Size 15; yellow
- Size 14; black
- Size 14; yellow
- Size 13; black
- Size 13; yellow
- Size 12; black
- Size 12; yellow
- Size 11; black
- Size 11; yellow
- Size 10; black
- Size 10; yellow
- Size 9; black
- Size 9; yellow
- Size 8; black
- Size 8; yellow
- Size 7; black
- Size 7; yellow

- Size 6; black
- Size 6; yellow
- Size 5; black
- Size 5; yellow
- Size 4; black
- Size 4; yellow
- Size 3; black
- Size 3; yellow
- Size 2; black
- Size 2; yellow
- Size 1; black
- Size 1; yellow
- Size 0; black
- Size 0; yellow
- Size 3/8"; black
- Size 3/8"; yellow
- Size 7/16"; black
- Size 7/16"; yellow
- Size 1/2"; black
- Size 1/2"; yellow
- Size 5/8"; black
- Size 5/8"; yellow
- Size 3/4"; black
- Size 3/4"; yellow
- Size 7/8"; black
- Size 7/8"; yellow
- Size 1"; black
- Size 1"; yellow

SHRINKABLE IRRADIATED POLYOLEFIN (FIT-221)

- Size 3/64"; black
- Size 3/64"; white
- Size 3/64"; red
- Size 3/64"; yellow
- Size 3/64"; blue
- Size 3/64"; clear
- Size 1/16"; black
- Size 1/16"; white
- Size 1/16"; red
- Size 1/16"; yellow
- Size 1/16"; blue
- Size 1/16"; clear
- Size 3/32"; black
- Size 3/32"; white
- Size 3/32"; red
- Size 3/32"; yellow
- Size 3/32"; blue
- Size 3/32"; clear
- Size 1/8"; black
- Size 1/8"; white
- Size 1/8"; red
- Size 1/8"; yellow
- Size 1/8"; blue
- Size 1/8"; clear
- Size 3/16"; black

- Size 3/16"; white
- Size 3/16"; red
- Size 3/16"; yellow
- Size 3/16"; blue
- Size 4; black
- Size 4; yellow
- Size 3; black
- Size 3; yellow
- Size 2; black
- Size 2; yellow
- Size 1; black
- Size 1; yellow
- Size 0; black
- Size 0; yellow
- Size 3/8"; black
- Size 3/8"; yellow
- Size 3/8"; blue
- Size 3/8"; clear
- Size 1/2"; black
- Size 1/2"; white
- Size 1/2"; red
- Size 1/2"; yellow
- Size 1/2"; blue
- Size 1/2"; clear
- Size 3/4"; black
- Size 3/4"; white
- Size 3/4"; red
- Size 3/4"; yellow
- Size 3/4"; blue
- Size 3/4"; clear
- Size 1"; black
- Size 1"; white
- Size 1"; red
- Size 1"; yellow
- Size 1"; blue
- Size 1"; clear
- Size 1 1/2"; black
- Size 1 1/2"; white
- Size 1 1/2"; red
- Size 1 1/2"; yellow
- Size 1 1/2"; blue
- Size 1 1/2"; clear
- Size 2"; black
- Size 2"; white
- Size 2"; red
- Size 2"; yellow
- Size 2"; blue
- Size 2"; clear
- Size 3"; black
- Size 3"; white
- Size 3"; red
- Size 3"; yellow
- Size 3"; blue
- Size 3"; clear
- Size 4"; black
- Size 4"; white
- Size 4"; red

- Size 4"; yellow
- Size 4"; blue
- Size 4"; clear

SHRINKABLE IRRADIATED POLYOLEFIN SEMI-RIGID (FIT-295)

- Size 3/64"; yellow
- Size 3/64"; clear
- Size 1/16"; white
- Size 1/16"; clear
- Size 3/32"; blue
- Size 3/32"; clear
- Size 1/8"; red
- Size 1/8"; clear
- Size 3/16"; green
- Size 3/16"; clear
- Size 1/4"; slate
- Size 1/4"; clear
- Size 3/8"; brown
- Size 3/8"; clear
- Size 1/2"; white
- Size 1/2"; clear

SHRINKABLE IRRADIATED HIGH TEMPERATURE (FIT-350)

- Size 3/64"; clear
- Size 1/16"; clear
- Size 3/32"; clear
- Size 1/8"; clear
- Size 3/16"; clear
- Size 1/4"; clear
- Size 3/8"; clear
- Size 1/2"; clear
- Size 3/4"; clear
- Size 1"; clear

SHRINKABLE IRRADIATED POLYVINYLCHLORIDE (FIT-105)

- Size 3/64"; black

- Size 1/16"; black
- Size 3/32"; black
- Size 1/8"; black
- Size 3/16"; black
- Size 1/4"; black
- Size 3/8"; black
- Size 1/2"; black
- Size 3/4"; black
- Size 1"; black
- Size 1 1/2"; black
- Size 2"; black

SHRINKABLE SURFACE-IRRADIATED POLYOLEFIN (FIT-300)

- Size 1/8"; brown
- Size 3/16"; grey
- Size 1/4"; white
- Size 3/8"; red
- Size 1/2"; blue
- Size 3/4"; yellow
- Size 3/10" (heavy-wall) blue

SHRINKABLE IRRADIATED TEFLON (FIT-500)

- Size 30; natural
- Size 28; natural
- Size 26; natural
- Size 24; natural
- Size 22; natural
- Size 20; natural
- Size 18; natural
- Size 16; natural
- Size 14; natural
- Size 12; natural
- Size 10; natural
- Size 8; natural
- Size 6; natural
- Size 4; natural
- Size 2; natural
- Size 0; natural

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Title _____

Company _____

Street _____

City _____ State _____ Zip _____

DESIGNER'S

P. R. MALLORY & CO. INC., INDIANAPOLIS, INDIANA 46206

New solid-state audible signal has low current drain, high reliability



The Sonalert® signal is a unique solid-state device which produces a compelling tone on as little as 3 milliamps. It consists of a piezoelectric transducer driven by a transistorized oscillator. It has no arcing contacts which cause explosion hazard and RF interference.

Sound intensity varies with applied voltage, and ranges from 68 to 80 db. Frequency is fixed by transducer characteristics, cannot be altered by external means, and is not affected by voltage. The device operates over a wide range of applied voltage.

Starting current is the same as operating current, and is exceptionally low. The 6 to 28 volt model draws only 3 milliamperes at 6 volts. The 110-volt AC model draws only 14 milliamperes (about the same as a neon pilot lamp).

Standard frequency is 2800 ± 300 cycles; a 4500 ± 500 cycle model is also available. AC and DC models are available, operating over the range from 6 to 28 volts; also a 110-volt AC model. A pulsed model produces "beeps" at a rate of 3 to 5 pulses per second. The high and low frequency units can be used in combination to indicate high or low limit alarms, or they can be used simultaneously to deliver a beat frequency signal.

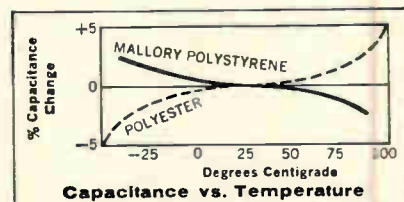
Because of its solid-state design, the Sonalert has maximum reliability. It is being used as an overvoltage or undervoltage failure alarm on computers, as a "wheels

CIRCLE 241 ON READER SERVICE CARD

New polystyrene film capacitors have superior stability, low cost

Now available from Mallory is a line of polystyrene capacitors which have temperature and life stability exceeding that of polyester film types. They are made of a unique form of stretched polystyrene film and high purity aluminum foil. The manufacturing process fuses the polystyrene to form a self-sealed case with excellent humidity protection.

Insulation resistance of these capacitors is exceptionally high—in the order of 100,000 megohms—and stays high throughout life. Temperature stability is excellent: from -10°C to $+70^{\circ}\text{C}$, total capacitance change is less than -1.3% . Temperature coefficient is -150 ppm/ $^{\circ}\text{C}$, ± 60 ppm/ $^{\circ}\text{C}$. Dissipation factor is less than 0.05% , and is constant over this temperature range.



Temperature stability of Mallory Polystyrene Capacitors compared with polyester film capacitors.

73 standard ratings from 5 pf to .01 mfd, all at 600 volts DC, are available. Standard tolerance is $\pm 5\%$. Maximum operating temperatures are -40°C to $+85^{\circ}\text{C}$. Production quantities can be obtained immediately from Franchised Mallory Distributors, at prices below polyester film capacitors.

CIRCLE 240 ON READER SERVICE CARD

UL-recognized switch and control for light dimmers



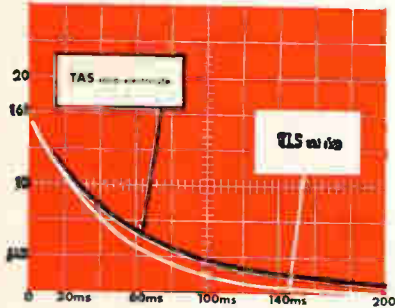
down" signal on aircraft, as a security or overheat alarm. Because of its low power requirements, it can be actuated by batteries, directly by photo-sensitive devices; and it can be connected in fail-safe circuits where breaking a safety switch will apply full voltage across the Sonalert. Operating temperatures from -60 to $+120^{\circ}\text{F}$ are permissible. The complete unit is compact and is mounted on a single $1\frac{1}{4}$ " panel hole.

A combined push-push three-way switch and intensity control, especially designed for use in light dimmers, is now available from Mallory Controls Company. The front section carbon control and the integral switch are both designed to meet Underwriters' Laboratories requirements for voltage breakdown test and for dimensional spacing for use in electronic light dimmer controls.

The intensity control is rated 1 watt nominal, and is supplied in values from 100 to 1,000K ohms, in standard linear taper... also with other tapers and with fixed end resistances. The switch is single pole double throw, permanently attached to the same shaft with the control. It has been designed to handle dimmer loads up to 5 amperes at 117 volts, 60 cycles.

CIRCLE 242 ON READER SERVICE CARD

Wet slug tantalum capacitors are best choice for timing circuits



Compare charging current-time traces, reproduced from oscilloscope photographs. Sweep speed: 20 millisecc/div. Vertical sensitivity: $3\frac{1}{2}$ μ a/div.

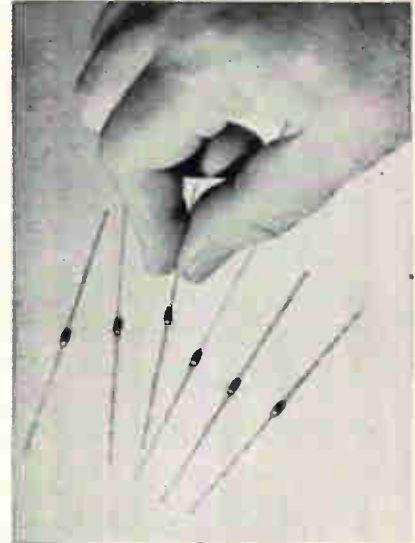
In an RC timing circuit, the value of time constant is usually calculated from the nominal value of capacitance and the value of the timing resistor. When tantalum

capacitors are used in timing circuits, the effects of error introduced by DC leakage should be considered. Wet slug tantalum capacitors, because they have DC leakage in the order of 10% that of solid electrolyte types, have inherently far lower time error.

The effect of the leakage resistance path, in parallel with capacitor terminals, is to cause an apparent increase in time constant. The time error is, of course, zero in a perfect capacitor where the leakage path has infinite resistance... and increases as leakage resistance approaches the value of the timing or series resistance of the circuit.

For this reason, Mallory engineers often recommend wet slug tantalum capacitors for use in timing circuits where maximum precision is required. We have an engineering report on this subject, and will be glad to send copies on request.

CIRCLE 243 ON READER SERVICE CARD



New small-size, low-price silicon rectifier line

The Mallory Type B rectifier is specifically designed for applications which require current capability up to 1 ampere in minimum size. It uses a passivated silicon junction for high temperature stability.

It's a new shape in rectifiers: the epoxy package is only .275" long and .135" maximum diameter, self-supported on .032" diameter axial leads. It needs no heat sink other than its own leads. Yet in this tiny size, it affords ratings of $\frac{3}{4}$ ampere and 1 ampere, at 50°C ambient. Peak inverse voltage ratings from 50 to 1000 volts are available.

Forward drop is only .9 volts for the 1-ampere units, and 1.0 volts for the $\frac{3}{4}$ -ampere type, at full rated current. Maximum surge current (4 millisecc) is 35 amperes. Accelerated environmental tests have demonstrated the Type B's ability to withstand severe humidity exposure.

Prices are as low as 10 cents in quantities of 100,000.

CIRCLE 245 ON READER SERVICE CARD

World's Smallest Primary Battery

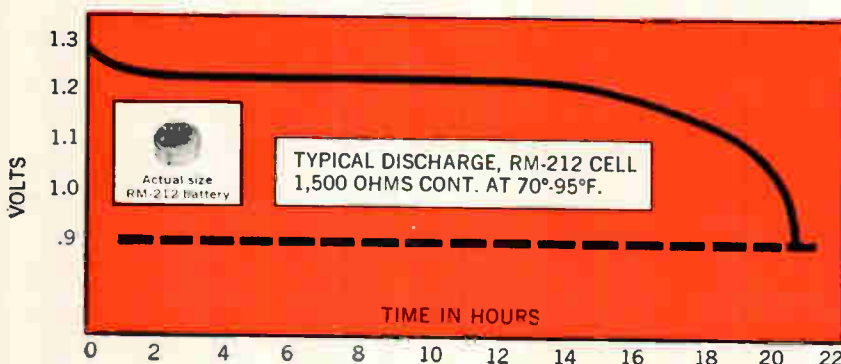
Mallory can now offer electronic designers the world's smallest primary cell actually in production. Only 0.130" high by 0.225" diameter, this 1.35 volt miniature power source is rated to produce 16 milli-ampere hours.

Because the battery energy is created through Mallory's mercuric oxide-potassium hydroxide-zinc system, voltage is extremely accurate and stable, and shelf life extraordinarily long.

Among the possible applications for the battery (designated as Mallory RM-212) are hearing aids small enough to hide inside the ear canal, "radio" capsules to transmit information from inside the body, and extremely small proximity fuses and telemetry devices.

If you're looking for extremely small power sources, this may be it. Or perhaps this breakthrough in battery size suggests designs not possible until now.

CIRCLE 244 ON READER SERVICE CARD



FOR TRANSDUCER BRIDGES

KEPCO'S POWER SUPPLY ISOLATION

MAKES THE DIFFERENCE!

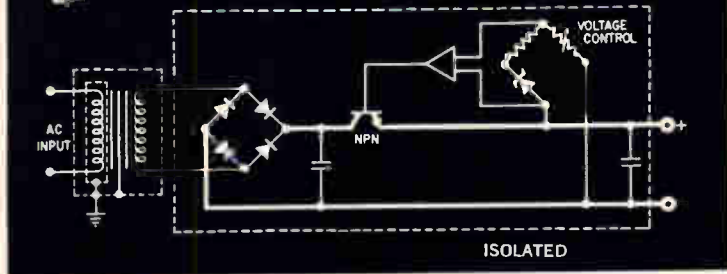


and in isolated Power Supplies, the new KEPCO "KG" Module leads the field!

A new, sophisticated reference regulator, permits output DC comparisons to be made with a long term (8 hour) stability of 0.005% (or 0.001 volts, whichever is greater). The Kepco Comparison Bridge, which performs the comparison, is fully programmable and may be connected to regulate either voltage or current output.

The Model KG 25-0.2 is especially configured for minimum stray coupling capacitance. It is entirely constructed on a 13 1/2" x 4 1/2" glass epoxy printed circuit card which mounts a special multiply shielded power transformer, transistor-driven reference, complementary comparison amplifier, and pass section (with heat sink). A non-metallic front panel continues the isolation theme, and mounts a ten-turn, wire-wound (low temperature coefficient) voltage adjustment, current limit adjustment (with a very sharp knee), DC operated pilot light, handle and fasteners.

The Model KG 25-0.2 Module is dimensioned for eight abreast plug-in mounting in a 5 1/4" H x 19" W standard rack housing, Model RA 19-8; or may be conveniently housed in a plug-in case-type Model CA 2. Encasement is enormously simplified by an ingenious mechanical design which employs minimum contact slide rails. There are no screws or other closures apart from the two panel-mounted (captive) thumb screws.



THE KG ISOLATED POWER SUPPLY FEATURES:

DC OUTPUT RANGE: 0-25V, 0-200 ma.

- with a *maximum* of:
- 1 picofarad line-to-output capacitance
 - 200 picofarads output-to-ground capacitance
 - 0.001%, line, 0.005% load regulation
 - 100 microvolts (rms) ripple
- and a *minimum* of:
- 10¹⁰ ohms output-to-ground resistance
 - 0.05% voltage resolution

REGULATION: LINE 0.001% - LOAD 0.005%

MODEL	DC OUTPUT RANGE		OUTPUT IMPEDANCE OHMS MAX.			PRICE
	VOLTS	AMPS	DC to 100 cps	100 cps to 1 kc	1 kc to 100 kc + μh	
KG 25-0.2	0-25	0-0.2	0.006	0.01	0.1+1	\$195.00

Patent Nos. furnished on request



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Electronics | June 27, 1966

Editorial

Europe votes, but isn't ready for color television

In Oslo, during the next few weeks, the die will be cast for color television in Europe. The experts predict that two systems will be approved at the CCIR meeting: The German PAL system for Western Europe, except France, and the French Secam system for France, the Soviet Union and Eastern Europe. The decision will not lead to any great technological advance. In fact, many of the countries that have been lobbying for one system or the other will not have color television for many years to come. Most of Europe is not ready for color tv.

Then why all the excitement? Partly it is political. In France, Secam has become a cause célèbre and a part of foreign policy. At the end of May, just before the CCIR delegates were ready to leave for Oslo, France sent a 100-man party to Portugal to persuade that somewhat backward country to vote for Secam. Almost everybody agrees that the economic potential of color tv in Portugal is almost nil and it may be as much as 10 years away from the start of color telecasts.

Partly, the pressure came from receiver and component makers in Western Europe where black-and-white tv sales have hit a plateau. In Great Britain, France, and West Germany, set makers are expecting a big lift from color tv but even here the enthusiasts may be in for a jolting surprise. The costs of telecasting color are so high that the broadcasters are likely to go easy. In West Germany, for example, the current plan is to telecast only 10 hours a week in color when the broadcasts start in 1967.

Experience in the United States has shown that the color-tv boom did not start until programming in color was extensive by all three networks and local stations. Another factor that will slow the sales of color tv will be the high price of receivers, particularly at the start when production volumes are low.

Color will not lure many new customers in Europe. The saturation levels of black-and-white tv in Germany and France are low, about 60% compared to the over 95% saturation in the United States. One reason why more people

don't buy television sets is economic. A sizeable percentage of the people in Europe cannot afford a black-and-white tv set. Clearly these same people will not be able to buy a color set which will be more than twice as expensive as black and white. Thus, color tv may turn out to give some of its strongest adherents some of the biggest headaches.

In the German Democratic Republic, the Socialist country, color tv has produced a frustrating dilemma. Probably the most devoted follower of Soviet policies, the government went for Secam as a matter of foreign policy and because it would like to export color tv sets to the other countries of Eastern Europe. But at the same time the people of East Germany want to be able to receive the PAL broadcasts of West Germany and to transmit color telecasts into West Germany.

In other Socialist countries of Eastern Europe, like Rumania, color tv caught the planners by surprise. There is no room in the plans for color tv. Rumania, which has a pent-up demand for black-and-white tv that will not nearly be satisfied before 1970, has programmed to double receiver production by 1970, but only black-and-white sets. To start color would mean not meeting their goals or importing sets, a practice that has been almost prohibitive because of the country's lack of foreign exchange.

But the worst problem of all may lie on the doorstep of the French company, Compagnie Générale de Télégraphie sans Fil (CSF), which created Secam and set up the Compagnie Française de Télévision (CFT) to exploit it.

As part of the French persuasion of the Soviet Union to accept Secam, so the rumor goes in Europe, the French promised to help the Russians set up a plant to build the new CFT color tube. The problem is that CSF has not been able to solve production bugs and produce the tube in quantity.

At another French company, an executive who has closely watched CSF's struggles and their effect on CFT summed up the delay this way: "If CSF put in the same amount of money that RCA put into setting up production of the shadow mask tube there would be no problem." But CSF does not have that kind of money.

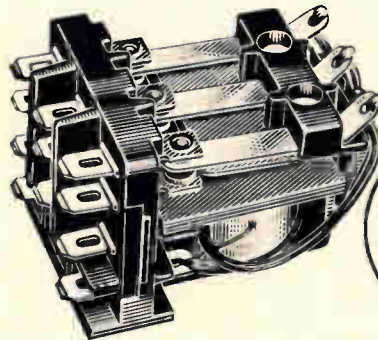
The French dilemma will make a lot of color tv pioneers in the U.S. chuckle because they have been trying to sell the American NTSC system to Europe on just that basis: that U. S. companies had spent a lot of money perfecting the system and had a lot of experience. Though Europe will have two tv systems almost all the color-tv sets built there will use shadow mask tubes for at least the next three to five years.

*Will this new
General Purpose P&B relay make
our best seller obsolete?*

Never!

Never?

*Well,
maybe!*



Our new KU relay is quite exceptional. For many relay users, it will be more convenient, more versatile, easier to install and replace . . . and cost substantially less money. Here's why.

MODERN, COST SAVING TERMINALS

Quick-connect terminals mean faster installation on your production line . . . easier replacement in the field. Standard models have .187" terminals, but .205" may be ordered. All terminals are punched for those who prefer solder connections. Barriers molded into the sturdy front meet U/L and CSA requirements.



TRUE 10 AMP NYLON SOCKET

A nylon socket—rated for carrying 10-amperes—can be supplied to make the KU a handy plug-in relay. Covered (KUP) relays, incidentally, cost



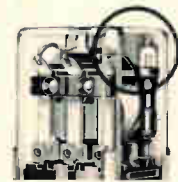
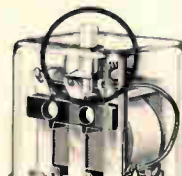
dramatically less than similar relays having octal-type plugs.

You may specify five- or ten-ampere KU relays. Longer movable arms and a unique method of staking the stationary contacts to the header contribute to the improved reliability and longer life of this new series.



WIDE CHOICE OF FEATURES

Two styles of heat and shock resistant polycarbonate dust covers are available. One, with slotted flanges, provides a quick, convenient method for mounting the relay directly to a chassis. A handy push-button which operates the movable contacts can also be supplied for manually checking circuits. KUP relays are



available with a neon lamp wired in parallel with their coils to indicate that power is reaching the relays.

Longer life, improved reliability, exceptional versatility and, in the case of covered relays, substantially lower costs are all part of the KU Series. Interested? Call your P&B sales representative today, or get in touch with us direct.

KU SERIES SPECIFICATIONS

GENERAL:

Description: 5 or 10 amperes General Purpose Relay.
Expected Life: 10,000,000 cycles, Mech.
Breakdown Voltage: 1,500V rms 60 Hz between all elements; 500V rms 60 Hz between open contacts.

CONTACTS:

Arrangements: Up to 3 Form C.
Rating: 5 or 10 amps @ 28V DC or 115V AC resistive.

COILS:

Voltage: DC to 110V; AC to 230V 60 Hz.
Power: DC 1.2 W; AC 1 and 2 poles 2.0 VA;
AC 3 poles 2.7 VA.

Resistance: 16,500 ohms max.

MOUNTING:

(open relay) 5/32" mtg. stud, 7/32" locating tab on 7/16" centers. Socket available.

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



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Export: AMF International, 261 Madison Avenue, New York, N. Y.

Electronics Newsletter

June 27, 1966

'Putting an elephant in a Piper Cub'

The Communications Satellite Corp., which received only one bid—from the Hughes Aircraft Co.—in its call for design of an aeronautical services satellite, is still evaluating the technical proposal. Several other companies with satellite-building capabilities declined to bid on the project, claiming that Comsat was unrealistic in expecting a company to produce, within 12 to 18 months, a satellite that could provide a communications link between transoceanic airplanes and ground terminals. As one industry observer noted: "It's like trying to put an elephant in a Piper Cub—especially when you only have a year to figure out a way to do it."

However, there's some speculation that Comsat, embarrassed by the fact that only one company entered a bid, may decide to reopen the bidding and change the engineering requirements of the satellite, in an effort to stimulate competition for the project.

IBM researchers make tunnel diodes from MOS junction

The discovery by scientists at IBM of a negative-resistance effect in a metal-oxide-semiconductor (MOS) junction may lead to a simple, inexpensive batch process for fabricating tunnel diodes. Leo Esaki, P.T. Stiles and W.E. Howard first observed the effect in a MOS junction of aluminum, aluminum oxide and tin telluride.

Experimental devices—made from layers of evaporated polycrystalline films—exhibit weak negative-resistance characteristics compared with those of conventional discrete diodes. The construction is simpler and less critical than single-crystal methods. Peak currents reach only about 1 microampere and valley currents are about 10% lower, for a modest I_p/I_v ratio. Peak current occurs at about 0.5 volt and valley current at about 0.8 volt. The International Business Machines Corp. experimenters believe new combinations of materials will improve these characteristics.

'Tuning fork' for IC's?

In another development, IBM has designed a device that might be used in tuned monolithic circuits; it contains a cantilevered silicon chip that vibrates at its resonant frequency.

Like a diving board, the chip is anchored at one end, and an input signal is applied to a resistor embedded near the anchored end. A sinusoidal thermal flux at the signal frequency is developed, causing differential thermal expansion of the silicon chip. At the resonant frequency of the chip (700 hertz to 15 kilohertz in the IBM tests) a second, sensing resistor alters the resistance and a simple sensing circuit containing the resistor provides an output at the resonant frequency.

Raytheon achieves 53 watts c-w from argon laser

Raytheon Co.'s research division has achieved a continuous output of 53 watts from an ionized argon laser in a discharge structure made of quartz. The previously announced high was 18 watts. Researcher Roy A. Paananen says mirror heating effects make it imprudent to attempt higher discharge current values while using internal dielectric-coated mirrors. Using a ceramic tube and higher power densities in other experiments, Paananen recorded the first continuous output in the ultraviolet region of the spectrum.

Electronics Newsletter

Matsushita develops diode for tuning radios

Variable-capacitance diodes developed by the Matsushita Electrical Industrial Co. of Japan may mean the end of tuning-knob twirling on broadcast-band receivers. The Matsushita silicon diodes have a capacitance ratio more than adequate for broadcast-band tuning. Their maximum capacitance, at 1-volt reverse bias, runs 250 microfarads. An increase in bias to 10 volts varies the capacitance by a factor of 23. Diodes offered currently by United States manufacturers have ratios of only 4 to 6—too low to tune the entire 525 to 1,605 kilohertz broadcast band.

Matsushita has readied for the market a transistor receiver with an electronic tuning circuit built around the new diodes. Bias on a pair of the variable-capacitance diodes is increased gradually to sweep the tuning circuit from the low end of the broadcast band toward the upper end. When the first station is tuned in, a two-transistor trigger and feedback circuit locks the set on the station and holds it there. The circuits sweep on from station to station under push-button control. The dial is a voltmeter calibrated in kilohertz.

Philco, monitor at BARTD tests, joins competition

The Philco Corp.'s Western Development Laboratory, which provided and monitored data-acquisition equipment for the Bay Area Rapid Transit District (BARTD) test track near San Francisco, has joined the competition for the electronic train-control equipment. Early this month, Philco successfully demonstrated a system that stopped one of the BARTD test cars within a foot of a target at speeds of 30, 50 and 70 miles per hour. Philco also has a system for regulating speed within a given zone, and has indicated that it will bid on the entire system when requests go out in September.

40,000-gauss superconducting magnet developed

A new stabilizing technique has produced the world's most powerful superconducting magnet, according to the Avco Everett Research Laboratory, Everett, Mass., a division of the Avco Corp. The magnet is 10 feet long, produces 40,000 gauss and stores 5 million joules of energy. Arthur Kantrowitz, Avco vice president and laboratory director, says the technique overcomes a major obstacle to construction of a large-scale commercial power generator working on magnetohydrodynamic (MHD) principles. An MHD generator produces electricity directly by passing a stream of super-hot gas, a plasma, through a magnetic field.

If a magnet suddenly goes resistive and loses its superconductivity, the results can be catastrophic. To prevent that, the superconducting windings are embedded in copper strips and cooled in liquid helium. If a winding develops a resistive hot spot, the current automatically transfers out of that area and into the copper, which acts like a shunt, allowing the current to bypass the hot spot until it cools and superconductivity is resumed.

Communication gear makes A.F., Army radios compatible

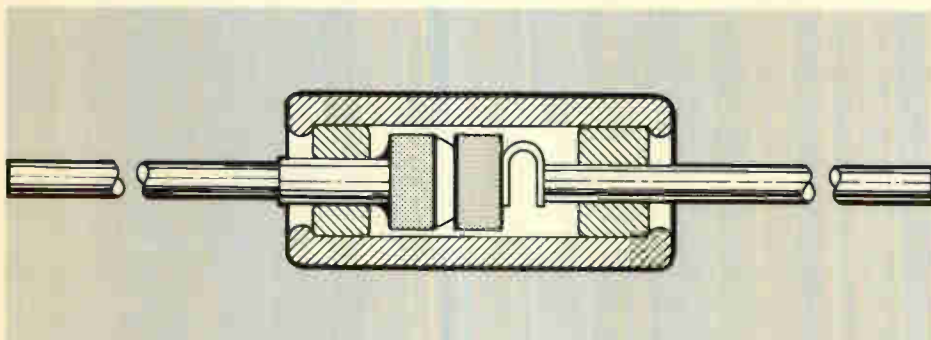
The first equipment designed specifically to overcome incompatibility between Air Force and Army communications gear is headed for Southeast Asia. The Jeep-mounted equipment will provide close air support for American ground troops in Vietnam. The design answers complaints that the Army and the Air Force radio gear operate at incompatible frequencies and methods of modulation [Electronics, Feb. 21, p. 38]. The equipment is being built by the General Dynamics Corp.

IDEAS

from SYLVANIA Electronic Components Group

RECTIFIERS

Newest glass device handles reverse transients up to 1000 watts



When circuit design engineers have problems, so do we. Sylvania's problem is to design and produce a device that will do the job better. A recent in-house problem was to make a line of rectifiers that would be reliable enough for use in military applications, yet economical enough for commercial equipment. We found the answer in glass encapsulation, larger junctions, and welded lead contacts.

A new silicon rectifier line combines the inherent advantages of glass encapsulation with improved device design. As a result, circuit de-

signers get both enhanced electrical performance and increased reliability. These five units, the first glass rectifiers from Sylvania, can handle outputs of 1 amp at reverse working voltages of up to 1,000 volts. A typical unit has a low reverse leakage current of 10 na at 25°C ambient and rated reverse voltage.

What makes these units different from comparable glass rectifiers are improvements in device design. Use of large double diffused junction means that, in addition to the standard 50-amp forward surge capability,

these units are also capable of withstanding extremely high reverse power transients.

A solid high conduction power sink lead, welded to an oversized heat conducting stud, aids heat dissipation. This increases power handling capability while extending device life by keeping the unit cooler.

Welded lead contacts (instead of the pressure or soldered contacts used in some other devices) and full-sized leads help assure full performance under severe vibrations. These units pass all the standard life and design tests outlined in MIL-S-19500.

Use of a glass package means not only improved insulating characteristics but also that the units are hermetically sealed to give a "Radiflo" (continued)

This Issue in Capsule

CRTs—Fiber optics tubes tailored to your system designs.

Integrated Circuits—A digital decade frequency divider on one chip handles both analog and digital signals.

Receiving Tubes—How you can improve life and performance of your mobile communications equipment.

Microwave Components—New approach to X-band tripling combines economy and efficiency.

Photoconductors—Now there's true stability in outdoor lighting control cells.

Television—A new 22" color picture tube to meet growing consumer demands.

ABSOLUTE MAXIMUM RATINGS:

-65°C to +175°C — Resistive and Inductive Loads — Single Phase, half wave at 60 cps.

	Units	1N4383	1N4384	1N4385	1N4585	1N4586
Continuous Reverse Working Voltage, V_R	volts	200	400	600	800	1000
RMS Input Voltage, V_{rms}	volts	140	280	420	560	710
Average Forward Current, I_o	amps					
@ 50°C		1.0	1.0	1.0	1.0	1.0
@ 100°C		1.0	1.0	1.0	0.6	0.6
@ 150°C		0.3	0.3	0.3	0.2	0.2
Forward Surge Current, 1 cycle — $I_{F sur}$	amps	50	50	50	50	50
Forward Surge Current, Recurrent, $I_{F sur}$	amps	6	6	6	6	6

ELECTRICAL CHARACTERISTICS:

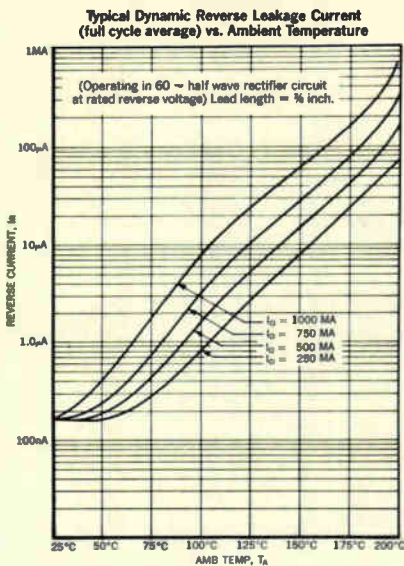
Typ. Dynamic Forward Voltage Drop, V_F @ 1.0 amp	volts				.56	.56
@ 50°C						
@ 100°C		.52	.52	.52		
Typ. Dynamic Reverse Current, I_R @ V_R	μa @ 1.0 amps				.55	.55
@ 50°C		8	8	8		
@ 100°C		10	10	10	10	10
Typ. Reverse Current, I_R @ V_R and +25°C	na					
Typical Junction Capacitance — All Types—	@ 0 V 80 picofarads					
	@ 10 V 21 picofarads					

RECTIFIERS (continued)

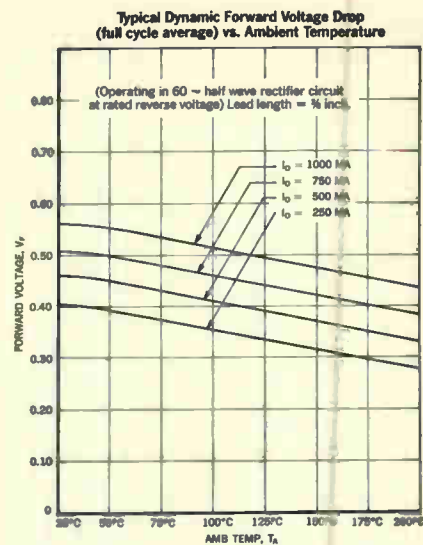
leak rate of less than 1×10^{-10} cc/sec. This low leak rate means longer life and higher reliability. The high voltage and wide temperature operating range (-65°C to 175°C) capabilities of these devices can't be matched by conventional non-hermetically sealed units. Use of a glass body also allows visual inspection during manufacturing. Enhancing the effectiveness of Sylvania's in-process quality control procedures, thus increasing the reliability level of the finished devices.

All devices in this new rectifier series have a wide application range. Packaged in the standard DO-29 outline, they can replace existing glass, epoxy or top hat types wherever higher reliability is required.

Military and industrial applications include use in communications, com-



puter, aerospace equipment as well as in commercial, household and automotive applications. They can be employed in a host of circuit configurations: as a full wave voltage dou-

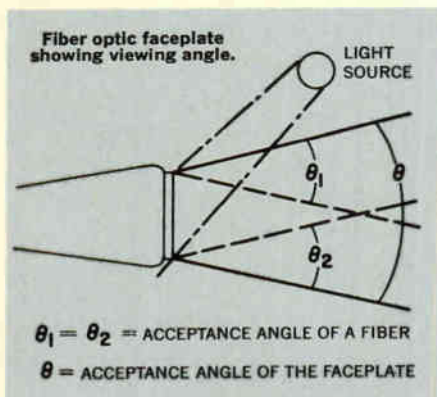


bler; as a half wave doubler, tripler, or quadrupler; as a single phase half or full wave rectifier; or in blocking, damper and surge suppression applications.

CIRCLE NUMBER 300

CRTs

Fiber optic tubes customed to your own system designs



Taking best advantage of fiber optics techniques often requires that standard CRT designs be altered, or completely new ones implemented to meet specific system needs. Thus, choosing the best CRT frequently becomes a job of selecting the right supplier, one qualified to translate your design concepts into reliable tubes that meet the required performance specifications. A first test in this selection process is to consider units already built by a manufacturer, assessing the design and production technology needed to make such units. Outlined here are some of Sylvania's credentials in this area.

The features available in the tubes listed in the table on this page indicate that your fiber optics CRT needs could probably be met by Sylvania. No matter the application, chances are we have designed a tube for it

or similar applications. And if we haven't, years of experience in fiber optics use, design and technology, form the solid base on which to build a unit that will meet your specific needs.

Sylvania has designed many types of high-resolution cathode ray tubes with fiber optics faceplates as well as full faceplate arrays. These custom types have included faceplates of up to 4" x 6", types with magnetic or electrostatic deflection and focus, and also various screen phosphors, aluminized or non-aluminized. Fiber sizes can range from 75 microns down to 4 microns.

In all the units listed in the table, the electron-optical system and fine grain screen achieve very fine trace width with conventional focusing and

deflection units and a simple beam-centering magnet. All use magnetic deflection.

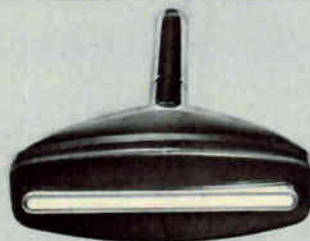
In its conventional version, the SC-3304 screen uses either P11 or P16 phosphors with a $\frac{1}{4}$ "-wide fiber optics strip. This multi-phosphor capability is characteristic of all units listed in the table.

Relatively large area fiber-strip sizes (active areas of $8\frac{1}{16}$ " x $\frac{1}{2}$ ") are key features of Types SC-3507, 3800 and 3876. All three use magnetic deflection, but the SC-3800 employs electrostatic focusing while the other two use magnetic.

A line width of only 0.0008" and an integral encapsulated high-voltage connector for high altitudes are the special design features of the 5-inch-diameter SC-3850.

BASIC CHARACTERISTICS OF FIBER OPTIC CRTs

Tube Type	Fiber Strip Size	Focus	Screen Size
SC-3304	$2\frac{1}{4}$ " x $\frac{1}{4}$ "	magnetic	3 " x $1\frac{1}{2}$ "
SC-3507	$8\frac{1}{16}$ " x $\frac{1}{2}$ "	magnetic	10 " x $3\frac{1}{2}$ "
SC-3800	$8\frac{1}{16}$ " x $\frac{1}{2}$ "	electrostatic	10 " x $3\frac{1}{2}$ "
SC-3850	$4\frac{1}{2}$ " x $\frac{1}{2}$ "	magnetic	5 " dia.
SC-3876	$8\frac{1}{16}$ " x $\frac{1}{2}$ "	magnetic	10 " x $3\frac{1}{2}$ "



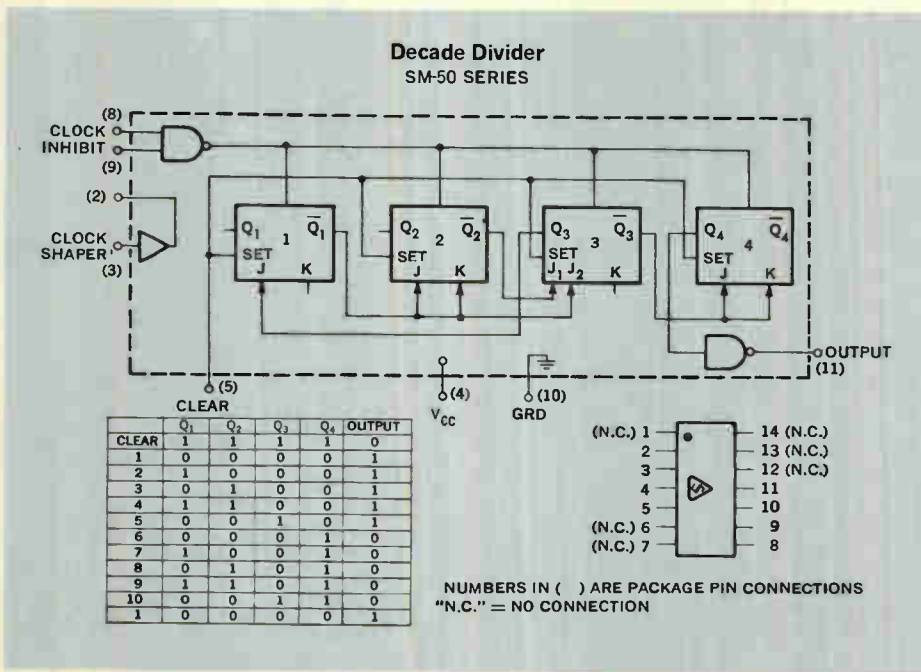
SC-3800 with $8\frac{1}{16}$ " x $\frac{1}{2}$ " fiber optic strip.



SC-3304 with $2\frac{1}{4}$ " x $\frac{1}{4}$ " strip.

CIRCLE NUMBER 301

New single-chip decade frequency divider handles both analog and digital signals



Where can you use the newest Sylvania IC? In multi-channel communications systems, in airborne telemetry, in computer main frame timing, for standard frequency generation, in remote digital-proportional control systems, in electronic organs, in precision timers, in general multiplexing, and perhaps in your next design. It's a monolithic decade frequency divider—on a single silicon chip.

Sylvania's new SM-50 series Decade Frequency Divider, which processes both analog and digital frequencies up to 30MHz, is industry's first single-chip IC capable of performing this function. Producing a symmetrical square wave output, this monolithic device handles digital signals of from dc to 30 MHz and analog signals of 5Hz to 30 MHz. The equivalent of forty integrated circuit gates, implemented by 116 discrete transistors, diodes and resistors, are combined on one standard chip meas-

uring 46 mils by 80 mils.

Input signal shaping is performed in the first stage of this new six-stage device. The buffered first stage is followed by three stages which perform a synchronous division of the signal by five. A divide-by-two in the fifth stage completes decade division. The final stage acts as an output buffer to provide ac and dc fan-out of up to 15.

Two separate input points, one for digital pulses and one for ac signals, are provided. (Digital inputs are de-

finied here as signals having positive voltage with respect to ground, and ac inputs as signals having a negative-going voltage lower than circuit ground.) A simple connection between two external pins (pin 2 and pin 8) is all that is required to implement the ac handling capability.

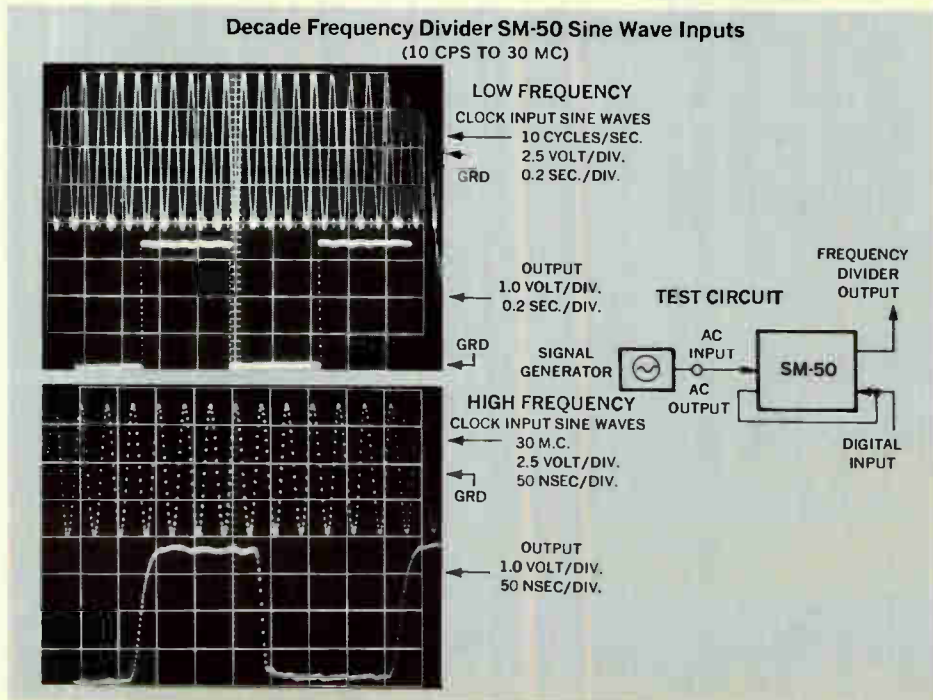
The SM-50 series also features Inhibit and Clear functions. Using the Inhibit feature in a system allows selective division of specific frequencies based on time. The Clear capability allows the decade divider to be recycled at any time.

Input and output characteristics of this functional array match those of Sylvania's two SUHL lines of integrated circuits. Since the decade divider input load is equivalent to a fan-in of one, a standard SUHL gate can drive 15 SM-50s, and a SUHL line driver, as many as 40 of the same units. The SM-50 output stage has SUHL drive capabilities as well as buffering between internal triggering and external load.

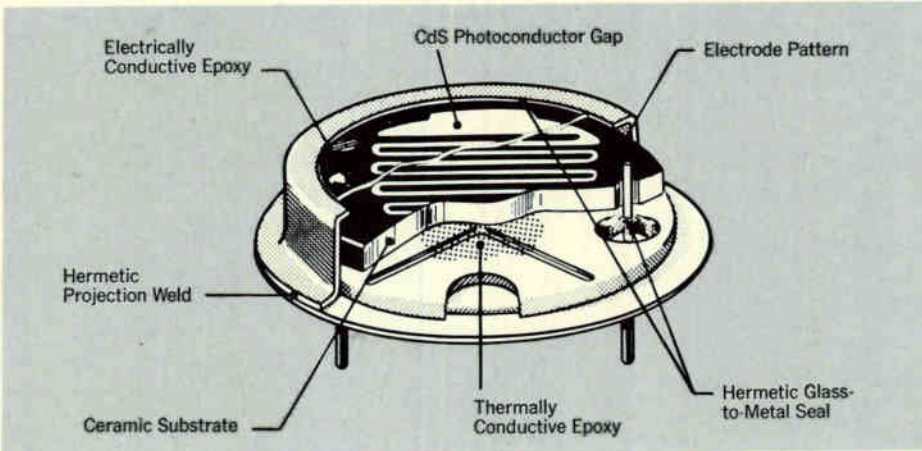
The SM-50 decade divider is characterized for two temperature ranges (-55° to +125°C, 0° to 75°C), operates from a single 5-volt source and is available in Sylvania's dual in-line plug-in package and the TO-85 flat package.

CIRCLE NUMBER 302

PERFORMANCE CHARACTERISTICS	
Characteristic	Typical Value
Digital input	dc to 30 MHz
Analog input	5 Hz to 30 MHz
Output	Symmetrical square wave 1/10 input frequency
Propagation delay	24 nanoseconds
Logic swing	
Output logic "0"	0.25 volts
Output logic "1"	3.3 volts
Noise immunity	+1 volt
Power dissipation	120 mW
Fan-out	6 to 15



Now, real stability in outdoor lighting control cells



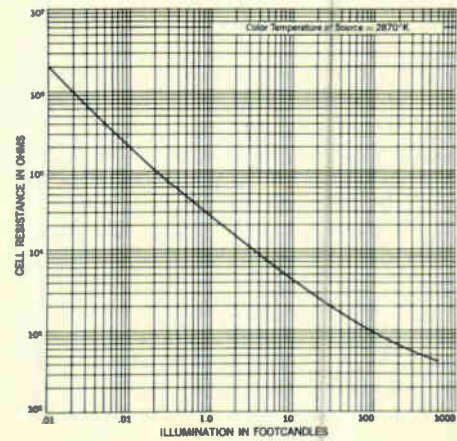
A change of only 1.5% in cell current after 500 hours at 0.5 watts dissipation...that simple phrase sums up all the design and process improvements that have gone into making Sylvania's new Type 7163 photoconductive cell. If the 1.5% figure doesn't impress you, check some competitive units; you'll find over four times (6.9%) as much change.

The Type 7163 head-on photoconductor, designed for outdoor lighting circuits, has a demand rating of 3/4-watt and a continuous rating of 1/2-watt. This cell easily operates relays directly in outdoor lighting control and industrial circuits. A response time faster than is found in the standard T-2 and T-4 photoconductor lines makes the 7163 one of the fastest cadmium sulfide cells and, therefore, a versatile vehicle for more industrial applications.

Design of the unit stresses rugged construction. The device starts as a

thin layer of cadmium sulfide deposited on a high-alumina ceramic wafer which is then bonded to the base with a thermally conductive epoxy. This thermal bond provides efficient conduction of heat away from the photosensitive material, insuring its stability at high current levels while eliminating hot spots. An electrically conductive epoxy bonds the leads to the photoconductive pattern, giving a permanent and reliable electrical connection.

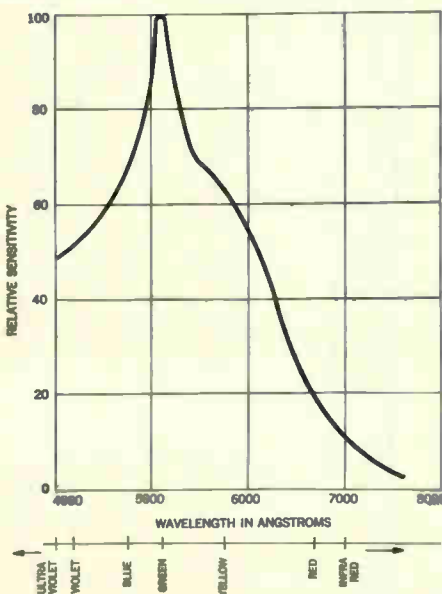
The benefits of this rugged construction would be lost if conventional welding techniques were used in final assembly to seal the case to its cover. To overcome the limitations of conventional welding, Sylvania uses a projection welding technique. The projection welding allows better control of the internal atmosphere surrounding the cell. This advanced type of dry box welding involves techniques similar to those used in



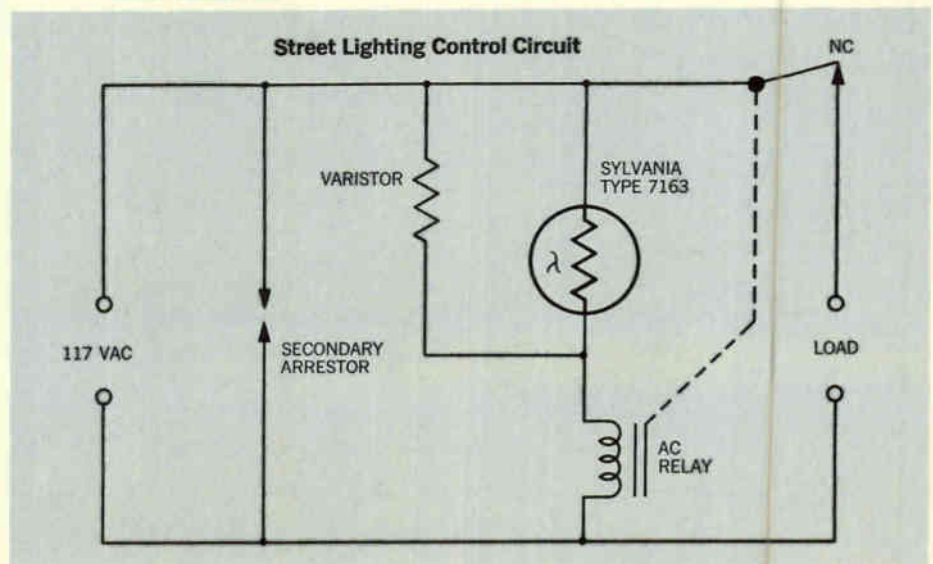
transistor assembly. Projection welding minimizes the amount of heat that the sensitive photoconductive pattern is subjected to during processing. It also minimizes the gas and moisture generated in the enclosure during sealing.

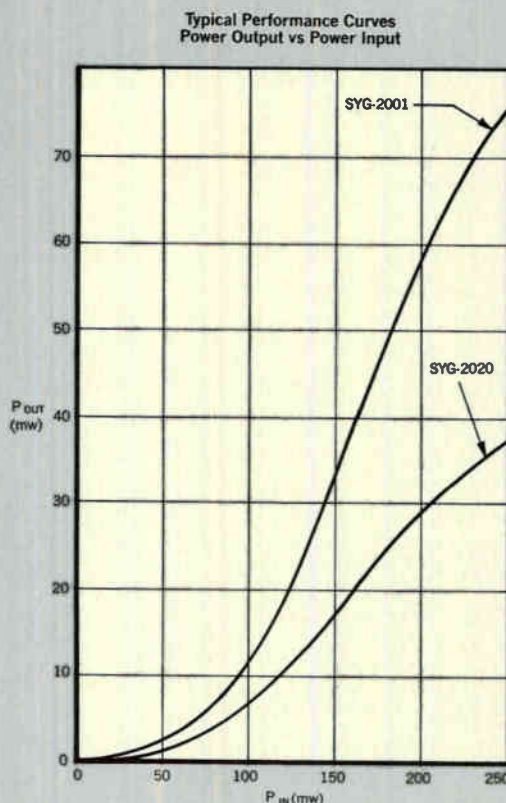
The result of all this care during processing is a device with stable electrical properties. Impedance is not greatly affected by changes in ambient temperature and is not voltage dependent. Also, the ac and dc cell impedance is essentially the same, meaning the unit can be treated as pure resistance in designing circuits.

The 7163 is orientated to north sky illumination and detects the blue end of the spectrum. It can be adjusted to provide uniform turn-on times, making it ideal for lighting streets (it meets utility specifications), parking lots, window displays, and work or recreation areas.



CIRCLE NUMBER 303





How to combine efficiency and economy in tripling X-band frequencies

When Sylvania introduced its high-frequency wave guide tripler SYG-2001 last fall, it was hailed as an excellent replacement for traditional Ka-band sources. The SYG-2001 offers designers a simple way to convert X-band power into economical output up to 37 GHz. In many applications, a new Sylvania tripler, the SYG-2020, reduces even further the cost of obtaining reliable operation in the same frequency range. Now, many low-power commercial communications, radar system, industrial monitoring and test equipment applications will no longer be held back by high initial cost of the microwave components.

Significant cost reductions result when Sylvania's new SYG-2020 or SYG-2001 wave guide triplers are used to replace Ka-band klystrons. The SYG-2020 can be used for less stringent output requirements. The

availability of the SYG-2020 means the microwave system designer can choose the unit that is better suited for his particular application. No longer is he required to pay for performance levels he doesn't need.

The SYG-2020 and SYG-2001 are fixed-tuned X- to Ka-band frequency triplers. Employing a special Sylvania (GaAs) varactor diode, these multipliers can be driven by either a klystron or a solid-state X-band generator.

SYG-2020 characteristics provide for a 10% minimum efficiency and minimum power output of 20 mw. Ratings for the SYG-2001 are 25% minimum efficiency and 50 mw minimum output. The two units are mechanically interchangeable. Both types are available with a minimum frequency output of 26.5 GHz (8.85 GHz input) and a maximum output frequency of 37.2 GHz (12.4 GHz input) having a bandwidth of 150 MHz.

They can be mounted in any position without degrading performance. Without an X-band klystron or wave guide transition attached, each type is 2.75" long and weighs 6 ounces.

Long-range performance reliability levels of these units are excellent. In tests still in progress, devices with 22,000 hours of steady operation continue to meet performance specifications without the need for any adjustments. Under normal conditions, operating life is limited primarily by the life of the driving source.

The economical and versatile approach to Ka-band power offered by the SYG-2020 and SYG-2001 opens up wide application areas. Recent use includes pumps for parametric amplifiers, high-resolution radar for ballistic research, and low-power test equipment.

You can improve life and performance of your mobile communications equipment

The very nature of mobile communications places severe operating conditions and service requirements on receiving tubes. To be worth their salt, the tubes should maintain high levels of performance in an environment of: high impact shock, severe vibrations over extended periods, wide thermal and humidity excursions, abnormally fluctuating operating voltages, frequent on/off cycling, and extended standby operation. The tubes must withstand these conditions while providing a long life of stable and dependable operation. And when a tube is to be changed, its replacement must be capable of bringing the equipment back to its initial performance level.

Conventional commercial-type receiving tubes are not necessarily designed to meet the requirements listed above. Sylvania's highly reliable mobile communications tubes do meet them. Specifically tailored for mobile use, they feature design innovations and manufacturing controls which eliminate the major causes of failure. And these tubes are available now from your Sylvania distributor.

The 24 types in Sylvania's special mobile line don't look much different than conventional receiving tubes. They just work better, and for a longer time. The improvements are inside the tube, in the materials and processes used to make them.

These improvements in tube construction are in turn reflected in up-

graded circuit performance. For example, a common problem is speaker noise, often generated by leakage between cathode and grid and between grid and plate as tubes age. This happens in conventional tubes because after a period of time material can boil off the hot cathode causing shorts, leakage, and the resulting static. In Sylvania's line of special tubes for mobile communications, this shortcoming is negated by use of a specially tailored powdered metal cathode. Other improvements are designed to overcome specific environmental conditions common to mobile applications.

Open and shorted elements resulting from high impact shock are eliminated by a ruggedized tube assembly which includes double mica insulation at key points, U-bolt locked mounts, and sturdy controlled-atmosphere welds. This rugged construction also means the vibration occurring in mobile equipment can be met. Impact shock testing at 350-g and long-term testing at 2.5-g vibration backs this up.

Specially formulated glass envelopes and bases, precision annealed for optimum stress and strain patterns, enable the tubes to be unaffected by extreme temperature changes and high humidity.

Long life and excellent emission at very low heater voltage are a result of Sylvania's unmatched powdered metal cathode technology. This tech-

nology permits the adding of controlled amounts of trace materials to the extremely pure base metal to get precisely the performance and life characteristics desired. In addition to being tailored for high activity, the powdered metal cathode also reduces sublimation at high temperatures. As described above, this means a major cause of interelectrode leakage paths is eliminated. A final plus from this technology is the elimination of unwanted trace materials which build up interface resistance layers during standby operation.

Use of Rhenium-Tungsten heater wire virtually eliminates catastrophic failure of the heater-cathode assembly because of heater embrittlement or breakage. Stress testing shows that these improved heaters allow the tubes to take up to 140% above rated heater voltage for 15,000 cycles.

Uniformity within tube types is assured through tight control of characteristics about rated values for each lot and from lot to lot.

These are some of the reasons why, even though these special mobile tubes don't look superior when sitting on your Sylvania distributor's shelves, they'll act superior in your equipment. One evidence of this superior performance is Sylvania's "B" version of the popular 6-volt 6146 beam-powered pentode which has the highest levels of efficiency and sensitivity ever offered in this tube.

CIRCLE NUMBER 305

Special Mobile Communication Types

6146 A.-B	7054
6660/6BA6	7055
6661/6BH6	7056
6662/6BJ6	7057
6663/6AL5	7058
6664/6AB4	7059
6669/6AQ5A	7060
6676/6CB6A	7061
6677/6CL6	7167
6678/6U8A	7258
6679/12AT7	7551
6680/12AU7A	
6681/12AX7	

NOTE: 6000 series tubes are designed to work from 3-cell batteries; 7000 series tubes, from 6-cell batteries.



New 22" color bright 85™ tube to meet growing design needs

Patent No. 3,243,625 was awarded this April to GT&E Laboratories for developing the now-famous rare-earth color picture tube introduced two years ago by Sylvania. It was pointed out in June, 1964, that the tube was 43% brighter in monochrome, had redder reds, whiter whites, and superior color registration—among other strong advantages. Today, other tube manufacturers are producing tubes using the same patented concepts. Not a company to rest on its laurels, Sylvania continues to extend rare-earth phosphors into newer tubes. Here's news on the fifth in the color bright 85 tube series.

Sylvania is now sampling its newest rectangular color picture tube to set manufacturers. The 22" color bright 85 tube will fill a strong need for sets that will best suit most residential living rooms. Until now, most rectangular-tubed color sets were 19" table models or 25" consoles. The latter is particularly well suited to large-room viewing.

The new 22" tube (Sylvania Type RE22KP22) rounds out a color bright 85 line consisting also of 15", 19" and 25" rectangular types as well as the 21" round. This newest type produces a color or monochrome picture measuring a minimum of 17.430" by 13.628" in a minimum projected area of 226 square inches. Spaced 120 degrees apart are the three electrostatic-focus guns with axes tilted toward the

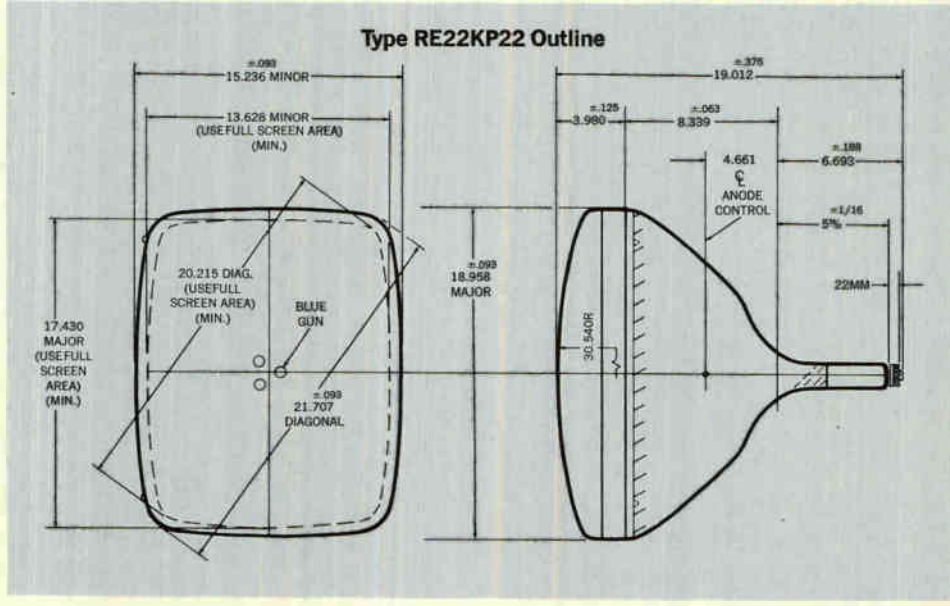
tube's axis to facilitate beam convergence at the shadow mask. Internal magnetic poles provide individual radial convergence of each beam.

The tricolor phosphor dot screen is

the result of Sylvania's own special screening process, a major reason for the favorable difference between Sylvania's rare-earth tubes and the others.

CIRCLE NUMBER 306

GENERAL DATA	
Focusing Method	Electrostatic
Deflection Method	Magnetic
Convergence Method	Magnetic
Deflection Angles (Approx.)	
Diagonal	90 Degrees
Horizontal	79 Degrees
Vertical	63 Degrees
Faceplate (Spherical)	Filter Glass
Light Transmittance (Approx.)	
Faceplate	69 Percent
MECHANICAL DATA	
Minimum Useful Screen Dimensions	17.430 x 13.628 In. (max. assured)
Minimum Useful Screen Area	226 Sq. In.
Overall Length	19.012 ± .375 In.
Neck Length	6.693 ± .188 In.
Weight (Approx.)28 Pounds



HOT LINE INQUIRY SERVICE

Use Sylvania's "Hot Line" inquiry service, especially if you require full particulars on any item in a hurry. It's easy and it's free. Circle the reader service number(s) you're most interested in; then fill in your name, title, company and address. We'll do the rest and see you get further information almost by return mail.

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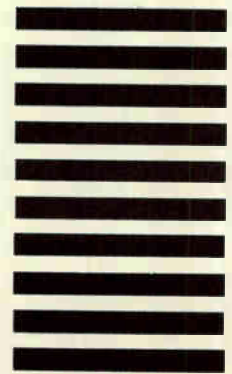
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Especially for computers, a concept without a limit

By now it's old news that the computer industry has adopted integrated circuits for their high reliability, reduction in size, low power dissipation and reasonable cost. Naturally, Sylvania is proud to have contributed to this situation. Now, having established this base, the computer industry is ready to accept an expanded utilization of these values.

The obvious expansion direction is the performance of more complex logic functions per package. But, immediately, the questions of which functions, how complex a function, and how to implement these functions, arise. The answers to these questions must be measured against the same base: reliability, reduction in size, power dissipation, and cost.

The answer to the first question, certainly, is the repetitive functions to attain the volume necessary to achieve low cost. The answers to the other two questions are more difficult and more than one engineering approach exists.

The logic portions of a computer can be implemented using just one type of simple gate, a concept used for certain computer applications. Thus, one approach to more complex functions could be to have an array of gates on a slice which could be interconnected by metallization into

arbitrary patterns, in much the same manner as packages are presently interconnected. However, general-purpose computers are normally designed with a variety of gate types for economic reasons. Fan-ins of 2 to 8 and fan-outs from 2 to 20 might be required. Thus the gate array concept, although possible in principle, does not appear sound from an economic point of view.

Another possible approach is as follows:

1. Analyze the various logic arrangements used in a variety of computers and select those functions which have general and repetitive usage.
2. Accept the fact that more than one complex logic arrangement is necessary, consider a family of such devices, and establish ground rules for the mating of the members.
3. Having selected those logic functions whose complexity is compatible with existing package and process technology, design these functions from a *circuit* design approach rather than from a *logic* design approach.
4. Lastly, recognizing the reliability and economy of interconnections within the package versus on the circuit board, design the function to minimize the amount of external wiring.

This 4-part approach was the one

selected by Sylvania and resulted in the Monolithic Digital Functional Array. The first of these arrays—the Fast Adder family, the Four-Bit Register and the Decade Divider—have been developed according to the above rules. In each case the inputs and outputs are buffered to withstand the agonies of the external world. Internally, circuit design ingenuity has been used to give high performance with minimum component count and power dissipation. In addition, the outputs provide only the true output and the inputs are designed to require only the uncomplemented variables. This design more efficiently uses the available package leads and reduces the external wiring.

This concept can be carried only so far before the circuit design problem becomes too difficult and time-consuming. At this stage, an advance to the unit cell array concept, in which the unit cell is now a Digital Functional Array is desirable. Thus, as technology develops, it becomes possible to consider in a single package 8-, 16-, or 32-bit registers and 4-, 8-, 16- or 32-bit adders. There is no limit to the final destination of this concept.

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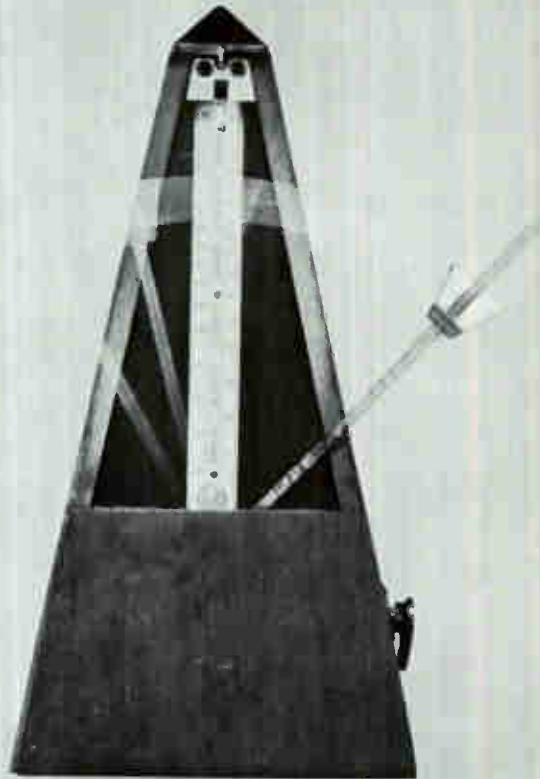
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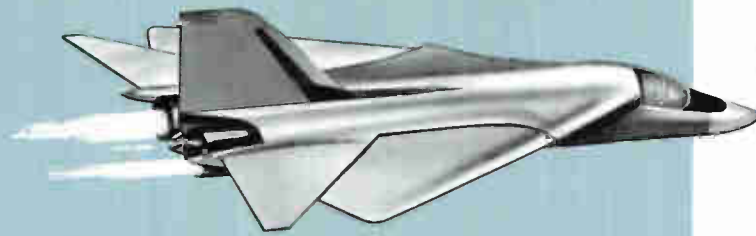
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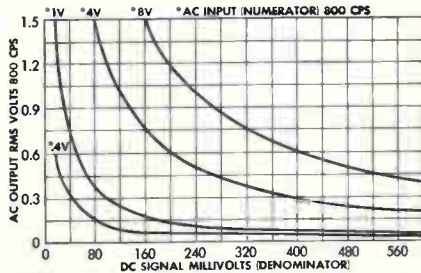
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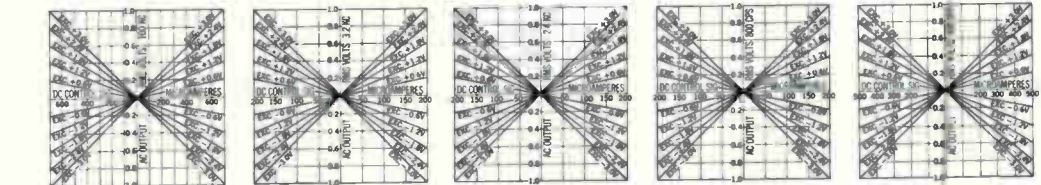
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TYPE NUMBER	MCM-827 2	MCM-836-1	MCM-845-1	MCM-847 1	MCM-848 1
Accuracy (% Error of Theoretical Prod.)	1% Maximum	Approx. 0.5%	Less than 1%	2% Maximum	5%
Input Control Signal Range	0 to $\pm 800 \mu\text{a}$ (DC to 5,000 cps)	0 to $\pm 200 \mu\text{a}$ (DC to 200 cps)	0 to $\pm 200 \mu\text{a}$ (DC to 100 cps)	0 to $\pm 200 \mu\text{a}$ (0 to 50 cps)	0 to $\pm 500 \mu\text{a}$ (DC to 40 cps)
DC Resistance of Input Signal Range	500 ohms	12.5 K ohms	12.5 K ohms	12.5 K ohms	70 K ohms
Input AC Sig. Range Amplitude, Freq.	0.6 V to 3 V RMS Phase Rev. 100 KC	0 to 3 V RMS Phase Rev. 3200 cps	0 to 3 V RMS Phase Rev. 2400 cps	0 to 3 V RMS Phase Rev. 800 cps	0 to 3 V RMS Phase Rev. 400 cps
AC Output Product Range	0 to 1 V RMS @ 100KC	0 to 1 V RMS @ 3.2 KC	0 to 1 V RMS @ 2.4 KC	0 to 1 V RMS @ 800 CPS	0 to 1 V RMS @ 400 CPS
Null at Max. AC Signal, Zero DC Sig.	15 mv RMS	10 mv RMS Max.	10 mv RMS Max.	10 mv RMS Max.	5 mv RMS Max.
Output Impedance	650 ohms	13 K ohms	12 K ohms	8 to 10 K ohms	15 K ohms
External Load	10 K to 100 K ohms	50 K ohms	50 K ohms	50 K ohms	50 K ohms
Temperature Range	-55°C to +85°C	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C	-55°C to +100°C
Null Drift over Temp. Range	0.1% of f.s.	0.1%	0.1%	0.1%	$\pm 0.2\%$
Accuracy Variation over Temp. Range	$\pm 0.5\%$	$\pm 0.2\%$	$\pm 0.2\%$	$\pm 0.2\%$	1%
Hysteresis in % of Max. Input DC Sig.	0.1%	0.1%	0.1%	0.1%	0.25%
% Harmonic Dist. in Output Prod. Wave	Less than 5%	3%	3% to 5%	5% Maximum	5%
Overall Dimensions (in Inches)	$\frac{5}{8} \times \frac{25}{32} \times \frac{1}{2}$	$\frac{37}{64} \times \frac{25}{32} \times \frac{1}{2}$	$\frac{37}{64} \times \frac{25}{32} \times \frac{1}{2}$	$\frac{37}{64} \times \frac{25}{32} \times \frac{1}{2}$	$\frac{37}{64} \times \frac{25}{32} \times \frac{1}{2}$
Approximate Weight (in Ounces)	0.26 oz.	0.26 oz.	0.26 oz.	0.26 oz.	0.26 oz.

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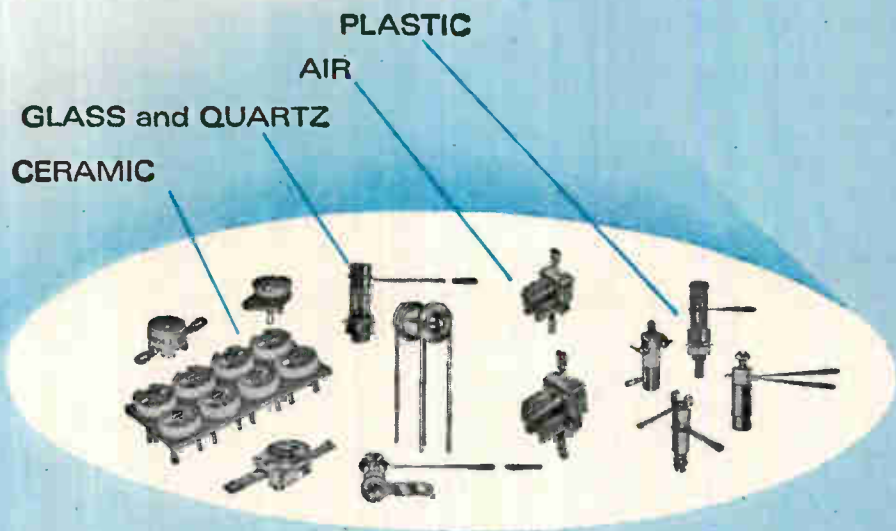
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<i>Manual Balancing</i>	OPERATION	<i>Fully Automatic</i>
<i>5-Digit Decade Dials</i>	READOUT	<i>4-Digit Nixie Display</i>
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These digital thermometers/temperature controllers offer a choice of features for high precision temperature measurement and control applications.

For temperature measurement, both operate by comparing the resistance of a sensor element of platinum (the material whose characteristics define the International Temperature Scale) with an internally generated reference function obtained by a unique resistance analog network that precisely duplicates the temperature-versus-resistance change of platinum.

Temperature measurements are obtained with the Model PT-2 by manually balancing a modified Kelvin

Bridge by means of 5 decade dials and a temperature deviation meter. In its most sensitive range the meter reads 0.01°C full scale which results in a resolution of better than ±0.0005°C.

The Model DTS-1 provides a fully automatic digital indication of temperature. In addition, this information is available in binary or 10-line decimal coded form for printer or computer input and in pulse code modulated form for telemetry applications.

For temperature control, both instruments provide an analog signal proportional to the difference between

the desired temperature set on the instrument panel and the sensed temperature. This signal may also be used for recording temperatures about a preselected set point, for expanded scale measurements, or for high/low alarm.

Complete information is available in Bulletins No. 122 (Model PT-2) and No. 118 (Model DTS-1).

*Subject to operating range of actual sensor used.



Electronics Review

Volume 39
Number 13

Space electronics

97-pound winner

For a program that has been plagued for eight years with technical problems and management revision, the mission was remarkable. Defense officials were unstinting in their praise when news flashed from Cape Kennedy on June 16 that the experimental and usually unreliable Titan 3C booster had placed its package of seven communications satellites into 18,200-nautical-mile-high polar orbits. A few hours later, ground stations around the world reported all seven spin-stabilized repeater satellites were relaying test messages.

The success of the mission indicated more than the engineering skill of the satellite maker, the Philco Corp.'s Western Development Laboratories, in Palo Alto, Calif. It indicated that the bugs which have been harrasing the Martin Co.'s Titan 3C had been ironed out; also, because of the complex launch, it proved that the rocket can handle a multitude of missions. To accomplish the latest trick, the booster had to fire three times in space so it could deposit its payload in various orbits.

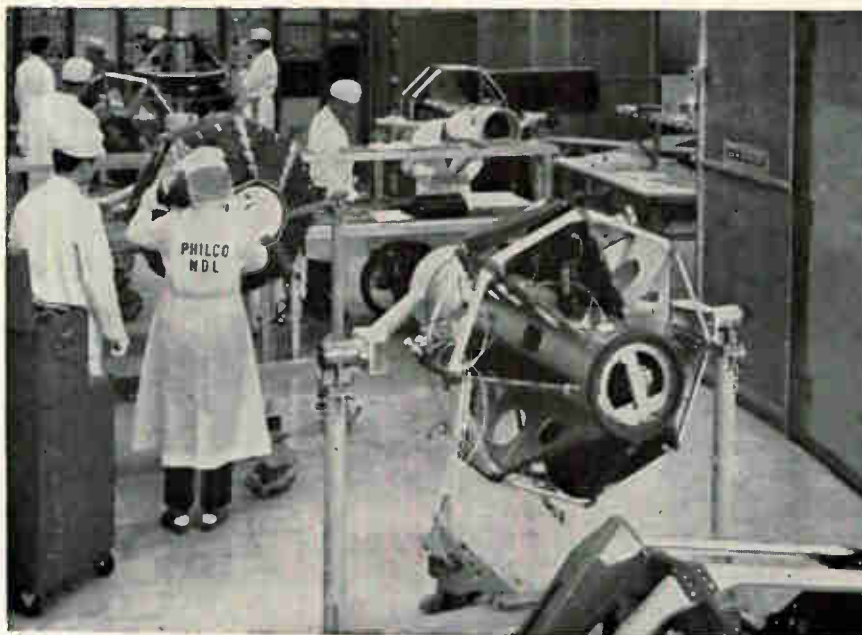
To provide backup for the 97-pound communications satellites, two more packages of satellites will be lofted into orbit this year, for a total of 22, to serve in this Initial Defense Communications Satellite Project.

Point of view. Depending on how it's calculated, the mission's scheduling and cost can be called either highly successful or a bust. At a jubilant press conference called after the launch, Air Force Secretary Harold Brown described the program as "very carefully managed." He said that it was only a few million dollars over its nearly \$100-million estimated cost of two years ago and was only a few

months behind schedule. But a look at the history of the military's plans for satellite communications reveals that because of some ill-fated starts, the over-all project cost \$400 million and was eight years abuilding.

The first plans for a communications satellite system date back to 1958; those plans were scrubbed in 1962 and new plans were drawn up.

At present, five ground terminals are in use. Two are veterans of a number of space communications missions, the 60-foot dishes at Fort Dix, N.J., and Camp Roberts, Calif. The Hughes Aircraft Corp. supplied the first three of an undisclosed number of more modern terminals with 40-foot dishes, these installations are in Hawaii, the



Assembly line for the production of military communications satellites. The Philco Corp.'s Western Development Laboratories built 35 of the satellites for the Initial Defense Communications Satellite Program.

In 1963 the plans were again sharply revised and Defense Secretary Robert S. McNamara approved the Initial satellite mission; this is the mission that Brown called "carefully managed." Looking back over the eight-year development program, Brown concluded that the military saved "tens of millions of dollars" by favoring the Initial mission over the earlier two missions.

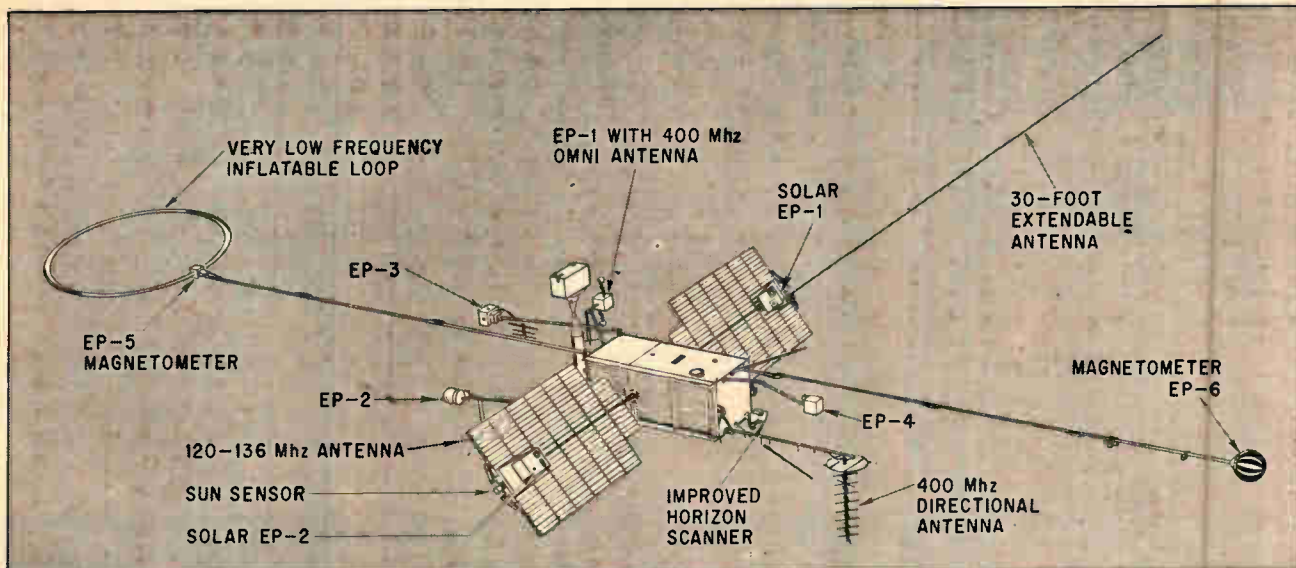
Ready for Vietnam. Although the network is still officially described as experimental, it will be used, when needed, to relay messages between Washington and Vietnam. To provide this service, Brown disclosed, a ground station will be ready in Vietnam by summer's end.

western Pacific and West Germany.

Riding into orbit with the seven despun satellites was an eighth; an experimental craft that is gravity-gradient stabilized. It was developed by the General Electric Co. and if it proves successful (and all indications are that it's working perfectly) the next series of military satellites may employ the earth's own gravity for stabilization. This marks the first time such a system has been flown so high.

No complaint

The National Aeronautics and Space Administration, which labeled the first two Orbiting Geo-



OGO's experiment packages

Experiment package-1. Ion trap to measure concentration and energy distribution of particles.

EP-2. Electrostatic analyzer with channeltron detectors to measure electrons and protons simultaneously; and radio beacon transmitting to a ground station to measure large-scale horizontal irregularities in electron distribution.

EP-3. Interplanetary dust particle detector; and radio beacon transmitting to a ground station to measure large-scale horizontal ir-

regularities in electron distribution.

EP-4. Electron spectrometer to measure electron energy spectrum and ionization; and Geiger-Mueller counters to monitor galactic cosmic radiation and the earth's trapped radiation.

EP-5. Instrument to measure terrestrial and other emissions in the very low-frequency range, using nine-foot diameter loop antenna; and magnetometer to study magnetic field fluctuations.

EP-6. Rubidium vapor and flux-gate magnetometers to measure the magnitude and the direction

of magnetic fields.

Solar EP-1. A sweep-frequency receiver to measure dynamic radio spectra of solar radio-noise bursts, scintillation detector to measure cosmic ray fluxes, and a double gamma ray spectrometer to measure positrons and solar photon bursts.

Solar EP-2. Gegendstein photometry in the ultraviolet, green and infrared spectrum regions, electrostatic analyzer to measure proton concentration, and Faraday cup probes to measure proton flux and energy spectrum.

physical Observatories failures even though most of their experiments are still functioning, can find no fault in the third OGO satellite, launched earlier this month.

NASA's Goddard Space Flight Center, Greenbelt, Md., says the stabilization of OGO 3 is "ideal" and expects all 21 experiments aboard the craft to continue to transmit data on the relationship between the sun and earth's environment. OGO 3 can send up to 200 billion (nine-bit word) measurements in a year, but Goddard is expected to record data only 10% of the time. NASA candidly concedes that evaluation of even that amount of data will take years.

Go for OGO. Problems in stabilization cut down the usefulness of the first two OGO satellites. Even so, the contractor for the craft, the TRW Systems group of TRW, Inc., Redondo Beach, Calif., has said: "... in spite of the earlier mal-

functions . . . OGO's 1 and 2 have performed in a very reliable fashion."

The facts largely bear out the TRW contention. OGO 1, which has been in orbit since September, 1964, is still sending data from 17 of its 20 experiments and OGO 2 has been transmitting from 19 of 20 experiments since it was launched last October.

Short-sighted. The major difference between OGO 3 and its predecessors is in the stabilization. The effectiveness of OGO 1 was hampered when the boom appendages failed to deploy fully and obscured the view of the horizon scanner. OGO 2 missed total success when the infrared horizon scanners confused the earth with high-altitude cold clouds in the tropics.

Early in the OGO-3 mission Goddard scientists feared another partial failure when only very weak signals were received from

the range and range-rate sensor, a highly accurate device for measuring spacecraft location. But for some reason, unknown to NASA, signal strength of the spacecraft sensors picked up after a week in orbit.

Among the jobs OGO 3 is to perform is to take a closer look at particles discovered recently in the transition and magnetospheric regions by Explorer satellites. Other space chores include studies of cosmic rays, plasmas, trapped radiation, magnetic field, the ionosphere, optical and radio emission and micrometeoroid investigations.

On the nose. The satellite is in a near perfect orbit for its mission. Apogee, at 75,768 miles, is only 232 miles short of flight plans and perigee is exactly 170 miles, as planned.

NASA plans to launch three more satellites in the OGO series. The next is scheduled during the first

quarter of 1967. Its mission will be to continue studies begun by earlier OGO crafts, and, in addition, to probe low-energy auroral particles and solar flares. Late in 1967, the fifth OGO will stress electron-measurement and thermal-energy studies. The final craft in the series, scheduled for launching in mid-1968, will make atmospheric and ionospheric studies at a time when the sun's radiation bombardment is expected to be high.

Moon portrait

With the tremendous triumph of Surveyor's soft landing on the moon still fresh, United States space scientists are preparing for two other dramatic lunar study feats—wide-area mapping and a comprehensive study of the lunar environment.

On June 30, or a few days later, an anchored interplanetary monitoring platform (AIMP) will be lofted into an orbit around the moon to send back information on what man may expect on the lunar surface. About two weeks later, a complex photographic laboratory—called the lunar orbiter—will go into an orbit around the moon. It will snap high-resolution photographs to make a map to help astronauts pick a landing site for

the Apollo spacecraft when men land on the moon for the first time in 1969.

All three missions—Surveyor, AIMP and the lunar orbiter—complement, but do not duplicate one another. Surveyor took close-in photos of a small area of the moon, which proved that at least some parts of the lunar surface will support the weight of a spacecraft. AIMP will take long-duration readings on solar and galactic cosmic rays, proton and electron densities, solar winds and other factors affecting the climate of the moon and its magnetic field. The lunar orbiter will do a comprehensive job of mapping a wide strip along the midline of the moon, where astronauts will take their first steps on the lunar surface.

Lunar geography. The AIMP will also perform selenodetic work—a study of the geography of the moon—with its range and range-rate instrument. Telemetry signals through the moon's weak atmosphere will give scientists another clue to what's ahead for space travelers. The Westinghouse Electric Corp. installed the nine experiments.

The lunar orbiter, a \$100-million project, will include a completely self-contained photograph processing laboratory. During its one-month mission, scientists expect

the craft to take 190 dual-exposure frames of film and provide about one million times the area coverage of the Ranger spacecraft series, which crashed into the moon last year.

Four other lunar orbiters will be launched in the next two-and-a-half years. Together they will map about 20% of the lunar surface.

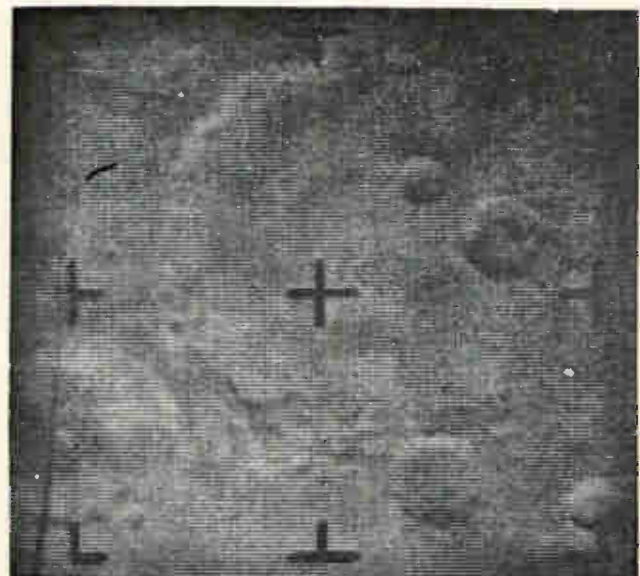
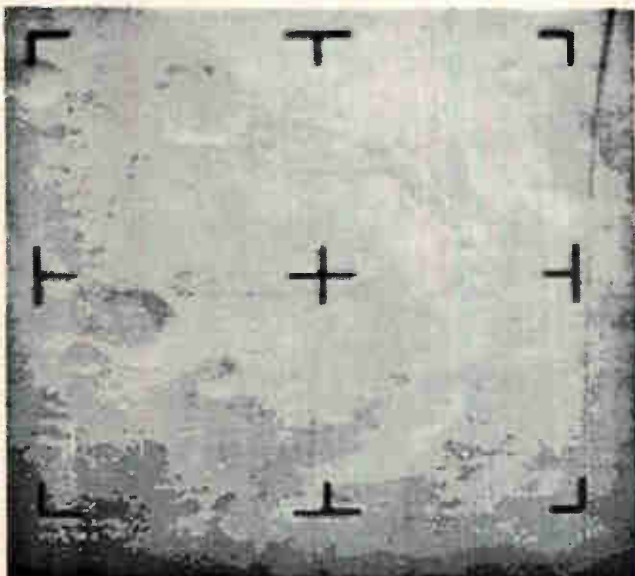
Instrumentation

Touch-type drawing

A scientist, frustrated by a nerve-racking five-hour wait as the binary code from Mariner 4 slowly resolved into a photograph, has come up with a simple teleprinter system that provides an immediate look at the photographic results from deep space missions.

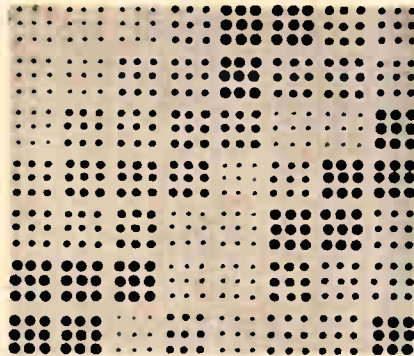
Henry Canvel of the Space Sciences division of Jet Propulsion Laboratory developed the system, which forms a picture in a half-tone format as each binary word is received.

This quick-look capability will allow an evaluation of the quality of incoming pictures so that corrective actions may be taken if needed and possible. Largely for this reason, the next Mariner-Mars fly-by



Quick picture of Mars (left) is provided by a half-tone typewriter developed by an engineer at the Jet Propulsion Laboratory. Final picture of the same area of Mars, after computer processing, is on right.

21	21	21	25	33	33	28	25
21	21	25	25	33	28	28	25
21	25	25	28	28	21	21	33
25	28	28	28	21	25	33	33
25	25	28	21	21	33	33	25
33	33	33	21	21	28	25	25
33	33	21	25	21	25	25	33



Binary digits received from Mariner 4, left, are translated into series of half-tones at the right. Each nine-dot block makes up an element of the picture.

in 1969 will employ the system. The photographic quality from Canvel's teleprinter system is not as good as that eventually obtained by computer and video processing but the advantage is in the time saved.

Black and white. The system uses a standard teletypewriter, slightly modified to block out part of the keyboard, change the type style and move the characters closer together. For the experimental system, only eight keys were used. The operational model will probably use 14. The type bar for each key has been replaced by a $\frac{1}{16}$ -inch square slug containing raised dots. The dot sizes vary from slug to slug—the larger the dot, the less white space and the print-out will be darker. For black, the slug is solid; for white, the teletypewriter skips the space.

In testing his teleprinter system, Canvel used tapes from Mariner 4 to prove its capability. He found that photos produced by his system and by the computer had errors. But he said foreknowledge of bit errors may be of value to a technician processing the data for photographic reproduction; the teleprinted system will provide this.

The slow bit rate transmission of deep space missions— $8\frac{1}{3}$ per second in the case of Mariner 4—will not be speeded up by the system. Eight hours and 35 minutes passed between the receipt of the first and the final bit from Mariner 4. Each photograph sent by the spacecraft was composed of 200 lines, each with 200 dots. Each dot was identified by a binary code that established its degree of shading between black and white. Only after

each bit was received could space agency personnel begin the complicated scan and read-out process.

Communications

Timely message

Until now, multiple access to communication satellites has been achieved by dividing up the frequency bandwidth among the continuously transmitting ground terminals. This year may mark the start of a new trend, however, as both the Communications Satellite Corp. and the National Aeronautics and Space Administration plan to conduct their first experiments with time-division multiple-access systems.

Comsat constructed its system from commercial components and will begin testing it early next month with the Early Bird satellite, which operates with two terminals simultaneously. NASA's system will be tested later this year with either the Relay 2 medium-orbit satellite launched in 1964 or the Applied Technology Satellite scheduled for launching late this year. The International Telephone and Telegraph Corp.'s Federal Laboratories in Nutley, N.J., is building synchronizing equipment for NASA and will test the entire system under a \$360,000 contract.

On time. With time-division multiple access, each ground terminal transmits for only a fraction of any second, but may utilize the satellite's entire power and bandwidth.

Since only one signal is present at the satellite at any one instant, time division eliminates a number of problems, including the intermodulation distortion that occurs with frequency division.

Present frequency-division systems use power efficiently (an important consideration, since present satellites have limited power capabilities), and it is expected that sophisticated coding techniques will give time-division systems the same power efficiency while permitting operation with reduced bandwidth. This will be a great advantage as demands for communication channels crowd the available bandwidth.

The problem of operating with terminals having various channel requirements is easily solved with time-division multiple access because a terminal can increase its channel capacity merely by increasing the length of its time slot. Of course, the additional time slots must be available and other stations will have to synchronize their transmissions, but the changeover is relatively simple.

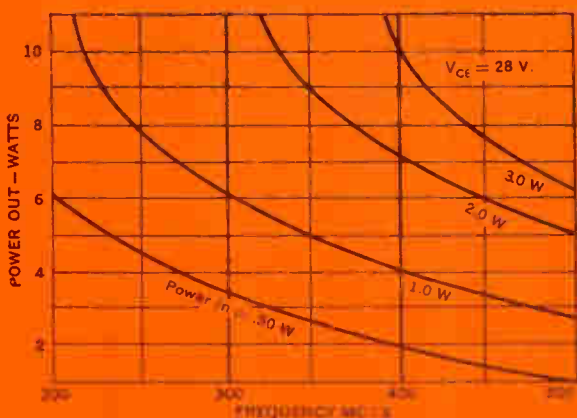
"All that has to be done is to move a few switches in each terminal since each additional carrier in a frequency-division system, however, when one terminal needs more channels, all the terminals must shift frequencies unless channels are available in adjacent transmission bands.

Power grab. Time synchronization is expected to be simpler than frequency-division multiple access; which requires controlling the power transmitted by each terminal since each additional carrier robs some of the satellite's power from the other signals. In frequency division, as the number of transmitting terminals or the number of channels is varied, the transmitted power has to be changed to keep the power constant at the ground receivers. With time division the power level is not affected by other signals because they are not simultaneously amplified.

This flexibility would be useful for Comsat because channel requirements vary both from country to country and almost hourly dur-

TRW ANNOUNCES

10 W 400 Mc 60% η



NEW UHF POWER TRANSISTOR

The new TRW 10W/400Mc (2N4040) UHF Power Transistor provides full rated performance in conventional circuits...no need to resort to emitter tuning or other techniques which contribute to circuit instability. TRW 2N4040 is available now at competitive prices.

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TRW designs and manufactures high performance transistors for the communications industry and specialized types for military and industrial applications.

TRW SEMICONDUCTORS

ing the day, depending on the communications traffic. Comsat's system will use pulse-code modulation of the voice signals, with each terminal capable of transmitting 24 multiplexed voice channels. The pulse-code signals in turn modulate the carrier signal by shifting its phase 0° or 180°, called phase-shift keying. "The system," one Comsat representative says, "is the simplest possible to give us a fair estimation of time-division techniques."

NASA says its system is purely experimental and is not intended to replace any existing facilities. The system is designed for terminals that have small antennas (10 feet in diameter) and inexpensive and relatively noisy receivers. It is probably designed for underdeveloped countries, navigation-communications systems for aircraft or, possibly, tactical military situations. In the latter two applications especially, the ability to readily change both the number of terminals and the channel capacities obviously would be useful.

Goddard Space Flight Center, at Greenbelt, Md., which is responsible for NASA's design, is building a modulator-demodulator (modem) unit for pulse-frequency-modulated signals. For a given error rate, the modem allows the ground terminal's receiver to operate at a signal-to-noise ratio 3 decibels lower than that required by a comparable pulse-code-modulation system.

Tracking

Hide and seek

Laser tracking systems have an inherent advantage over radar: they can pinpoint a target more accurately because their tracking beams are narrower. But, if the target passes behind a cloud, the laser is about as effective as headlights in a fog. The General Telephone and Electronics Corp., however, has developed a laser tracker that can quickly relocate its target if it loses it briefly behind a cloud.

The helium-neon laser tracker, developed under a \$100,000 contract with the National Aeronautics and Space Administration, uses a rapid scanning system to search the sky for its target. GT&E says its system can pinpoint a target to within 12 inches at an altitude of up to 8 miles. The tracker is scheduled to be tested next year during a Saturn-5 launch.

The search. The scanning operation is performed by 20 mirrors, each of which is cemented to a piezoelectric prism. Passing alternating current through the piezoelectric elements drives them into a rapid vibrating motion; this, in turn, vibrates the mirrors. By reflecting the laser beam off the vibrating mirrors, the beam is steered in a zigzag motion.

During a tracking operation, the

laser is aimed at a corner reflector attached to the skin of the target; for NASA's purposes, the target is a test missile. When the laser beam hits the corner reflector, it is reflected back to the tracker, and the system remains locked on the target. Only when the beam is reflected back are the piezoelectric elements not vibrating. If the reflected beam isn't detected—because the tracker loses sight of the target—the mirrors are set in motion.

Computers

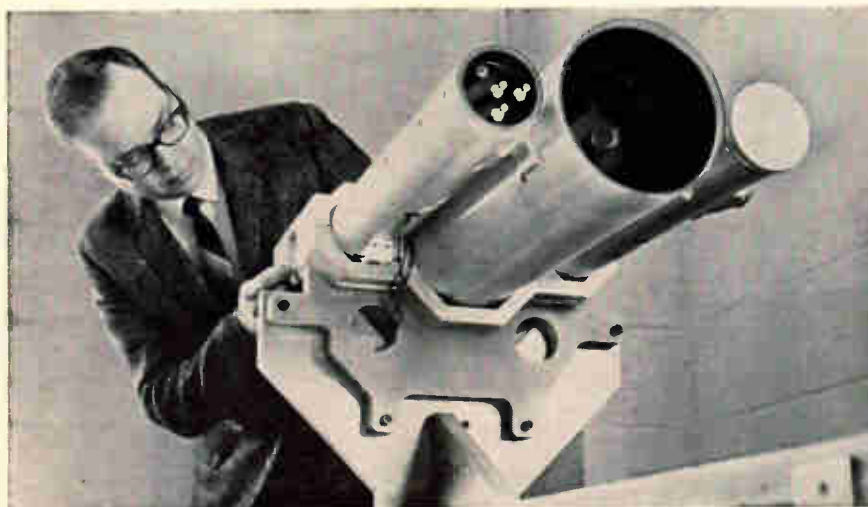
Speed reading

As an instrument for feeding data into a computer, an electronic typewriter generally fills the bill because few people can frame complex questions faster than an efficient typist can type them. But the eye is faster than the hand, despite the old adage, so the mechanical typewriter isn't nearly as suitable as the output terminal for a high-speed computer.

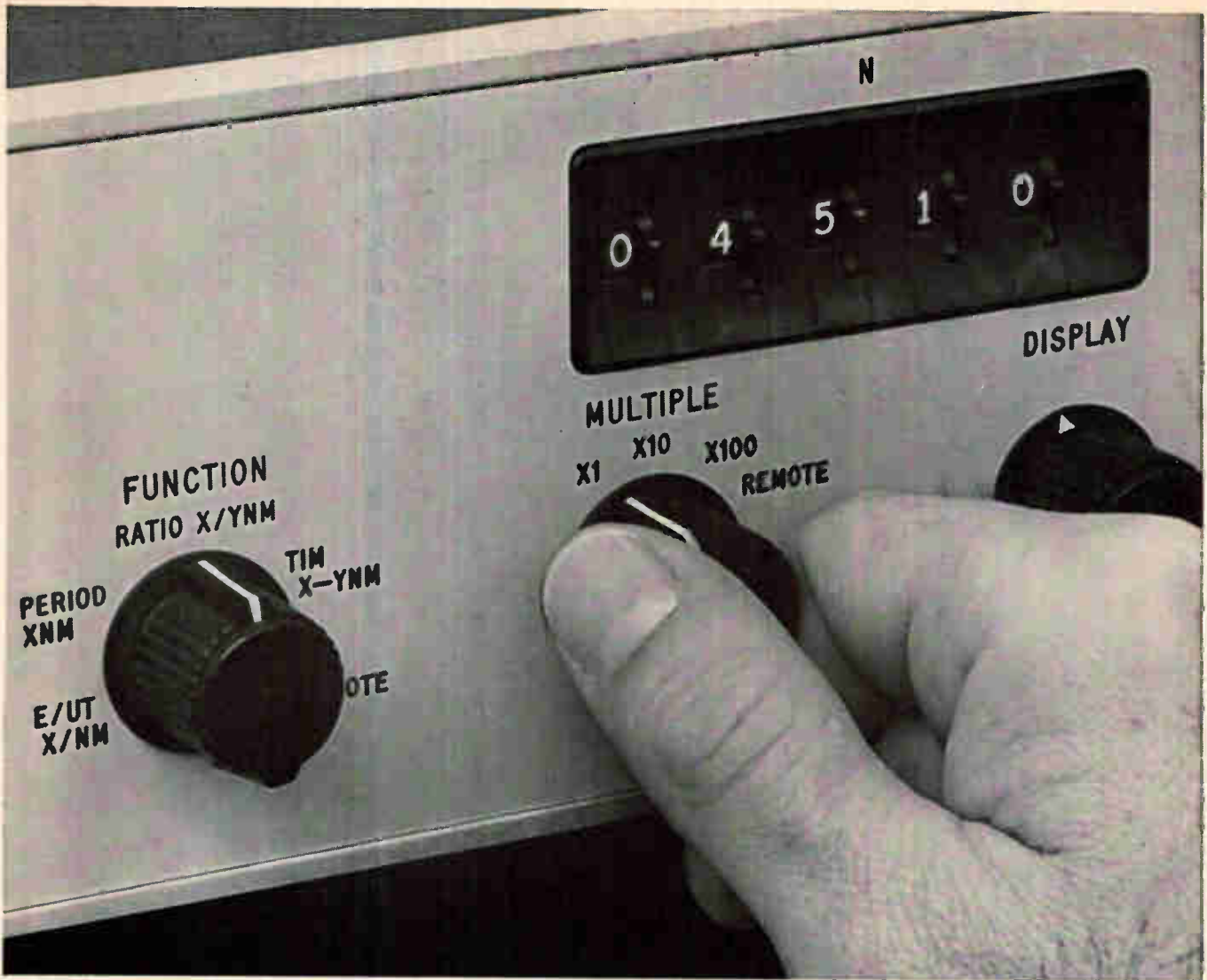
To prepare for the time when hundreds of remote stations will be tied into some of the huge time-shared computer systems being produced, a group at the Massachusetts Institute of Technology is developing a low-cost terminal to replace the teletypewriter, giving the user higher speed and providing some kind of limited graphic display.

"About 70 large computer systems designed for time-sharing are now on order around the country," says John E. Ward, head of the display group at MIT's electronic systems laboratory. He estimates each will have about 300 user terminals, for a total of more than 20,000. Ward sees a large market for output terminals that can generate vectors, plots and graphs as well as alphanumeric.

Keep cost down. The project to develop a new kind of terminal is sponsored by MIT's Project MAC [Electronics, Nov. 29, 1965, p. 83]. It is estimated that when this pio-



Sky watcher. Laser tracking system developed by General Telephone and Electronics Corp. can automatically relocate fast-rising rocket even if it's momentarily lost in a cloud bank.



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neering time-sharing system goes into full operation, it will have about 500 user stations on the MIT campus and elsewhere. His goal is to develop a station that will cost no more than \$5,000 in production quantities.

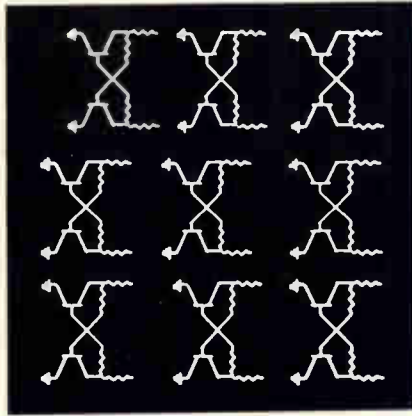
The sophisticated, dynamic type of display, which can do such display tricks as rotating molecular models, will always be in the Cadillac class, says Ward. "At the other end of the spectrum is the device we're looking for, to replace the typewriter. A man can afford to put one in his office."

Ward gives these goals for the terminal:

- A display area of at least 10 inches, without flicker, readable in a reasonably lighted room without eyestrain.
- An ability to accept data from a standard 2,000-bit-per-second Dataphone over telephone lines.
- Information storage of at least 5 minutes without refreshing by the computer.
- Ability to plot lines, points and characters in any format.
- A writing speed of at least 200 characters per second and a line-drawing speed of at least 200 inches per second.
- Display of at least 1,000 characters.
- A character set of up to 128 symbols that can easily be replaced.

First attempts. Early in the program it was found that a vector generator designed for the device could not satisfactorily handle alphanumeric characters as well. Though the characters could be drawn using short line segments, it slowed the machine to about the speed of a teletypewriter. It was decided to add a character generator that accepts a single binary code to specify a desired character. By referring to its internal memory, the machine produces the appropriate voltages to cause the image of the character to appear. A code can be received every 5 milliseconds, so 200 characters per second can be written on the cathode-ray tube—20 times the speed of a teletypewriter.

The MIT device is expected to use North American Aviation, Inc.'s



Vectors generated directly from computer data is one of requirements for the terminal under development at the Massachusetts Institute of Technology. The display was drawn in 1.6 seconds on a 5-inch storage oscilloscope driven by a breadboard display generator.

silicon-on-sapphire diode arrays for the read-only memory in the character generator [Electronics May 30, p. 152A]. "The attraction of SOS diodes is price," says Ward. "We're picking the technique that is moving toward low-cost, batch fabrication. And that's the way we see integrated-circuit arrays moving."

The breadboard display now in the MIT laboratory has a resistor array, chosen in the early stages of the program because of its cost advantage over diodes. It is estimated that the SOS technique will provide arrays at a cost of between one cent and three cents per diode, at the same time avoiding the "sneak path" problem of resistor arrays, in which a signal takes an unwanted path through the resistor array.

The MIT developers may eventually go to arrays also for the shift register, dot matrix generator and selection logic. The dot matrix generator produces signals to cause the electron beam of the storage to move through a desired seven-by-nine pattern of points. In the prototype, integrated circuits are used, but not arrays.

Ward expects to receive the SOS arrays in July, and to have the prototype device ready by the end of the year.

Refreshing approach. "We are counting heavily on image storage,"

says Ward. "The refresh-type of display is a barrier to low cost. Everything has to be done so fast. The character and vector generators have to go a mile a minute—and this costs more money. Even so, the amount of data that can be displayed in a 30-millisecond refresh cycle is limited.

"We feel that the right approach is to store the picture at the image surface. In direct-view crt's, the image traced by the electron beam will remain for up to an hour and can be erased quickly. Ward would like a 10-inch-square display, but all that's available now is a 5-inch tube.

However, the day is near for a tube of Ward's choice. Tektronix, Inc., for one, is working to develop a large, high-resolution bistable storage tube. In fact, the company recently set up a separate division, under the direction of C. Norman Winningstad, for the new product line. Winningstad says that an inexpensive tube, with a resolution of about 100 lines per inch is under development. The magnetically focused tube will provide the resolution over a spread of 1,000 lines in a usable area about 8.6 by 11 inches.

Before this larger tube is introduced, Tektronix plans to offer an electrostatically focused tube with a diagonal measurement of 5 inches.

Plated-wire memory

As expected, the Sperry Rand Corp.'s Univac division has introduced a line of computers with plated-wire main memories. The memory is made of printed circuits surrounding a series of wires coated with a thin film of Permalloy [Electronics, May 30, p. 36].

The machines, the Univac 9200 and 9300, are small-scale, general-purpose computers that represent the first of a new 9000 series. Next will be the 9500, which will probably be introduced in the fall.

Univac gives its computer memory size in bytes, each of which consists of eight bits and corresponds to one alphabetic character

RESOLVER/SYNCHRO INSTRUMENTATION

A very short course for engineers engaged in testing and evaluation of resolvers and synchros as components or as system transducers.

Selecting a resolver/synchro test instrument for any engineering, production or system requirement is remarkably simple from North Atlantic's family of resolver and synchro instrumentation. Because this group has been developed to cover every area of need in both manual and automatic testing, obtaining the desired combination of performance and package configuration usually demands no more than 1) determining what you need and 2) asking for it.

Remote Readout of Angular Position

For remote indication of resolver or synchro transmitters in system testing, North Atlantic's Angle Position Indicators (Figure 1) provide the advantages of low cost and continuous counter or pointer readout. These high-performance instrument servos are accurate to 4 minutes of arc, with 30 arc seconds repeatability and 25°/second slew speed. Dual-mode capability, multi-speed inputs, integral retransmit components and other optional features are available to match application needs. Priced from \$895.



Figure 1. Angle Position Indicators are available in half-rack, quarter-rack and 3-inch round servo packages.

High-Accuracy Testing Of Receivers And Transmitters

Measuring receiver and transmitter performance to state-of-art accuracy is readily accomplished with North Atlantic's Resolver/Synchro Simulators and Bridges (Figure 2). Each of these dual-mode instruments tests both resolvers and synchros, and provides direct in-line readout of shaft angle, accurate to 2 arc seconds. Simulators supply switch-selected line-line voltages

from 11.8 to 115 volts from either 26 or 115 volts excitation, and so can be used to test any standard receivers. Bridges have constant null voltage gradients, making them ideally suited for rapid deviation measurements. Simulators and Bridges each occupy only 3½ inches of panel height and are available in a choice of resolutions. They are priced in the \$1500 to \$3000 range.

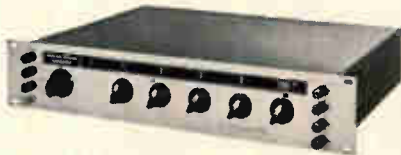


Figure 2. Resolver/Synchro Simulator provides ideal source for receiver testing.

Automatic Measurement And Conversion

Where systems require continuous or on-command conversion of resolver or synchro angles to digits, North Atlantic's Automatic Angle Position Indicators (Figure 3) handle the job without motors, gears or relays. These solid-state automatic bridges accommodate all standard line-to-line voltages and provide both Nixie display and printer output, accurate to 0.01° and with less than 1 second update time. Many variations, including 10 arc second accuracy; binary, BCD or decimal outputs; multiplexed channels and multispeed operation, are available for specific requirements. Ballpark price: \$5900.



Figure 3. Model 5450 Automatic Angle Position Indicator. It measures shaft angles, converts them to digital data.

Measuring Electrical Characteristics

Combine a Resolver/Synchro Bridge and a Simulator with a North Atlantic Ratio Box, a Phase Angle Voltmeter and a test selection panel and you have an integrated test facility for determining all electrical characteristics of resolvers and synchros in component production or Quality Control. An example is the North Atlantic Resolver/Synchro Test Console shown in Figure 4. It measures phasing, electrical zero, total and fundamental nulls, phase shift and input current, as well as angular accuracy. Standard North Atlantic instruments are used as modules, making it a simple matter to fill the exact need. The unit shown sells for about \$7500.

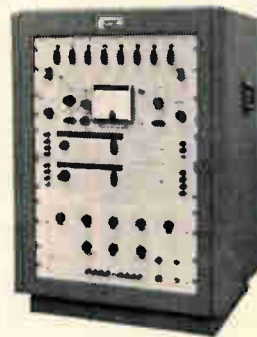


Figure 4. Model RTS-573 Test Console is a complete facility for the production line or in quality control.

If you require performance, reliability and convenience in resolver and synchro testing, we want to send you detailed technical information on these instruments (also on related instruments for computer system interface). Or, if you prefer, we will arrange a comprehensive technical seminar at your plant. Simply write to: North Atlantic Industries, Inc., 200 Terminal Drive, Plainview, N. Y. 11803 • TWX 516-433-9271 • Phone (516) 681-8600.



of two decimal digits. The 9200 has a maximum memory size of 16,384 bytes and a memory cycle speed of 1.2 nanoseconds. The 9300 has a top memory size of 32,768 and a memory cycle speed of 0.6 nsec.

Univac has made an about-face in another respect. Along with the new computer series, a line of 80-column card machines was announced, including a keypunch, a verifier, a sorter and an interpreter. The line ends Univac's long hold-out for a 90-column format, bringing the company into line with the unofficial standard established many years ago by the International Business Machines Corp. The new machines have electronics in place of many more or less traditionally mechanical features; for example, the keypunch and verifier have a core storage permitting all the data to be keyed in before punching or verifying at high speed.

Solid state

Channels for IC's

Some electronics companies have recently been using U-shaped channels to attach transistors face down to substrates, a handy way to cope with the tiny devices [Electronics, April 18, p. 39]. Now engineers at the Collins Radio Co., Raytheon Co., Philco Corp. and Texas Instruments Incorporated, among others, are currently experimenting with mounting integrated circuits in the channels.

Gambling that the channels will catch on with the IC manufacturers, Frenchtown/CFI, a subsidiary of Alloys Unlimited, Inc., of Melville, N. Y., is gearing up for volume production by July.

Mounting a chip. A smaller U-shaped channel package, developed by Alloys Unlimited and Amperex Electronic Corp., is being used by Amperex for two of its transistor families. Amperex also expects to offer dual diodes in the package shortly. Amperex calls the transistor chip mounted in the channel a LID, for leadless inverted device. Frenchtown/CFI calls its package a Versa-pak.

"The variations of the basic IC channel are limited only by the engineer's imagination," says Frenchtown/CFI sales manager Charles G. Elliott.

The basic unit can accommodate chips requiring up to 12 leads. However, Elliott says Frenchtown/CFI is prepared to supply, on special order, units that can accommodate chips needing up to 40 leads.

More than one IC or semiconductor device can be mounted in the channel, making each channel a hybrid IC in itself. The channel is flipped over after the chip has been mounted and then mounted to a substrate. The availability of channels for IC chips, as well as for discrete components, makes it possible for all of the external components to be mounted to a substrate in one step. The IC channel will eventually sell at prices from 15 to 17 cents apiece in large quantities, says a spokesman for Frenchtown/CFI.

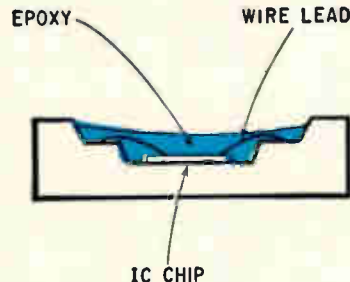
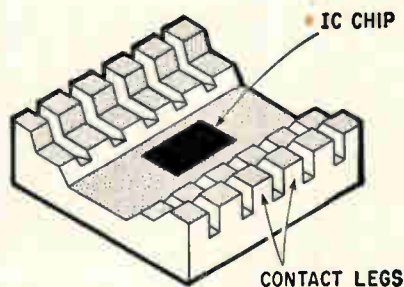
Electronics notes

▪ **Test center.** The Ford Motor Co. is moving its proving grounds indoors. It has opened a reliability laboratory and technical computing center in Dearborn, Mich., designed to simulate road conditions for trucks and cars. Using telemetry equipment and computer analysis, the Ford engineers will evaluate entire vehicles and small parts under a variety of road conditions.

▪ **Seal patent.** A Federal district court in Massachusetts has upheld a patent held by the Philips Electronics and Pharmaceutical Industries Corp. for hermetically fused glass-to-metal compression seals. Philips, affiliated with Philips Gloeilampenfabrieken NV of the Netherlands, has three other suits pending. It believes that another 50 or 60 companies are using the patent technique, although only two companies hold licenses. Philips estimates that the compression seal business amounts to \$50 million annually.

▪ **C-w radar.** Army research engineers at the Electronics Command in Fort Monmouth, N.J., are developing a continuous-wave radar system for ground-surveillance. The system, say the Army researchers, will be more efficient than the pulse doppler radars, AN/PPS-6 and AN/TPS-45 [Electronics, May 17, 1965, p. 104], now being developed by the Army for Marine and Army use; both units can be hauled by a soldier. C-w, they say, will yield more intelligence per watt of average power output than the pulsed systems. The radars will be smaller, use integrated circuits extensively, and require less power to operate. The Westinghouse Electric Corp. is also developing a c-w radar for the military.

▪ **Chaff simulator.** The Whittaker Corp. has developed a system for simulating chaff—the metal strips that pilots drop to confuse enemy radar. The computer-driven system will be used in Navy training schools to teach radar technicians to pick out targets when their screens are chaff-cluttered.



U-shaped channel simplifies mounting of integrated circuit chip to substrates. Diagram at right shows application of epoxy coating to protect IC chip and leads connecting to channel bonding areas.



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Transistor Can, SATURN IC stage



10 amp., Crystal Can, Latching & Non-Latching SATURN II & IVB stages



10 amp., 4 PDT Latching & Non-Latching APOLLO service module



1/2-Size, Latching and Non-Latching, APOLLO command module

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The Amperex A485 NPN silicon planar epitaxial transistor is intended for applications in which low noise, low intermodulation distortion and high gain at frequencies through the UHF region are required. Advances by Amperex in the design of etching masks and improved material and process controls have allowed us to produce a transistor with high linear f_T and h_{FE} characteristics from 2 ma to 20 ma.

The A485 allows the design engineer to optimize his circuit at an operating point of his choice while maintaining the outstanding features of the device.

Typical applications for the new A485 are in small signal RF amplifiers, telemetry, test equipment and any equipment requiring a high quality RF front end.

For complete data and applications information on the new A485 and the Amperex 2N2857, write: Amperex Electronic Corporation, Semiconductor and Receiving Tube Division, Department 371, Slatersville, Rhode Island, 02876.

COMPARISON OF ELECTRICAL PARAMETERS

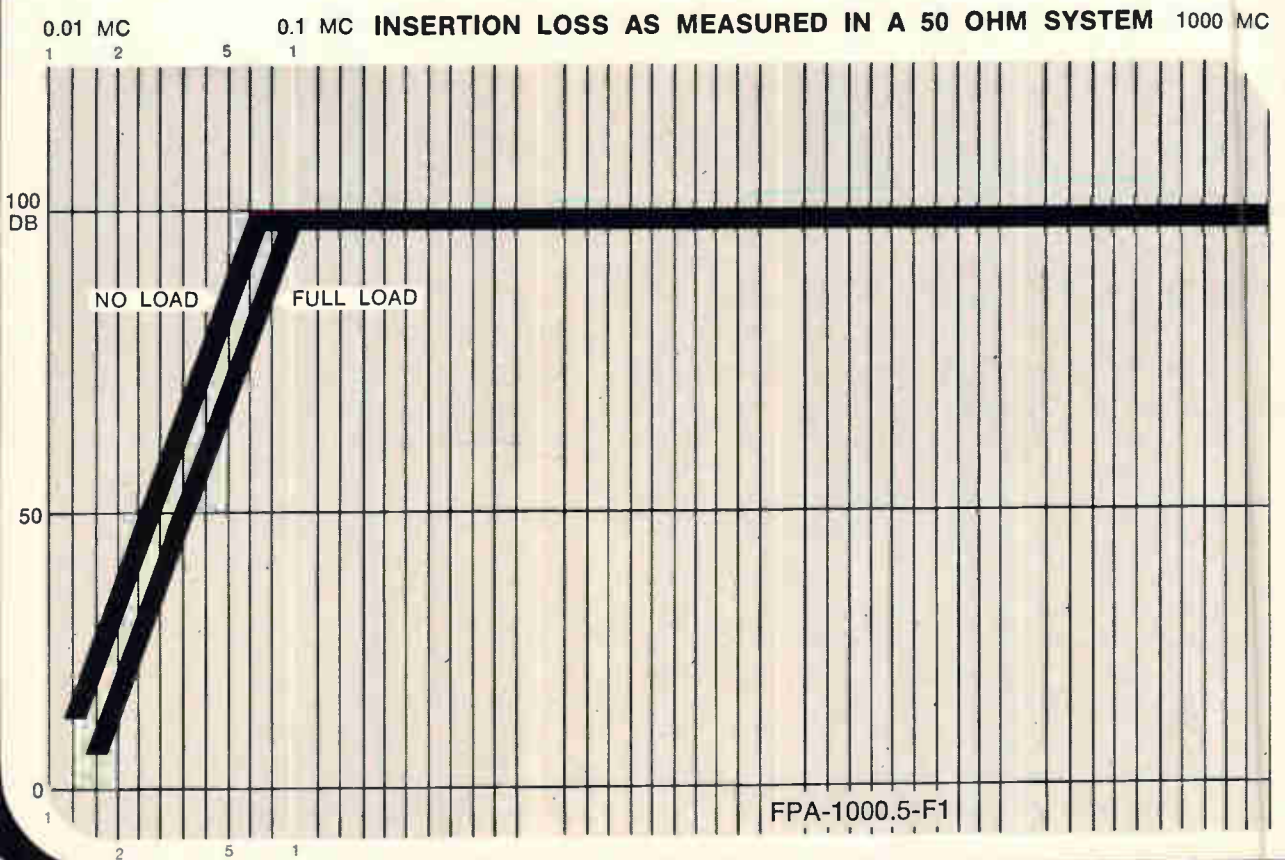
Parameters	Amperex 2N2857	Amperex A485
f_T (min) $V_{CE} = 5V$ 1000 Mc at $V_{CE} = 6V$ $I_C = 5\text{ ma}$		1000 Mc at $I_C = 2\text{ ma}$ 1300 Mc at $I_C = 20\text{ ma}$
h_{FE} (min) $V_{CE} = 1V$ 30-150 at $I_C = 3\text{ ma}$		25-200 at $I_C = 2\text{ ma}$ 20-200 at $I_C = 20\text{ ma}$
NF (max) 200 Mc -		3.5 db
450 Mc 4.5		4.5 db
C_{obo} (max). 1.8 pf		1.5 pf
C_{re} (max). -		0.8 pf
$V_{CE\text{ sat}}$ (max) -		0.25 V
$V_{BE\text{ sat}}$ -		0.75-0.95 V
d_{1m} (Intermodulation distortion) -		-53 db typ.
	$I_C = 14\text{ ma}$, $V_{CE} = 6V$	
	$f = 217\text{ mc}$	
	$V_O = 10\text{ mv}$, $R_2 = 37.5\Omega$	
	$f_1 = 183\text{ Mc}$, $f_2 = 200\text{ Mc}$	

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Washington Newsletter

June 27, 1966

Air Force to ask for funds to develop advanced missile

When the budget for fiscal 1968 is being drawn up this fall, the Air Force will push for funds to initiate contract definition for an advanced intercontinental missile to be deployed in six or seven years. The new weapon, tentatively known as the ICM, for improved capability missile, would incorporate new devices for penetrating enemy missile defenses and for increasing accuracy.

The missile would be an outgrowth of work already under way to develop a maneuverable warhead and multiple warheads, and to substantially improve electronic devices for confusing and jamming enemy defensive radar. The improved guidance might make use of a stellar inertial system or more accurate terminal guidance that would involve matching an on-board radar map of the target area with views of actual geographic features below.

The Army meanwhile continues to refine its deployment concepts and to push technological improvements in an attempt to win a go-ahead from Defense Secretary Robert S. McNamara for production of the Nike X antimissile system.

To bolster its case, the Army is now suggesting as one possible development an austere anti-Chinese system costing considerably less than the version originally proposed. This would be a system providing a thin area defense for the entire nation and costing \$3 billion to \$4 billion, rather than the \$8 billion to \$12 billion as originally contemplated.

Deciding whether priority should go to Nike X or to the new ICM involves judgments on contemplated enemy advances in both missile offensive and defensive capabilities. From all indications, defense officials are leaning toward an anti-Chinese Nike X deployment with the possibility of expanding the system to defend against a light Soviet attack.

Optical system may spot missiles better than radar

The Pentagon's Advanced Research Projects Agency will soon open an installation in the Hawaiian Islands capable of making optical measurements of intercontinental missiles during the midcourse of their trajectory. Resolution of the optical tracker is expected to be better than that now obtained by radar.

Improved optical profiles of incoming missiles and their warheads promises to ease the problem of sorting out decoys and chaff. If this can be done in midcourse, it increases the chances of knocking down an enemy warhead with a long-range interceptor missile.

At present, missile defense is heavily oriented toward the terminal phase of a warhead's trajectory—its entry into the atmosphere where air resistance creates different "signatures" to distinguish between real and dummy warheads.

FCC bends, decides to let TRW build six satellites

Mounting pressure from the State Department reportedly has convinced the Federal Communications Commission to approve development of six 1,200-channel communications satellites by TRW, Inc. [Electronics, June 13, p. 67]. Without this nod from the FCC, TRW's contract with the Communications Satellite Corp would have been canceled.

FCC approval is being given reluctantly—and over the strong protest of several top staff members. The decision to initial the contract involves an understanding between the State Department and the FCC: in the future, Comsat will consult with the FCC on contracts involving inter-

Washington Newsletter

national communications before a contract is awarded.

The FCC has maintained that the 1,200-channel satellite, which will cost \$65 million, will be too small to handle the projected traffic. It thinks Comsat should go immediately to a 6,000-channel satellite.

The international consortium that shares ownership in communications satellites argued that there was undue interference by the FCC and apparently has won the backing of the State Department.

FCC chairman

With the appointment of Rosel H. Hyde as chairman, the FCC's policies should remain substantially unchanged. Hyde has been serving as acting chairman since the resignation recently of William Henry.

Shortages plague suppliers of gear for Vietnam

Electronics manufacturers are running into tougher priority problems in supplying the Vietnam needs of the Defense Department. And at the same time the department is getting tougher about insuring that Vietnam comes first. The \$20-billion level of the Pentagon's contracting for the last six months won't peak on the production lines until late summer, but already manufacturers of servomechanisms, electronic instrumentation and computers, among others, are feeling the pinch.

Defense contractors are filing more than 120 requests a week with the Commerce Department's Business and Defense Services Administration for priority ratings and assistance in getting the materials they need. And where a phone call from the Pentagon used to be enough to goad suppliers into honoring priority orders, toughly worded orders to deliver the goods are now more common.

Officials believe the current priority system is working well enough so far. But if Vietnam spending steps up any, a new system with stricter controls will be necessary, says one official.

Defense firms get bigger copper bite

In the next three months industries producing civilian goods will receive less copper as defense contractors get a larger share of available stockpiles. "Hardship" civilian cases obtained more than 75% of the almost 100,000 tons released from government stockpiles during the last quarter; but that will be cut to about 60% of a similar amount between July and September.

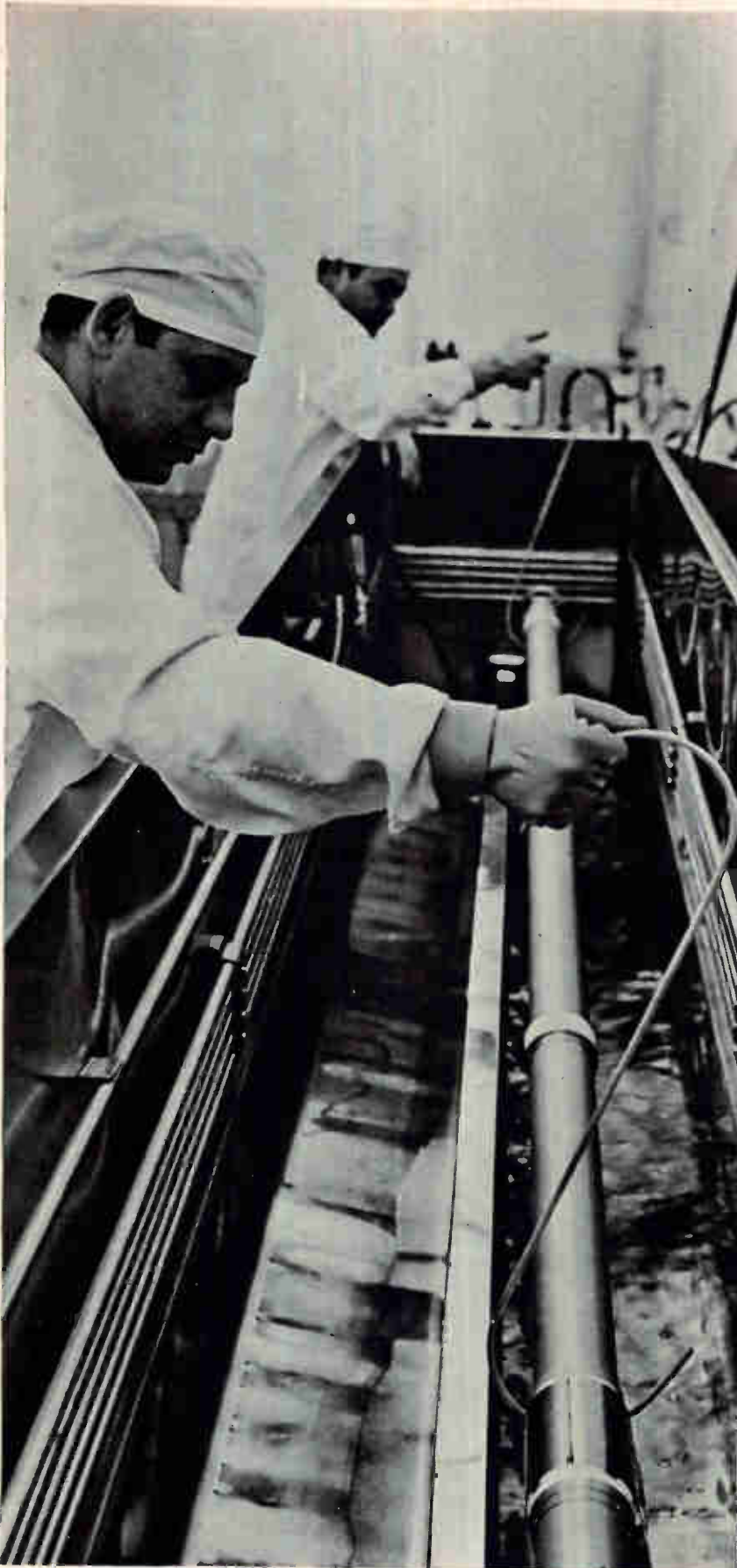
Britain loses in competition for military orders

The Defense Department finds itself in an embarrassing position in trying to provide Britain a quid pro quo in its purchase of more than \$2 billion worth of American aircraft over the next 10 years—principally the General Dynamics F-111 and the McDonnell F-4.

In return for this purchase, Defense Secretary McNamara waived the "buy American" act and invited the British to compete on up to \$325 million worth of U.S. military purchases. The British responded with plans to bid on some 150 items on which they thought they could compete effectively. But on the first try—a competition to build tugboats for the Navy—the British lost out to an American company.

In a new development, the British have lost out again. The purchase this time involved Decca aircraft navigation equipment—originally a British development. To add to the embarrassment, the loss was to Laboratory for Electronics, Inc., which holds the U. S. license for the British equipment.

Although the Pentagon has been insisting that the British enter the U.S. market on the basis of competition, officials say they may have to reconsider this position in light of the two recent losses.



What solvent meets "white room" standards for rocket fuel systems?

Liquidometer says: **FREON[®]** Precision Cleaning Agent.

Liquidometer Aerospace Division of Simmonds Precision Products, Inc., in Long Island City, N. Y., maintains one of the world's most efficient "white rooms" to insure the microscopic cleanliness of their rocket fuel sensing devices. That's because the slightest particle of metal, organic residue or other contaminant could endanger the success of space missions. And that's why the solvent used to clean these critical components is FREON Precision Cleaning Agent.

FREON is a selective solvent—it cleans without affecting commonly used materials of construction. Its low surface tension penetrates the smallest pores and crevices. Its high density floats away all particulate matter. Its excellent stability permits reuse after recovery by simple distillation and filtration. FREON is nonflammable, and unlike many other solvents, relatively nontoxic. Special exhaust systems are rarely needed.

Whether or not you clean to "white room" standards, chances are you can clean better, faster and at lower cost with a FREON solvent. For more information, write Du Pont Co., Room 3865, Wilmington, Delaware 19898. (In Europe, write Du Pont de Nemours International S.A., FREON Products Division, 81 Route de l'Aire, CH 1211 Geneva 24, Switzerland.)



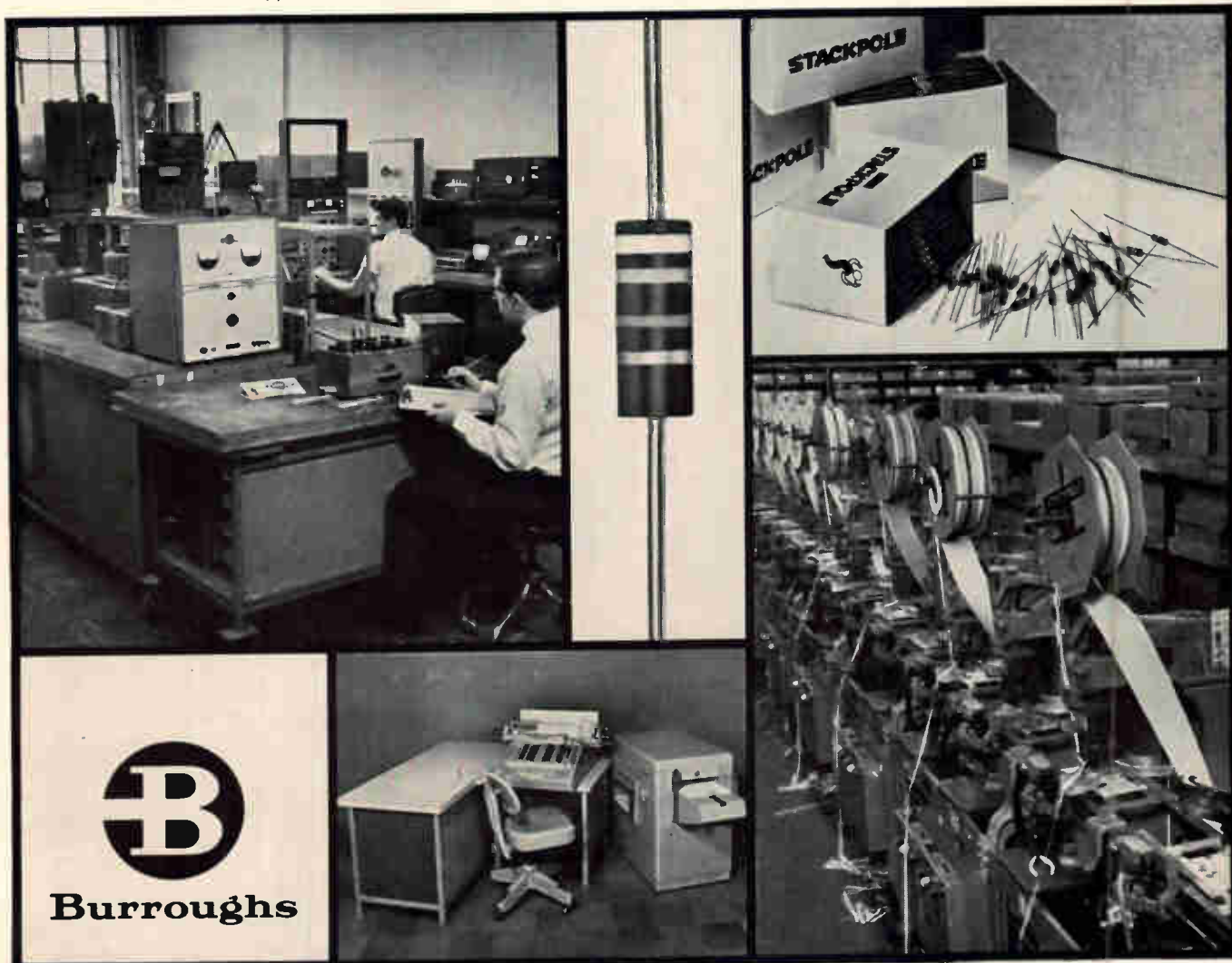
Better Things for Better Living
...through Chemistry

Six months of evaluation testing by Burroughs engineers revealed four things about Stackpole commercial resistors.

Quality, performance, value and service.



At their Plymouth, Michigan, Evaluation Testing Laboratory, Burroughs engineers put Stackpole resistors through the paces. What they discovered was a commercial resistor that more than matched their demanding requirements. Stackpole commercial resistors are manufactured carefully and backed by prompt delivery and service. Such attention to quality assures trouble-free machine or hand assembly and lifetime operation. These are but several reasons why Burroughs selected Stackpole commercial resistors for use on their E 2100 Direct Accounting Computer. Dependability, performance and accuracy are essential to Burroughs. Stackpole, too. For the full added-value story, write: Stackpole Carbon Company, Electronic Components Division, Kane, Pa. 16735.



for the first time in a silicon power transistor...

HIGH BREAKDOWN VOLTAGE ($BV_{CEO}^{(sus)} = 350 \text{ V}$)
HIGH GAIN BANDWIDTH ($f_T = 20 \text{ MHz}$)
LOW CAPACITANCE ($C_{cb} = 6 \text{ pF}$)
AND
20 WATTS DISSIPATION



The RCA 2N4296 family is designed for high voltage, wide-band amplifiers and other military and critical industrial applications.

Use it for: high-voltage switches • relay drivers • switching and series regulators • waveform amplifiers • converters (low-voltage DC to high-voltage DC or AC) • high-voltage inverters • differential and operational amplifiers in analog computers • video amplifiers in camera chains, TV monitors, color-difference amplifiers.

Packaged in a TO-66 case, the RCA 2N4296, 2N4297, 2N4298 and 2N4299 are triple-diffused silicon NPN high-voltage power transistors, with exceptionally

high-frequency response and fast switching speeds. And they are priced *below* virtually every other transistor on the market with similar characteristics.

For delivery information, and for your copy of a technical bulletin which has all pertinent performance curves, applications data and electrical and mechanical specifications, call your local RCA Field Office; or write: RCA Electronic Components and Devices, Commercial Engineering, Section EN6-4, Harrison, N.J.

RCA 2N4296 SILICON POWER TRANSISTOR FAMILY CHARACTERISTICS					
	2N4296	2N4297	2N4298	2N4299	
Collector-to-Base Voltage, BV_{CBO}	350	350	500	500	max volts
Collector-to-Emitter Voltage, $BV_{CEO}^{(sus)}$	250	250	350	350	max volts
Emitter-to-Base Voltage, BV_{EBO}	4	4	4	4	max volts
Collector Current, I_C	1	1	1	1	max amps
Collector-to-Emitter Saturation Voltage $V_{CE}^{(sat)}$ $I_C = 50 \text{ mA}$, $I_B = 5 \text{ mA}$	0.9	0.75	0.9	0.75	max volts
Base Current, I_B	0.25	0.25	0.25	0.25	max amps
DC Forward Current Transfer Ratio, h_{FE} (at $V_{CE} = 10 \text{ V}$, $I_C = 50 \text{ mA}$)	50-150	75-300	25-75	50-150	
Transistor Dissipation T_C up to 25°C T_A up to 55°C	20 2.0	20 2.0	20 2.0	20 2.0	max watts max watts
	\$1.50*	\$1.75*	\$2.25*	\$2.50*	

Available Through Your RCA Distributor

*Prices indicated are for quantities of 1,000 and up.



The Most Trusted Name in Electronics

For industrial and military control, instrumentation and communications switching you now get more contact capability...more versatility...with

NEW CLAREED[®]

MERCURY-WETTED and HIGH VOLTAGE REED RELAYS

Clare's newest innovations in Clareed contacts provide more design flexibility...more application versatility than ever before possible with any reed-contact relay. For instance:

New Power Output Capability—You can handle up to 50 va power output loads . . . and be assured of good low level performance, too, with the mercury-wetted Clareed.

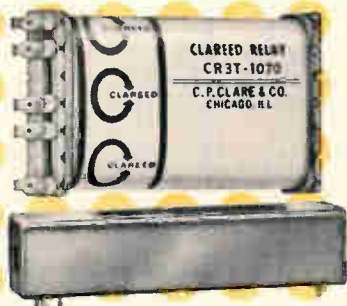
New Voltage Stand-off Capability—You can perform hi-pot functions at 1500 v stand-off with the new high voltage Clareed relay... up to 5000 v peak with special assemblies.

New Bounce-Free Contacts—You are assured of faster response time. No waiting with bounce-free mercury-wetted Clareed contacts.

New Low and Consistent Contact Resistance—You can depend on mercury-wetted Clareed relays to hold original contact resistance to within ± 2 milliohms throughout life.

New Longer Life Ratings—You can specify mercury-wetted Clareed contacts and be sure of millions of operations at rated load over the life of your system . . . *billions* of operations at low level.

CLAREED Relay Versatility Meets Every Packaging Requirement



... for printed circuit boards

Types CRT, CRTN,
CHT, CHTN,
CRM, CHM



... as functional pcb assemblies

combining Clareed relays and other components



... for wired assemblies

Types CRA, CHA,
CRB, CHB

CLAREED RELAY CHARACTERISTICS	For WIRED ASSEMBLIES		For PRINTED CIRCUIT BOARDS			
	Type CRA, CRB	Type CHA, CHB	Type CRT	Type CHT	Type CRM	Type CHM
Contact Arrangements (Maximum)	12 Form A 6 Form B 2 Form C 6 Form A and 6 Form B	12 Form A 6 Form B 6 Form A and 6 Form B	12 Form A 6 Form B 4 Form C	12 Form A 6 Form B	3 Form A 2 Form B 1 Form C	3 Form A 2 Form B
Operating Voltages	.5 vdc to 340 vdc		1 vdc to 550 vdc		1 vdc to 145 vdc	
Coil Resistances	2 ohms to 27,500 ohms		7.3 ohms to 35,500 ohms		10 ohms to 12,700 ohms	
Operate Times* (Nom. coil power)	.6 to 9 ms		.6 to 3.4 ms		.6 to 2.8 ms	
Must Operate Sensitivities*	80 mw to 2.3 watts		110 mw to 1.8 watts		110 mw to 750 mw	

*Depending upon number of contacts.

CONTACT CHARACTERISTICS	GENERAL PURPOSE	HIGH VOLTAGE	MERCURY-WETTED
Contact Rating Switched Load	15 va max, non-inductive 1 amp max, 250 v max	15 va max, non-inductive 1 amp max, 250 v max	50 watts DC resistive 25 watts AC resistive
Carry Load	5 amps max, not switched	5 amps max, not switched	3 amps max, 500 v max 5 amps max, not switched
Life Expectancy Full Rated Load Low Level	20 x 10 ⁶ operations 100 x 10 ⁶ operations	20 x 10 ⁶ operations 100 x 10 ⁶ operations	100 x 10 ⁶ operations 1 x 10 ⁹ operations
Stand-Off Voltage	500 v rms	1500 v rms, standard 5000 v peak, special	1000 v rms, standard 3000 v peak, special
Available Contact Assemblies	All indicated for wired assemblies or pcb		All indicated for wired assemblies or pcb—except Form C arrangements

Clareed relays help to assure that your system will operate dependably . . . to its design characteristics . . . over its planned life. Here's how:

Inherent Reliability—You can optimize your system design and depend on it to perform. Fully defined Clareed initial and life ratings allow you to design optimum performance into your system. Maintenance-free switches are sealed in glass and are not subject to environmental contamination or mis-adjustment.

Ample Speed for Most Applications—You'll realize ample switching speeds for most industrial control functions—particularly for applications having electromechanical input and output devices where solid state microsecond switching speeds are impractical . . . and expensive. Clareed relay switching speeds in the high microsecond and low millisecond range are entirely compatible with your system requirements.

Immunity to Transient Noise—Your Clareed relay system is not subject to inadvertent switching by ambient or line transients. No need to buffer or use special logic levels. And, by the way, you need only one power source . . . 24 vdc \pm 20% does the job.

Special Design Capability—You're not confined to standard relay ratings and packages. If your system demands special requirements, turn your problem over to the switching experts—Clare's Application Engineers. They have more experience than anyone else in providing effective time and money saving solu-

tions for special switching problems.

Added Bonus! Clareed switches and relays are built by Clare from start to finish to one high quality standard. Careful production control procedures pay off in longer life, consistent performance and greater reliability for you.

Combine these new contact developments with the basic Clareed capabilities. Add the variety of packages available. You'll discover a relay line that meets the switching needs for practically any control function.

For complete information contact your nearest CLARE Sales Engineer

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relays and related control components

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General use Gudebrod Tapes are unaffected by temperatures to 250°F.; specially designed tapes are essentially stable in excess of 1500°F.
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Most popular Gudebrod Tapes are stable down to -67°F., others are designed to take temperatures as low as -100°F.
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Gudebrod has a tape that won't outgas in outer space—especially suitable for space, or industrial applications in vacuum.
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Whenever possible with the material of construction Gudebrod guarantees its tapes to be fungistatic or fungicidal.
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Gudebrod's Gudelace 18 meets all requirements of specification MIL-T-713A, type P, class two. Other Gudebrod Tapes meet or surpass these specs.
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All Gudebrod Tapes are available in a number of widths and thicknesses to meet varying size requirements.
- CUT LENGTHS**
Gudebrod Tapes can be supplied in handy dispenser packs of cut lengths to suit your harnessing needs.
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From the wide range of basic materials and finishes used in Gudebrod Tapes the selection of a tape compatible to your insulation is easy.
- COLOR CODED TAPES**
For complicated circuitry, color coding with Gudebrod Lacing Tapes makes assembly and tracing easy.
- SPECIAL APPLICATIONS**
Gudebrod will work with your engineers to develop a special tape to meet sophisticated requirements.

THEN GET THE RIGHT TAPE FROM **GUDEBROD!**

Perhaps you are regularly using Gudebrod Gudelace 18, the standard, wax impregnated nylon tape that's known round-the-world for its non-slip knotting (meets MIL-T-713A specs, too). You are doing well then—with the finest tape and saving money on harnesses, too!

But when you are making gear for tropic or arctic use, if you are involved with outer space or

special industrial applications—come to Gudebrod. Here is your one best source for lacing tape information. Ask for a copy of our Product Data Book describing the more than 200 different tapes in our regular stock. In it you'll probably find the tape that fits your requirements—but if you don't, inquire about having one made to your particular specifications.

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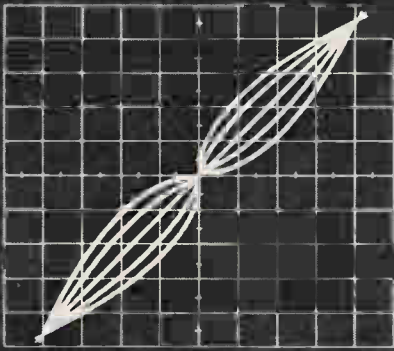
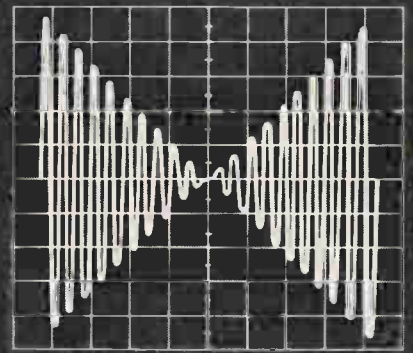
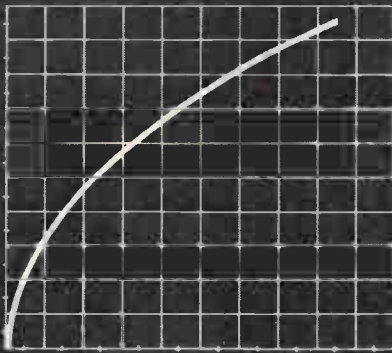
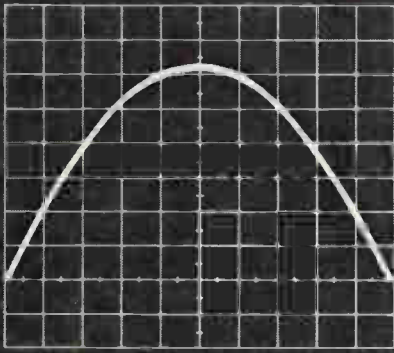
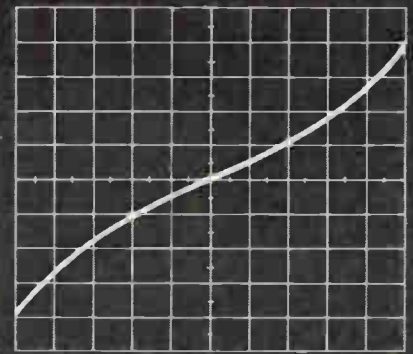
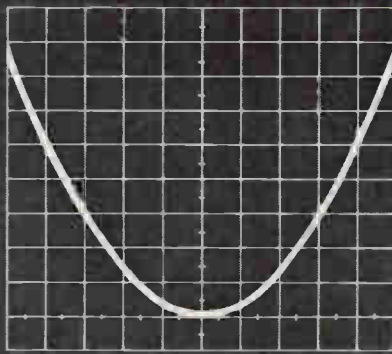
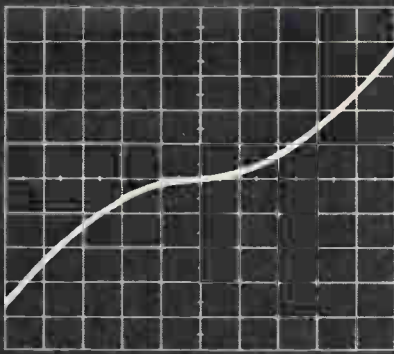


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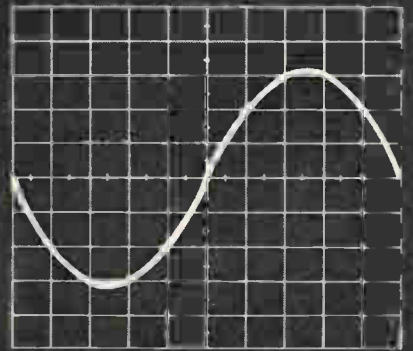
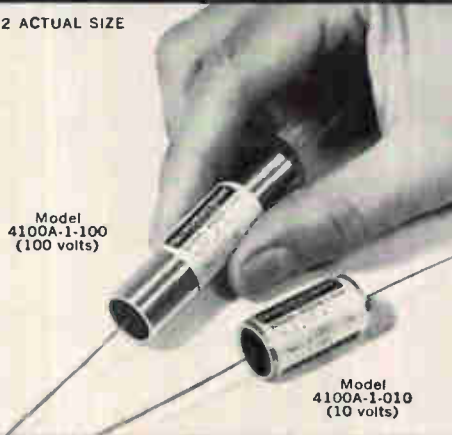
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1/2 ACTUAL SIZE



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This new Bourns product offers a simple, inexpensive, and accurate means of obtaining an especially broad class of non-linear mathematical functions.

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Other QUADRATRON advantages include origin symmetry, bidirectional signal output, absence of discontinuities, and elimination of errors at zero input. Since the Model 4100 has no requirement for reference voltages, there is no need for a separate power supply.

This unique device is an idea generator, too, suggesting new applications in control, instrumentation, simulation, and original equipment. A new four-page technical and applications bulletin has been prepared that details all specifications. Write for your copy today!

Peak input voltage	4100A-1-010: 10V, Max. 4100A-1-100: 100V, Max.
Required signal-source current	1.5 ma, Max.
Squaring error	10V unit: 0.3% of peak input voltage, Max. 100V unit: 0.2% of peak input voltage, Max.



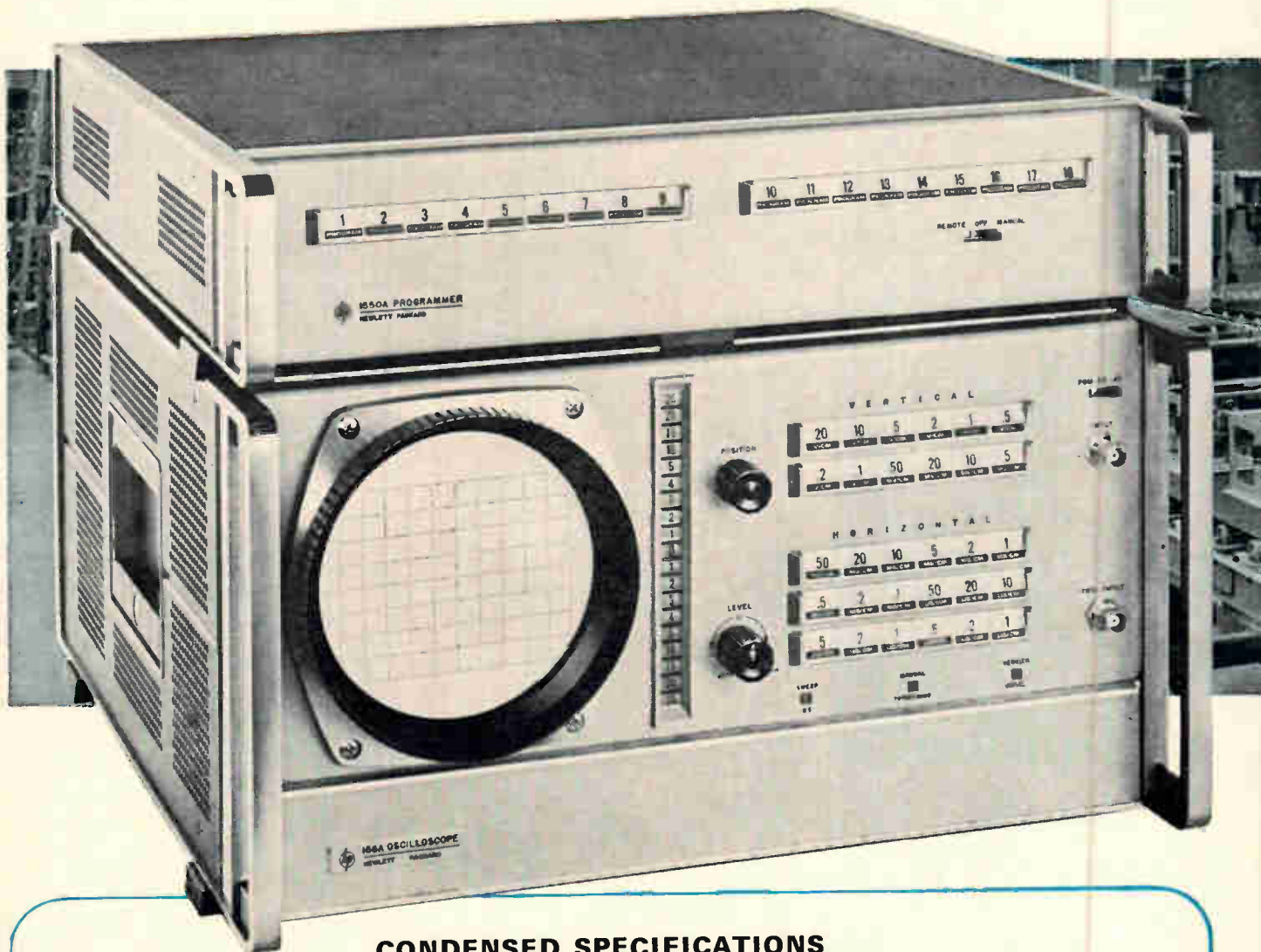
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Circle 65 on reader service card

SPEED SEQUENTIAL

Push a Button...



CONDENSED SPECIFICATIONS

MODEL 155A OSCILLOSCOPE

Vertical Deflection System

Deflection Factor (Sensitivity): 5 mv/cm to 20 v/cm.
Bandwidth: DC coupled: DC to greater than 25 MHz.
 AC coupled: 2 Hz to greater than 25 MHz.
Position: Base line can be offset ± 25 cm from center screen of CRT in calibrated steps.
Signal Delay: Signal is delayed so that leading edge of fast rise signals is visible at start of sweep.
Input Impedance: 1 megohm shunted by approximately 50 pf.

Horizontal Deflection System

Internal Sweep: From 0.1 μ s/cm to 50 ms/cm.
Magnification: X 5 expansion available on all ranges.
Slow Sweeps: $\div 10$ slows sweep to 0.1 sec/cm, 0.2 sec/cm, or 0.5 sec/cm.
Triggering:
Automatic: Internal, external, or from line.
Trigger Slope: Positive or negative.

Amplitude Selection: Internal, or external.

Trigger Point and Slope: Internally from any point on the displayed wave form; externally from any point between ± 5 volts, positive or negative slope.

Single Sweep: Front panel switch selects single sweep operation.

Remote Programming

Programming is accomplished by contact closures to an isolated common line. Programmable functions are listed below.

Vertical: Deflection factor (sensitivity). Input coupling. Vertical positioning.

Horizontal: Sweep time. Trigger source. Trigger slope.

Price: \$2450.00.

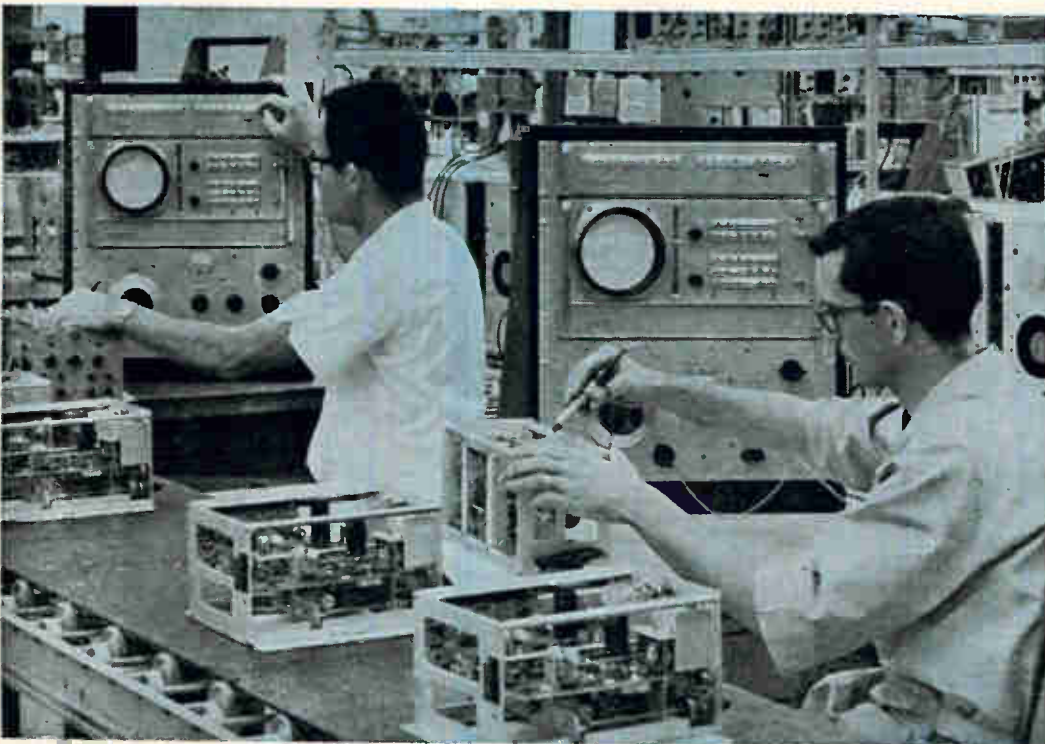
MODEL 1550A PROGRAMMER

Up to 18 programs can be preset in the 1550A Programmer. Plug-in diodes provide the means for programming vertical sensitivity, vertical positioning, vertical input coupling, sweep time, trigger source, and trigger slope in the 155A Programmable Oscilloscope. Price: \$600.00.

WAVEFORM TESTS

Read a Trace!

NEW PUSH-BUTTON, PROGRAMMABLE OSCILLOSCOPE



- Push-Button Speed
- All Major Functions Digitally Programmed
- No DC Drift
- ± 25 cm Calibrated Positioning
- High Sensitivity 5 mv/cm
- Wide Bandwidth 25 MHz

Sequential testing is now a one-two procedure with the new hp Model 155A/1550A Push-Button, Programmable Oscilloscope! All you do is select a test point, then — *push a button . . . and read a trace.*

This new automated hp oscilloscope is the first scope specifically designed for production line and automatic systems applications. It will reduce test time per unit, simplify test procedures, minimize operator errors, shorten training time — and can even reduce the number of required test stations! Check-out routines in automatic systems are speeded by eliminating all manual adjustments.

The 155A oscilloscope embodies all the features of a conventional laboratory instrument, with push-button convenience. Most frequently used controls are located on the front panel. All other controls are located behind the swing-down access door.

You can insert up to 18 test programs in each 1550A digital programmer, or cascade programmers for additional capability. Each test program can control any or all major scope functions — including vertical positioning, sensitivity, input coupling, sweep time, trigger source, and trigger slope — with the press of a button! Each programmed function can

be manually over-ridden at any time. Back-lighted indicators show program, sweep, sensitivity, and vertical position for error-free readout.

Only a few minutes are required to insert diode pins for setting up programs in the all-digital programmer. Diode-controlled, digital programming makes the 155A/1550A fully compatible with any contact-closure-to-ground programmer for high speed, automatic check-out systems.

Measurements are repeatable, because the unique hp DC stabilizer circuitry eliminates DC drift. The trace stays where it is positioned for measurement confidence, regardless of sensitivity or sweep. Calibrated positioning over ± 25 cm dynamic range can eliminate need for voltmeters. Typical DC measurement accuracy is $\pm 2\%$ of reading.

To find out what this *new measure of scope performance* means to you in speeding your sequential testing, call your nearest hp sales office for a demonstration of the new hp Model 155A/1550A Push-Button Programmable Oscilloscope. Or, write Hewlett-Packard, Palo Alto, California 94304, Tel. (415) 326-7000; Europe: 54 Route des Acacias, Geneva. Price: hp Model 155A Oscilloscope, \$2450.00; hp Model 1550A Programmer, \$600.00, f.o.b. factory.

HEWLETT  PACKARD
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only from Burroughs

IMMEDIATE DELIVERY READOUT DRIVERS

and from your local Burroughs stocking dealer



Actual size all
six modules

Industry's enthusiastic acceptance of the type BIP-8211P NIXIE® tube readout driver and the versatility of its basic design has led to the development of other circuit variations. These compact, attractive modules not only save you design, development, testing and production costs, but also give you the best device for translating low-level BCD inputs to decimal readout. Modules currently available from stock include:

- **BIP-8211P**—accepts 8-line low-level (2V-35V separation) 8-4-2-1 BCD and drives the standard-size rectangular NIXIE tube, type 8422.
- **BIP-8224P**—accepts low-level 4-line, 8-4-2-1 BCD and drives the standard-size rectangular NIXIE tube, type 8422.
- **BIP-8227P**—identical to the BIP-8211P except it accepts logic-level separations as low as 0.7V (from 0° C to +85° C) making it compatible with low-level, monolithic, integrated circuits.
- **BIP-8225P**—used for computer readout, it drives a NIXIE tube with an integral decimal point (type B-59956). Type BIP-8225P accepts twelve 4-bit, binary-input

combinations (numerals 0-9, decimal point and blanking) and has the capability of being electronically dimmed via a separate low-level control input. ● **BIP-8222P**—drives the type B-59956 NIXIE tube with integral decimal point from low-level, 8-line, 8-4-2-1 BCD. Decimal point is independent of BCD input and can either be "on" or "off" when a numeral is "on". ● **BIP-8223P**—identical to the BIP-8211P except it operates over the wide temperature range of -55° C to +85° C.

Other modules which accept other BCD codes as well as decimal inputs are also available individually or in complete Bezel Assemblies. They are completely described in a new brochure, Bulletin 1108. For further information contact your Burroughs Stocking Dealer in your area or Burroughs Corporation in Plainfield, New Jersey. Dealers names, addresses and phone numbers are listed for your convenience.

Only Burroughs manufactures NIXIE Tubes



Burroughs Corporation

ELECTRONIC COMPONENTS DIVISION
PLAINFIELD, NEW JERSEY 07061

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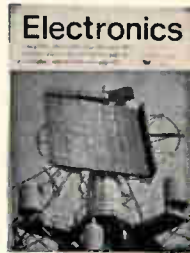
Arnold Barnes Company
(512) 342-7311.

Technical Articles

**Improving performance
of multipurpose IC's
with feedback:
page 70**

The circuit designer's workaday tool for increasing gain and frequency response can be applied between transistor pairs in IC's to derive a wide variety of circuit functions, from amplifiers to modulators.

**Faster, lighter 3-D
radars in sight
for tactical warfare:
page 80**



The need for more sophisticated radars that can determine the height as well as the range and azimuth of targets has been accentuated by the growing importance of missiles in tactical warfare. As a result, procurement and development of 3-D radar is booming. The most advanced types are those that scan electronically, like the AN/SPS-48 shown on the cover. Photog-

rapher Arthur Dubinsky spent a day clambering around the Navy's newest guided-missile-equipped destroyer, USS Fox, to take the picture.

**Success story—
Japanese originals:
page 93**

After a slow start, the Japanese are making spectacular progress in computer technology—enough to boost them into third place in computer production behind the U.S. and West Germany. Now they are shedding their dependence on American technology and are developing their own designs to meet the needs peculiar to their market and the problems imposed by the Japanese language.

**Modules are mass-produced,
but the systems are
one-of-a-kind:
page 102**

Substantial savings in cost and time can result from the use of standard modular components in the development of custom, one-of-a-kind digital systems. Two modular package designs that have been developed—one for ground support equipment and another for airborne command and control—provide quick response to the unique needs of major equipment development programs.

**Coming
July 11**

- Switching laser colors
- Low-noise, low-impedance amplifiers
- Detecting component flaws
- Interconnecting ultrahigh-speed IC's
- Complex arrays: promises and compromises

Improving the performance of multipurpose IC's with feedback

Feedback can be used in integrated circuits to increase gain and raise frequency in a large variety of applications, and the circuits can be built from the same multipurpose IC, thus lowering cost

By Vasil Uzunoglu

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Engineers working with integrated circuits are applying an old technique with new methods to increase gain and raise frequency in a variety of circuits. The old technique: feedback. The new method: using feedback between transistor pairs on the same chip. The result: better circuits—from amplifiers, to frequency modulators, to OR-gates—with very little additional cost in building the IC. In amplifiers, for example, feedback can increase the gain at a particular frequency or raise the maximum frequency at which useful gain can be obtained—or do both.

There are two main types of feedback at the engineer's disposal—series-to-shunt and shunt-to-series—and each has its advantages and disadvantages, too. In series-to-shunt feedback, as illustrated at the top of page 71, an emitter resistor, R_E , is in series with the output transistor, and the feedback path, shown in solid color, is in shunt with the input. Additional feedback also may be obtained in this circuit by the use of the secondary feedback paths indicated by the broken colored lines.

In shunt-to-series feedback on page 71, the feedback path, drawn in color, is in shunt with the

output and the emitter resistor is in series with the input.

A circuit with series-to-shunt feedback has two important advantages over one with shunt-to-series feedback. First, the series-to-shunt feedback circuit does not need a separate biasing resistor because the resistance, R_F , supplies biasing current to the input. Second, the feedback lowers the input resistance of the circuit and, therefore, decreases its time constant. On the other hand, shunt-to-series feedback increases the input resistance, thereby raising the time constant and reducing the high-frequency capability of the circuit. Further frequency degradation is contributed by the separate biasing element, a distributed resistance-capacitance element placed at the input.

Despite this, there are some cases where shunt-to-series feedback may be preferable. For example, in low-frequency applications, high input impedances are often desirable and the lower power dissipation of a circuit having shunt-to-series feedback may be desirable. In some cases, both types of feedback may be used to achieve a compromise of properties.

Multipurpose chip

A multipurpose, analog integrated circuit chip will be used to illustrate the benefits obtained by the use of feedback in five different applications and in each case series-to-shunt feedback will be used. Using the same integrated circuit in each case simplifies the discussion and since many different circuits can be derived from the same basic feedback circuit, it also illustrates the economies possible with the feedback technique.

The five applications to be described are: a video amplifier, an additive amplifier (also called a sum-

The author



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ming amplifier or a distributed amplifier), a frequency modulator, a voltage-controlled oscillator and an exclusive OR-gate.

The chip selected—one of several multipurpose chips now available—is the Lava integrated circuit¹ built by the Westinghouse Electric Corp. The Lava chip, an acronym for linear amplifier for various applications, contains three pairs of transistors, four diodes and 16 separate resistors. Several of the resistors have taps, increasing the number of resistors externally available to 46. Large metal bonding islands on top of the chip make it possible for the designer to select any of the components or tap off the desired amount of resistance by placing wire leads and jumpers on the bonding islands. The Lava chip also has low parasitic capacitances resulting from the use of the double-diffusion process in building the chip. IC's built by triple-diffusion or double-diffusion epitaxy use reverse biasing of junctions to obtain isolation between components, and this results in higher parasitics. In a double-diffused IC, isolation is provided by a intrinsic (high resistivity) region between the collectors.

Video amplifier

The performance of a video amplifier built with a transistor pair can be improved by externally adding a few feedback elements to the circuit. In the video amplifier circuit at the right the components on the chip are shown in black and the external feedback elements are shown in color. Of course, when a number of chips are required, the feedback elements probably will be diffused into the chip.

The addition of resistor R_K and capacitor C_K to the circuit increases the feedback at low frequencies.

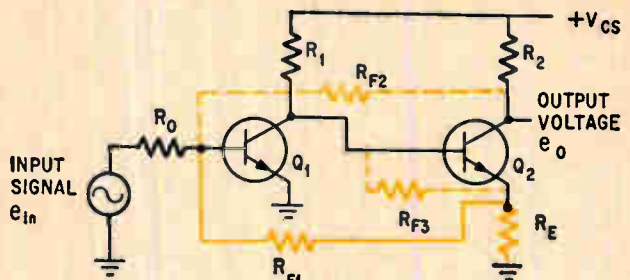
At higher frequencies, the feedback increases, but the rate of increase slows until a frequency is reached where the reactance of C_K becomes negligible compared with R_K and the feedback levels off to a constant. A pole-zero is introduced in the return ratio, and by choosing the proper values it is possible to eliminate an open loop dominant pole by the zero of the feedback network.

The bandwidth capability of the circuit is extended by shunting the emitter resistor, R_E , with the capacitor, C_E , which reduces the a-c feedback at higher frequencies. Usually the value of C_E is less than 10 picofarads.

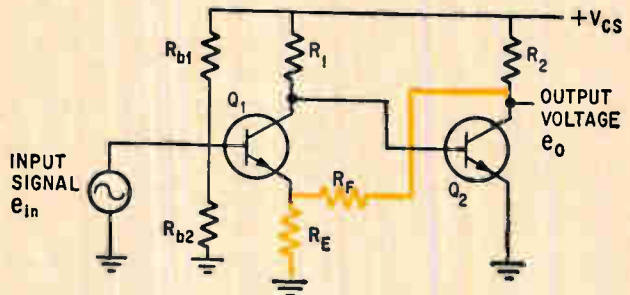
The optimum value of R_o , typically from 50 to 100 ohms for the circuit being discussed, can be found by trial and error. Resistor R_o must be chosen carefully so that the biasing conditions and amount of feedback are the best for greatest gain-bandwidth product.

Before the addition of the external feedback components, the video amplifier circuit provided an over-all gain of 24 decibels at 76 gigahertz. With the addition of R_K , C_K , C_E and by adjusting R_o , the value of the gain of the circuit at 76 Ghz is increased to 32 db.

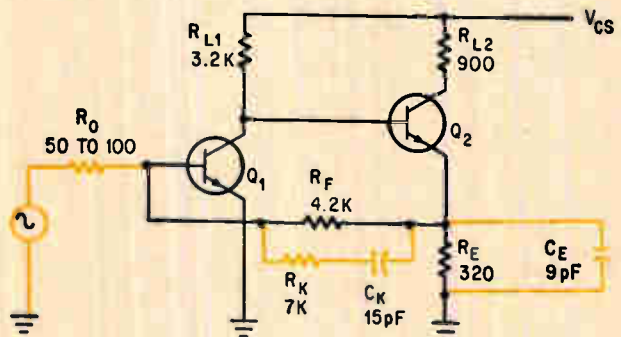
The gain bandwidth product of IC transistors



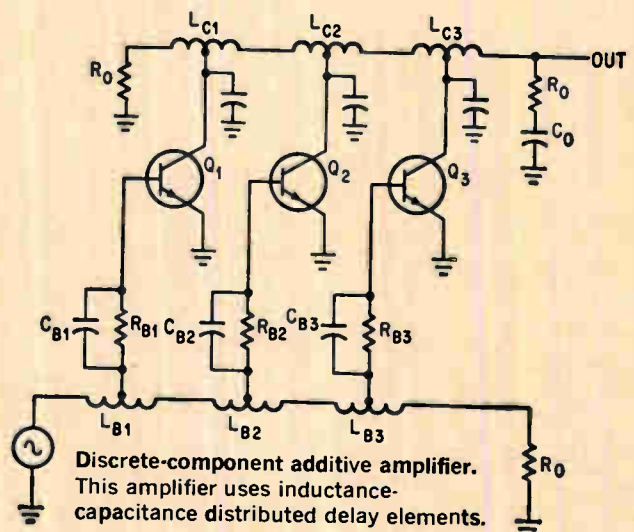
Series-to-shunt feedback in circuit. The primary feedback path is through R_{F1} . Additional feedback may be obtained by using secondary paths through R_{F2} and R_{F3} . The feedback paths are shown in color.



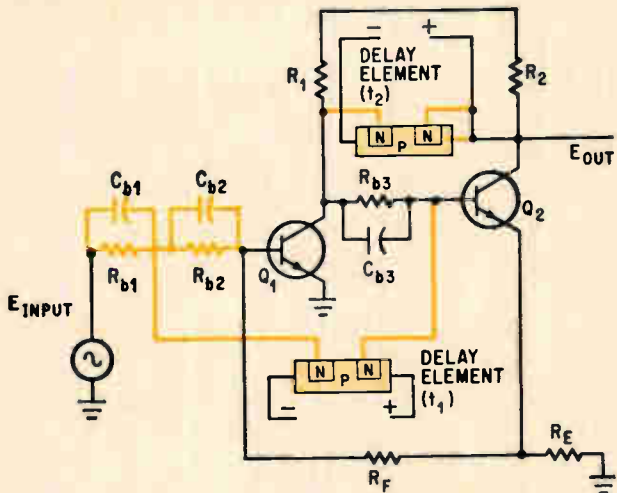
Shunt-to-series feedback in circuit. Unlike the series-to-shunt circuit, this circuit requires a separate biasing arrangement. The feedback path is shown in color.



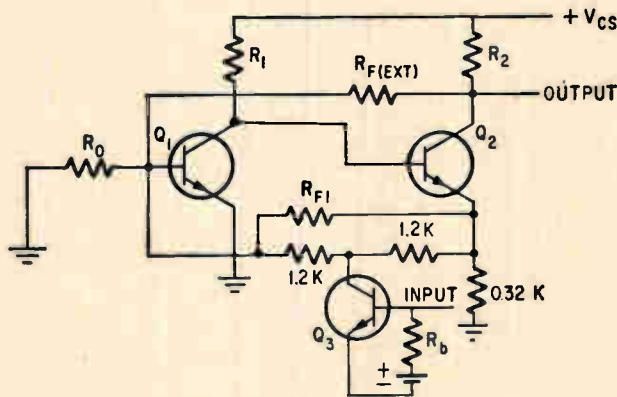
Video amplifier. This circuit was built with components on the multipurpose chip, in black and external discrete components, in color. The external components, added to provide the circuit with feedback, increased the power gain from 24 to 32 db at 76 Mhz.



Discrete-component additive amplifier. This amplifier uses inductance-capacitance distributed delay elements.



Hybrid additive amplifier. Semiconductor delay elements are used in place of inductance-capacitance distributed elements. This circuit provides a power gain of 13 db at 150 Mhz. Discrete components are in color.



Frequency-modulator circuit. A transistor, Q_3 , is used to control the amount of feedback in the circuit. With a 120-millivolt sinusoidal input, the frequency of oscillation varies from 3.5 to 10 Mhz.

also can be increased by reducing the size of the transistors, but a point is soon reached where smaller transistors increase fabrication difficulties and suffer from impairment of other aspects of electrical performance. Another factor which limits the gain bandwidth product of an IC amplifier is interstage coupling capacitance. The interstage coupling capacitances shunt the input and output; they are additive in direct-coupled stages.

Despite the limitations imposed by size and interstage coupling capacitance, the gain bandwidth product capability of IC transistors can be improved by additive (summing) amplification.

Additive amplifier

In the concept of additive amplification, the same input signal is fed to each of several stages from a series-connected lossless line. Each of the output signals is added in series so that no shunting capacitors are introduced during the process.

The two-stage additive amplifier, shown on page 71, is built with discrete components and uses inductance-capacitance delay elements which, un-

fortunately, are not compatible with integrated circuit techniques so another way must be found to design an IC equivalent of this circuit. One way to overcome the handicap is to use semiconductor delay elements arranged to simulate an additive amplifier in place of discrete LC components. The external delay elements are placed in the forward path, as illustrated in the circuit at the left. Equal delays are introduced by each element.

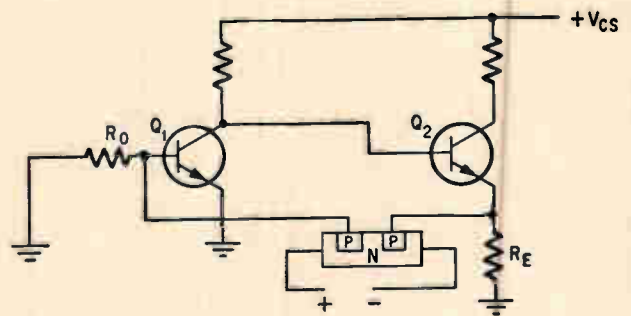
The phase shift corresponding to the delays must be π radians so that the signal to input of Q_2 and at the output of Q_1 must be the same. Thus, the first signal following the path of Q_1 and the delay element and the second signal after the delay element and Q_2 can be added arithmetically at the output of Q_2 . The output at 150 Mhz is 13 db, obtainable only with external components.

Despite the elimination of the inductors, complete integration of such a circuit is not practical although it can be done. The reason: the delay elements must be biased so that their operating characteristics are linear with respect to changes in the frequency of the input signal, and the biasing must be adjusted so that the same delay is supplied to both input and output elements.

The ideal element for coupling two outputs in an integrated additive amplifier would be a two-terminal unidirectional amplifier. The device that approaches the ideal most closely is a tunnel diode connected between the two transistor collectors, although the principle of the unidirectionality is not met. Unfortunately, biasing of a tunnel diode² on the negative resistance portion of its operating characteristic is very difficult. Thus far, a truly practical IC additive amplifier has not been built.

F-m modulator

The circuit with series-to-shunt feedback shown on page 71 may easily be modified to perform many other functions; this helps keep processing costs to a minimum. For example, with minor changes, the circuit can be converted to a frequency modulator. The desired amount of positive feedback can be set by adjusting resistors R_{F1} and R_{F3} , both of which will vary the bias on transistor Q_1 . The Lava chip contributes two additional positive feedback paths, R_{F2} and R_{F3} , and with proper bias adjustment, feedback through R_{F2} and R_{F3} can be further



Voltage controlled oscillator. In this circuit a semiconductor delay element is employed to control the amount of feedback.

improved. Additional positive feedback can be obtained, if desired, by placing an external resistor between the Q_2 collector and the base of Q_1 . Once oscillation is achieved, the frequency of the oscillation can be changed by varying the amount of feedback, which in turn changes the phase shift in the feedback loop. If the circuit is biased so that the frequency of oscillation varies linearly with the input signal, it can be used in pulse-compression radar to increase transmitted power.

An effective means of controlling feedback phase is with an active element in the feedback loop as in the modulator circuit on page 72. A 120-millivolt sinusoidal voltage applied to the input of the transistor Q_3 varies the output capacitance of Q_3 sufficiently to vary the frequency of oscillation from 3.5 to 10 Mhz, but distortion occurs in the output waveform at higher frequencies.

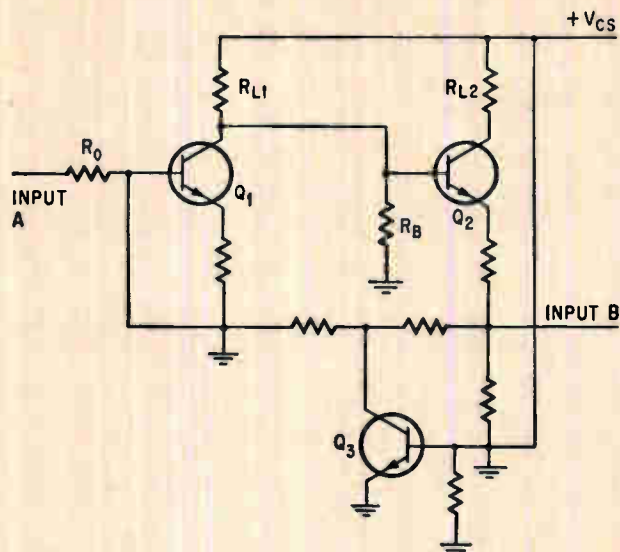
The series-to-shunt circuit can also be used as a voltage controlled oscillator. A variation of this circuit, shown on page 72, controls the frequency of oscillation with a delay element instead of a transistor. Applications for this circuit include phase-lock loop circuits and analog voltage-to-frequency converters.

Exclusive OR-gate

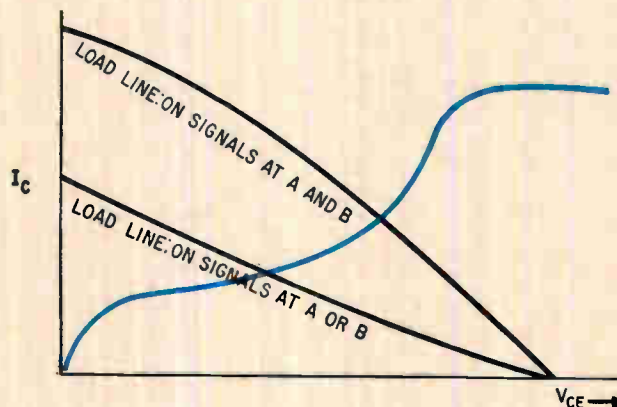
The exclusive OR-gate circuit at the right further demonstrates the economic aspects of deriving circuits from a basic feedback circuit. With only slight modification, the circuit on page 71 can be turned into the exclusive OR-gate as in the diagram on the right. With both of the inputs off, only Q_2 conducts and the output voltage is low.

However, suppose an on signal is applied at input A. This turns Q_1 and Q_2 off, and the output voltage becomes high. If an on signal is applied at input B, then Q_2 is turned off so that the output voltage also is high. The operating point on the current-voltage graph at the right is point M with an on signal at either A or B. With on pulses at both A and B, however, the load line shifts and the operating point changes to N; and this turns on transistor Q_3 , bypasses both pulses to ground, and maintains a low voltage output.

Positive feedback also can convert a Lava IC transistor pair to a Schmitt trigger. The Schmitt trigger is formed by connecting the emitters of a



Exclusive OR-gate. The circuit is a modification of the series-to-shunt feedback circuit shown on page 71.



Operating characteristics for the exclusive OR-gate.

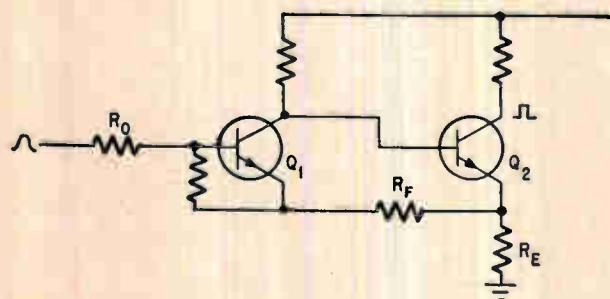
series positive-feedback amplifier as at the left.

Increasing voltage at the input produces a large amount of positive feedback to Q_1 , which is switched on rapidly and driven into saturation. The feedback is actually a combination of positive feedback, through R_F , and negative feedback through R_E , which can be varied to adjust the stability.

With the increasing use of multipurpose IC chips, feedback techniques are particularly important because of the versatility they offer—at low cost—in modifying the basic chip for various applications. With feedback, the same chip can be used as a foundation in designing a large variety of circuits. From an economic standpoint, this means lower production costs; from the engineer's viewpoint, this means more information on reliability and performance.

References

1. Jerome Eimbinder, "General-purpose IC chips speed analog design work," *Electronics*, March 21, pp. 88-92.
2. H.C. Josephs, J.T. Maupin, and J.D. Zook, "Nonlinear coupling with silicon tunnel junctions in integrated logic," *IEEE Transactions on Electron Devices*, May, 1965, p. 237.



Schmitt trigger circuit. Feedback from transistor Q_2 occurs through resistors R_F and R_E and is adjusted so that Q_1 is driven rapidly into saturation.

Designer's casebook

Designer's casebook is a regular feature in Electronics. Readers are invited to submit novel circuit ideas, packaging schemes, or other unusual solutions to design problems. Descriptions should be short. We'll pay \$50 for each item published.

Feedback choke reduces power supply ripple

By Jesse T. Quatse

Carnegie Institute of Technology, Pittsburgh

Extremely low ripple and light weight can be obtained from an inexpensive, regulated power supply by placing a high-inductance choke in the feedback path. The circuit illustrated is a simplified example of a supply that weighs less than 3 pounds and costs less than \$30. It is useful for lightweight digital equipment where low ripple and only moderate regulation are important. Over the full range of zero to 1 ampere, d-c regulation is 1% and the ripple is less than 2 millivolts rms at 1 ampere.

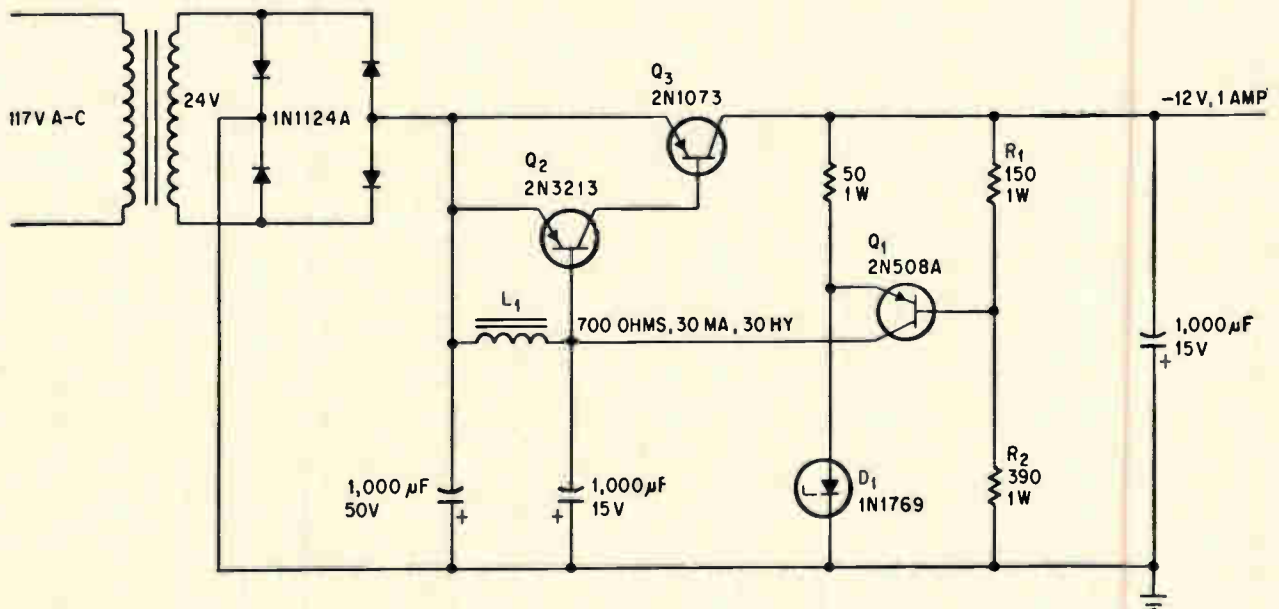
Reducing ripple with a choke in series with the load—the usual location—greatly increases both the cost and weight of the regulator. But when the choke is placed in a feedback circuit, a much smaller choke can be used. Choke L_1 has a d-c resistance of 700 ohms, an inductance of 30 henries,

a current rating of 30 milliamperes and a weight of 1 pound; it costs approximately \$1. A 4-henry choke in series with the load would, in this case, require a current capacity of 1 amp, a resistance of a few ohms and would weigh 25 pounds. It would cost about \$25.

A 30-henry choke with a current-carrying capacity of 1 ampere is difficult to obtain commercially because its large size limits the demand for it.

In the circuit illustrated, power is supplied to the regulator by a standard full-wave bridge. Regulation is obtained by comparing the feedback through transistor Q_1 with the 8.2 volts across zener diode D_1 . The current passed by the d-c resistance of L_1 is amplified by Darlington amplifier Q_2 - Q_3 and supplied to the load. The voltage at which this current is supplied can be selected by the ratio of R_1 and R_2 . In this circuit, the ratio provides an output of 12 volts.

Ripple is reduced by feedback through the Darlington amplifier. The ratio of ripple to d-c voltage at the emitter of Q_3 cannot exceed this ratio at the base of Q_2 . Since all the base current of Q_2 passes through L_1 , the small choke reduces ripple as if it were in series with the load.



Choke L_1 , placed in the feedback path from Q_1 to Q_2 , holds down the ripple in the current supplied to the load through Darlington amplifier Q_2 - Q_3 . The choke acts as if it were in series with the load since all the base current of Q_2 passes through it. However, the current is not as great as a series choke would carry.

Modified tape recorder stores timing signals

By Gordon Silverman
Rockefeller Institute, New York

A low-cost analog magnetic tape system can be converted to a system for recording the time of events. In the biomedical experiments for which the system was devised, it was necessary to record, for later analysis, nerve responses and the intervals at which stimuli were applied.

In the unmodified model, the damped sinusoidal characteristic of the responses to step and pulse inputs, as illustrated below, right, produces errors and results in an unsatisfactory timing system. However, if the timing pulse is narrow enough—containing frequency components beyond the recorder's passband—the system works satisfactorily.

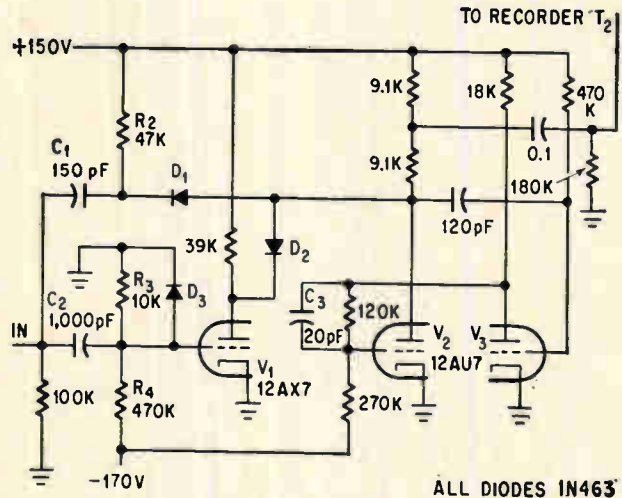
In practice, the second pip in the pulse response is eliminated by integrating the trailing edge of the recorded pulse.

Signal waveforms in the system, below right, illustrate how the system functions. The input gate signal is differentiated in the pulse-shaping circuit shown above right by C_1 and R_2 . At the same time, C_2 and the parallel combination of R_3 , R_4 and D_3 produce a series of differentiated signals at the grid of V_1 . The series of alternately positive and negative pulses corresponds respectively to the leading and trailing edges of the gate signal. Since V_1 is biased off, it is insensitive to negative-going signals. But positive signals drive the tube into conduction and cause the plate voltage to drop. The negative signal that results passes through diode D_2 . A sequence of negative pulses then appears at the common anode junctions of D_1 and D_2 , each pulse corresponding to an edge of the input gate.

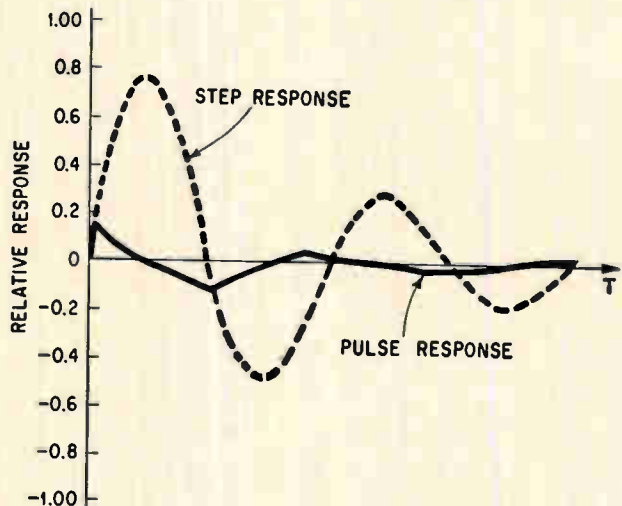
Tubes V_2 and V_3 form a standard monostable circuit, and V_3 is normally on, V_2 normally off. Each negative pulse turns V_3 off and V_2 on. The output at T_2 then consists of 30-microsecond negative pulses with a peak of 50 volts, which can be fed to the tape recorder.

On playback, the signals from the tape recorder pass to the circuit on page 76 through D_4 , and tube V_4 acts as a pulse amplifier. Each edge of the original gate signal appears as a negative-going pulse at this tube's plate. The signal magnitude can be adjusted with the recorder's volume control.

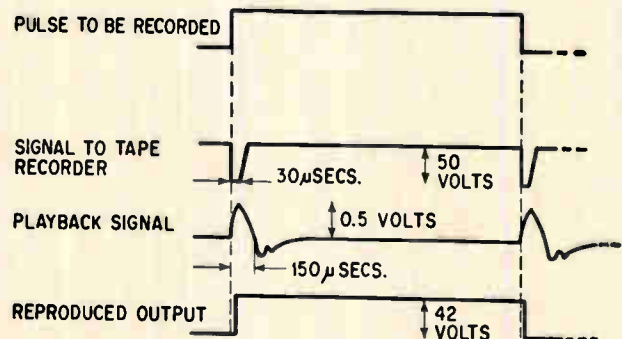
Tubes V_5 and V_6 form a standard bistable circuit. It is possible for the circuit to assume a state equivalent to the gate's being on when the power



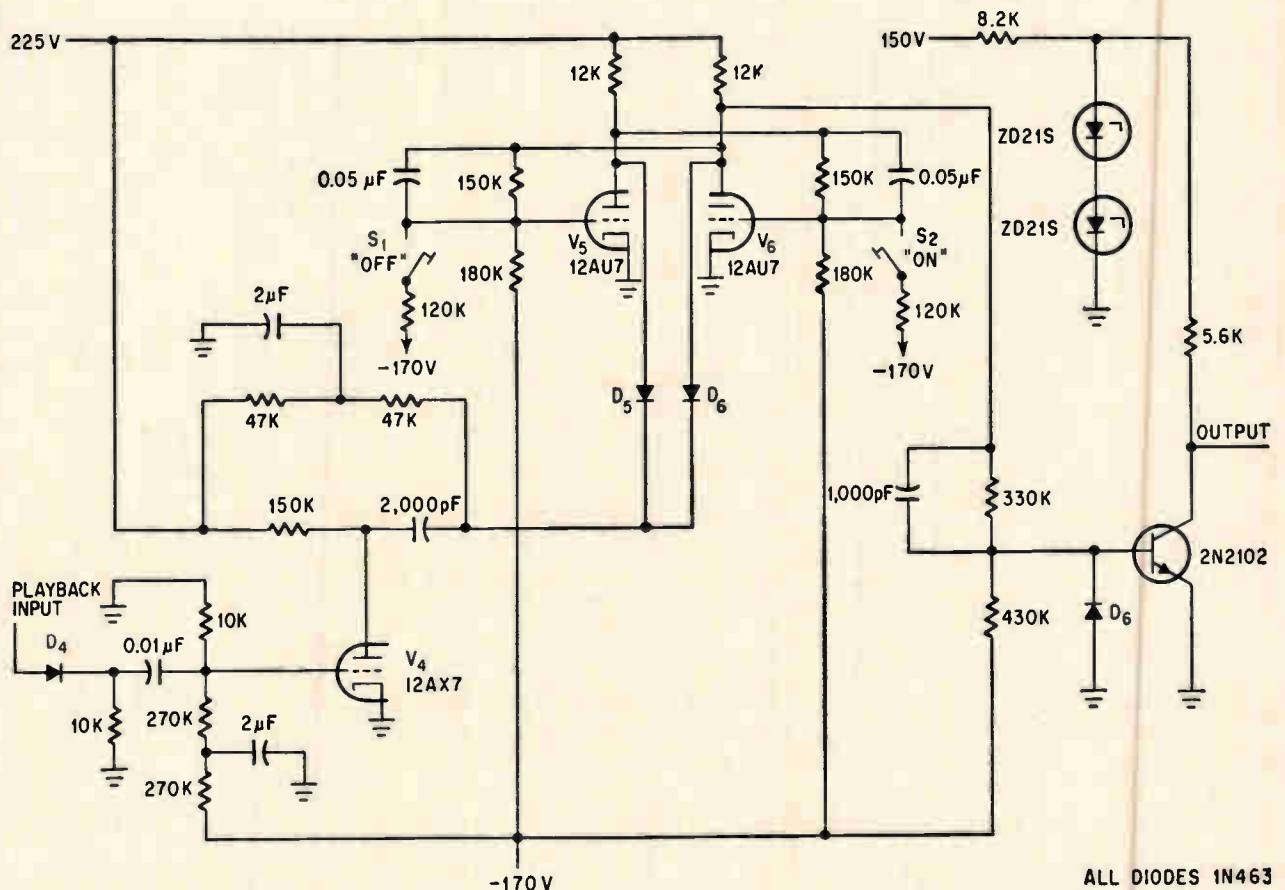
Recording circuit consists of a differentiating section and a standard monostable tube circuit. The output is a series of pulses, 30 microseconds in duration, with a peak of -50 volts.



Response of tape recorder to step and pulse inputs. Step input signal can not be used for timing marker since many processing errors result from its sinusoidal nature.



Pulse to be recorded is converted in the record circuit to a series of negative-going pulses. Each pulse corresponds to an edge of the pulse. The output of the tape recorder is another series of pulses from which the pulse is reconstructed in the playback circuit.



Playback circuit consists of pulse amplifier and bistable circuit. The negative pulses change the state of the bistable, reproducing the original pulse at its output.

is first turned on. However, switch S_1 can be operated to manually turn off the gate. Each successive negative pulse corresponding to the gate edge changes the state of the bistable, and reproduces the original timing pulse. The first negative pulse, corresponding to the leading edge of the original

gate signal, turns the bistable circuit on. When the second negative pulse arrives, the bistable changes state. The transistor output is summed to boost the output signal level sufficiently to allow the driving of data-processing equipment without additional amplifier circuitry.

Diode lowers multi's reset power level

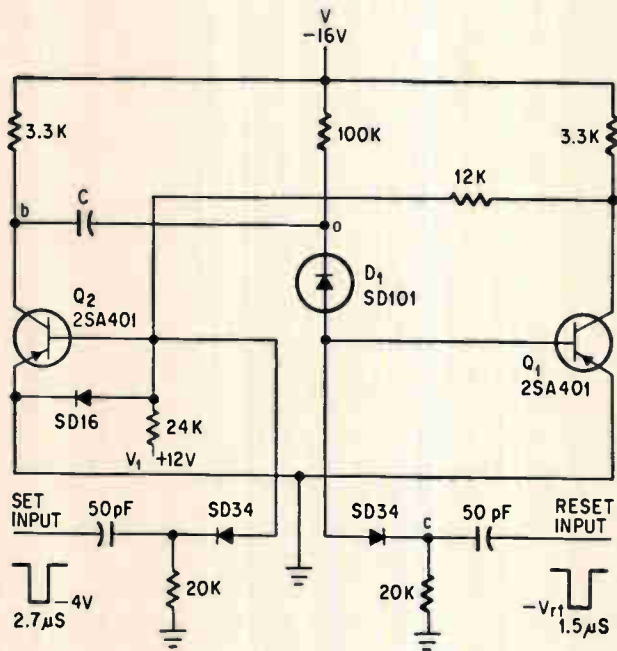
By Hiroshi Inose and Tadahiro Tomiyama

Faculty of Engineering, University of Tokyo

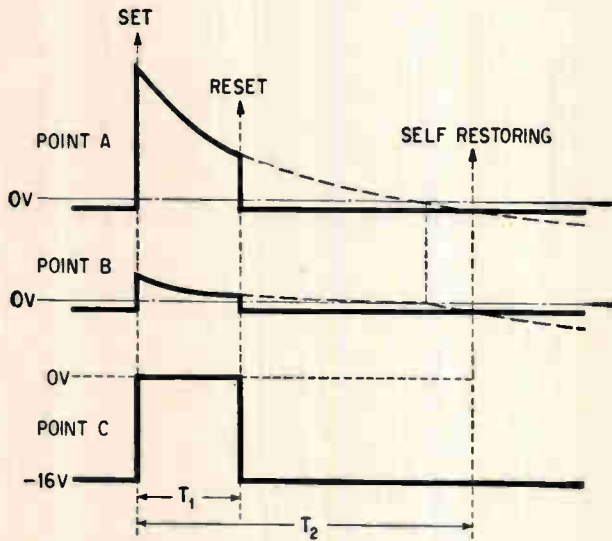
A single diode added to a conventional astable or monostable multivibrator, as shown in the schematic, greatly reduces the energy required to reset the circuit before its normal self-restoration period. Usually, a high-energy reset pulse is needed for

rapid reset because the almost fully charged timing capacitor must be discharged at nearly the same instant.

In the quiescent state, when Q_1 is on and Q_2 is off, the voltage at point b equals the supply voltage, -16 volts. The voltage at point b is the base-emitter forward voltage of Q_1 plus the forward drop of diode D_1 . Transistor Q_2 conducts when triggered by a negative pulse of sufficient amplitude. The potential at point b rapidly rises almost to ground potential, cutting off D_1 and Q_1 , and setting the monostable multivibrator. The voltage at point a, which has followed the rise in voltage at point b, now decreases exponentially towards -16 volts with a time constant RC as



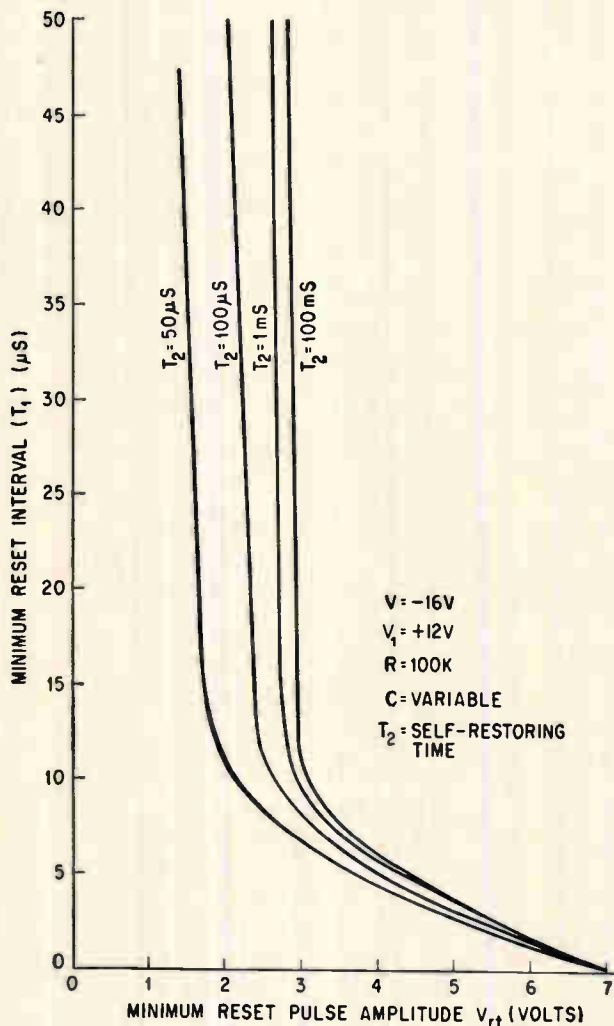
Addition of diode D_1 to conventional multivibrator decreases required amplitude and duration of reset pulse.



Curves show that monostable multivibrator is reset in minimum possible time interval, T_1 , when triggered by a negative pulse of fixed sufficient amplitude. The minimum interval is a function of the self-restoring time of the multivibrator, T_2 .

shown in the waveforms above.

Without the diode, the voltage at the base of Q_1 would be identical to that at point a. To reset the circuit immediately after setting, a reset trigger of large energy would have to be applied at the base of Q_1 . The additional diode isolates the base of Q_1 from point a, so that the potential at point c is approximately zero except for the negligible voltage drop caused by the leakage current through



Trigger sensitivity of an experimental monostable multivibrator with reset diode added. Minimum reset pulse amplitude must be increased slightly for higher self-restoration time, T_2 .

silicon diode D_1 . Therefore, a trigger pulse with an amplitude approximately that of the set trigger is sufficient to reset the monostable multivibrator at any time after it has been set. The diode D_1 is also helpful in protecting Q_1 from possible base-emitter breakdown caused by large inverted pulses or from large voltage swings of the timing capacitance.

The curves for an experimental circuit show the relation between minimum reset interval T_1 and the minimum required reset pulse amplitude, V_{rt} , for various self-restoring times, T_2 , and a reset pulse width of 1.5 microseconds. Q_1 and Q_2 are germanium-drift transistors with alpha cutoff frequencies of 230 megahertz. The experimental monostable multivibrator with a self-restoring time of 100 milliseconds is reset in 6 microseconds with a trigger of 4 volts. The added diode can also be applied to synchronization of an astable multivibrator.

Period of sawtooth ramp extends to 5 hours

By Ron Chapman

Electron Physics Section, National Research Council, Ottawa, Canada

The measurement of the energy spectrum of particles frequently requires a stable reference sawtooth voltage of exceptionally long duration. The circuit shown generates a ramp whose period is stable to 0.03% and deviates from linearity by less than 0.1% for periods of up to 5 hours.

An operational amplifier and its feedback network, resistor R and timing capacitor C, integrate a small step voltage to form the ramp, which resets when the output reaches a predetermined amplitude. A push-button switch in series with the silicon-controlled switch Q₁, opens the relay circuit which normally shorts the timing capacitor, C, and open-circuits Q₁. Capacitor C begins to charge through resistor R. When the ramp voltage rises to a peak of 5 volts, the operational amplifier's output voltage appears at the gate of unijunction transistor, Q₂, causing it to fire. Capacitor C₁ then discharges through resistor R₉ and produces a positive pulse at the anode of diode D₁ and at the cathode gate of Q₁. The switch fires, energizing the relay and terminating the cycle.

The ramp amplitude and period are calibrated by potentiometers R₁ and R₂ respectively. The peak ramp voltage, 5 volts, is independent of the period.

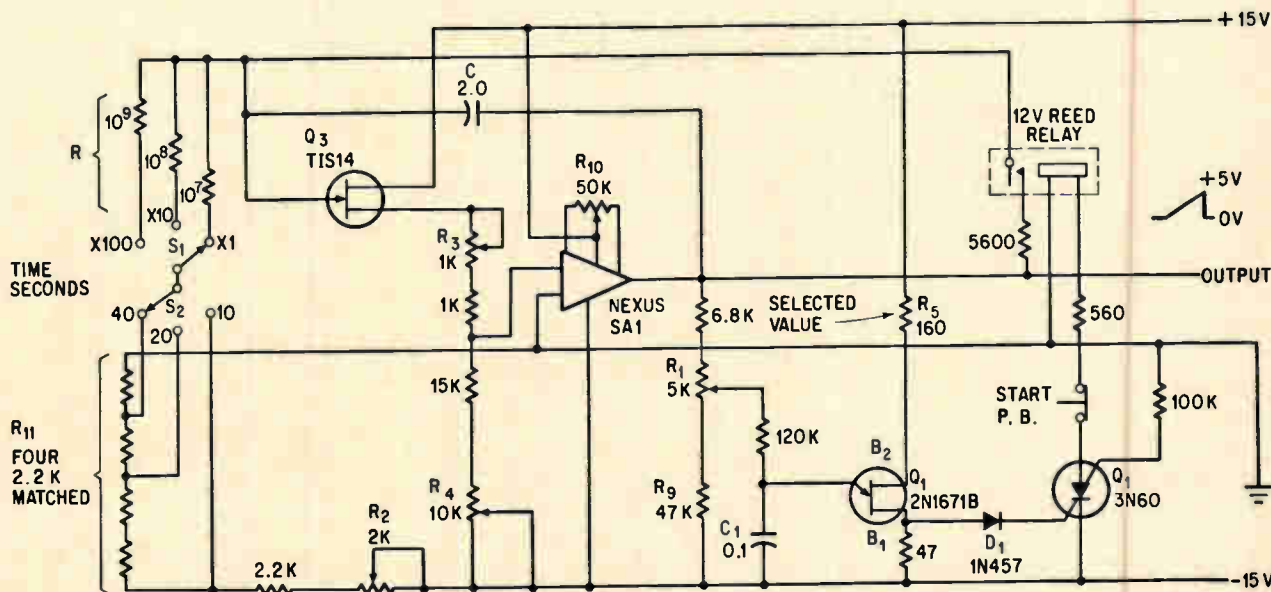
The tapped voltage divider network, R₁₁, serves as a constant current source for the charging resistor, R. The amount of current is selected by the position of switch S₂, and the charging resistance is selected by the position of switch S₁. The ramp period is the product of the settings of both calibrated switch positions.

The two temperature-compensating potentiometers, R₃ and R₄, are adjusted to set the critical drain current of the field effect transistor, Q₃, at its zero temperature coefficient value while maintaining the input to the operational amplifier at zero voltage level. Temperature changes from 25° to 50°C do not change the ramp perceptibly, and reduce the period by only 0.03%. Q₃, matches the impedances between the timing resistor, R, and the input to the operational amplifier. The resistor, R₅, provides temperature compensation for the unijunction transistor circuit. Its value is determined experimentally.

All leads to Q₃'s gate are Teflon-insulated to minimize leakage. The positive and negative power supplies are regulated to within 0.1%. Ramp amplitudes up to 200 volts can be obtained by amplifying the signal with a vacuum-tube operational amplifier. For signal readout, the gate voltage from the anode of Q₁, serves as a synchronizing signal for the readout device.

To obtain a 5-hour period, the timing capacitor must be replaced with a 10-microfarad low-leakage type of capacitor. A 10-millisecond period requires a 0.005 μf timing capacitor.

In addition to the push-button method of initiating the ramp period, a pulse can be applied to one electrode of the silicon-controlled switch.



Ramp periods from 100 to 4,000 seconds are selected by the positioning of switches S₁ and S₂. Periods up to 20,000 seconds are possible by changing timing capacitor C to 10 μf. Potentiometer R₁₀ adjusts the amplifier output to 0 when the input is 0.

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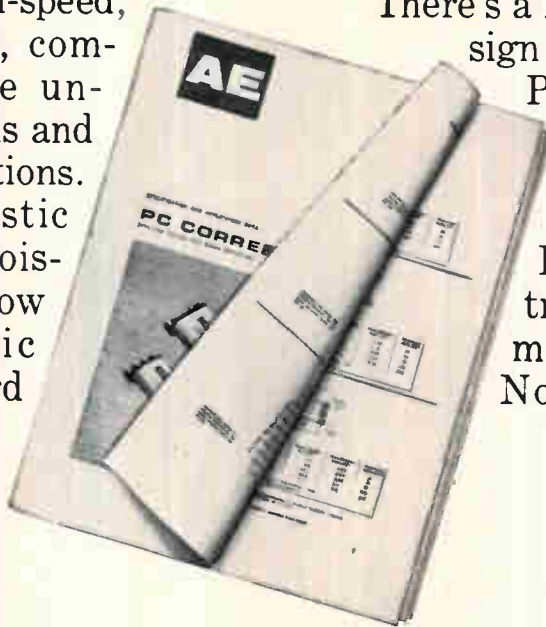
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By W.J. Evanzia

Avionics Editor

The escalation of the Vietnam war, the threat of new brushfire conflicts, the growing use of missiles in tactical warfare—all are prodding the procurement and development of radars that can rapidly determine the elevation as well as the range and azimuth of flying targets.

Three-dimensional radars have many roles in modern warfare: detecting enemy missiles and aircraft, guiding interceptor aircraft and missiles to targets and evaluating the kill. Military air-traffic controllers also use them.

The newest of the 3-D radar systems are electronically scanned and computer controlled. They can find a target—in some cases, many targets—in microseconds, a thousand times faster than the height finders with mechanically nodding antennas, which date to World War II.

The Navy has been using 3-D radar on ships for several years. This year, a new electronically scanned system became operational aboard the new class destroyers and frigates that carry Terrier and Tartar air-defense missiles. One, just commissioned, is shown on the cover; another is on patrol off North Vietnam. A land-based version of the system is being developed for the Marine Corps. The Navy is evaluating a still newer system—also for missile control—that is almost completely solid state and has integrated circuits in its digital subsystem.

The Air Force and the Army are also pressing the development of solid state and microminiature 3-D radars. Both services require tactical systems that are small and light enough to be carried to new battle zones by air. In 1968, the Air Force hopes to begin replacing two older radars at forward air-control posts with one 3-D radar packaged

in two helicopter-transportable huts. Each prototype will cost about \$1 million.

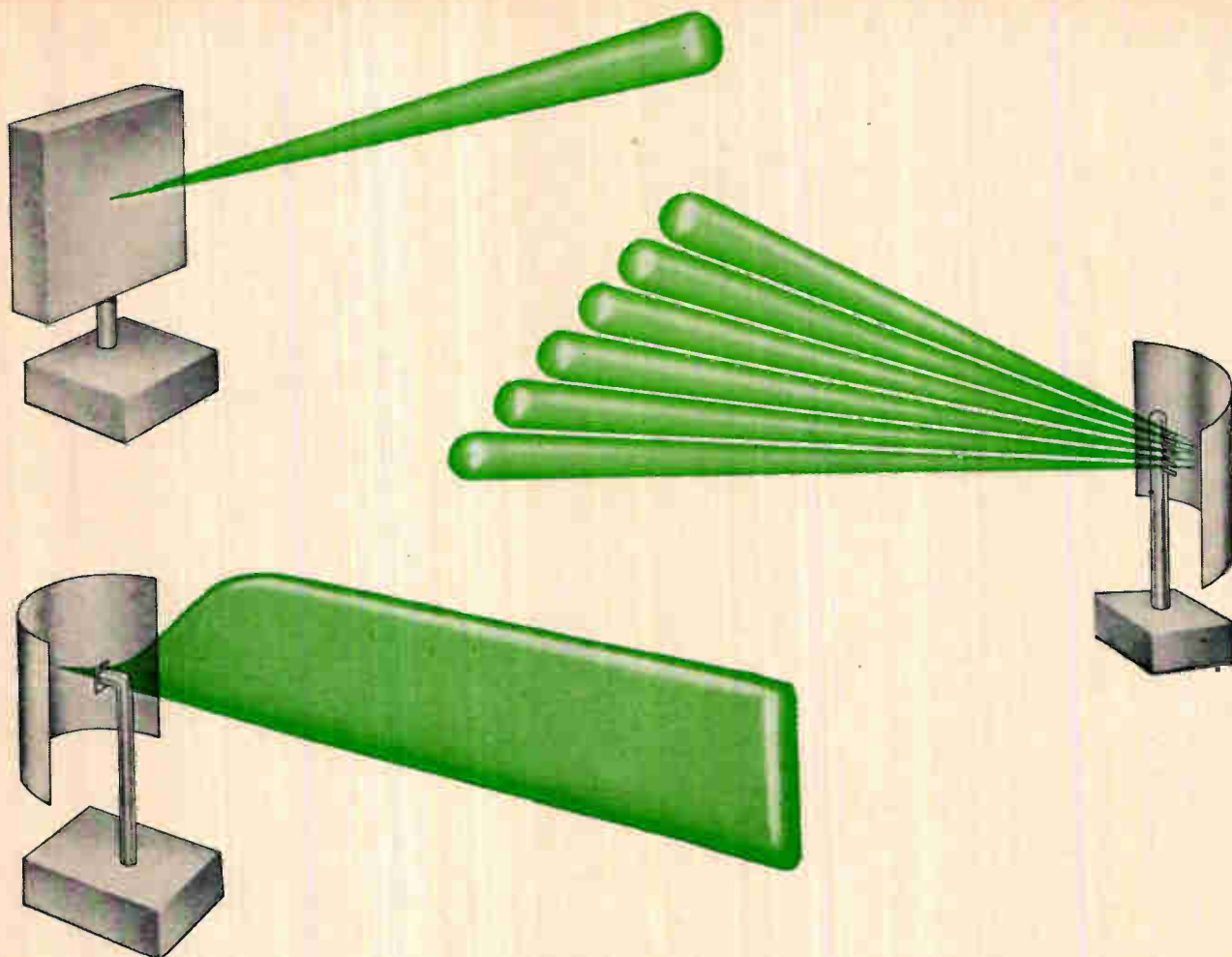
The Army's renewed interest in 3-D radar stems as much from the Army's resurgence as an air power as from its use of tactical missiles. Counting the combat helicopters and reconnaissance and spotter planes in Vietnam, the Army now has more aircraft than the Air Force. The Army needs radar to control the traffic around its busy airfields.

Besides shrinking equipment size, solid state and integrated-circuit construction is expected to raise the reliability of radars sharply. At present, mean-time-between-failures is measured in hundreds of hours, and sometimes it drops to hours in combat. The military wants mean time between failures raised to years.

The high-speed, multibeam capability of the newer 3-D systems has been achieved with costly multielement transmitting and receiving antennas and complex signal-processing circuitry. But researchers are working on new designs that promise to do the job with simplified hardware.

One system the Air Force is evaluating transmits a series of overlapping beams by feeding radio-frequency power from a single transmitter through a slotted feed. The system then analyzes the phase changes in the returned signals to determine target height. It can scan as much of the sky as a conventional 2-D radar, and as rapidly, with only one relatively simple antenna.

Another technique for obtaining the effect of a multibeam system is to transmit a search beam with a conventional radar transmitter and detect the reflected signal with a passive array of receiving antenna elements. Elevation is determined by analyzing phase changes in the return signals at the



Most 3-D antenna systems transmit one of these beam shapes. The narrow pencil beam, above left, is from electronically scanned array; the group of pencil beams, stacked in the vertical plane, center, is transmitted by a stacked-beam antenna. A fan beam such as the one at lower left is also used to measure height. It is the least accurate method of the three.

elements. A passive array was tried in 1960 in the only 3-D radar built in the United States for civilian use—an air-traffic-control system that the Federal Aviation Agency has rejected [see panel on page 87].

Antenna trade-offs

The improvements in 3-D radar have been tied to a series of advances in antenna design.

Until 1960, volumetric antennas, which include stacked-beam, V-beam, and vertical-fan beams, predominated. They determined elevation by detecting the presence of a target in one of a series of beams, or its position in a V-shaped or fan-shaped beam.

In stacked-beam antenna systems a number of pencil beams are stacked in the elevation plane. V-beam antennas transmit two fan beams, one vertical and a second tilted at an angle α with respect to the first beam. These and most other volumetric antenna arrays use amplitude or phase-comparison techniques, or both, to extract elevation information.

Since 1960, the emphasis has been upon electronically switched phased arrays and frequency-scanned arrays. In both, the positions in space of

one or more beams depend upon phasing of the transmitted beam, which is generally programmed by a computer. The target location is determined by the position of the beam and by a change in phase of the reflected signal. Because of their inherent ability to position a narrow radar beam in space in nanoseconds, electronically switched phased-array radar antennas are favored at present for 3-D work.

Most phased-array radars use ferrite phase shifters or traveling-wave tubes to control the phase relationship between radiating antenna elements. A ferrite phase shifter is a two-port radio-frequency transmission line in which the phase of the output signal is varied by changing the d-c magnetic field in which the ferrite is immersed. Traveling-wave tubes control phase through variations in the helix voltage.¹

Frequency-scanned antennas change the position of a beam in space by utilizing the frequency-dependence of phase shift in an electromagnetic wave moving through a piece of waveguide. The amount of phase shift and consequently the direction of the beam changes with frequency. The required frequencies are obtained from a number of free-run-

ning oscillators and the required switching is controlled by a computer.

No single approach dominates the antenna field. Engineers dispute which type is best for a given application. The Westinghouse Electric Corp. has been building stacked-beam systems. The Hughes Aircraft Corp. and ITT-Gilfillan Inc., a subsidiary of the International Telephone and Telegraph Co., prefer frequency-scanned antennas. The Raytheon Co., which is developing 3-D radar systems for the Air Force, likes a dual-antenna technique.

Frequency- and phase-scanned systems make full use of their antenna apertures so they have the advantage of intercepting maximum return signal strength. Also, the beam's elevation angle is capable of being programed in small increments, and scanned systems offer a wide choice of pulse-compression techniques. But they have only limited capability for detecting moving targets—and frequency agility to counteract jamming cannot easily be attained.

The exception is a phase-scanned, pencil-beam system, in which frequency agility can be had at the expense of phase-shifter loss and additional control complexity. These systems are also generally restricted to S-band (1.5 to 5.2 Ghz) because C-band (5.0 to 6.5 Ghz) apertures are not large enough to overcome the larger beamshape, duplexer and signal-processing losses that occur. And since these systems operate at relatively low microwave frequencies, they are subject to weather clutter.

Stacked-beam antennas, on the other hand, offer a much wider choice of frequency bands and inherently greater frequency agility. Because the total transmitted beam is fan shaped, more radar hits per antenna rotation occur. This results in high capability for moving target indication and good random-pulse suppression. Cross-polarization techniques can be used to reduce weather clutter. Antennas can be made simple and light in weight. Stacked-beam systems, however, require multiple receivers—one for each beam—making pulse compression difficult and reducing programing capacity and flexibility of control. Stacked-beam antennas are also limited in ability to resolve elevation angles independent of the other two radar coordinates, range and azimuth. The table on page 86 compares the efficiencies of a dual stack-beam system with three successive generations of radars using scanned pencil beams.

Carried by helicopter

An example of the lightweight, easily transported radar needed in Vietnam is the AN/TPS-43, which Westinghouse is building for the Air Force. It will have six stacked beams. The contract, for \$15 million to \$20 million, calls for delivery of 18 prototype systems by January, 1968. Eventually, they will replace the AN/MPS-11 and MPS-16 radars that are now used at forward air-control posts and at the rear control areas, which the Air Force calls recording centers.

The TPS-43 must have an absolute elevation ac-

curacy of 1,500 feet at 150 miles. The accuracy of distance measurement between targets is expected to be even better.

The AN/TPS-43 will weigh 7,000 pounds and be divided into two packages, each of which could be carried by a helicopter. One package will contain the antenna, pallet, and microwave components—the power dividers, duplexers and radio-frequency amplifiers; the second package will contain the receiver, transmitter and data-relay equipment.

The TPS-43 will be set up in out-of-the-way positions about the perimeter of the control post's operations center. The antenna system will be mounted on a pallet and connected to the transmitter-receiver van by waveguides. Processed radar video information will be sent by coaxial cables or microwave links to the operations center where the radar operators will control air traffic and direct target-intercept missions.

Westinghouse entered the 3-D radar business in 1953 when it built a mobile stacked-beam radar called the AN/MPS-20 for the Air Force. Next came a contract to build the AN/TPS-27, which the Air Force wanted to use in its 412 L system—a tactical air-weapons control and warning system. Westinghouse is under contract to build the AN/TPS-48, an Air Force modification of the TPS-27.

3-D at sea

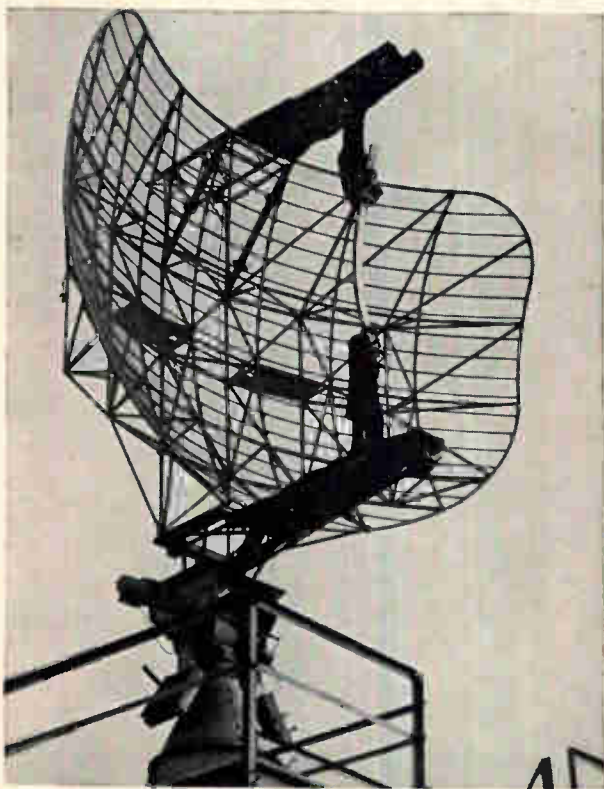
The new radar for the Navy's guided-missile, destroyer-leader class ships (DLG's) is the AN/SPS-48, built by ITT-Gilfillan Corp., a subsidiary of the International Telephone & Telegraph Corp.

The SPS-48 is a frequency-scanned missile-designation and air-control radar for use aboard guided-missile destroyers or frigates carrying the Navy's Terrier and Tartar missiles. The USS Fox DLG 33, recently commissioned at the Todd Shipyards in Long Beach, Calif., the USS Wainwright DLG 28 and the USS Warden DLG 18 carry the SPS-48. The Warden is now on combat patrol off North Vietnam in Tonkin Bay.

The SPS-48 provides target range, azimuth and height information to the ship's combat information center. The data can be relayed to interceptor aircraft through the Navy's tactical data system or used for missile guidance and tracking radar positioning.

The Navy considers the SPS-48 a follow-on development of the earlier inertialess frequency-scan SPS-39/52 series radars made by Hughes. Unlike the earlier radars, the SPS-48 can transmit multiple beams. The Navy points out the AN/SPS-48 also has a digital rather than an analog computer for performing stabilization computations.

The multiple-beam format gives the SPS-48 long range and a high data rate, while its higher power and flexible power management give it a superior performance over the 39-52 series in a countermeasures environment—such as when jamming occurs. As might be expected, the AN/SPS-48 weighs more and costs more than the somewhat less capable SPS-39/52, the Navy says.



The 3-D Sletten antenna undergoing evaluation at Air Force Cambridge Research Laboratory testing facility at Ipswich, Mass., can provide absolute height measurement accuracies of ± 200 feet. It is parabolic in azimuth plane and circular in elevation plane. A section of sky 1.5° wide and 30° high is illuminated by reflected energy from its slotted line feed. The beams are positioned by the phase of the radiation from the slots.

The AN/TPS-32, a land-based frequency-scanned radar system is also being developed for the Marine Corps by ITT-Gilfillan. Work on the TPS-32, which uses many of the scan and processing techniques found in Gilfillan's SPS-48 shipboard system, was started in 1959—before the SPS-48. Since 1959 the program has been an on-again-off-again affair. Gilfillan received its latest TPS-32 development contract from the Marines last December. Prototypes of the partially microminiaturized radar system are expected in about a year.

Scanning for blips

Hughes has built most of the inertialess-scan radars used in the fleet today. In December, 1960 Hughes began equipping the Navy's missile-armed cruisers and destroyers with 3-D systems. Hughes' AN/SPS-39, 39A, 42 and 52 are frequency-scan systems.

According to Nicholas Yaru, vice-president of Hughes and manager of its communications and radar division, the frequency-scanning technique was a development of Nicholas A. Begovich, also a Hughes vice-president. Begovich derived the basic equation for frequency scanning from Maxwell's wave equations, expressed as

$$\psi = e^{-i\beta_s}$$

where ψ is the phase shift and β_z is the phase constant of the waveguide. β_z in turn is given by

$$\beta_z = 2\pi f \sqrt{\mu - \epsilon} \sqrt{1 - \left(\frac{fc}{f}\right)^2}$$

where μ is the relative permeability of the medium in the waveguide, ϵ the dielectric constant, and f_c the cutoff frequency—the lowest frequency at which the waveguide supports propagation. This is determined by the waveguide dimensions.

In the Hughes system, the frequency shifts are provided by a bank of free-running crystal oscillators that operate from 50 to 1,000 megahertz. Their outputs are gated by a computer into a mixer. The upper and lower sidebands are multiplied to attain the appropriate microwave frequency; the resulting signal is fed to the antenna.

Hughes radars use computers to program the beam's elevation angle in space. The computer also compensates for ship motion; but azimuth angle information is derived through conventional mechanical rotation of the antenna.

Hughes claims its 3-D radars will track a 1-square-meter target at a distance of 170 nautical miles, and that elevation accuracies of $\pm 1,500$ feet at 100 miles are possible.

Hughes also has produced an electronically scanned 3-D radar, the AN/SPS-33, which it says, "is the only operational 3-D phased array in the world". It was installed aboard the carriers Enterprise and Long Beach about four years ago. The SPS-33 scans electronically horizontally and vertically, and with four antennas, it has no mechanical movement. The Navy says, "It is the most advanced and effective 3-D radar in the fleet today."

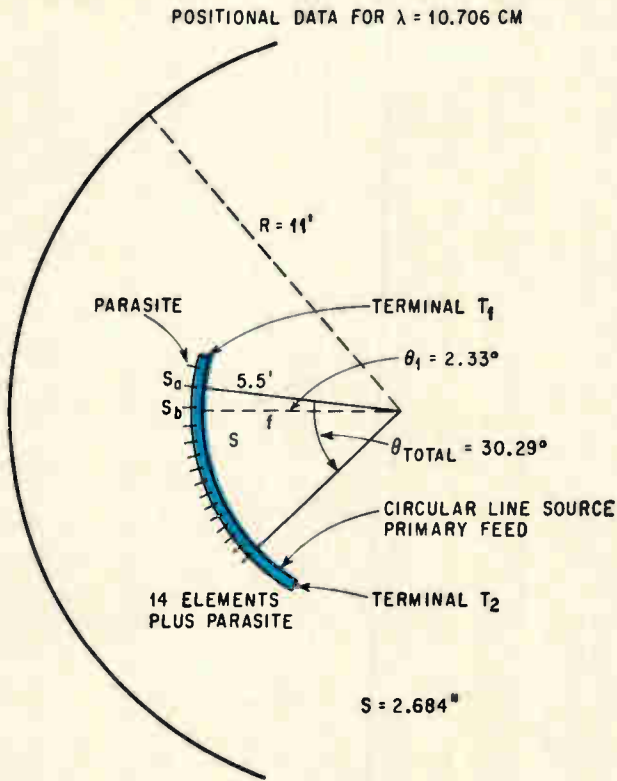
Integrated-circuit computer

Not operational, but probably the most sophisticated 3-D radar built to date, is the AN/SPG-59, developed by the Applied Physics Laboratory of the Johns Hopkins University, and built by the surface division of Westinghouse in Baltimore.

The SPG-59 is computer controlled. It has a phased-array antenna with switched ferrite devices that can place a single, very narrow beam anywhere in space within a volume described by a hemisphere. The antenna is built in the shape of an orange with the lower third cut off.

The computer can program the single beam to search and track a single target or it can generate multiple tracking beams. The computer can also program the radar's multiple receiving arrays independent of its transmitting arrays so that it can guide missiles toward targets while continuing other surveillance and tracking.

The AN/SPG-59 was delivered last summer as part of the Navy's most advanced weapons control system, Typhon—which consisted primarily of the SPG-59 with weapons-direction equipment and missiles. The SPG-59 is being evaluated aboard the USS Norton Sound VMI, a converted seaplane tender. Its circuitry is almost completely solid state



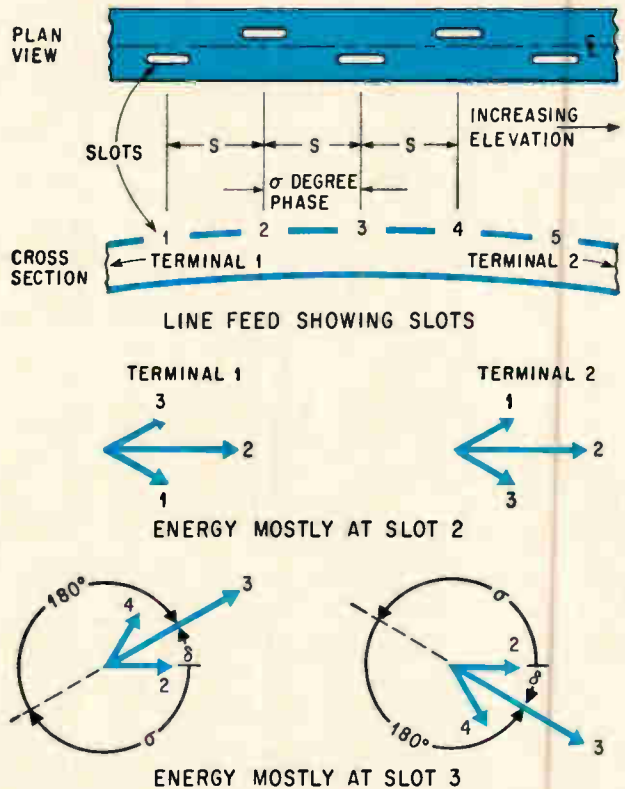
The slots in this 2.8-gigahertz experimental Sletten antenna feed are spaced 6.817 centimeters apart. At $\lambda = 10.706$ cms, slots are 0.927λ apart so that in waveguide they progressively lead in phase by $0.73^\circ \lambda_c$ or 26.3° .

and integrated circuits are used in some of its digital logic processing circuits.

New antenna techniques

One of the latest Air Force research projects in volumetric (fan-beam) 3-D radar antennas is being carried on at its Air Force Cambridge Research Laboratory in Bedford, Mass.² Under evaluation is a system which utilizes the phase-in-space characteristics of a cosecant squared θ antenna beam—the standard beam pattern for search radars—to extract elevation angle. The revolutionary antenna was designed by Carlyle J. Sletten, who is the chief of the Microwave Physics Laboratory at Cambridge. Though its purpose is to obtain the third coordinate—elevation—the system retains the large volume and rapid scan features of a conventional search radar and is less complex in design than stacked-beam systems, or single-beam systems which scan in elevation.

It is the design simplicity which makes this tricoordinate system so attractive to the Air Force. The parabolic torus antenna on page 83 comprises a single feed and single reflector. The reflector is parabolic in the azimuth plane to form a pencil beam 1.3° wide. It is circular in the elevation plane as illustrated above. This arrangement results in a cosecant squared θ beam of about 30° . The antenna's feed is a circularly curved, 15-element slotted array as shown. The slots are stacked ver-



Phase relationships of microwave energy at radiating slots of Sletten antenna. Phase angle changes are caused by slot spacing and slot positions relative to waveguide centerline. Aperture illumination is a function of the distance of the slot from the centerline.

tically to produce overlapping beams, which are combined to give the beam pattern. The beam's spatial positions are controlled by controlling the phase of the radiation from the slots.

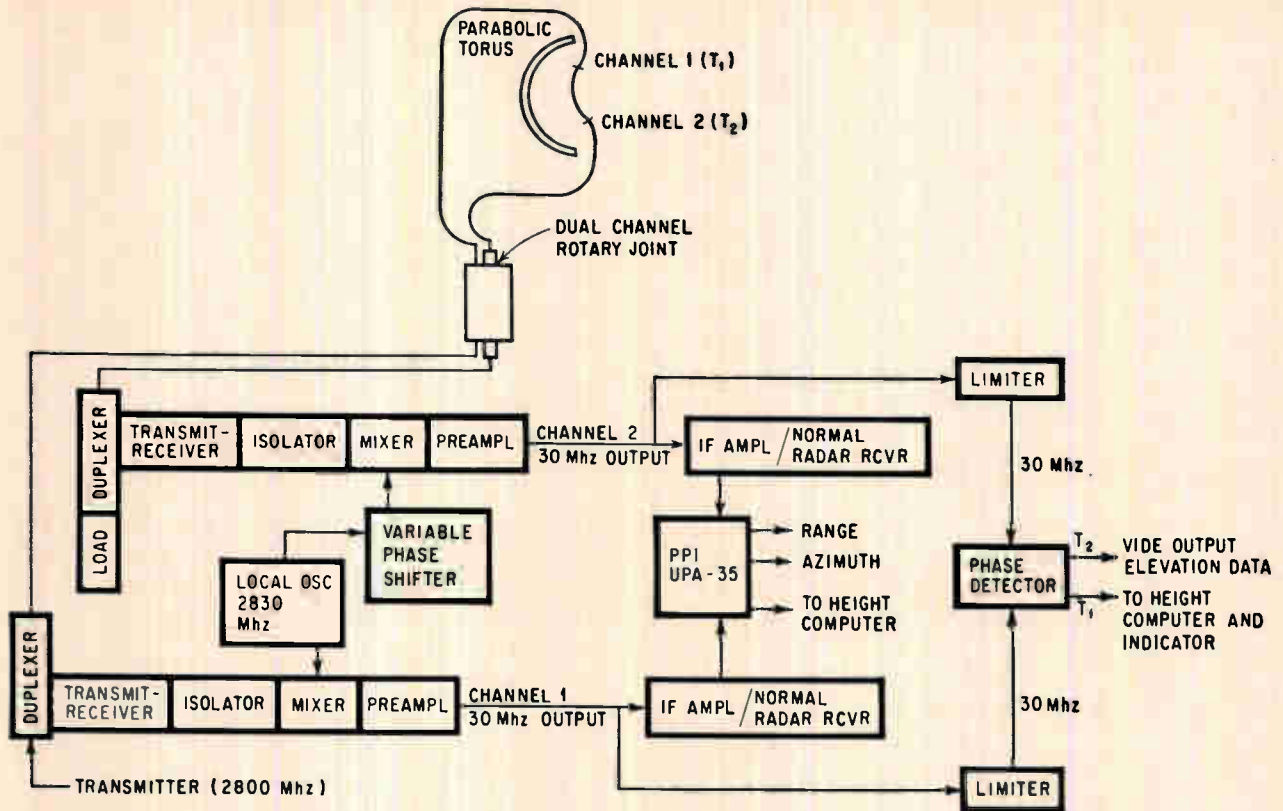
A signal received by the Sletten antenna splits into two components and goes to the two terminals of the line feed. The electrical phase difference between the signal components is uniquely related to the elevation angle of the signals.

Measurement of the phase difference gives the elevation angle. For example, a target return echo striking the reflector at some angle, say 20° , will also be focused at a related angle on the line feed. As the elevation angle of the target changes θ degrees, the point at which the energy is focused on the feed moves a distance l .

$$l = R\theta \frac{\pi}{180} \quad (1)$$

where R is the radius of the curvature of the feed.

If the radar return energy is entering slot 2, at right/left, some of the return energy is present in slots 1 and 3. The middle vector diagrams show the phase relationships existing between slots 1, and 2 at the two line feed terminals T_1 and T_2 . If the incident energy moves from slot 2 to 3 then the phase relationship at the terminals are those shown in the lower diagram. The new vector positions result from the propagation of the radar energy through a different length of waveguide, and from



Signals from both ends of Sletten antenna array are used to obtain tricoordinate information. Inputs from terminals T_1 and T_2 are fed into matched receivers converted to 30 Mhz. One branch from each channel is fed into normal radar receiver; other branches are fed to phase detector, which extracts height information from the detected i-f signals.

a phase shift of 180° because successive slots are located on opposite sides of the waveguide. The signal at T_2 has been advanced by an angle $\sigma + 180^\circ$ while it has been retarded at T_1 by $\sigma + 180^\circ$ (σ is the phase shift of a length of waveguide) or

$$\sigma = 360^\circ \left(\frac{S}{\lambda_g} \right). \text{ The vector of the signal at } T_2$$

has advanced in phase almost 360° although it has been retarded by a small angle δ , while the phase of the T_1 terminal signal has advanced by the angle δ . δ can then be written

$$\delta = 360^\circ - (180^\circ + \sigma) = 180^\circ - \sigma$$

or

$$\delta = 180^\circ - 360^\circ \frac{S}{\lambda_g} \quad (2)$$

Therefore increasing elevation angle moves the point of focus toward terminal T_2 . Moving the focus a distance S toward T_2 causes the phase at terminal T_1 to lead that at T_2 by 2δ .

The elevation angle change, θ_s can be found by letting $l = s$ in equation 1 so that

$$\theta_s = \frac{180S}{\pi R} \quad (3)$$

Since the phase change ϕ_s which corresponds to θ_s is 2δ , the ratio $\frac{\phi_s}{\theta_s}$ can be derived from equa-

tions 2 and 3 or

$$\frac{\phi_s}{\theta_s} = 2 \frac{180^\circ - 360^\circ \frac{S}{\lambda_g}}{180S} = 2\pi R \left(\frac{1}{S} - \frac{2}{\lambda_g} \right) \quad (4)$$

which is the ideal relationship between phase and elevation angle.

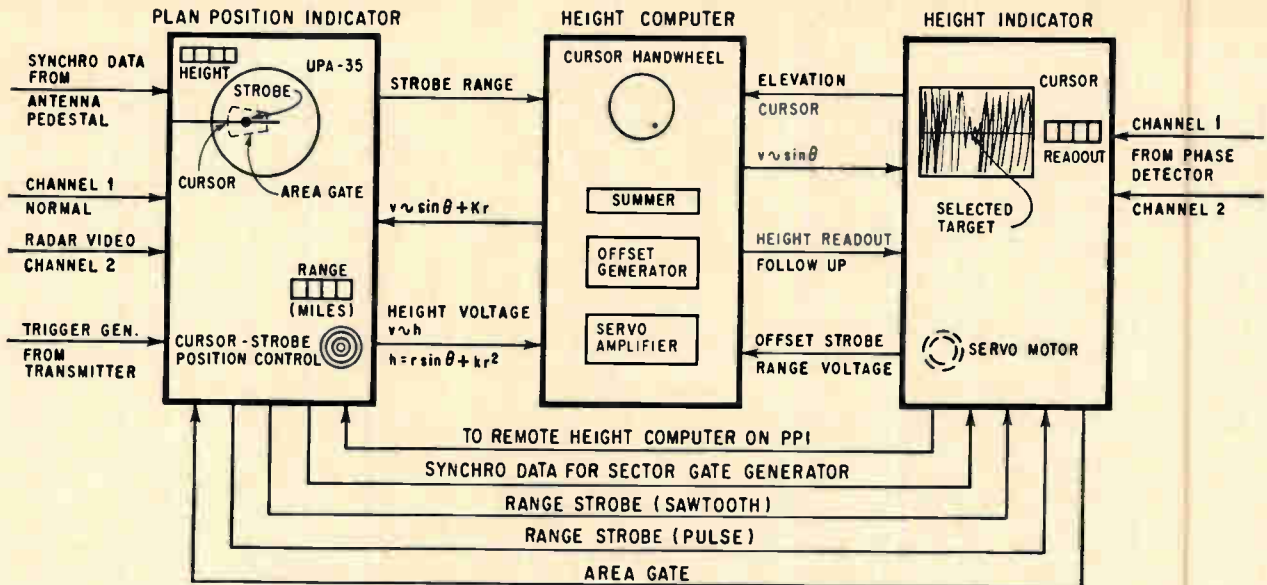
In these equations ϕ is equal to the phase change in degrees between antenna terminals resulting from an elevation of θ_s degrees, λ_g is the guide wavelength and R is the feed radius.

Equation 4 can be used to find the necessary slot spacing for the desired ratio of phase to elevation degrees. The ratio can be varied by using non-uniform slot spacing to obtain greater elevation accuracies at low elevation angles for fixed-phase measurements.

The amount of power which a slot radiates, and therefore the aperture illumination, is controlled by the distance of the slot from the centerline of the waveguide.

Finding the height

The Cambridge lab radar operates at 2.8 gigahertz (S band). When the transmitter sends a pulse of microwave energy, the energy first passes through a high-power isolator and duplexer as in the illustration above. Next the energy proceeds



Range and azimuth data are shown on conventional UPA-35 plan position indicator; but the Sletten system utilizes a special height computer and indicator scope (in color) to indicate height

through the high-power (outer) channel of the dual-channel azimuth rotary joint to the upper terminal, T_1 , of the antenna feed. Most of the energy is radiated through the slots in the feed and illuminates the radar reflector. The remaining energy leaves the lower terminal T_2 of the feed and passes through the low-power (center) channel of the rotary joint to a second set of duplexers. The duplexers fire and permit dissipation of the remaining energy in a dummy load. After the pulse ends, the duplexers switch the antenna terminal connections from the transmitter and load to the receiver input terminals.

When a target is in the antenna beam, the reflected signal received by the antenna divides between the feed terminals, T_1 and T_2 , and flows

through the dual-channel rotary joint, the duplexers and low-power isolators, and enters balanced mixers. There they are heterodyned with a common 2,830-megahertz oscillator. The difference frequency of 30 Mhz is filtered out and amplified by low-noise preamplifiers.

The signals from each of the two channels are separated into two branches, one of which is fed into a normal search-radar receiver. The other goes to a special phase-detecting and signal-limiting receiver for elevation measurement.

The limiter receiver removes all amplitude variations so that the phase detector responds only to the instantaneous phase difference between the two channels. The phase detector receives the elevation-angle information (phase change), which is contained in the two i-f (30 Mhz) signals, and converts it into video pulses with amplitude proportional to elevation angle. The conversion is made by subtracting the sum and difference of the detected i-f signals.

Conventional radar information, range and azimuth, is displayed on a standard plan position indicator; elevation data is processed by the height computer and displayed on a height indicator.

Comparison of search efficiency

	Dual-antenna stacked beam	Phase-scan pencil beam		
		A	B	C
Radar hits per scan	11	1	1	1
Detection probability	50 to 99%	50%	90%	99%
Losses in decibels:				
Azimuth beamshape	1.6	1.6	3.3	4.4
Elevation beamshape	0	1.6	3.3	4.4
Video integration	2.0	0	0	0
Energy distribution, 0-20°	1.0	2.5	2.5	2.5
Phase shifters	0	2.0	2.0	2.0
Transmitter duplexer	0	0.4	0.4	0.4
Receiver protection	0.2	0.4	0.4	0.4
Transmitter aperture illum.	1.0	2.0	2.0	2.0
Reduced receiver aperture	1.8	0	0	0
Relative power needed for given total aperture (db)	7.6	10.5	13.9	16.1

Other Air Force research

For three years much of the Air Force's work on airborne warning and control radar systems has been carried on at Raytheon's Missiles Systems division. Tests on an airborne, phased-array surveillance radar have been made aboard an Air Force C-141 aircraft. The system has successfully detected planes flying below the C-141, despite large amounts of ground clutter, and has measured the altitude of the targets. Details of the system design are not available.

More is known about Rayscan 3, a ground-based system for determining aircraft elevation, that Ray-

theon is developing for the Air Force. Radar energy reflected from a target illuminated by a conventional search radar is received by a vertical array of passive antenna elements spaced at equal intervals of distance S . Amplitude and phase of the return signal determines elevation.

A plane passing through the antenna beam will have an angle ϕ with respect to a line perpendicular to the array, so that the wavefront from the plane is also inclined at an angle ϕ to the array. Therefore the path difference from the target point

and adjacent antenna elements is

$$\Delta = S \sin \theta$$

so for a wavelength, λ , the phase shift between adjacent elements is

$$\phi = 2\pi \frac{S}{\lambda} \sin \theta$$

Rayscan 3 makes use of the regular phase spacing between antenna elements to process the signals in a way that the elevation angle θ can be measured during each pulse received from the target.

But no 3-D for civilians

A huge tower near Atlantic City, N. J., stands as a lonely monument to the only attempt by the federal government to apply 3-D radar to civilian air-traffic control.

The tower was built in 1960 by the Maxson Electronics Corp. when the Airways Modernization Board decided to experiment with 3-D radar. The board, a predecessor of the Federal Aviation Agency, hoped that a 3-D radar could determine the altitude of en route aircraft with sufficient precision and range to develop an automated control system.

The tower was to be the receiving antenna in a two-radar, 3-D system. A 2-D air-route-surveillance radar operating at S band would illuminate the aircraft. The receiver was to consist of a triangular structure 164 feet high, with 111 antenna elements stacked on each side. The receiving radar would determine the height of aircraft within its range of 50 miles.

Not good enough

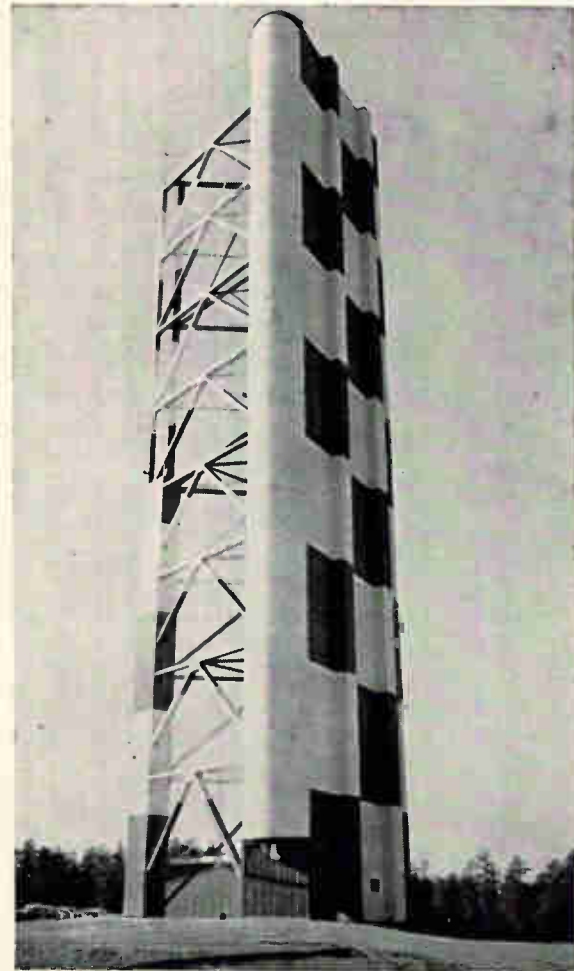
Only one side of the antenna—the tower at the National Aviation Facilities Experimental Center—was built. The FAA abandoned the experiment when the air-traffic-control program was reoriented in 1961 by the Project Beacon report. The report concluded that 3-D radar is too expensive and not sufficiently accurate for en route control. A method of resolving altitude separations of 100 feet between aircraft would be needed for automatic control; the best 3-D radars of that day were only accurate to $\pm 1,000$ feet at their maximum range.

So the FAA and the military set up programs to monitor military and commercial aircraft by means of radar beacon transmitters and 4,096-code altitude-reporting transponders in the aircraft. Aircraft identity, assigned altitude and actual altitude will be displayed to the ground controllers. The first display will become operational this year at Lake Ronkonkoma, N. Y.

However, the system will not be effective nationwide until the 1970's, when the FAA's National Airspace System is ready. Also, a recent survey by the Air Transport Association showed that most airliners aren't equipped yet to report altitude. Of 1,645 aircraft checked, 399 had 4,096-code units and 924 had 64-code transponders, but only 92 of these had operational altitude-reporting equipment. Of 626 airliners on order by 1970, only 409 will have altitude-reporting systems.

Around the airports

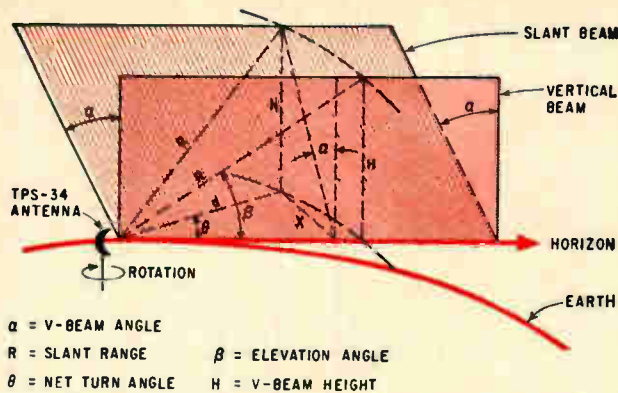
Proponents of 3-D radar concede it is still too expensive for en route surveillance, but they see possible advantages for close-in surveillance around



Abandoned air height surveillance tower at the FAA's Atlantic City test facility is all that's left of a planned civilian 3-D system.

airports. A new system, such as the Air Force's AN/TPS-43, would probably cost less than the 2-D airport radars the FAA now has: they cost up to 1.5 million installed, while the price tag on the military 3-D prototypes is about \$1 million.

Three-dimensional radar, it is argued, might have prevented some of the midair collisions and crashes near airports in recent years. Investigators think it possible that pilot errors in altimeter settings or altitude readings caused some of the crashes. Ground controllers with 3-D radar could warn pilots circling at the wrong altitude or descending too low.



In the Sperry AN/TPS-34 3-D antenna system the vertical beam precedes the slant beam. Solution of beam geometry enables the aircraft's altitude to be determined.

The number of channels (antenna elements) N determines the elevation angle resolution.

After the channel signals have been converted to an i-f frequency, the N signals enter a second mixer for processing. In the first channel, the signal is converted to a lower i-f by mixing with a frequency f_L . In the second channel the signal is mixed with $f_L + f_c$, where f_c is a clock frequency. The signal in channel 3 is mixed with $f_L + 2f_c$ and the relationship continues through the remaining channels. The signal in channel i is mixed with $f_L + (i-1)f_c$. The outputs of all the mixers are added together and create a waveform which reaches a peak during the period of signal f_c . The position of the peak within this period is a function of the phase shift.

In 1965 Raytheon designed and constructed a 20-channel receiver that operated at L band (390 to 1,550 Mhz.) Balanced crystal mixers were used to convert the outputs of the antenna elements to the first i-f of 105.5 Mhz. This was followed by a ceramic tube preamplifier and a solid state i-f amplifier which brought the signal to a high enough amplitude for the second mixers. The 20 coherent local oscillator signals required for the mixers were generated by mixing the output of a 63-Mhz crystal oscillator with a 500-khz clock oscillator. Various beat frequencies were then extracted by means of crystal filters. These frequencies were 63 Mhz, 63.5 Mhz, 64 Mhz, 64.5 Mhz and so on; the second i-f's are 42.5 Mhz, 42 Mhz, 41.5 Mhz, 41 Mhz and so on.

To test the system, Raytheon engineers flew a B-26 World War II bomber toward the radar from a distance of about 15 nautical miles. They attempted to maintain a constant altitude of about 10,500 feet. The mean value of the radar observations was 10,623 feet. The square root of the mean value of $(H-H_{\text{mean}})^2$ was 222 feet, which is the standard deviation of the measurement accuracy if the aircraft's altitude was constant. At a distance of 8 nautical miles this corresponds to an angular error of 0.25° .

3-D for Marines

The Marine Corps' transportable early warning systems have been built by the Sperry Gyroscope

Co. An engineering prototype, called the AN/MPS-21 was built under a 1954 contract. Electronic counter-countermeasures were added to the system, resulting in the AN/TPS-34. It has been in production since 1963.

A typical TPS-34 site consists of three separate groups of equipment: a primary power source, a radome which houses the antenna, transmitter equipment and receiver preamplifiers, and the operations shelter where the receiver's video-processing equipment, height computer and other data-processing equipment is stored. The system weighs nearly 25,000 pounds and is packaged in boxes that average about 400 pounds.

In the TPS-34, 3-D performance is obtained through a single V-beam antenna energized by two separately controlled transmitter systems. Return signals from each beam are processed in separate receivers and integrated separately for display. The video signals are in turn sent to a computer which derives radar range, azimuth and target elevation.

At long range, targets are detected in both receiver beams as if there were two separate radar systems. However, the position of the target in the vertical and slant beams permits determination of the target's height by solving for the geometry of the V-beam at that point in space.

When the antenna is rotating, the vertical beam precedes the slant beam and is therefore the first to illuminate the target. As the antenna continues to rotate, the slant beam hits the target, and the angle of rotation between the vertical and slant beams is measured. This angle, called the turn angle, together with target range provides the data for the V-beam.

Sperry developed a special altitude computer for height computation. It uses the target's radar range, R , and azimuth as a means of determining the exact centers of the beam scan envelopes and to isolate the target from other returns in the receiver channels of the slant and vertical beams—the angular interval between beam centers is a measure of the turn angle. In the computer, the turn angle is obtained digitally by counting pulses, which are generated by a magnetic pickoff which senses the rotation of a ferromagnetic gear. The gear moves synchronously with the antenna. The digital count is converted into an analog voltage and later combined in a function generator with an analog of range. The function generator then solves the V-beam equation

$$\frac{H}{R} = \frac{\sin \theta}{\sqrt{1 + \sin^2 \theta}}$$

for the height of the target.³

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1. Merrill I. Skolnik, "Introduction to Radar Systems," McGraw-Hill Book Co., 1962, p. 309.
2. E. R. Wingrone Jr., "Investigation of AFCRL Tri-coordinate radar techniques," The General Electric Co., Report Contract No. AF 19 (628)-335, Dec., 1964.
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Curves optimize lead impedance

The characteristic impedance of optimum reactance leads and the corresponding input impedance can be quickly calculated for uhf circuits

By A.L. Rossoff

General Instrument Corp., Hicksville, L.I., N.Y.

Parasitic lead impedances are a critical problem in ultrahigh-frequency circuits. In this frequency range, circuits often require lumped reactive elements, but these elements cannot be wired into the circuit without introducing additional distributed lead reactance.

In the microwave region, the dimensions of connecting lines and impedance junctions are carefully controlled. At lower radio frequencies, the problem is usually solved with short and direct lead connections. This approach is not good enough for uhf circuits. The method described here for optimizing lead impedances makes use of design curves based on an analytical approach. It specifies the value of the optimum characteristic impedance for interconnecting leads to a lumped reactive element. From this value, the conductor's diameter or width can be calculated to realize the optimum impedance for a lead of specified length and height.

Assume that the leads of the uhf circuit are less than one-quarter wavelength long ($\theta < \pi/2$) and that attenuation can be neglected. Then, by standard transmission line theory, the expression for input impedance X_i when X is a lumped reactive load is

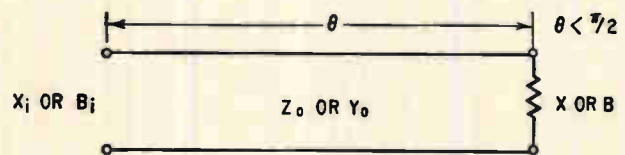
$$\frac{X_i}{Z_0} = \frac{X/Z_0 + \tan \theta}{1 - (X/Z_0) \tan \theta}$$

where Z_0 is the characteristics impedance of interconnecting line and θ is its electrical length.

The author



Arthur L. Rossoff is a vice president of the General Instrument Corp. where he formerly was chief engineer of the Semiconductor division. He has taught electrical engineering and is the author of a textbook, "Transistor Electronics."



Leads connecting a lumped reactive element to a uhf circuit are transmission lines.

Let $y = X/Z_0$, then $X_i/X = \frac{1 + (\tan \theta)/y}{1 - y \tan \theta}$

Note that the ratio X_i/X is always greater than 1 whenever θ is less than $\pi/2$. To find the optimum lead impedance, X_i/X is minimized in the usual manner by taking dX_i/dy , setting it equal to zero, and solving for y_{min} which yields

$$y_{min} = \frac{1 - \sin \theta}{\cos \theta}$$

Substituting back into the original expression for X_i/X gives

$$(X_i/X)_{min} = \frac{\cos^2 \theta}{(1 - \sin \theta)^2} = F^2(\theta) \tag{1}$$

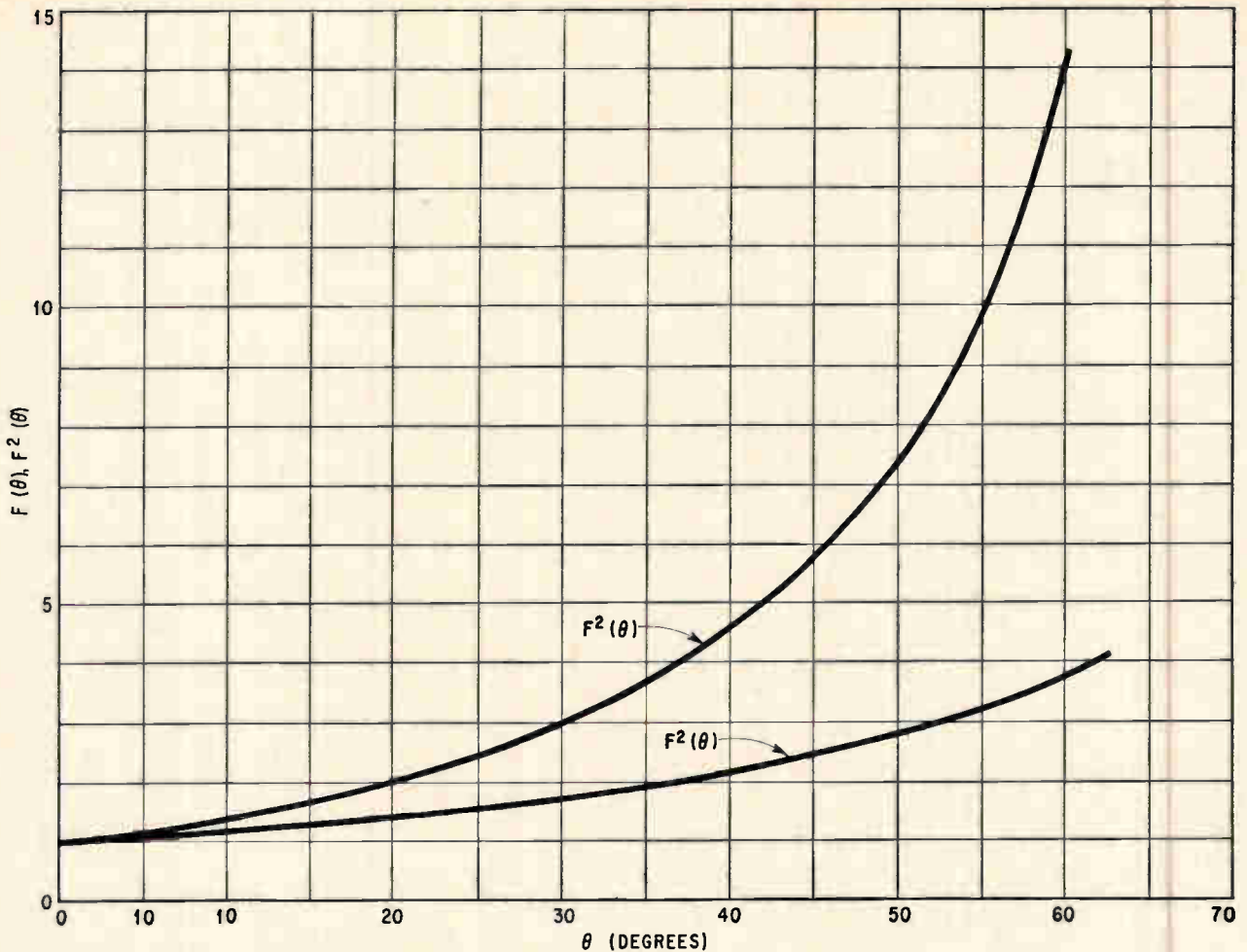
$$\text{Then } F(\theta) = \frac{\cos \theta}{1 - \sin \theta} = \frac{1}{y_{min}} = \frac{(Z_0)_{min}}{X} \tag{2}$$

Equations 1 and 2 are shown on the next page.

The curves also apply to a capacitive load. Set the load susceptance equal to B , then $F^2(\theta) = B_i/B$, and $F(\theta) = Y_0/B$ where Y_0 is the characteristic admittance of the line.

Applying the curves

The curves can now be used to minimize the parasitic effects of short interconnecting leads. Starting with a lead of fixed length θ and a lumped inductive load X , read the appropriate value of $F(\theta)$ from the curve to determine $(Z_0)_{min}$, the value of Z_0



Design curves yield appropriate values of $F(\theta)$ and $F^2(\theta)$. Using these values, the characteristic impedance of fixed length, optimum reactance leads and the minimum input impedance of the circuit can be calculated in one step.

which yields the smallest possible value of X_i/X .

Leads with the required $(Z_o)_{min}$ can be selected using the standard formulas for the characteristic impedances of typical conductors:

- For a round wire conductor,

$$Z_o = \frac{138}{\sqrt{\epsilon}} \log_{10} (4h/d)$$

where $d \ll h$, d is the wire diameter and h is the parallel height of the conductor above the chassis. (In a nonparallel conductor situation the average height is probably a valid approximation for h .)

- For a thin ribbon conductor of width d' , the round wire equation above can be used to solve for d and the approximation $d' = 2d$ can be used to find the required ribbon width.

- For printed-circuit wiring with the underside of the substrate metallized, the approximate formula for the characteristic impedance of a microstrip applies, $Z_o = 377(h/w) \epsilon_r^{-1/2}$, where h is the thickness of the dielectric, w is the strip width, and ϵ_r is the relative dielectric constant of the substrate.

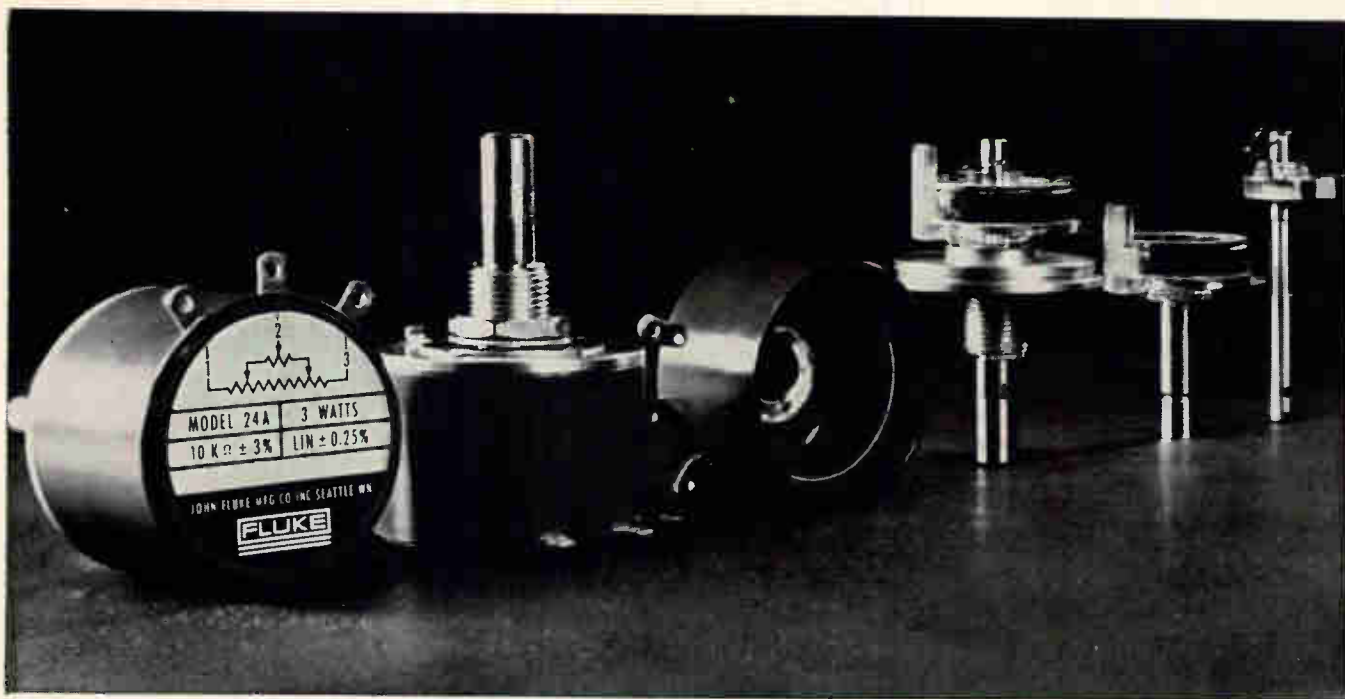
Usually h is fixed so that the diameter or width of the conductor is uniquely determined by the above formulas. The $F^2(\theta)$ curve can be used to find

the value of the minimized input impedance X_i for any combination of lead-length θ and load reactance X . If this value of X_i proves to be intolerable, load reactance X or lead length θ may have to be altered to get the desired input impedance.

A numerical example demonstrates the importance of this analytical approach to optimizing lead impedances. If $X = 100$ ohms of inductive reactance, the lead length is $\lambda/12$ ($\theta = 30^\circ$), then, reading from the curves, $F(\theta) = 1.73$, and $F^2(\theta) = 3$. Using these parameters we calculate the optimum characteristic impedance $(Z_o)_{min} = XF(\theta) = 173$ ohms, and the minimum input impedance $X_i = XF^2(\theta) = 300$ ohms.

If, without any calculations, a wide ribbon lead is chosen for its low impedance, say Z_o of 100 ohms, the ribbon may add so much shunt capacitance that X_i increases to 373 ohms or 73 ohms higher than minimum X_i . A still lower value Z_o , say 50 ohms, carries the circuit beyond parallel resonance and X_i becomes capacitive.

On the other hand, if a fine wire lead is used to minimize shunt capacitance, Z_o may well be larger than 173 ohms. At 250 ohms, for instance, the input impedance X_i becomes 318 ohms or 18 ohms higher than minimum X_i .



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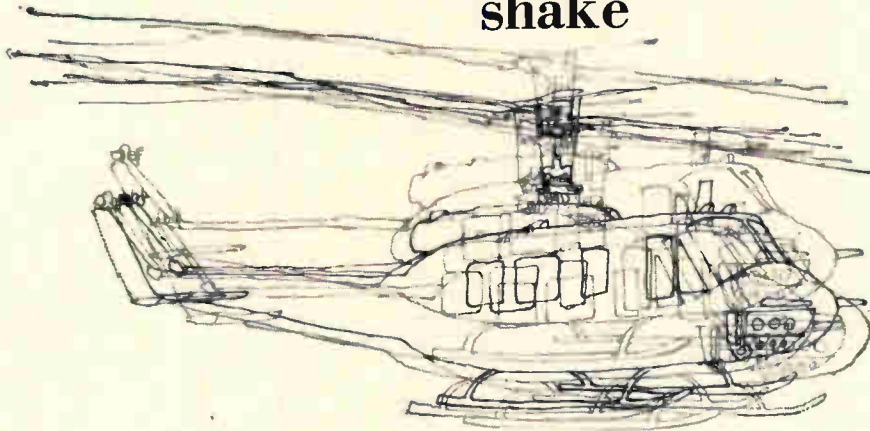
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Success story: Japanese originals

More and more, the 'made in Japan' label is going on computers as the Japanese shed their reliance on American technology and develop their own techniques to adapt computers to the Japanese language and market

By Katsuhiko Noda

Electrotechnical Laboratory, Japanese Ministry of International Trade and Industry

Japan jumped from nowhere to third place in the world computer industry in six years, ranking behind the United States and West Germany in computer installations.*

Three major factors have contributed to Japan's spectacular leap forward. One is government sponsorship and protection of computer technology. The second is the need to adapt Western computers to Japanese needs. The third is the advance in original Japanese technology—for example, the parametron [See "Industry skips a step," p. 95] and new forms of memories.

I. Government lends a hand

The government has played a vital role in the growth of Japan's computer industry. It has fostered domestic development of computer technology by erecting an import umbrella to protect Japan's still-young industry from competition.

The Ministry of International Trade and Industry (MITI) has kept import controls on computers even though they were lifted from most other industrial products, including automobiles.

The ministry is limiting the number of companies

* figures for the Soviet Union are not available.

The author

Katsuhiko Noda is chief of the electronic computer division, Electrotechnical Laboratory, Japanese Ministry of International Trade and Industry. Noda studied at the Lushin Institute of Technology in China and earned his Ph.D from Tokyo University in 1957. The same year he was named chief of automatic control research for ETL. In 1961 he was made chief of the laboratory's electromagnetic research section, a post he held until he accepted his present assignment.

that can produce business computers to the six existing firms.

In 1961, the ministry helped create the Japan Electronic Computer Co. (JECC)—a private agency that purchases computers from manufacturers and leases them to users. This frees manufacturing companies from the burden of rentals.

Preferred treatment

MITI also provides grants for advanced research to the six business computer firms.

When developments are completed at a government laboratory, the results are given or sold to Japanese electronics companies. Almost every Japanese computer company owes its technical start in electronics data processing to the development of the Mark IV computer, the first machine built at the government's Electrotechnical Laboratory [Electronics, Dec. 13, 1965, pp. 77-81].

The government aims to make Japanese firms independent of computer imports. Regulations are growing tighter in an effort to discourage Japanese producers from becoming subcontractors for American computer firms. One future rule may require that a certain portion of a computer be designed in Japan to qualify for rental through JECC.

MITI has drawn up a \$37 million five-year plan for research and development of a large-scale, high-speed electronic computer. The minimum target is a system with an addition time of 50 nanoseconds, a memory cycle time of 200 nanoseconds and a memory capacity of 128 kilowords. Special emphasis will be given to multiaccess computer concepts, problems arising from the complicated Japanese language and integrated circuit techniques.

Things are looking up

Government protection of the Japanese computer industry has started to pay dividends. Japanese

firms have become strong enough to gain half the home market and begin some exports.

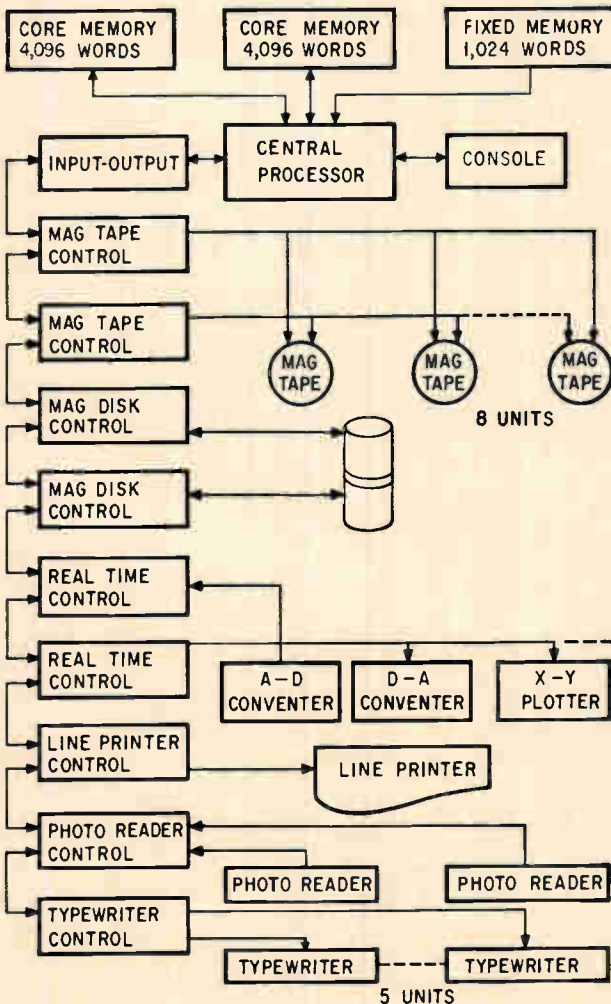
Japanese computer makers accounted for only 20% of all computers installed before April, 1958. Virtually all the rest were imported from the U. S. But by March, 1966, Japan's cumulative dollar share of the market had zoomed to 36.9%.

The value of computers installed in Japan this year may exceed \$190 million (half imported, half domestic) compared with the estimated U. S. figure of \$2 billion to \$3 billion.

All Japanese computer manufacturers began by making small Japanese-designed computers. But they found it hard to compete with the sophisticated American developments in both software and hardware.

The six companies produce a complete range of computers using basic IBM patents and other imported technology. It was initially necessary to use non-Japanese techniques for system design, program development and for part of the input-output equipment development.

Many of the general-purpose models now made



Experimental computer, NEAC-L2, built by Nippon Electric Co. is represented by this block diagram. The machine features 10-megahertz logic circuits, two internal core-matrix NDRO memories and a read-only memory. Interface control permits order execution time of one microsecond.

Memory units, ETL-MK VI

Memory-type	Capacity (words)	Cycle time (μ s)
Tunnel-diode	64	0.25
Thin-magnetic-film	64	0.5*
Capacitive-type read-only	4,096	1.0
Ferrite-core (A)	8,192	2.5**
Ferrite-core (B)	4,096	1.0
Drum	2 ¹⁸	20 ms

* Access time for instruction look-ahead is 0.25 μ s

** Overlapped core banks allow 1.25 μ s cycle time for sequential addressing

in Japan are produced under license from U. S. firms. But all ultrasmall computers are original Japanese designs. Fujitsu is the only Japanese company in the computer business whose general-purpose models are not derived from U. S. designs. All computers manufactured by Fujitsu are original Japanese designs.

II. The problem of translation

Changes are required to adapt American-designed computers for use in Japan. Most of the changes are in input and output equipment. The NEAC series 2200 model 100 is equipped for punched tape but not cards, although the corresponding Honeywell computer works only from IBM cards. However, IBM cards are not as popular in Japan as in the U. S.

One of the biggest changes is to adapt the computers to accept input and deliver output in Japanese characters as well as the Roman alphabet.

The language is almost 100 times more complex than English; it has nearly 2,500 characters.

Ordinary Japanese is written in a combination of Chinese characters and the Japanese katakana and hiragana syllabaries.

The ancient Japanese had no written language, but about 1,500 years ago the Chinese and Koreans taught them the Chinese method of writing with characters—each character representing a word.

Unfortunately, Japanese is an inflected language which could not be conveniently written with Chinese characters only. So the Japanese did their writing in Chinese for several hundred years. But about 1,200 years ago they started using Chinese characters as phonetic symbols, each character representing one syllable. Soon they began to abbreviate the characters to form the present katakana and hiragana syllabaries. In a syllabary each symbol stands for one syllable.

Katakana uses a portion of a more complex Chinese character as a phonetic symbol. Hiragana consists of an entire Chinese character written in a sketchy and simplified form.

Hiragana is normally used in ordinary prose with katakana reserved for words derived from foreign languages and for emphasis. Katakana

was originally used in telegrams. No Japanese would be happy to read a book written in katakana but it is adequate for addressing and adding remarks in business forms, names of commodities on bills and communication with a computer.

The use of katakana with computers seems to be the best way out of a difficult situation.

III. Japanese-designed computers

In its quest for speed, flexibility and low cost, the Japanese computer industry has come up with a series of general-purpose computers and two experimental machines in which new technology is being tested.

Fujitsu developed a family of seven general-purpose computers with upward compatibility (the program for any computer can be used on all larger models in the series).

This family, Facom series 230, has memory

capacities ranging from 65,536 to 4,718,592 bits and addition times as fast as 1.15 microseconds.

Two-way split

Series 230 is designed with emphasis on hardware and software compatibility and on optimum cost-to-performance ratio. To achieve the latter, the series is divided into two groups. One group is represented by a variable word-length mode of operation; the other by a fixed word-length mode of operation.

In variable word-length mode computers, efficient use of the core memory capacity is possible. The variable word-length mode is advantageous for small or medium-scale general-purpose computers in which memory capacity is not very large. Moreover, because it can process one digit at a time, this type of computer is useful in documentation-control applications such as editing. But high-speed computation is difficult to obtain.

The fixed word-length mode has the advantage of higher computing speed because the group of

Industry skips a step

The Japanese computer industry is so new, compared to the computer industry in the West, that no vacuum-tube systems have ever been made commercially in Japan.

Two major advances in the 1950's—the invention of the parametron in 1954 and the development of the first transistor computer in 1956 — formed the groundwork for today's thriving computer business in Japan.

Small parametron computers still top all Japanese models in sales. The leading model is the Nippon Electric Company's 1210B—a very small machine with a memory of 500 words of six decimal digits each.

Credit for the invention of the parametron goes to Ei'ichi Goto of the University of Tokyo.

In its simplest form, the parametron is a resonant circuit, in which either the inductance or capacitance is made to vary periodically. In an inductive parametron, exciting current of frequency $2f$ causes the inductance L to vary at frequency $2f$. Similarly, in a capacitive parametron, the effective capacitance of the circuit is made to vary at frequency $2f$. If the resonant frequency of the parametron is made to be f (half the excitation frequency), then an oscillation of frequency f will be sustained by the resonant circuit.

This oscillation has the property of being stable in either of two phases, which differ by π radians. These phases are made to correspond to the zero and one of binary

logic, and therefore provide the basis of any type of logic or memory function required in a computer.

Almost all parametrons now being used are of the inductive type, made of ferrite material. Their chief advantages are long life, high reliability and low cost.

The University of Tokyo and the Electrical Communication Laboratory of the Nippon Telegraph and Telephone Public Corp. teamed up in 1957 to construct a parametron computer, the Musashino I.

A small parametron computer, the PC-I, was completed at the University of Tokyo in 1958. This was followed by a much larger model, the PC-II, designed jointly by the University of Tokyo and Fujitsu Ltd. and finished in 1960.

Soon afterward the Senac-I was built by Tohoku University and the Nippon Electric Co. Many parametron computers have been produced commercially since then.

Stiff competition. At present, however, the parametron is running into stiff competition from the transistor and integrated circuits. The transistor's higher speed and smaller size have edged out the parametron in medium and large computers. Integrated circuits are expected to beat out the parametron in the very small models.

The first transistor computer was produced in 1956—the ETL-MK III. The ETL-MK IV followed in 1957 and then came a stream of commercial models.

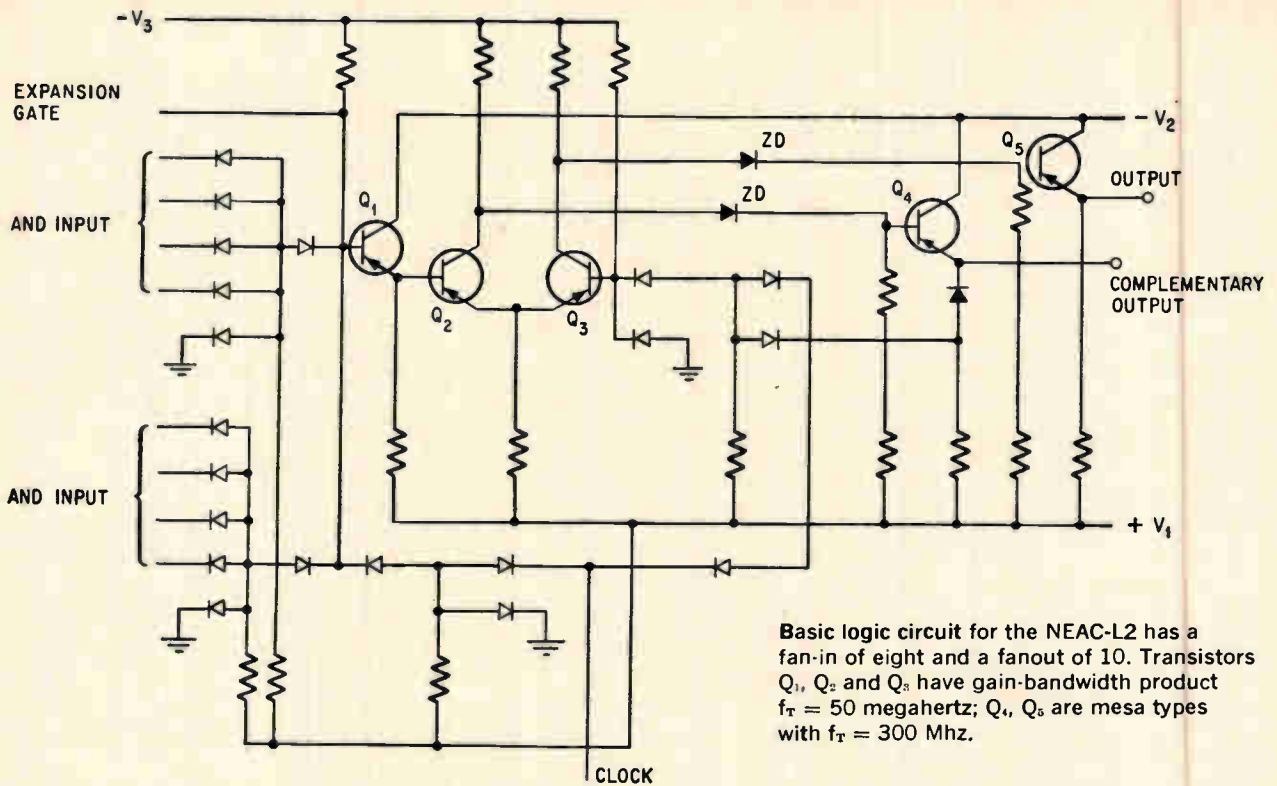
Many of the current Japanese-developed computers have borrowed heavily from the designs of PC-I and II and ETL-MK III and IV. Several design features are quite different from those advanced in other countries.

Original theories. Japanese digital computers date back to the 1952 relay computer ETL-MK I—a pilot model developed at the Electrotechnical Laboratory (ETL). One of the world's largest relay computers, the ETL-MK II, was built in 1955 and is still in use. Design of both these computers was based on original theories perfected at ETL.

Fujitsu Ltd. carried the computer concept a step further. Using techniques advanced at ETL, Fujitsu manufactured two types of commercial general-purpose relay computers, the Facom-138 and the Facom-128B. The first unit of the latter was installed at the Canon Camera Co. in 1958 and is still in operation. An earlier model, the Facom-128A, was set up at the Ministry of Education in 1958 for scientific use only.

The first electronic digital computer was a vacuum-tube model developed by physicists at the Fuji Photo Film Co. Called the Fujic, the machine had a mercury delay line memory. Design was started in 1949. Construction was begun and completed in 1953, with debugging in 1956.

The combined efforts of the University of Tokyo and the Tokyo Shibaura Electric Co. resulted in another vacuum-tube computer, TAC, in 1959. No other tube computers of significance were produced in Japan.



Basic logic circuit for the NEAC-L2 has a fan-in of eight and a fanout of 10. Transistors Q_1 , Q_2 and Q_3 have gain-bandwidth product $f_T = 50$ megahertz; Q_4 , Q_5 are mesa types with $f_T = 300$ Mhz.

digits which corresponds to one word can be processed together. For a computer with a large memory capacity, the fixed word-length mode is usually best despite the somewhat inefficient use of memory capacity.

Accordingly, for the medium and small-scale computers—Facom series 230 models 10/20/30/40—variable word-length mode is employed. For the large-scale, high-speed computers—Facom 230 models 50/60/70—the fixed word-length mode is used.

Software compatibility between the two groups of computers is achieved by Fortran, Algol or Cobol compilers or by assemblers such as Compass (Compatible Assembly System).

These computers are equipped with multiprogramming for real-time operation. The 50, 60 and 70 have dynamic relocation and multiple access for improved real-time operation.

Kana characters

Facom series 230 computers operate with seven-channel or nine-channel IBM magnetic tapes. These have information arranged by bytes, or

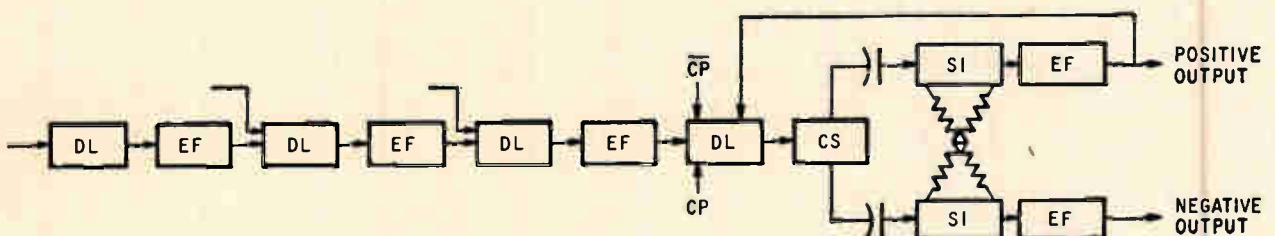
eight-bit units, and include a check bit.

The eight-bit format is important in Japan. The six-bit characters used in many earlier computers are inadequate because of the large number of kana characters required in addition to the Roman alphabet, numbers and common symbols.

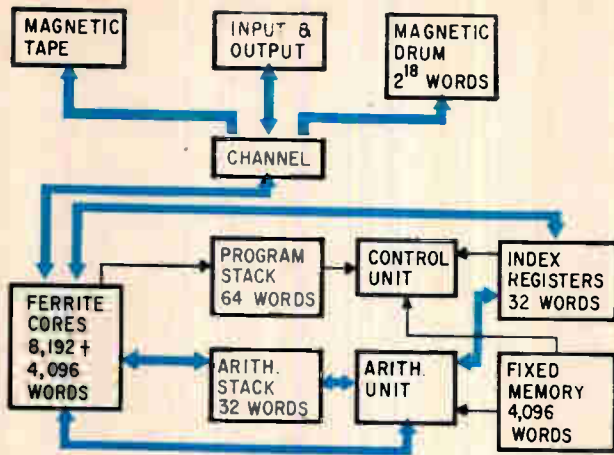
Models 10, 20, 30 and 50 are assembled from discrete components; models 40, 60 and 70 contain integrated circuits. Model 50 was the first computer in the series to be developed. The central processor for model 50 was developed by Fujitsu as the central processor for Fontac, a computer produced jointly by Fujitsu, the Oki Electric Industry Co. and the Nippon Electric Co. with MITI financial support.

NEC's guinea pig

In 1964, the Nippon Electric Co. built an experimental computer as a vehicle for developing new techniques for the production of commercial high-speed machines. The computer, NEAC-L2, uses newly developed hardware techniques including two-phase 10-megahertz logic circuits, high-speed adding circuits, tunnel-diode memory, nondestructive



Basic building block of the ETL-MK VI. DL represents diode logic; EF, emitter follower; CS, current switch; SI, saturated inverter; CP, clock pulse.



Simplified block diagram of an experimental computer, ETL-MK VI, constructed in the Electrotechnical Laboratory of the Ministry of International Trade and Industry.

tive readout (NDRO) core memory, and read-only eddy-card memory.

Internal memories include a read-only memory (p. 98) with 1,024 words and two units of core-matrix NDRO memory with 4,096 words each. Virtual access time of the core memories is shortened by interlace control. The read-only memory or the core memory is selected by the most significant digit of the address, and one of the two units of the core memories is selected by the least significant digit. Access is possible to any one of the three memories every 0.5 microsecond.

The memory registers are able to read out the orders from the memories in advance and store up to three orders or up to two operands, making it possible to perform memory and arithmetic operations at the same time. With advance control of two units of one-microsecond core memory, the execution time of one order is only one microsecond for the fastest case, and 1.2 microseconds on the average. Without interlace the execution time would be two microseconds.

The two-phase nonreturn-to-zero (NRZ) synchronous amplifier circuit shown on page 96 is the basic logic circuit. It has a fan-in of eight and a fanout of 10.

Of interest in the NEAC-L2 is the high-speed adding circuit, which uses the skip-carry system. Add operation time for 40 bits is 80 nanoseconds. The adder is fabricated on a total of 80 printed circuit board packages.

MITI's experimental computer

Another pilot machine is the ETL-MK VI, a computer designed and constructed in the Electrotechnical Laboratory of the Ministry of International Trade and Industry. New technology pioneered in the ETL-MK VI includes a thin magnetic-film memory and a tunnel-diode memory.

A simple block diagram of the ETL-MK VI is given above. Main features of the computer are: a) a first-in-first-out thin magnetic-film memory used for the program stack which stores up to 128 steps of program currently under execution,

b) a last-in-first-out tunnel-diode memory used in the arithmetic stack for ease of program compilation written in problem-oriented languages. c) advance control (as many as four successive instructions may be in process of execution at one time). d) priority interrupt scheme, fully adapted for using eight channels concurrently.

Memory units installed in the computer include, in addition to the tunnel-diode and thin magnetic-film memories, a capacitive type read-only memory, two ferrite core memories, and a drum memory. Capacity and cycle times are listed in the table on page 94.

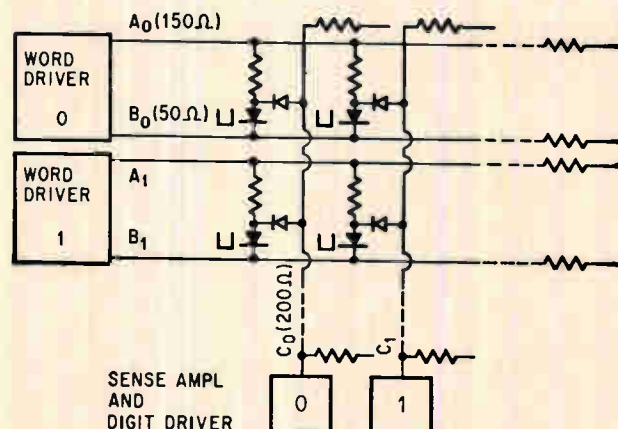
Add operation time for the ETL-MK VI ranges from 0.125 to 4.0 microseconds. The basic building block is shown at the bottom of the opposite page and the tunnel diode memory is shown below.

IV. Much ado about memories

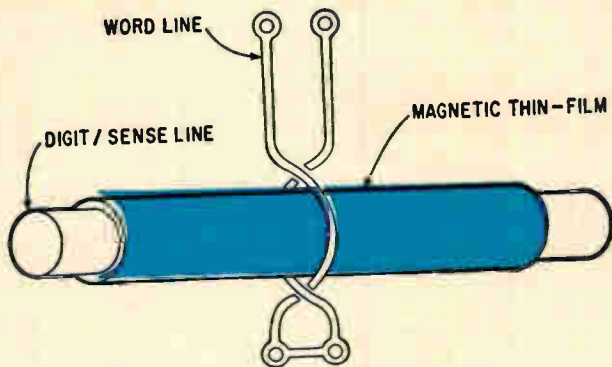
The Japanese have elected to tackle new computer designs at the point calculated to do most good: the memory. They seek the universal goal of higher speeds, noting that most of the time computer speeds are memory-limited. One development slanted toward high speeds at low cost is the thin-film plated-wire memory. In addition, Japanese inventors are working on memories that are semipermanent in nature—that is, for uses where memory must be nonvolatile but where content must occasionally be altered. A pair of solutions to the latter are the eddy-card and metal-card memories.

The thin-film plated-wire memory was invented by Shintaro Oshima at the Research Laboratory of Kokusai Denshin Denwa Co., the organization that runs Japan's overseas radio and cable system. Production has been achieved by Toko Inc. (woven-types) and NEC (nonwoven types).

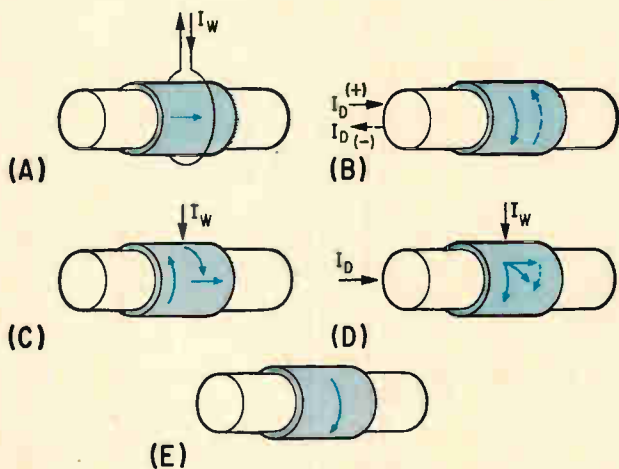
At ETL, a pair of practical high-speed memories with a cycle time of 500 nanoseconds was developed. One is a 64-word, 50-bit-per-word register memory, and the other is a 256-word, 20-bit-per-word memory. ETL also cooperated with Toko in



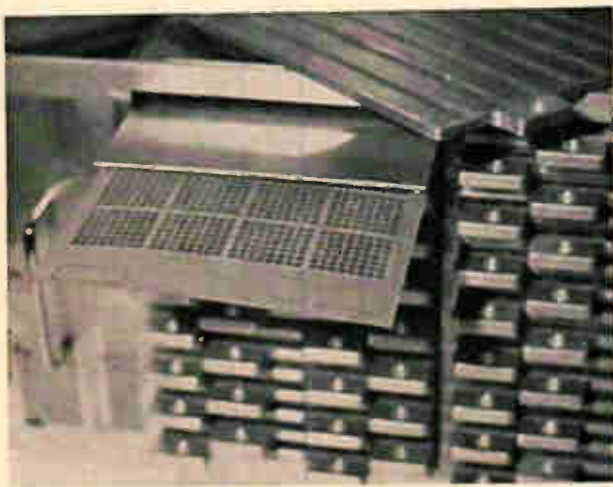
Tunnel diode memory for the ETL-MK VI has 64-word capacity, cycle time of 0.25 microseconds.



A bit element in the thin magnetic film memory. Plated magnetic film is nickel-iron.



Write-in process for the plated magnetic film memory. a) word-drive current develops magnetization in axial (hard) direction. b) digit-drive circuit produces magnetism in circumferential (easy) direction. c) assuming bit is originally magnetized in direction of the solid curved arrow, word drive is applied, rotation to hard direction is effected. d) application of digit drive rotates magnetism to easy direction, e) word drive is removed, then digit drive, leaving magnetization fixed in opposite, easy direction.



Memory stack of the NEAC-L2 computer uses eddy-card (being slid out) to write in semipermanent memory. This memory has a capacity of 1,024 words of 42 bits each, and a cycle time of 0.5 microseconds. Driving and reading lines are on 32 boards of 32 words each. Interchangeable boards with conductor rings are smaller, and correspond to only eight words each.

the development of a 4,096-word system.

NEC has constructed a 4,096-word memory, which consists of 64 memory planes with 64 words on each plane.

How it works

As shown in the illustration at the left, one-turn insulated word lines are wound on the 0.2 millimeter diameter electroplated digit lines. Plating is a nickel-iron magnetic film about five microns thick.

Although the thin film on the digit line is continuous, only the cylinder-shaped region directly under each word line plays a part in memory operation. Coupling of word and digit lines is extremely close.

In each bit, magnetization by the digit-drive circuit is in the easy, or circumferential direction. Magnetization by the word-drive current is in the hard direction.

Write-in begins with word drive, which rotates the magnetization from the easy to the hard direction regardless of the initial magnetization, as shown in the sequence at the left.

Readout is accomplished by impressing a current on the word line, which rotates the magnetization to the hard direction. Rotation of the magnetization induces a voltage in the plated wire, which serves as the sense line during readout. The voltage passes through an amplifier and gate circuit. The circuit is designed to pass the digit drive current during write-in and pick off the sense voltage during readout. Polarity of the read-out voltage depends on whether the stored information is one or zero. After readout, the bit is remagnetized in the easy direction with random polarity and requires a new write-in. This is the destructive read-out (DRO) mode.

Memory planes can also be designed to operate in the nondestructive read-out mode (NDRO).

Electrical characteristics of a woven-memory plane developed by ETL and Toko Inc. are as follows: Word-line inductance and capacitance per bit are 10 nanohenries and 0.15 picofarads, respectively. Capacitive coupling between word line and digit line is 0.2 picofarads. For digit lines, impedance Z_0 is 95 ohms, propagation delay per plane is 1.3 nanoseconds, and attenuation per plane is 2.5×10^{-2} decibels.

In the design of a practical wire memory, some noise cancellation techniques are desirable to reduce noise caused by capacitive coupling between the digit and the word lines during the write-in cycle. These techniques also are needed to reduce noise caused by direct excitation of sense amplifiers through the common digit-sense lines during the write-in cycle.

Sense voltage versus digit current for a typical woven-wire memory is shown by the curves on the opposite page.

Eddy-card memory

A simple, but ingenious, read-only memory is the eddy-card memory developed by NEC for its

NEAC-L2 computer. It is fast, easy to fabricate and inexpensive.

When a conducting ring is placed at the crosspoint of two conductors, as shown in the illustration below, current flowing through A causes an eddy current to flow in the ring, which in turn causes a flux component perpendicular to the plane of the drawing. This flux interlinks with conductor B and induces a voltage in conductor B.

Therefore a read-only memory can be fabricated with one and zero corresponding to the presence or absence of the ring. Wire A is the word line, and is driven with a pulse for readout. Wire B is the digit line.

In a practical memory, drive lines, equal in number to the number of words to be stored in the memory, are printed on one side of a printed circuit board. On the opposite side, perpendicular to the word lines, digit lines equal in number to the number of digits per word are printed. Circular conductors whose locations correspond to the crosspoints of the word and digit lines on the first board are printed on a second board. Conductors are open-circuited to produce zeros.

Memory content is changed merely by removing the board containing the conductor rings and replacing it with another. This is shown in the photograph on the opposite page.

An eddy-card memory will be used in the NEAC 2200 series model 500 developed by NEC. This memory will have a read-out time of 187 nanoseconds and a capacity of 4,096 words of 100 bits each.

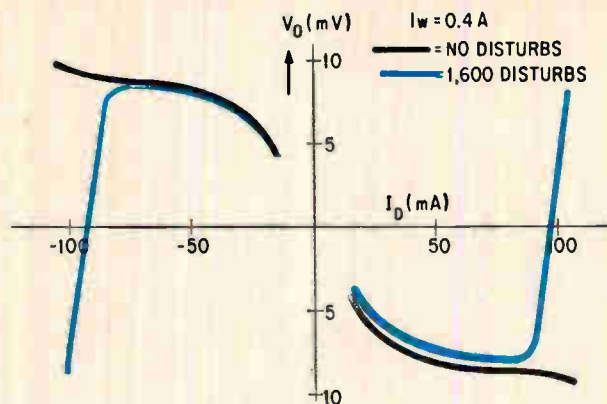
Metal-card memory

Like the eddy-card memory, the metal-card memory is a read-only, semipermanent memory. That is, to write in a new content, an entire metal card is changed. The memory was invented and developed at the Electrical Communication Laboratory of the Nippon Telegraph and Telephone Public Corp. It is designed for program storage and translation in electronic telephone exchanges and accounting systems, and also for similar purposes in computers and control systems.

A large memory with a total capacity of more than one million bits, arranged in modules of 104,000 bits each, was completed by the ECL in March, 1965. Access time is less than one microsecond; cycle time, less than two microseconds.

The metal-card memory consists essentially of many transformers, each with a single-turn primary and secondary. Primaries are connected in series to form the memory drive lines, and secondaries in series to form the sense lines—which are at right angles to the drive lines. A pulsed high-frequency current forms the read-out signal, and is transmitted by induction from drive to sense lines.

Metal cards are inserted between the primary and secondary. Shielding afforded by the cards reduces induction by about 30 decibels, and all readouts are then zeros. Ones are written by



Sense output voltage as a function of digit drive for typical plated-wire memory system.

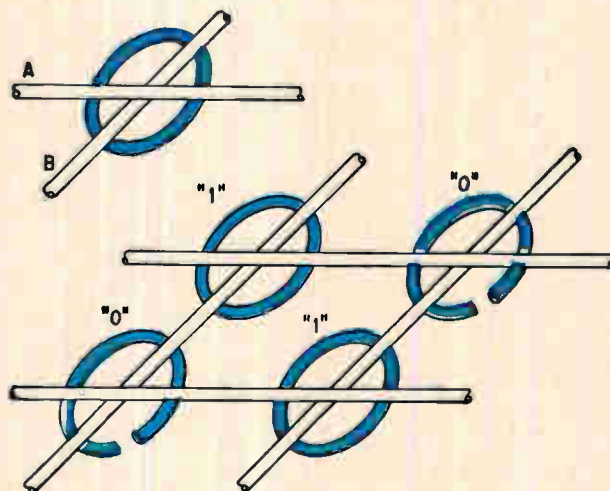
punching holes in the card at the point where the coils for the drive and sense lines coincide.

Lumped vs. distributed constant

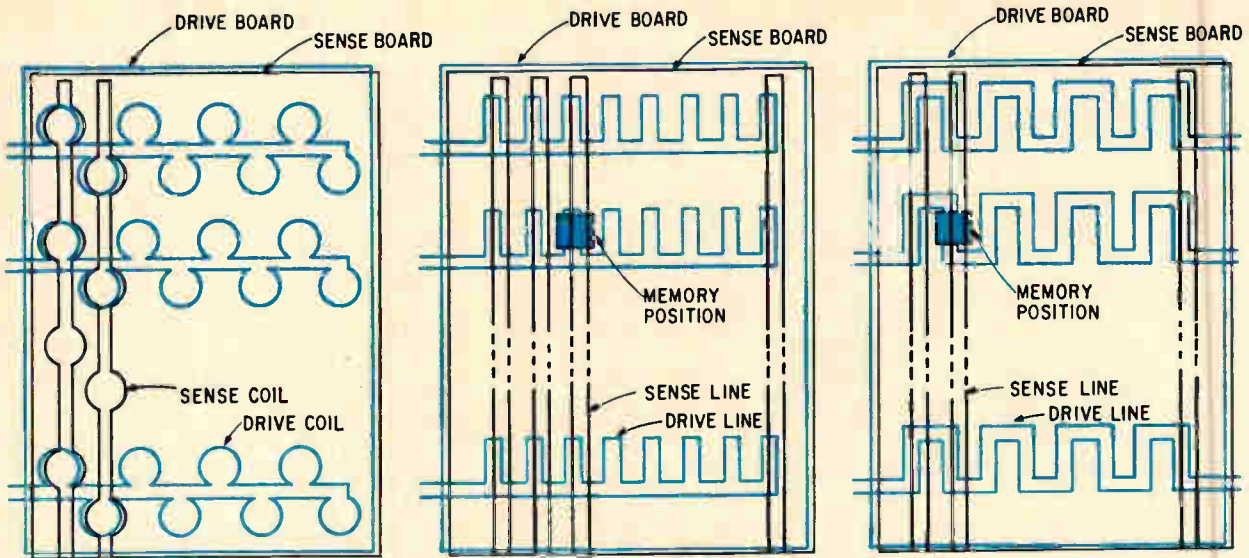
How the metal memory evolved is shown in the sequence on page 100. Early models were lumped-constant circuits—the first (a) used space-consuming circular coils and round holes. In a later version (b) rectangular coils and slots saved space but speed was still slow.

To speed up the memory, it was redesigned as a four-terminal distributed-constant circuit (c). Lines terminated in their characteristic impedance replace the individual coils. Reflections and distortion of signals do not occur and the balanced configuration cancels between-circuit interference.

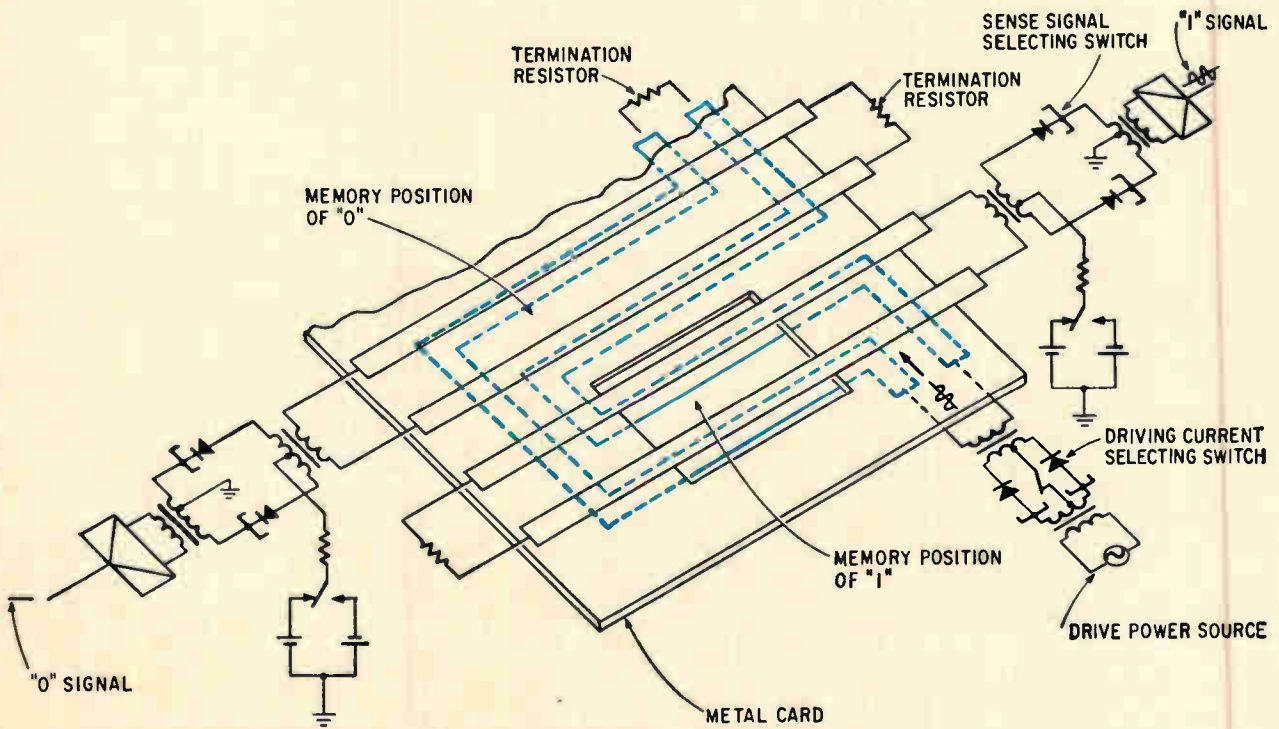
Characteristic impedance of the lines in a practical memory built using these techniques is approximately 110 ohms, although it increases somewhat in the presence of a hole. Normal drive frequency is six Mhz. With a current of 200 milliamperes into the 110-ohm drive lines the one output at a sense gate is about two millivolts, and



Eddy-card memory is based on this memory bit. Current flowing through A induces no current in circuit B until ring is placed at crosspoint. By open circuiting the ring, a zero is stored.



Layout of first metal-card memory made. One's are written by punching holes where coils for drive and sense lines coincide. Next, a second-generation metal-card memory uses rectangular "coils" and holes to save space, boost speed. Finally, distributed-constant metal-card memory built in form of balanced-four-terminal circuit.



Semischematic illustrates principle of distributed-constant metal-card memory. Driving signal is propagated down zig-zag line and absorbed by resistor at far end.

the output after amplification is about 4.2 volts. A semischematic of the balanced four-terminal type metal-card memory is shown in the lower illustration above. The drive signal is propagated down the zig-zag drive line and absorbed by the resistor at the far end. At bit locations where there is a hole in the metal card a current is induced in the sense line. Currents in the sense line flow in the direction they are propagated, and only a very small voltage due to reflection appears at the opposite end of the sense line. Because the zig-zag

word line propagates currents in opposite directions in alternate sense lines, detectors on alternate lines are at opposite ends of the line. Where there is no hole in the card there is negligible voltage at either end of the sense line. A practical memory is arranged in modules, which are medium-sized units with a large number of drive and sense lines. In the ECL million-bit memory, each module has 104,000 bits. There are 1,040 drive lines, each comprising two 50-bit words in series. Memory density is 8 bits/cm³.

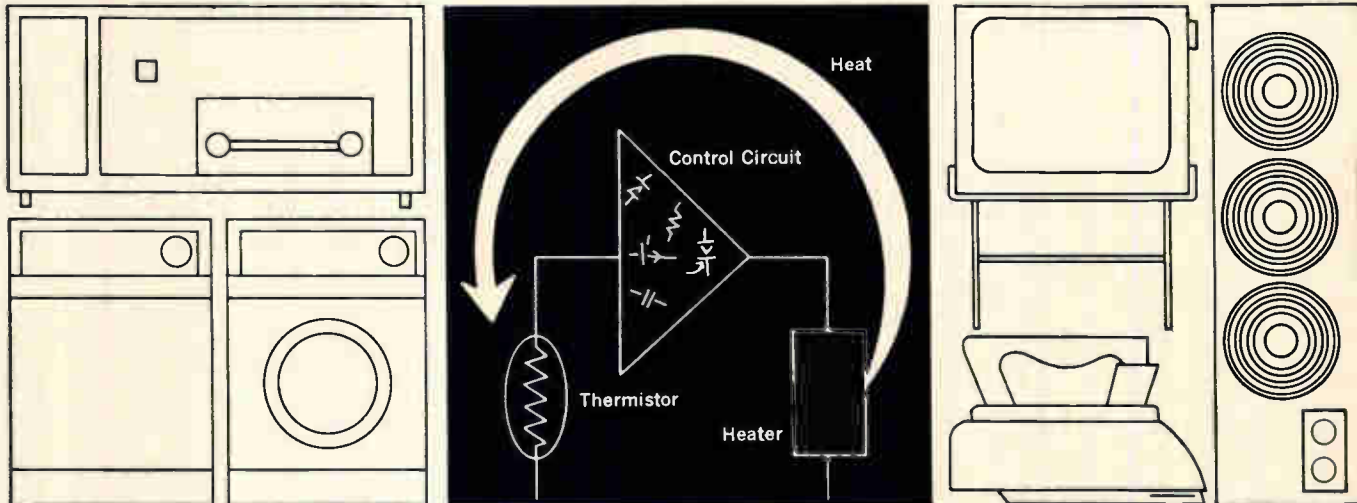
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The modules are mass-produced, but systems are one-of-a-kind

Ground and airborne digital equipment needed during development of missile and space systems can be built quickly and at low cost with standardized modules interconnected by wrapped-joint wiring matrixes

By C.H. Alford* and D.L. Brown,

Lockheed Missiles & Space Co., a division of Lockheed Aircraft corp., Sunnyvale, Calif.

One-of-a-kind digital instrumentation and data-processing equipment are frequently needed during development, testing and evaluation of major systems. So it pays to prepare standardized modular components that can be assembled quickly and economically into a wide variety of sizes and types of special systems.

Two modular packaging approaches that update this concept, through the extensive use of monolithic integrated circuits, have been developed at the Lockheed Missiles & Space Co. Their practicality has been demonstrated during more than a year of use.

One design, developed by the ground data sys-

*Now with Stewart-Warner Microcircuits, Inc., a subsidiary of Stewart-Warner Corp., Sunnyvale, Calif.

The authors



C.H. Alford was responsible for the ground-system packaging method, as a research specialist in Lockheed's ground data systems department. He has been involved in all phases of digital design, concentrating recently on applications and packaging of integrated circuits.



D.L. Brown worked out the packaging technique for airborne equipment. A senior design engineer in the communications and command department, he has designed miniaturized equipment for the Terrier, Tartar, Polaris, Agena and Apollo missiles and space vehicles.

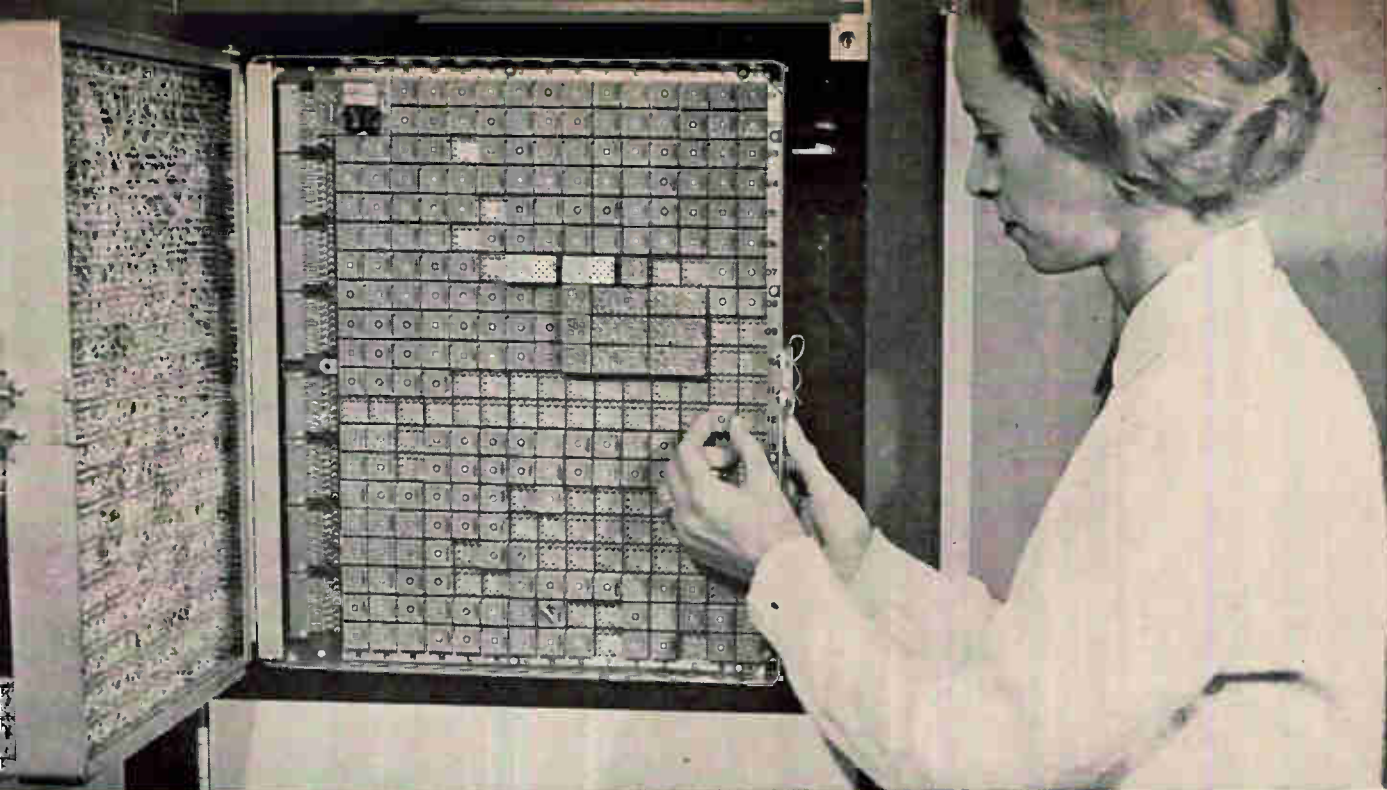
tems department, is used to make ground support equipment. Its basic modules are generally small, single-function units that are plugged-in, in bread-board fashion, to large wiring matrixes. These matrixes are mounted in racks and the modules interconnected with wrapped-joint wiring to form sturdy operational equipment.

The other design, by the communications and command department, is based on a series of multi-circuit modules that are also interconnected by wrapped-joint wiring. The modules can be assembled in various combinations, as shown in the table on page 105, to form about 90% of the circuitry needed for command, control and digital-data handling equipment installed in aircraft, missiles and space systems. The construction is compact and meets the environmental specifications of such programs as Polaris and Agena.

Although the packaging methods were developed for distinctly different applications, they are alike in several important respects. They provide the in-house capability required if a major contractor is to react quickly to the unique needs of major programs. Both employ prefabricated modules to provide a base for production by low-cost techniques. While monolithic circuits perform most of the digital functions in both classes of equipment, the modules of each can be made with hybrid integrated circuits or discrete components. The use of wrapped-joint wiring allows the interconnections to be made by hand or by computer-programmed wiring machines and simplifies the tasks of making tests and changing the wiring design.

Ground-system packaging

The ground-system modules can be assembled with equal ease as small equipment or large com-



Ground-support equipment is assembled by plugging digital modules into wiring matrix. Hung like pages in a book, the assemblies form large data-handling systems. The system can be one-of-a-kind, or serve as a prototype.

plex systems. The modules, wiring matrixes and rack-mounting arrangements are illustrated by the photos on this page and the next page.

The basic modules are about $\frac{3}{4}$ inch square and in most cases contain a single IC in a 10-lead transistor-type can. Up to 300 of these modules plug into a matrix board designed to swing within a 19-inch opening. A single board can be mounted horizontally between standard rails. Or, up to six boards can be mounted vertically like pages in a book and interconnected with flat cabling. Four such books will mount on a 70-inch-high panel 19 inches wide, allowing up to 14,400 modules to be housed in a standard 24-inch-wide rack.

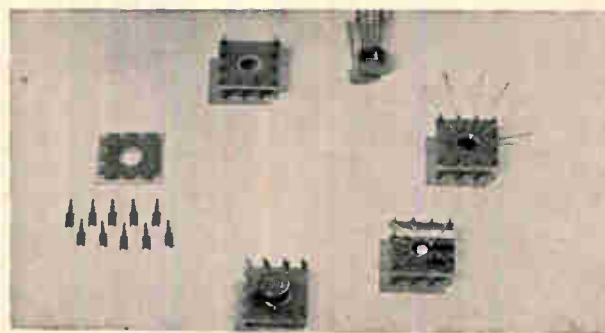
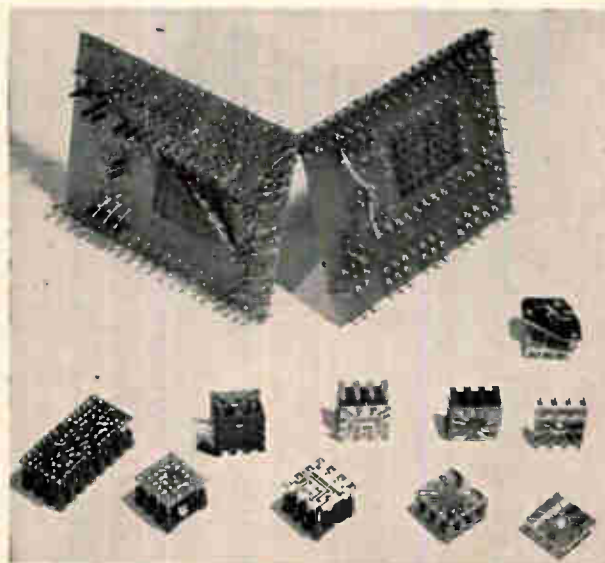
Between the one-board and 48-board extremes, many variations are possible. For example, a three-page book could be set back behind a control and display panel or a power supply.

Modules and matrixes

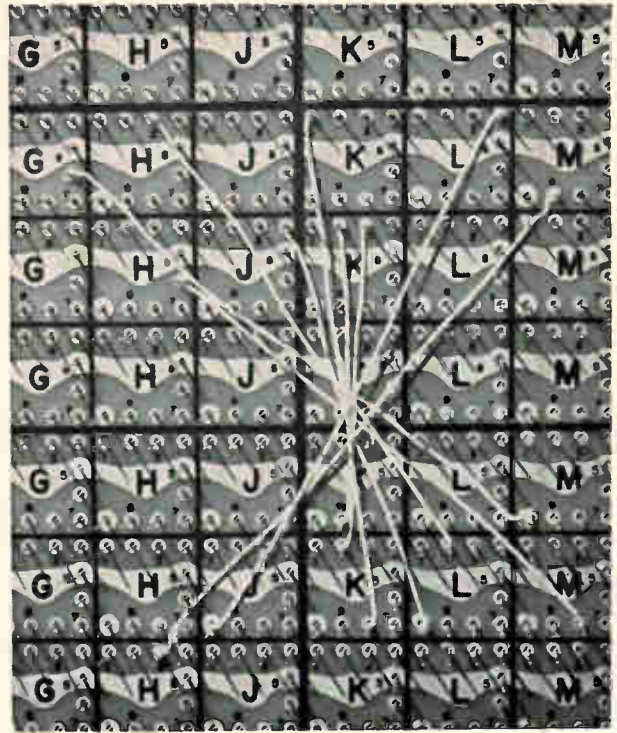
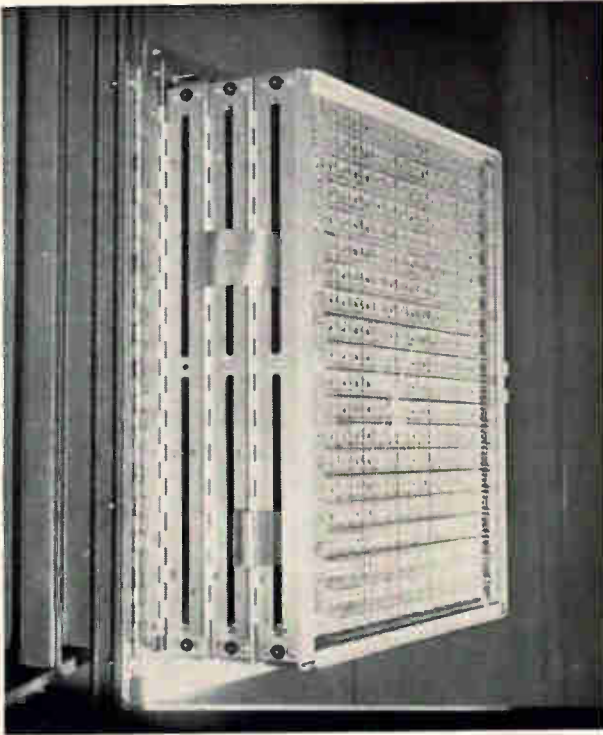
The basic module's small size permits the mass production of many similar parts and assemblies. The arrangement of the 10 contact pins as three sides of a square leaves the fourth side open for adding to the size and number of contacts on the module. Additions in four-pin increments best conserves space on the matrix boards. The pins of the modules and the mating contacts of the matrix are located on a 0.2-inch grid. Large modules, requiring many pins—such as the character generators in the photo at the right—readily plug into this grid.

The color-coding bands on the modules and the polarizing, open-ended pin arrangement prevent mistakes in assembly.

Contact pins on the modules mate with pins that are interference-fitted into plated-through holes in



Plug-in-modules contain monolithic or hybrid integrated circuits or conventional circuits. The large modules are character generators. At the right in the upper photo is an indicator module plugged into a logic module. The lower photo details a logic module's construction.



Hinging method and cable-access slots are visible in rear view of book, left. The wired section of the outer page is shown in detail in the right-hand photo, illustrating the choice of point-to-point wire routings.

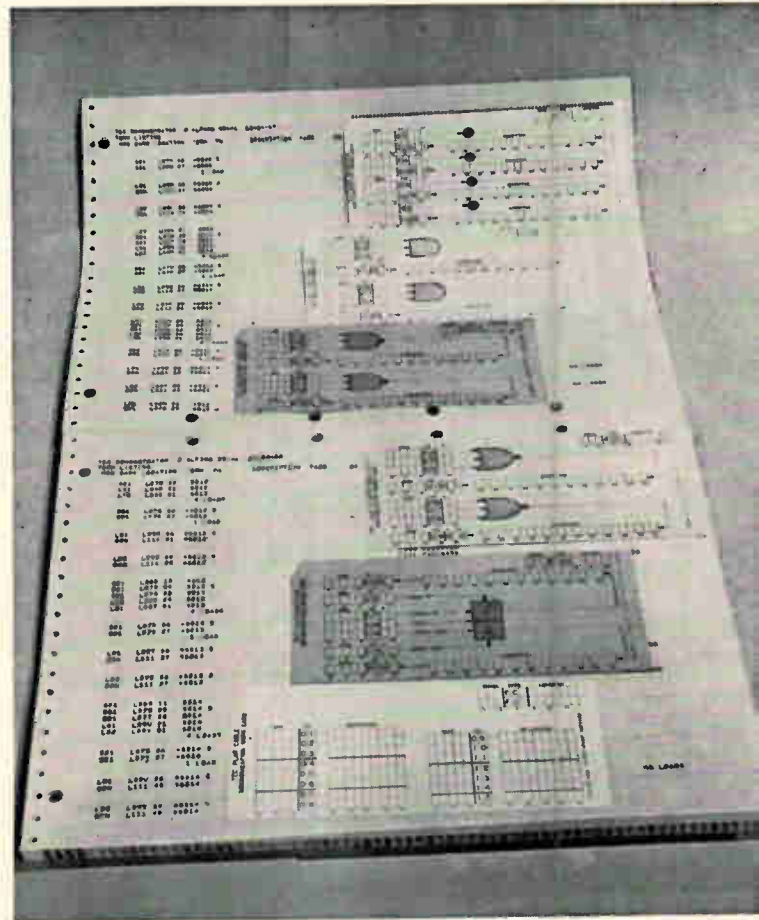
the matrix board. The matrix pins are Elco Corp. Varicon connectors that have standard noses and 0.025-inch-square tails for solderless wrapped-joint or welded-wire connections.¹

The boards are etched from copper-clad laminate. The signal-wiring pins are insulated from the copper by etched clearance holes. On the module side of the board, the copper forms a low-impedance ground plane that eliminates ground-noise problems. The broad, wavy lines on the rear of the board form a low-impedance power distribution network, also etched.

Wiring and testing

The 0.2-inch spacing between the pins is a comfortable one, compared with the 0.05 inch between flatpack leads or 0.1 inch of high-density wiring matrixes. The selected spacing allows the wrapped wiring to be routed along many possible paths without congestion, so that wiring can be traced visually. Probes can be attached to the pins during check-out without disturbing the wiring.

When only one of each assembly is needed, the wiring is usually wrapped with hand guns. If more assemblies are needed, the wrapping is done by automatic wiring machines after check-out and revision of the prototype's wiring is completed. Wiring lists are prepared by computers, with the aid of color-coded punched cards that identify the modules by function and pin locations. The printed list, as in the photo at the right, gives the wire routing according to the numbered and lettered row and pin locations printed on the rear of the matrix board.



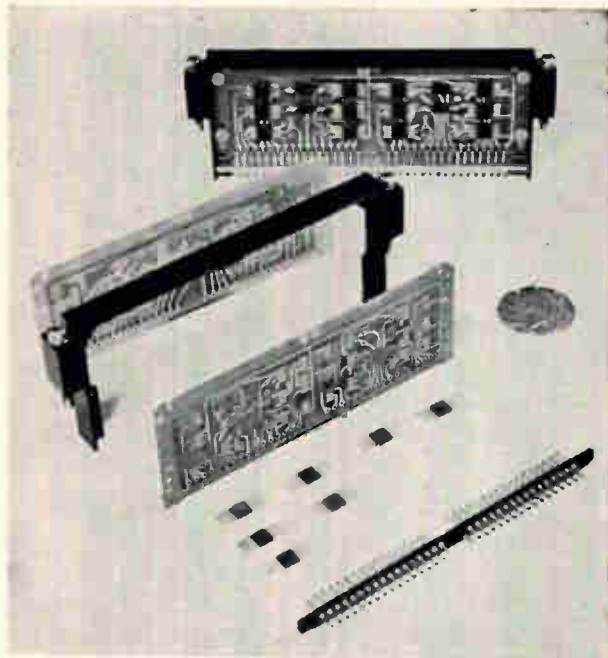
Mechanization cards, color-coded according to the module type, facilitate design and aid the preparation of wiring lists with a computer.

The coordinate assignments², marking of module locations (also on the wiring list) and module color coding allow signal tracing and fault isolation to proceed rapidly during equipment check-out. Any terminal of any module is accessible. The pin extensions projecting from the tops of the logic modules can be used to attach probes or for mounting piggyback modules that indicate with a lamp the state of flip-flops. These modules, seen in the photo on page 103, don't increase the size or cost of the equipment since they are removed before the equipment is delivered to the customer.

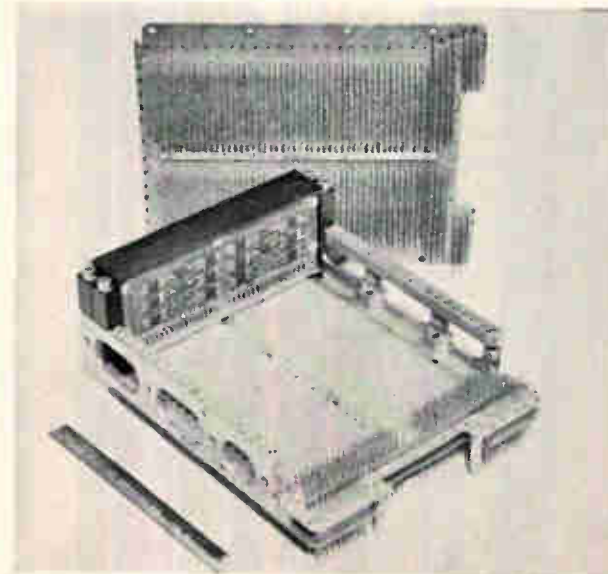
Airborne packages

The packaging hardware for the avionics modules was developed to implement the Lockheed Universal Electronic Subsystem Program (UES). The objective was to build many different kinds of command and data-handling equipment with the fewest number of standard module types. A study indicated that the five module categories and 20 types in the table below would provide 90% of the digital-circuit requirements in such equipment as decoders, programers, data multiplexers, analog-to-digital converters, data compressors, timers and general-purpose computers. The prototype system, shown below right, was a random-access telemeter demonstrated in 1965.^{3, 4}

Construction and assembly of the modules are illustrated at the right and on page 106. Monolithic integrated circuits, conventional circuits, custom thin-film integrated circuits, or small core-memory



Connector frames vary in depth according to the height of the components on the printed circuit module cards. The thinnest, above, holds integrated circuit modules.



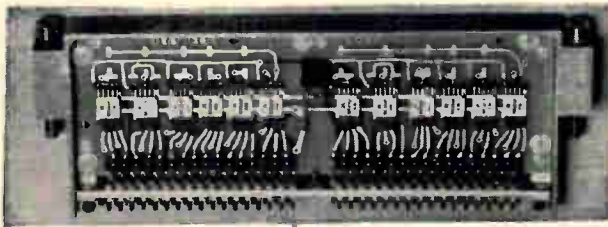
Airborne equipment is assembled with standardized modules and hardware. Each of the frames plugged into the wiring matrix contains two printed circuit modules.

Module types for avionics equipment

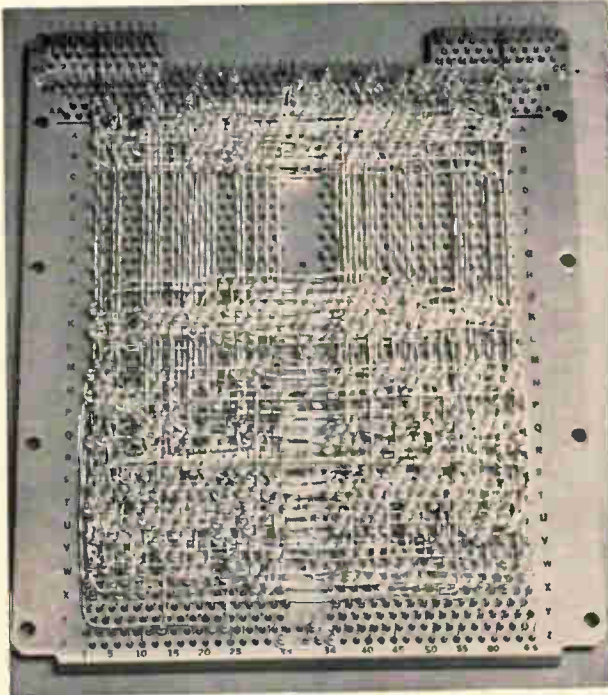
Module Category	Module Type	Random-Access Telemeter	Multiplexer (128 channels)	Command Decoder (32 channels)	Programer (256-word memory, 16-channel output)	Data Compressor (256 channels, 10 data bits, 5 control bits)
Clock	general purpose high stability multivibrator	1			1	1
			1			
Memory	16 × 16 DRO current drivers	8			16	15
	32 × 32 DRO diode matrix	4			4	4
	strobe and control	2			2	2
		1			1	1
Logic	nand/nor binary	14	2	4	8	8
		5	1	4	6	4
Power Supply	±6 v at 15 w	1			1	1
	±28 v at 15 w	1			1	1
	±28 v and ±6 v at 3 w		1	1		
Input/Output and Miscellaneous	data gates	9	5			
	comparator	1				
	programer	1				
	relay drivers			4	2	
	low-level amplifier	1				
	high-level amplifier	1	1			
	register and translator	1				



First equipment made with the avionics modules was this prototype of a random-access telemeter, consisting of 51 modules and four matrixes, housed in four boxes.



One side of a two-module frame assembly.



Hand-wired prototype of a wiring matrix. The contact pins are arranged $\frac{1}{8}$ inch apart in a staggered grid, making their density 128 per square inch.

planes with their associated circuits are soldered to etched printed circuit cards. The cards are two-sided with plated-through holes. The card size, 2×5 inches, has proved to be a nearly optimum size for all 20 types of modules. Male connectors are soldered to the card.

Two such cards—each a module—are fastened with screws to a cast-aluminum frame. Frame depths vary in $\frac{1}{4}$ -inch increments, according to the height of the module components. Frame assemblies plug into a wiring matrix and are locked in position by captive screws that engage threaded holes spaced $\frac{1}{4}$ inch apart in C rails. The module-matrix assemblies fit into dip-brazed aluminum enclosures. The telemeter requires four enclosures, weighs 15 pounds, has a volume of 526 cubic inches and operates on less than 25 watts.

Interconnection matrix

When printed circuits are made for specific systems, it is usually desirable to do as much of the circuit interconnection as possible on the circuit card. This reduces the amount of connector hardware and external wiring required. However, in this case, it was desirable to have the bulk of the inter-

connections external so that the circuits could be interconnected as needed. So a technique popular for off-the-shelf modules was adopted—making the circuit card essentially a device for carrying the circuits and extending their leads into a wiring matrix.

Wiring density and reliability requirements ruled out all the available interconnection techniques except multilayer circuit boards and wrapped-joint wiring. Integrated circuits require pin densities up to 100 pins per square inch for good packaging densities. The pin density of Lockheed's wrapped-joint wiring matrix exceeds this. The pins are in a continuous field and spaced on a staggered $\frac{1}{8}$ -inch grid—that is, the pins in each row are $\frac{1}{8}$ inch apart, but the rows are only $\frac{1}{16}$ inch apart, as in the photo of the matrix at the left, giving a density of 128 per square inch.

Multilayer boards save time in connector assembly, since the female connectors can be soldered into the board rather than being assembled mechanically as is required of a wiring matrix. Also, equipment made with multilayer boards would require less volume because the multilayer boards are thinner than the wiring matrices. However, when the highest density and lowest weight are not mandatory design criteria, the wiring matrices offer many attractive trade-offs.

Multilayer boards lost out on reliability, tooling, production costs, design flexibility and documentation requirements. Tests have shown that wrapped-joint wiring is superior to soldered connections in reliability⁶. Multilayer boards require relatively complex documentation and the difficulty of changing their design does not make them suitable for short-run production. Wire wrapping does not have the latter shortcomings. It is simple to document, easily adapts to complex interconnection patterns and design changes and can be produced at high speed when automated.

The matrix at the bottom left was wrapped by a hand gun, but the hardware—as in the ground-system packaging—is designed to be wrapped by fully automatic machines programed by punched cards. The maintainability of the wiring is comparable with that of the ground equipment, in which maintainability is a primary design requirement. In the avionics modules, the wiring is designed so that only one or two wires are wrapped to each pin. This leaves room for addition of a third wire to make wiring changes and repairs.

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4. N.N. Berger and R.W. Ulrickson, "Lockheed UES Random Access Telemeter," Proceedings of the IEEE National Telemetry Conference, 1965.
5. W.K. Antle, "The Determination of Failure Mechanisms and Environment Limits for Electronic Connections," Proceedings of the Electronics Components Conference, 1963.

CONSIDER COLORADO

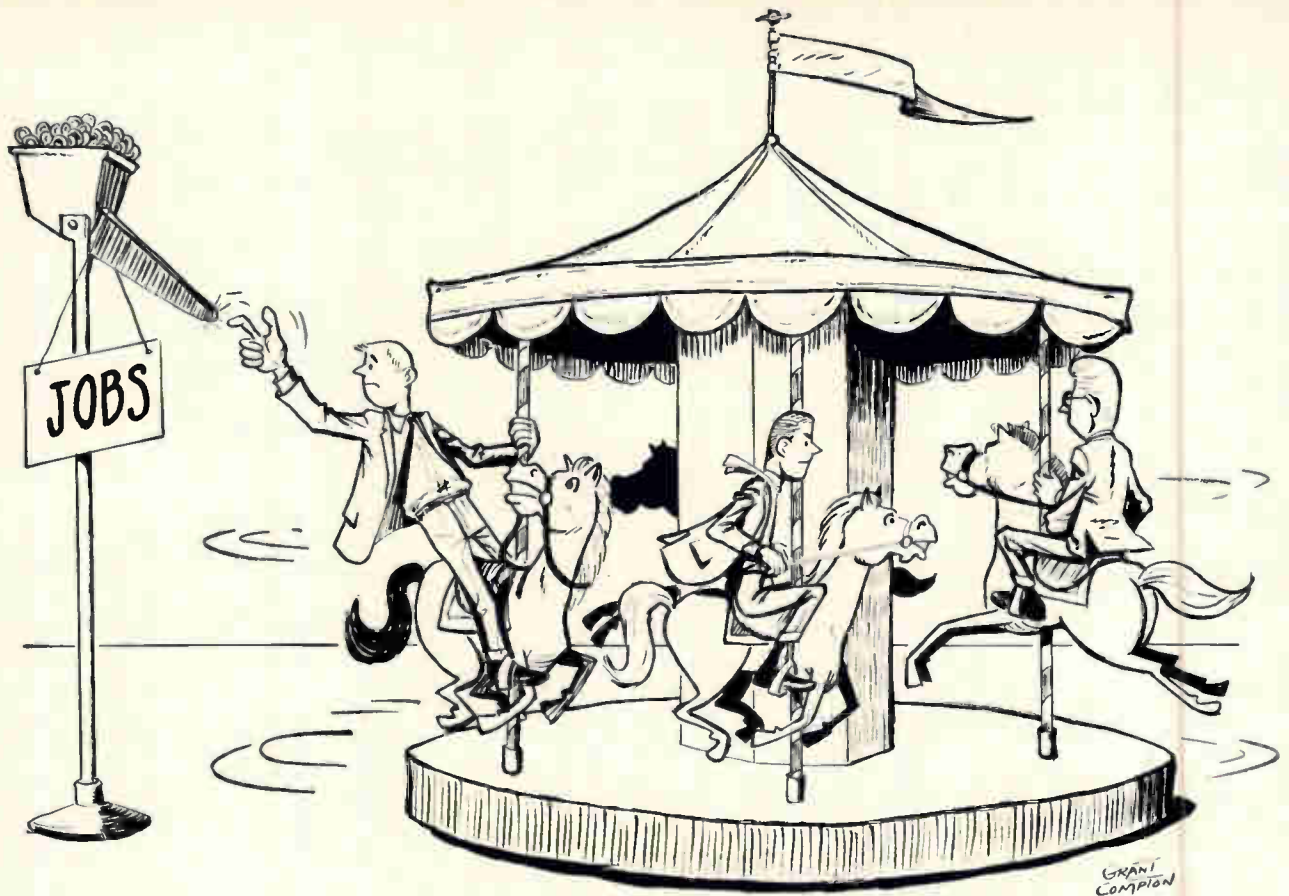
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INDUSTRIAL COLORADO





Opinion

The recruiting merry-go-round

A disillusioned engineer recounts his job-seeking experiences with the hope that others may identify and avoid misleading advertisements and deceptive claims by employers

By Anonymous

Making a satisfactory job change is not easy; important decisions are involved and, if they are to be made intelligently, should be based on considerable study. Unfortunately, there is evidence to support the view that for the electronics engi-

The author

For reasons that are self-evident, the author of this article has asked that his identity be withheld. He is a senior engineer with 12 years experience, the author of numerous articles, holds two patents and has a master's degree.

neer, in many cases, some of the decisions in the job-changing process may be based on misrepresentation and/or misunderstanding.

Despite the importance of the subject, there is practically no published material to aid the engineer who is thinking about taking a new job. I am by no means about to suggest a how-to-do-it step by step approach to making a job change. My aim is to discuss those misrepresentations which I have encountered (names of concerns withheld) in the hope that others may identify and avoid similar situations. The long-range hope is that engineers

who have had experiences like mine will be impelled to speak out, thus providing prospective applicants with some guidelines. Such guidelines would help an engineer to ask the right questions at the right time and aid him in making what is, at best, a difficult decision.

One point should be emphasized right at the start. The typical engineer spends perhaps, on the average, one or two days a year looking for a job. He reads advertising written by experts in motivation. He deals with personnel people whose full-time job is recruiting. Recruiting is a large endeavor and electronics is a very dynamic field where the employment tide has been known to reverse quickly. Even though the engineer may consider himself competent to write resumes and to conduct an interview, his experience in these matters is on a part-time basis. He relies on information that may become stale very quickly.

This article seeks to describe some instances of misleading recruitment advertising; to show how information has been withheld or falsified and, finally, to suggest how the engineer might guard against these pitfalls.

At present there is a very large apparent demand for engineers. As evidence of this, look at the advertising pages of the trade press or your local Sunday newspaper. A good barometer of the apparent job market is the average employment advertising lineage in a selected list of publications.

There is also a considerable turnover of engineers from job to job. As evidence of this, I suggest that one observe the asterisks on author bylines in the trade press that read: "Formerly with X Company, now with Y Company." A monthly indication of turnover rate could be tabulated; indeed, it might be very interesting to correlate these indications with the more traditional business statistics. I am sure the circulation manager of this magazine could give a reasonable measure of movement by counting the number of change-of-address notifications on his mailing list each month.

There is ample evidence to indicate that there is an adequate supply of engineers. Certainly, many job changes represent normal professional growth and advancement. However, many changes represent attempts by the individual to find a more suitable job for himself because, for a variety of reasons, his present position is unsatisfactory.

If one judges by the advertising, it is quite apparent that some companies appear to be in search of applicants. Where do they hope to get them? From their competitors. They suspect that because their competitors' engineers are as discontented as their own, they can be lured away.

A little thought will convince one that at any given instant the supply of engineers is substantially constant. Due to large industry growth in recent years, the average electronics engineer is quite young compared with those in other more established fields (i.e. civil) and the retirement rate

is low. Increases in the supply come at discrete intervals. Every June a crop of engineers is graduated and presumably is quickly absorbed by offers made prior to graduation.

Unlike consumer-oriented advertising that seeks to reach an untapped market, engineering recruiting advertising is beamed to a market of relatively fixed size, in which "volume" cannot be increased as in other markets. What the advertisements do is to appeal to the disenchanted engineer to give it a whirl at a new company. Why are the companies advertising for help? In many cases to replace the engineers in the circulating current stream.

Anybody who has read Vance Packard's "The Hidden Persuaders" will probably recognize the psychological stimulus these well written recruiting ads give to the frustrated engineer. Compare the art work and text of these advertisements with that of ads in the consumer field. Are they characterized by fact and value usually associated with engineering problems?

All too often advertising is shaded to cover up deficiencies. How about the case where no opening exists? If the advertisement that one answers is not backed up by an opening, there is little chance of making the wrong decision. But the practice is still harmful in a number of ways. Most importantly, it wastes time and blocks the investigation of bona-fide leads. Timing is of the essence when applying for an opening that might soon be filled. Wasting time chasing nonexistent openings will cause an occasional legitimate and possibly desirable opening from being investigated due to lack of time. Searching out nonexistent openings is time-consuming and often frustrating.

I have a master's degree and about 12 years experience in the Boston area. Prior to the summer of 1964, I had made three job changes and felt I had considerable experience and wisdom in the subject. The spring and summer of 1964 found the Boston area openings almost nonexistent, although the volume of local newspaper advertisements was quite substantial. I was then employed by a concern that sensed the true local market and as a result instituted a policy of an extended work week for an indefinite period without additional compensation. Additional policies described as "tightening the screws" were instituted. A change to a more progressive outfit was in order.

A resume was prepared using techniques that had been successful in the past. The resume, along with an appropriate cover letter was submitted in response to many advertisements. The results were spectacularly poor. Most letters were not answered. The few that were, resulted in cordial interviews but no offers.

It seemed that while a few openings did exist, they were at a low salary level. There seemed to be a mood of bargain basement shopping at the engineer's expense. A frequent comment went to the effect: "At your salary level, we expect much more specific experience in our field." The fact



that I had 10 years of experience in a wide segment of the industry, held two patents, and was the author of about a dozen technical papers counted not at all. One firm conceded that while my general background was impressive, they required, in order to justify placing me, five years experience in the specific field. Since the field was linear integrated circuits, how many qualified candidates were there in the entire country in the fall of 1964?

The ads to which I replied were all of the large display type with a specific company and division reference. Nothing in the advertisements implied the restrictions that were set forth at the interview. After several weeks of seeing the same advertisement Sunday after Sunday, literally printed from the same type, I became suspicious. A response to similar advertisements a few years prior to 1964 would almost certainly result in an interview and a good chance of an offer. After considerable discussion with fellow employees, it was apparent that others were experiencing the same sort of treatment. One offer at current salary level with a small firm in a very narrow field was rejected.

After several months of searching without success, I decided to use an agency. A few were contacted and supplied with resumes. An interview with agency personnel was granted promptly. Optimism on the part of the agency man was abundant. These people did seem to have more openings listed than were advertised; many were with the smaller companies. My resume is explicit as to my specific experience but the agency arranged many local interviews which were complete duds; literally, square-peg-in-the-round-hole situations.

The most frequent stumbling block was salary. Many of the openings were at a much lower level than my experience justified. There is a lack of industry standardization on job titles, organization structure, etc. Presumably given the three coordinates of previous experience, level or length of experiences and salary level, a reasonable preliminary "goodness of fit" test can be made. My complaints to the agency about the kind of jobs

they were offering me resulted in promises like "it was a misunderstanding — it won't happen again". But happen again it did and repeatedly.

It was apparent that there were few, if any openings for a qualified senior circuit designer. It was equally apparent that on the slightest chance that there might be something there (a placement fee), the agency would arrange an interview.

After a few such instances, I made it a practice to call the firm before the interview to ask, in my own manner, about the legitimacy of the opening. Whenever possible, a direct pre-interview phone conversation with the technical manager was arranged. This latter technique proved to be very satisfactory. A number of obvious cases of lack-of-fit were uncovered and promptly dropped. Advice from the technical people was remarkably candid. Many warned that employment would be contingent on a forthcoming contract award and that failure to get the award would result in layoffs of existing employees. In a number of instances, this happened. A surprising number of technical people had never seen my resume—they were limited to interviewing candidates screened by their personnel people.

About this time, blind advertisements were answered out of desperation. Many advertisements were answered but no replies or acknowledgments were received.

Most of the worthless interviews described were confined to the Boston area. They represented the waste of a few hours but worse was to follow.

After several months of fruitless search in the Boston area, the grass started to look greener in the other fellow's pasture. Although reluctant to relocate because of strong family ties, I began to consider seriously the possibility of a long-distance move. On face value, the out-of-town advertisements might be just as phony as the local ads, but one could not tell.

By this time, the winter of 1964, news reports around the country described increasing layoffs due to a peace scare. One day I received what



appeared to be an authentic lead from an out-of-town agency about a position in upstate New York. Over the years, I had received an occasional unsolicited call or telegram about glorious non-existent openings that were usually disregarded. But this seemed genuine. The caller at the other end was a stranger, yet it was apparent from his conversation he had considerable information, most of it up to date, from my latest resume. His description of a section manager's opening in my field was quite detailed.

After I sent him a resume (which seemed to be a formality) the company instituted arrangements for an interview date. Recalling the previous square-peg-in-the-round-hole experiences, I personally called the personnel manager of the facility to be visited. He strongly assured me of the level (both technical and salary) of the opening.

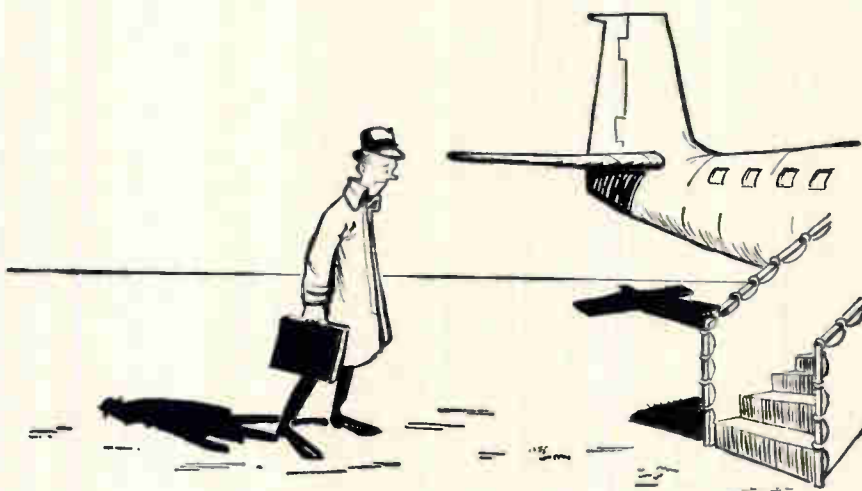
About a week later, the 500-mile flight was made. The personnel manager met me at the airport and drove me to the plant. Very smooth talker. Told me how busy they were, etc. Introduced me to the chief engineer. I was queried about my experience with sonar receivers. I explained that my experience, as stated in the resume, was accurately described and included about three years of sonar

transmitter design. Although I had some knowledge of sonar receivers, I did not consider myself at the level of a section manager.

A friendly lunch followed. After lunch, a quick tour of the plant. Back to the office. Great. How is my old friend Mr. X who used to work here, (now chief engineer of the candidate's employer). One hour's discussion followed in which it becomes fairly obvious that I am being cast in the role of unpaid spy or informer. A friendly goodbye. A 500-mile flight home, one day shot, and never an answer. Call two days later from the agency. "How did things go?" My answer: "Get lost and don't bother calling back." Three weeks later, a big layoff in the prospective employer's plant when a large contract was canceled.

Another unsolicited call, this time from an agency, was greeted with great skepticism but the opening again seemed legitimate. An advance call to the personnel manager at the prospective employer's plant "confirmed" the level and nature of the opening. Looked good. Another 500-mile-plus trip. Again a dud. Again a case (although less obvious) where a company was trying to find out what a competitor was doing.

However, I have developed a valuable technique



for getting rid of unsolicited calls. My wife answers all calls at home during the working day with a firm "If there is a specific opening, call back". Calls are seldom, if ever, returned. For some reason most of these calls are made to my residence during the working day. The caller usually asks for me by first name, often nickname.

Certain factors in the job hunting process are stacked against the engineer. The professional placement people and personnel-director types are far more skilled in handling and placing people than the engineer is in dealing with them. He can't tell what they have to offer till he gets there. The engineer is forced to play his cards first. He must apply in writing, giving a reasonable amount of specific technical information about himself. His resume and application are carefully screened and analyzed by the hiring company, by experts in this field. He is usually called in for an interview, lasting a few hours, in which he meets his prospective employers, is given a quick tour of the plant, laboratories, etc. While the hiring company has considerable time and money available to check every detail of the applicant as a routine business procedure, the applicant has little time or opportunity to check on the company in the same detail. If he is ambitious, he may obtain such data as the last few annual reports, list of contracts, facilities brochure, etc. This is important information on a general scale. Concrete information is needed such as work assignments and their nature, turnover rate, organization structure, company policy on patents, time off for trade shows, overtime, advancement, education, etc. But specific details that affect the day-to-day job are hard to come by.

On paper, most companies quote impressive policies dealing with these matters, but actual executive policy frequently leaves much to be desired. Whereas companies openly exchange salary data, the average engineer has only a vague idea of what the man at the next desk earns. With a supposed shortage of engineers, salary levels have not increased to what one might expect on a strict supply and demand basis. This is because the salary offered to an engineer is a function of his past salary and is not set on a free and open market. Having no specific information on salary structure, the engineer has his salary determined by people who have the full statistics available and who will not commit themselves until they know his present salary.

As a crowning injustice to the whole process, the engineer usually signs (often as part of his application) a statement which typically reads: "Any false statements by the applicant make him subject to immediate dismissal".

This would not be so hard to take if the employer had to sign a statement which said: "Any factors affecting the conditions of employment that have been willfully withheld or fraudulently represented will make the employer liable to furnish unlimited time off with full pay and benefits to permit the employee to find a new job."

Several years ago I took a job as a "senior engineer." It was not stated at the time of hire that this particular organization had two staffs, a junior staff and a senior staff. Although I had the title of senior engineer, I was assigned to the junior staff. Essentially, this meant working as a technician for those on the senior staff. The difference in the treatment of the two staffs was striking.

Superficial distinctions such as office size, quality of furniture, etc. were annoying. The technical assignments to senior engineers on the junior staff were in total disregard of a man's education and experience. For example, I was given the "challenging" job of designing a cathode follower. Another time, when a subcontractor failed to deliver on schedule, I was asked to help the contractor expedite delivery. This meant that I was virtually a mechanic for a three-month period.

In another instance, I accepted a job with a small, growing company (or so I thought). After a few months on the job, it became apparent the company was not growing in the accepted sense. It was actually growing smaller. The seemingly impressive financial reports, if very carefully studied, showed a cleverly concealed steady loss pattern. The apparent growth was due to a steady merger pattern. The actual business and profits of the parent company were falling, but specific amounts could not be easily determined because the new acquisitions were consolidated with the parent company.

Perhaps the tone of this article is harsh. Many engineers have read a draft of it and some have described experiences similar to mine. Others said that engineers are not "100% clean," that many resumes claim nonexistent degrees and/or experience. No doubt these counterclaims are often true. The fact still remains that the engineer is at an unfair advantage. While a medium-to-large company may lose a bit of production due to an incompetent engineer, the loss is relatively small. The production may be averaged over large numbers of engineers. For the engineer, the wrong average over a single company may be disastrous.

Based on the job advertisements many people believe that unlimited opportunity abounds for the electronics engineer. Good men in all fields are supposedly hard to come by, so it's hard to understand why electronics, and engineering in general, which commands a few percent of the total employment has to use 80% of the advertising lineage to attract candidates for employment. It has often been said if the companies paid their advertising fees to engineers in the form of a salary adjustment, supply and demand would quickly adjust to fill any void.

In articles of opinion, authors are given complete freedom for the expression of their views. The editors welcome readers' comments and will publish those letters which are most interesting

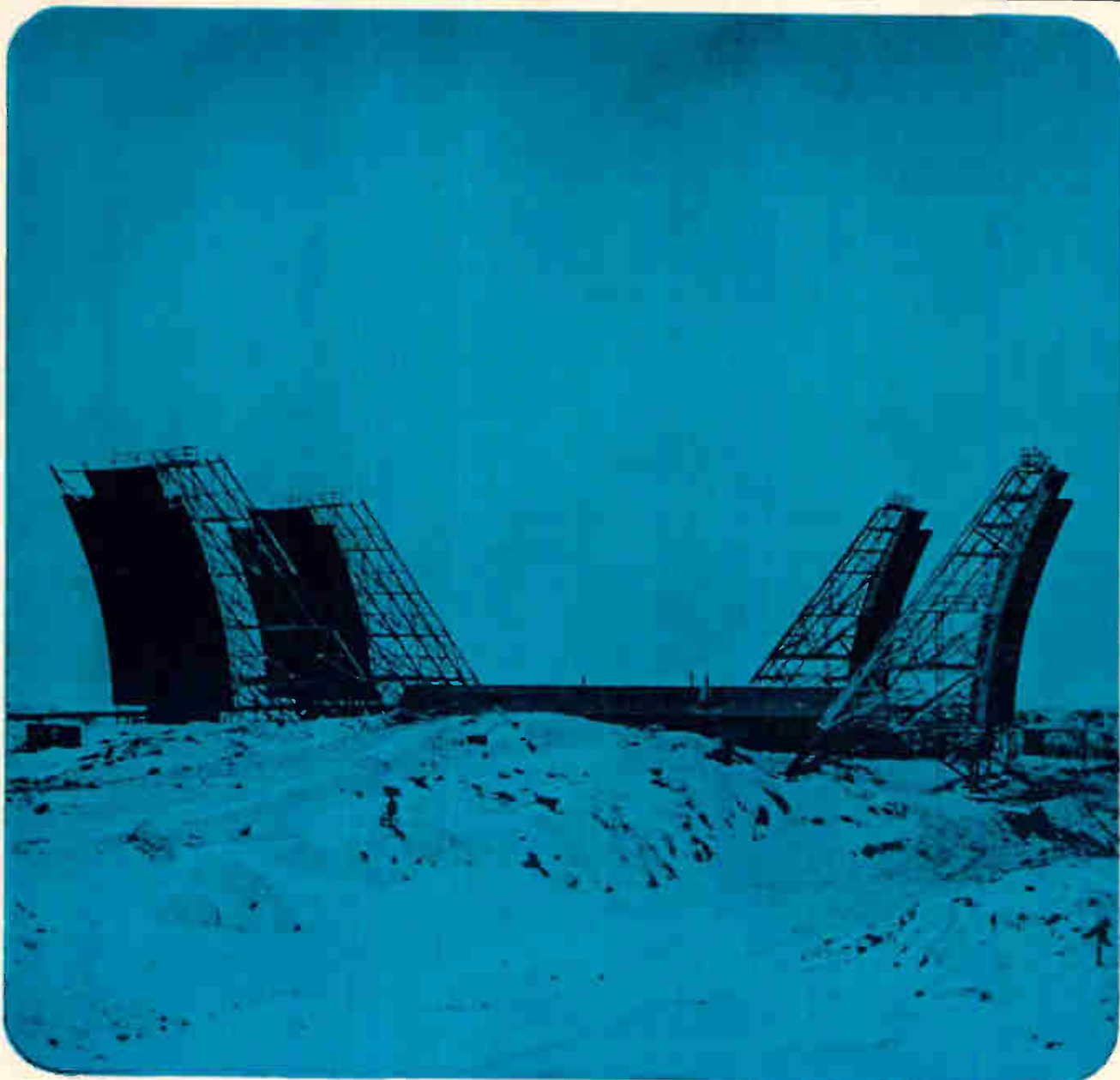


Photo courtesy of Dominion Bridge Company, Ltd.

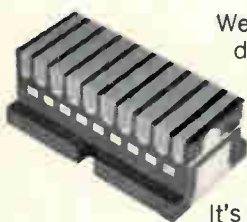
For your tropospheric scatter antenna needs, whether they be component part or complete feed system, avail yourself of the talent and experience of TRG.



With little or no change in the feed run arrangement, performance of existing tropospheric scatter communication links can be improved several db on each link by replacing the conventional feeds with the TRG Scalar Feed. This is a typical TRG contribution. The same kind of talented engineering can be applied to a complete new feed system. For details on how to put TRG Microwave Antenna experience to work for you, contact your TRG representative or write to: TRG Inc., 400 Border Street, East Boston, Massachusetts 02128. Phone (617) 569-2110.

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Ferroxcube recording heads offer 5X greater packing density than conventional heads.



We're talking about data bits on a recording medium. Have you ever tried to photograph them?

It's true Ferroxcube's new glass-bonded recording head assemblies can give you up to five times the packing density possible with other types—with your present coating or plating. How come? Because all-glass-bonding, a patented Ferroxcube technique, allowed us to squeeze every critical dimension of a recording head; gap height,

gap length, track width, track spacing. These flying heads fly low—less than 100 microinches. Even effective gap lengths of 100 microinches pose no problem.

The secret of this performance lies in the combination of a high density, high permeability ferrite, 4R5, and a special glass bonding process. Together they form a homo-

geneous assembly which lends itself to very precise micro-finishing. How precise is very? Less than 2 microinches on surface finish, 10 to 30 microinches on flatness.

This happy combination also gives you lots of elbow room to specify the recording format desired. In this area Ferroxcube Applications Engineers are eager to help with suggestions for customized design. If you're looking for more bits per dollar, pick up your phone or write and ask for Bulletin 1007A.

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And it has its problem.

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We sell the best line in each product area. Whoever makes it.

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Would You Believe...\$39⁵⁰ ?

It may be hard to believe that a microelectronic operational amplifier — which can outperform monolithic amplifiers in such critical parameters as noise figure, offset voltage drift, output voltage swing and slew rate — can still sell for as little as \$39.50 in quantities of 100 and up. Nevertheless, General Instrument's new PC-210 and PC-212 can and do.

A new method of employing thick-film/cermet resistors in these low noise, wide band multichip hybrid units provides an open loop voltage gain stability of ± 1.5 dB over the entire military temperature range of -55°C . to

$+125^{\circ}\text{C}$., and a linear output voltage swing of ± 15 volts (This appreciably exceeds swings available in monolithic amplifiers). Low noise, low offset voltages and input currents are obtained by extremely close matching of two high quality 2N930 transistors. For these reasons and others, GI's PC-210/212 operational amplifiers are particularly suitable for low level pulse and high frequency signal amplification, and high speed voltage comparisons.

The table below shows how the PC-210 and PC-212 outperform the most popular operational amplifiers now in use. And you can believe the price. It's only \$39.50.

Available now in hermetically sealed flat packs from your authorized GI Distributor.

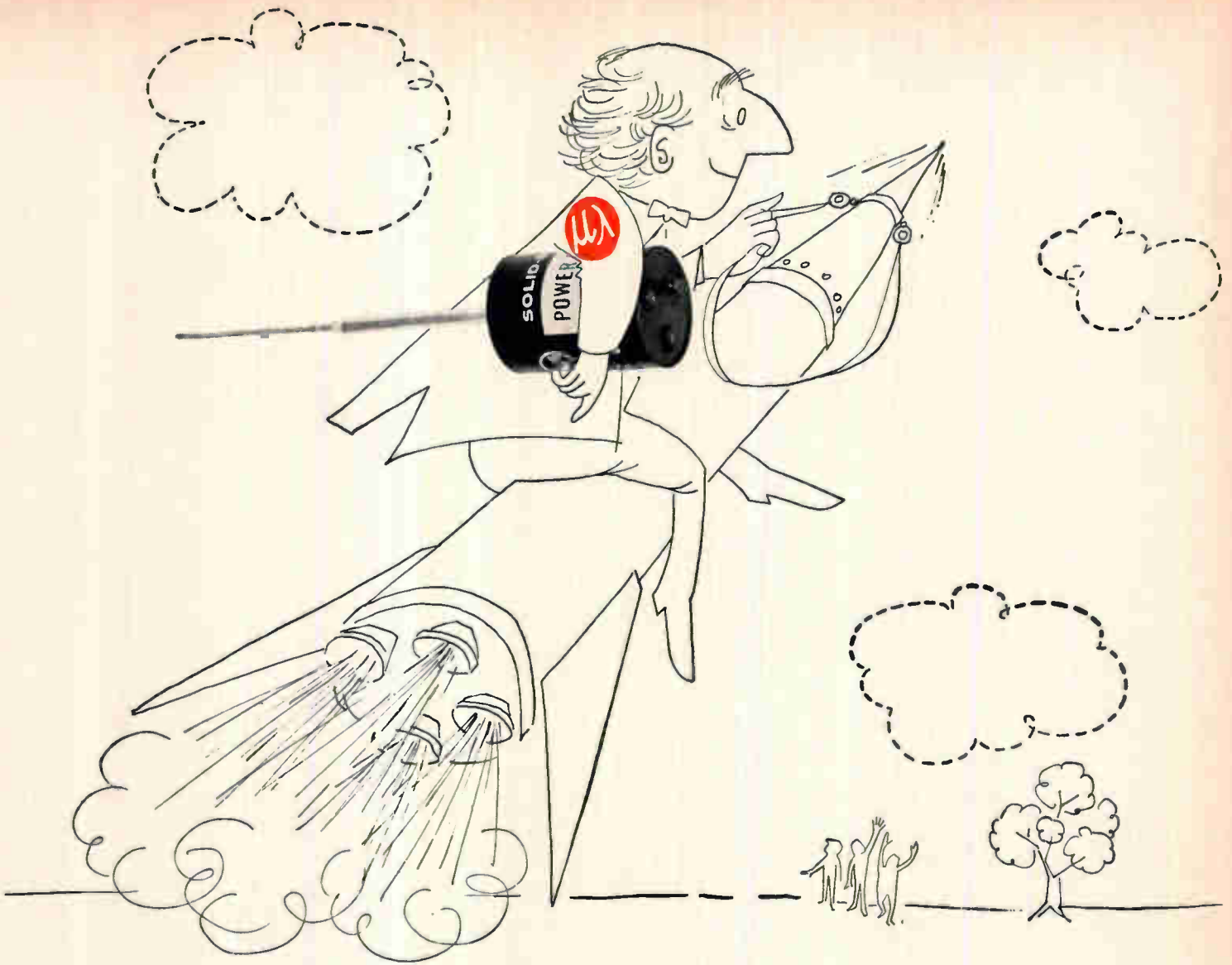
For full information call or write

Typical Characteristics	G.I. Hybrid Operational Amplifiers		Commonly Used Monolithic Operational Amplifiers		
	PC-210	PC-212	Type 2	Type 9	Type 10
Bandwidth (kHz) 3dB Open Loop	1500	1200	800	20	3000
Noise Figure dB $R_s = 10\text{ K}\Omega$ $f_o = 10\text{ kHz}$ $\Delta f = 10\text{ kHz}$	1	1	Not Specified		
RMS Input Noise Broadband (11 mHz)	4 μV	4 μV	Not Specified		
Slew Rate (Volts/ μsec)	± 100	± 100	Not Specified		± 100
Output Voltage Swing (Volts)	± 15	± 10	± 5 (with 100 k load)	± 10	$+2.05$ -1
Differential Input Current (nA)	40	30	700	50	1000
Input Bias Current (nA)	600	500	4000	200	25000
Offset Voltage Drift -55°C to $+25^{\circ}\text{C}$ $+25^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ -55°C to $+125^{\circ}\text{C}$ } $\mu\text{V}/^{\circ}\text{C}$	4	4	10 5 —	6 3 —	5
Voltage Gain V/V	3200	1600	2600	45000	1200



**GENERAL INSTRUMENT CORPORATION
SEMICONDUCTOR PRODUCTS GROUP**

600 West John Street, Hicksville, L. I., N. Y.



\$90* will put you "up in the air"

WITH RCA-S170 SOLID-STATE POWER SOURCE

RCA-S170 is an ideal L- and S-Band solid-state microwave power source. Providing frequency stability over a range of -55°C to 71°C , and 200 mW power output at 1.68 GHz, this 1" diameter x 1.4" unit features an attractive low cost for balloon and rocketsonde applications.

S170 is a transistor-oscillator-multiplier (TOM). This simplified design uses the famous RCA "overlay" transistor which acts as a fundamental oscillator while, at the same time, its varactor characteristics enable it to be used as a multiplier.

*In production quantities of 25 or more. For prices on developmental samples, consult your RCA representative.

The unit will operate directly from a small battery power source.

Available in 28V and 12V (+ or - polarity) versions, S170 has a dissipation rating of 4.0W at 71°C , well above the requirements for experiments in near and outer space. Units are available in the 1.4 to 2.3 GHz range.

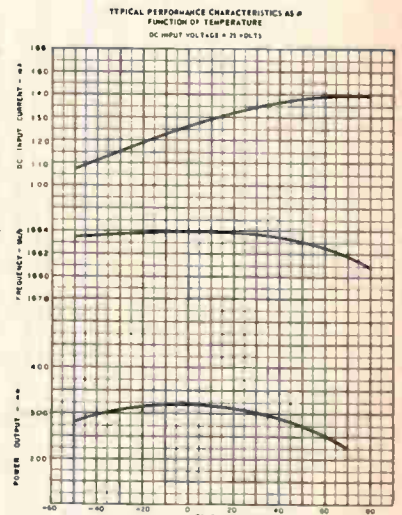
S170 is one of a family of solid-state power sources available from RCA. Check with your RCA Representative. For technical data, write: RCA Commercial Engineering Sec. F19Q-4 Harrison, N.J.

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See the RCA Display at WESCON



Circle 117 on reader service card

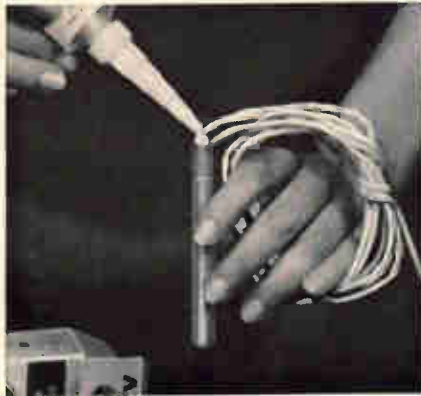
Only G-E RTV silicone adhesive/sealants are UL recognized for

insulating...



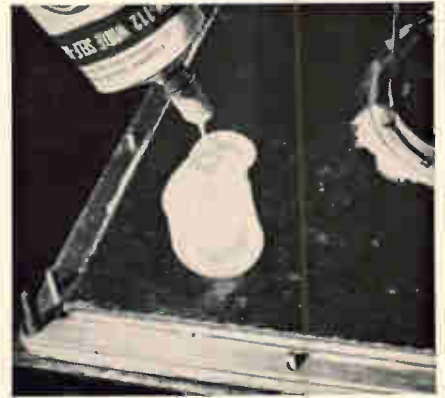
Instant see-through insulation provided by translucent RTV-108 sealant. Outstanding electrical properties. RTV also comes in colors.

sealing...



High temperature moisture sealing of heating elements. Costs less and sets up faster than epoxy. And G-E RTV stays flexible permanently.

bonding...



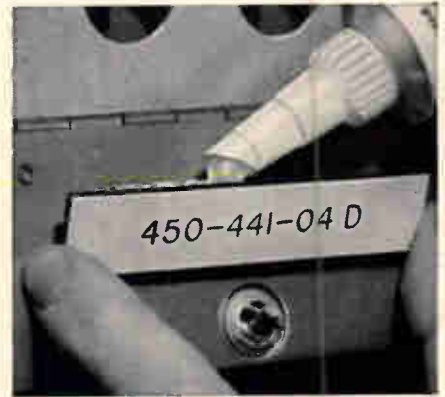
Laminated layers of mica sheeting are securely bonded with RTV sealant. Ready to use, it needs no catalyst and bonds without a primer.



Shock and vibration are cushioned by RTV's permanent resilience. Protects over wide temperature range. Won't harden, soften, crack or shrink.



Eliminate capping, taping and splicing with RTV. Easily speeds assembly line sealing. Also used to lock nuts firmly in place.



Eliminate screws and drilling by adhering identification plates with RTV. It bonds to metal, glass, wood, most plastics — almost all materials.

General Electric's RTV adhesive/sealant is a resilient electrical insulating material, weather-resistant and ready-to-use adhesive.

Recognized by Underwriters Laboratories for electrical uses, RTV sealant maintains its rubber-like properties at temperatures as low as -75°F , high temperatures up to 600°F . It stays flexible *permanently*, does not crack or shrink.

For complete information on G.E.'s family of RTV silicone adhesive/sealants write Section N6209, Silicone Products Department, General Electric Company, Waterford, New York 12188.

GENERAL  **ELECTRIC**

SCIENCE/SCOPE

Nimbus satellite launched May 15 carries a five-channel scanning radiometer designed and built by Santa Barbara Research Center, subsidiary of Hughes Aircraft Company. Purpose of the radiometer is to measure infrared radiation and solar energy emitted from the surface and atmosphere of Earth.

A new gyro-stabilized gunsight -- designed to aim the Army's wire-guided TOW anti-tank missile from helicopters -- enables the gunner to keep the crosshairs on target even while the pilot is taking evasive action to avoid ground fire. Missiles for the helicopter weapon system are identical to those used in the infantry TOW system Hughes is developing for the Army Missile Command. Prototype TOW missiles scored bullseye hits on tank-size targets more than a mile away in recent tests at Redstone Arsenal.

Recent tests in Hawaiian waters proved that the new towed-array sonar system Hughes is building for the U.S. Navy is much less affected by interference from the mother ship. In conventional sonar systems the hydrophones are clustered. In the towed-array system they're arranged in tandem, in what looks like a segmented string of fire-hose sections, about three inches in diameter and nearly a hundred yards long. They're trailed at the end of a long cable, so that they can follow their submarine prey into the depths.

The Early Bird satellite operation has proved so successful in its first year of service that similar synchronous satellites definitely will form the basis for the initial global system of communicating by satellites, reported President Joseph V. Charyk to Communications Satellite Corporation shareholders at the recent annual meeting. Meanwhile, on Early Bird's first birthday, NASA's Syncom 2 and Syncom 3 continued to operate without failure over the Indian Ocean and the Pacific.

Systems analysts, circuit designers, weapon systems engineers: We have a number of senior-level openings in data processing, radar, and infrared...other openings in 600 projects. We'd like to hear from you, especially if you have an advanced degree and several years experience. Write: D. A. Bowdoin, Hughes Aircraft Co., Culver City, Calif. An equal opportunity employer.

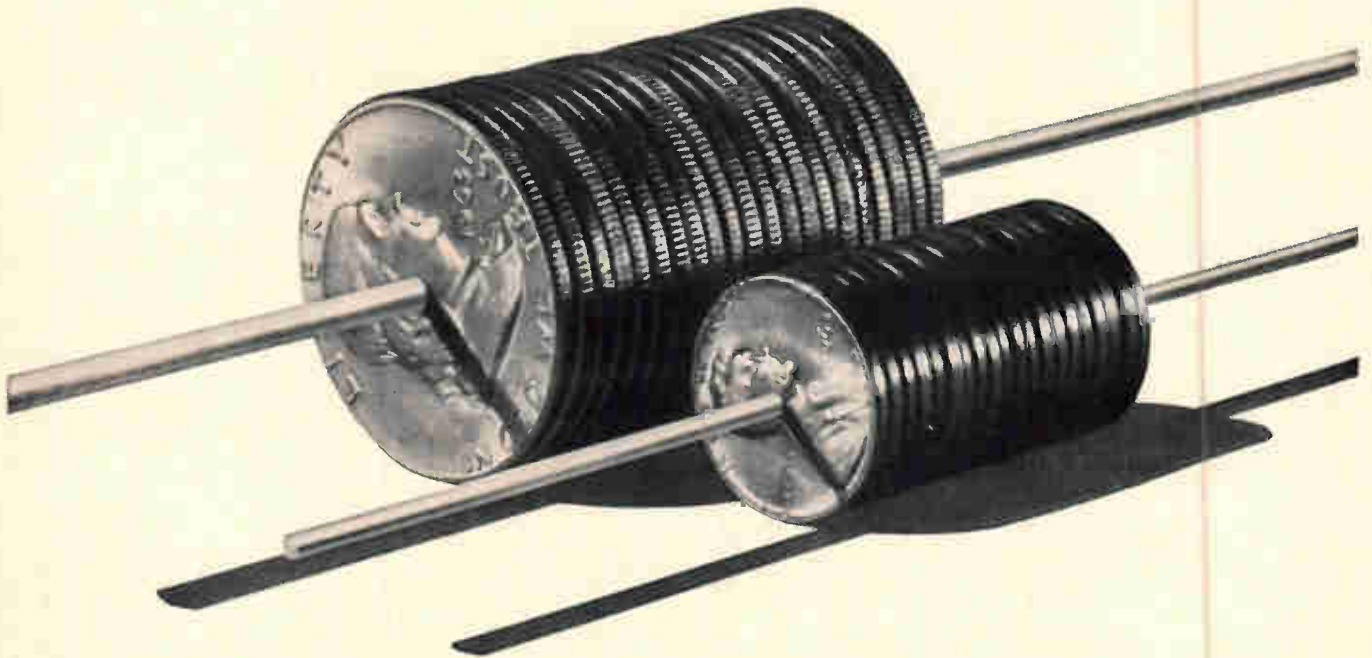
A 30-megabit laser communication system, sponsored by NASA's Manned Spacecraft Center, employs polarization-modulation techniques. It was demonstrated recently between stations a few miles apart in the Los Angeles area. This system has a 30-million-bit-per-second capacity. It simultaneously transmits a 5-megacycle TV channel, a 4-kc voice channel, and a 1-kc telemetry channel. Big potential of laser communications is its ability to handle very high data rates with one installation. Thus, laser technology and systems have moved closer to being practical long-range, high-data-rate space communications systems.

Hughes' new real-time digital computer, the microelectronic HM-4118, was demonstrated recently to the military in Boston, Washington, D.C., and Langley AFB. Designed for real-time command and control data processing, the HM-4118 is built to operate in any military environment. Hughes plans to propose it for USAF's 407-L tactical air control system.

Creating a new world with electronics

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Component reliability to fit your budget

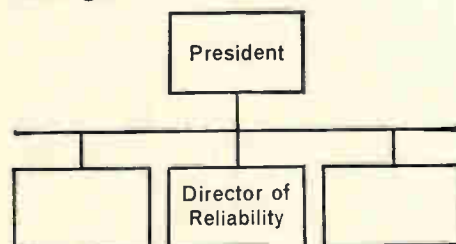
We believe you should pay only for the degree of component reliability you need. And no more.

That's why we offer you a complete choice of optimum economical levels of reliability—from precision films to carbon composition resistors, from trimming to multi-turn potentiometers, from signal to control semiconductors.

We've gone a step further and *published* prices for three levels of reliability in standard metal film resistors . . . an industry first.

At IRC, reliability is management

economics . . . not merely a statistical exercise. Address your questions on reliability to our Director of Reliability. They will get the attention of top management.



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Familiar with TEFLON®? Try this quiz.

①	TEFLON is transparent!	TRUE	FALSE
②	TEFLON can be cemented!	TRUE	FALSE
③	TEFLON can be heat sealed, thermoformed, heat bonded!	TRUE	FALSE
④	A TEFLON film is made by Du Pont!	TRUE	FALSE

All are true with TEFLON® FEP film: a new dimension in TEFLON

Let us tell you more.

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TEFLON FEP fluorocarbon film brings the familiar properties of TEFLON *plus* a new form, versatility and ease of fabrication for applications like: conveyor belting, critical industrial packaging, gaskets, roll covers, reinforced plastics curing, closures, high temperature electrical insulation, flexible flat cable, printed circuitry.

The application I am considering is _____

To do the job, a material with the following critical properties is required:

TEFLON FEP FILM

- Mechanical high impact, abrasion, tear strength. Useful at cryogenic temperatures
 - Thermal resistance from -240 to +200°C. continuously.....
 - Chemical resistance the most inert of all plastics.....
 - Release, anti-stick superior.....
 - Electrical No tracking, non-wettable, non-flammable, low power factor and dielectric constant, dielectric strength: 4,000 vpm for 2 mil film.
 - Weatherability high transmittance of ultraviolet and all but far infrared, inert to outdoor exposure
- I am interested in these forms and processing techniques:
- Film thickness ½, 1, 2, 5, 10, 20 mil.....
 - Heat bonding directly to metals.....
 - Heat sealing provides a plastic weld at 300°C.....
 - Cementing available with one or both surfaces treated to accept conventional adhesives, for laminating to metals, rubber, glass cloth, asbestos fabric, etc.
 - Thermoforming a true thermoplastic, thermoform at 525°F., with conventional equipment.....

MY REQUIREMENTS

from _____ to _____
to _____
yes _____ no _____

thickness _____
substrate _____
yes _____ no _____
substrate _____
one side _____
both sides _____
yes _____ no _____
shape _____

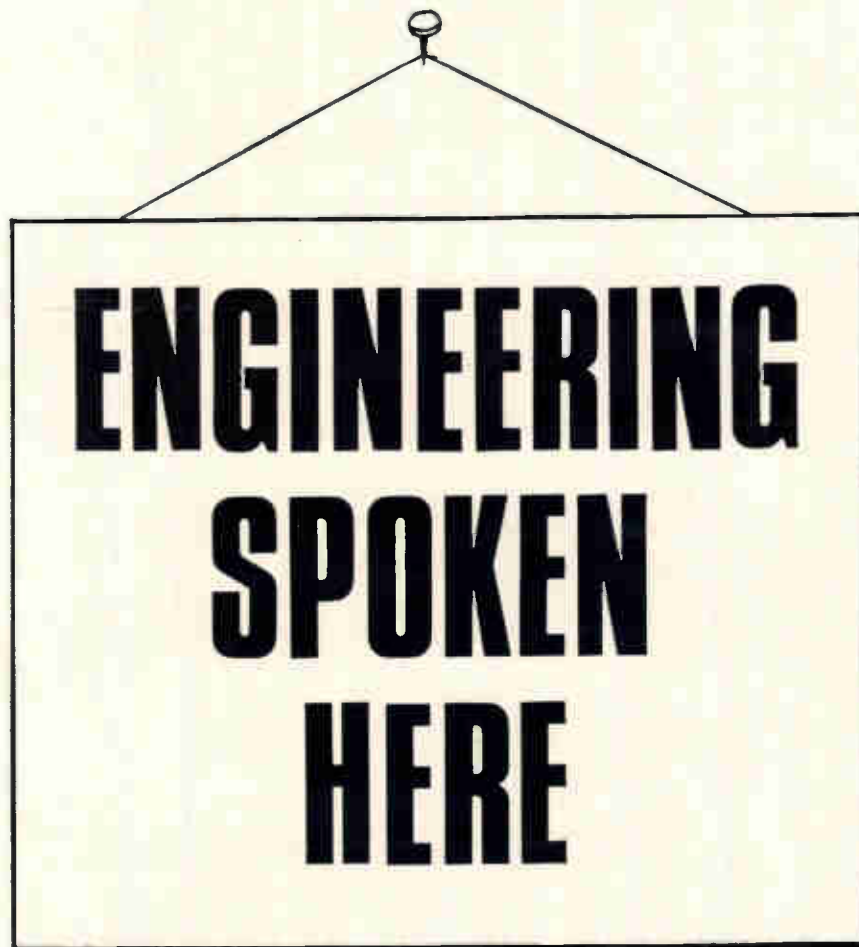
Please send full appropriate technical data.

Name _____ Address _____
Company _____ City _____ State _____ Zip _____
Job Responsibility _____ Business Phone _____



TEFLON® FEP fluorocarbon film

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(WITH A PHOTOGRAPHIC ACCENT)

Many an engineer who has a need to record data is not a photographic engineer. This is why we have a *Special Applications Department*. In it are photographic specialists who have a speaking acquaintance with the various other kinds of engineering. Backing them up are some 35,000 people whose work is photography.

With one or more of these people to talk to, you may be able to solve the stickiest of data-recording

problems—through the application of materials and techniques you may not have heard about, or by collaboration in the development of new ones.

If you dial (716) 325-2000 and ask for Ext. 5129, the man who answers will connect you with the particular specialist who speaks your language best. Or you can write him by addressing **Special Applications, Eastman Kodak Company, Rochester, N. Y. 14650.**

Kodak

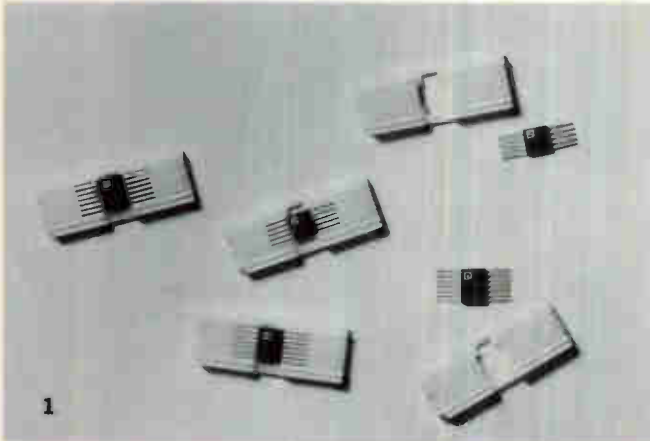
SIGNETICS



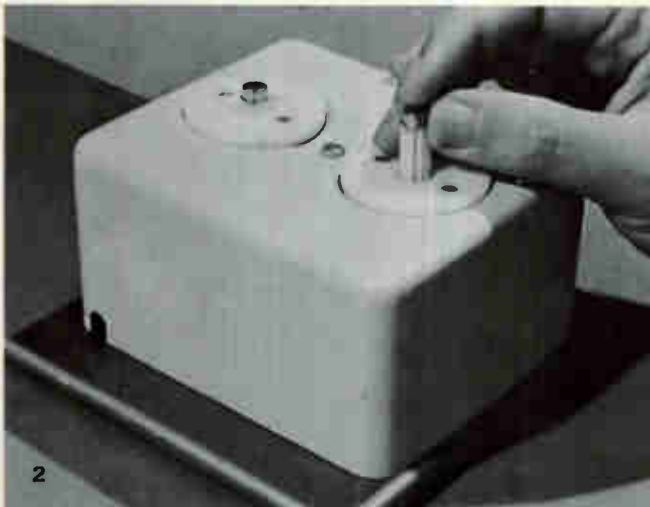
INTEGRATED CIRCUIT NEWS AND APPLICATIONS

SIGNETICS USER-ORIENTED PACKAGING

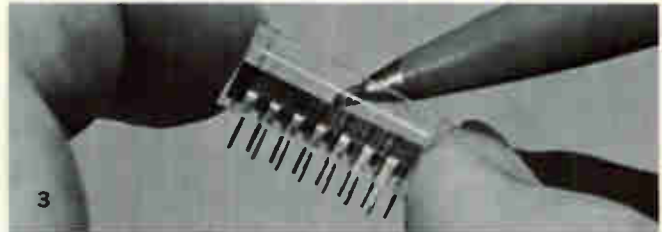
All integrated circuit users face the problem of reliably testing, sorting, and handling these products during assembly without incurring damage to the leads of the device. Endeavoring to ease this problem, Signetics provides device carriers which are designed with the user in mind. Ease of test, storage, and minimum carrier cost to provide the "throw away" feature are all part of this program.



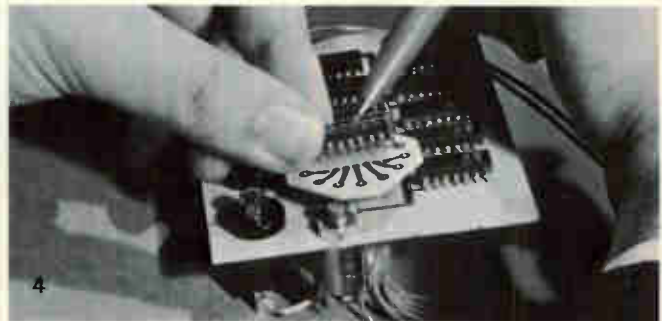
The outcome of this program is a group of throw-away plastic carriers designed for each type of circuit package. The flat package carrier, Figure 1, will accommodate either the $\frac{1}{4}$ by $\frac{1}{4}$ -inch 10-lead flat package, (TO-91), or the $\frac{1}{4}$ by $\frac{3}{8}$ -inch 14-lead flat package (TO-88). The package body opening in this carrier is under-cut so that the package snaps in and is retained even if the carrier is accidentally turned over. The flat, ribbon-like leads are fully protected within the grooves of the carrier body which also serve to guide the wipers of a multi-point test head into contact with them.



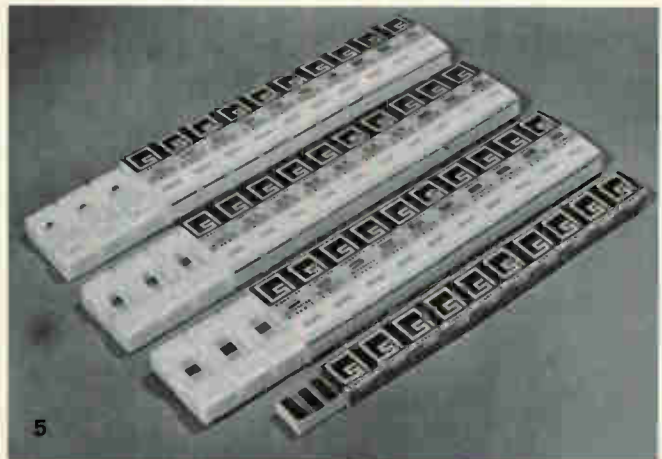
A similar approach was taken in designing the carrier for the familiar modified JEDEC TO-5 can. In this case the carrier is a grooved plastic cylinder. Carrier and circuit plug into a Signetics-designed test socket as shown in Figure 2.



The carrier designed for Signetics' new "A" package, a solid plastic 14-lead dual in-line type, serves, as do the others, to protect the leads and guide the test head. It has one additional outstanding feature. This new carrier also serves as a throw-away alignment jig for insertion of the circuit into a PC board. As indicated in Figure 3 a slight downward pressure on the package body is used to extend the leads slightly beyond the bottom of the carrier. The leads can then be easily registered in the hole pattern in the PC board. A final downward push seats the circuit in the board, Figure 4. The carrier is then discarded.



This carrier is equally useful whether hand or machine insertion is involved. It should be noted that for machine insertion, the normal shipping box for Signetics dual in-line packages serves as a throw-away magazine for loading automatic machinery.



Shipping containers for each type of circuit package are shown in Figure 5.

Signetics Data Circle 250



**SIGNETICS
INTEGRATED
CIRCUITS**

NEW SAGE I ELECTRONIC CALCULATOR USES SIGNETICS INTEGRATED CIRCUITS

A new, low-priced electronic desk-top calculator designed for general purpose business and engineering use has recently been introduced by Dero Research and Development Corporation of Huntington, New York. Called Sage I, the 12-pound portable-typewriter-sized unit performs computations in fractions of a second, in complete electronic silence. Featuring a simplified 10-key keyboard, the machine has a 20-digit capacity and displays results in $\frac{7}{8}$ -inch high numerals on a brightly illuminated screen.

The self-contained Memory of Sage I permits storage and recall of entries and results, facilitating continuous calculations and the accumulation of products and quotients. A number need only be entered once for raising to powers or for repetitive use. The device has four registers—entry, answer, memory and accumulate—and its typical speed is 0.008 seconds for addition and subtraction, and 0.25 seconds for multiplication and division.

Sage I operates in the same sequence in which a normal problem is expressed and thus no special instructions are required to learn how to operate the machine. The unit "remembers" both the last number and command entered, permitting an automatic repeat of either or both. Sub-totals are automatically indicated and any result may be further operated upon without re-entry. Automatic reciprocal division is also possible.

A special "double precision" feature of Sage I permits calculation capacity to 20 digits on its 10-digit display, with the 10 most significant digits presented first, and the remaining least significant digits presented when the "D" key is pressed. A second press of the "D" key returns the most significant digits to the display.



This advanced electronic desk calculator uses Signetics integrated circuits in the new easy-to-handle dual in-line plug-in package. The low cost of these units and the manufacturing economies they permit have helped keep the price of Sage I below \$1000, which makes it less than the cost of many conventional mechanical calculators.

Signetics Data Circle 251

Sage Data Circle 252

SIGNETICS 8-BIT MEMORY ELEMENT IN SDS SIGMA 7 COMPUTERS

The remarkably high Input/Output rate of Scientific Data Systems' new Sigma 7 family of computers (up to 160 million bits per second) can be attributed in large measure to the liberal use of very high speed scratch pad memories assembled from Signetics 8-bit memory elements. These new monolithic I/C's incorporate 8 flip-flops, decoding and write networks, and an output buffer all on a single chip.

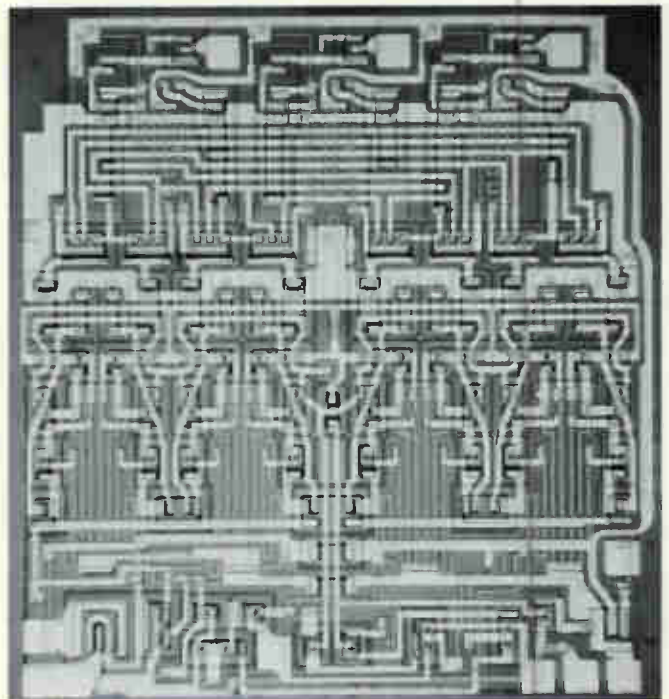
The principle function of the scratch pad memories is to speed up system response to multiple inputs by reducing dependence on the much larger and slower main memory. The basic scratch pad building block is a PC board carrying 16 of the 8-bit memory elements, and drive circuitry to form a 16 byte module of 8 bits per byte.

Sigma 7 features a total capability for both business and scientific data processing and is uniquely designed for real time computation while operating in time sharing, multiprocessing and multiprogramming environments. Because of its extensive use of monolithic integrated circuits, Sigma 7 is considered a third generation computer.

A 12-page reprint of an article describing the SDS Sigma 7 and the function of the Signetics 8-bit memory element in it is available on request.

Signetics Data Circle 253

SDS Data Circle 254





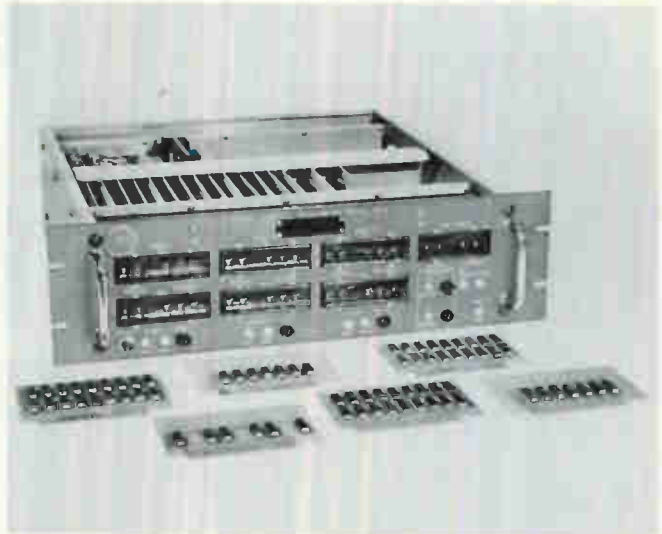
VITRO LABS TIMING AND CONTROL SYSTEM FEATURES SIGNETICS DTL IC'S

High reliability, compactness and low cost are the major advantages of a new Event Control Sequencer manufactured by Vitro Laboratories of West Orange, New Jersey. Designated model 3219, this device was designed by Vitro to fill the need for more reliable data timing and control systems. It provides means for separate on-off control of three independent events to a resolution of 0.1 sec., operating on a time base of one hour. A seven-segment incandescent display indicates elapsed time in minutes, seconds and tenths of seconds. Outputs consist of three independent relay closures. These have mercury-wetted contacts rated at 28 volts, two amperes DC.

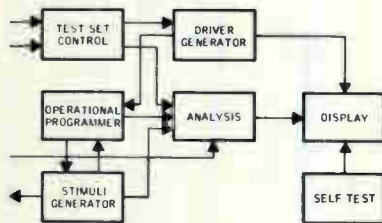
The 5 1/4" x 19" x 17" 30-pound unit, designed for rack mounting, is assembled using Signetics DTL integrated circuits in the new dual in-line plastic package on standard Vitro micro-circuit board assemblies. All components are mounted on one side of 3x5-inch epoxy-glass plug-in printed-wiring boards for standardization and ease of manufacture and maintainability.

Signetics Data Circle 255

Vitro Data Circle 256



INTEGRATED CIRCUITS REDUCE SIZE OF MINUTEMAN PORTABLE TEST SET

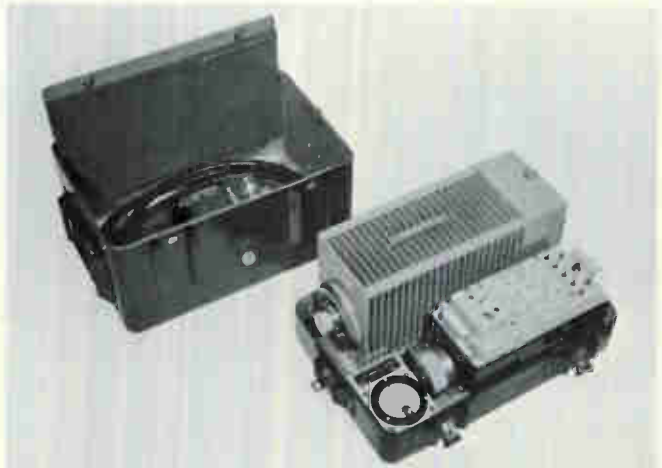


A portable automatic digital test set using Signetics integrated circuits has been designed by Sylvania Electronic Systems Division for part of the Minuteman ground electronic system. By using IC's, a volume reduction of 30 times and a weight reduction of 6 times has been achieved. If the test set were designed for conventional solid state printed circuit construction it would weigh 90 pounds and occupy 5 cubic feet of space. At 14 pounds, this set is light enough to be plugged directly into a rack connector, eliminating the need for cables.

Designed to limit operator decision-making (and thus minimize personnel training requirements) the test set is an automatic go/no-go readout unit capable of isolating a malfunction in a communications subsystem to one of seven drawers by simple indicator lamps. The unit automatically tests itself and then proceeds to program a series of tests on the subsystem. It is capable of performing the self test plus analysis of 42 test points required to check the subsystem in 20 seconds.

Two techniques are used for subsystem analysis. One is direct comparison of digital type signals from the subsystem with similar signals generated by the test set. The second technique is the checking of analog signals with a threshold level detector which indicates a no-go condition if signal voltages fall below a minimum preset level.

A block diagram of the test set is shown in the accompanying figure. Test start and stop signals, gating functions and synchronization are provided by the "Test Set Control." Clock pulses and pulse rates are developed in the "Driver Generator," and the "Operational Programmer" provides duplicating and controlling of the subsystem operations. The "Self Test" function checks for proper basic timing rates in the test set and assures that all analysis and readout circuits are capable of a no-go indication.



Signetics SE100-Series DTL circuits in "G"-type package are used extensively in this test set, and are shown on a typical circuit board in the accompanying photograph.

Signetics Data Circle 257

Sylvania Data Circle 258

DUAL J-K FLIP-FLOP ADDED TO SE800-SERIES TTL FAMILY

Signetics has added a 35 Mc dual J-K flip-flop to its TTL family. Introduced at the IEEE convention in March, the new monolithic element, designated SE826 provides opportunities for greatly reducing can counts in TTL systems. Each of the two flip-flops has independent Preset, J, K, Q, \bar{Q} , and clock inputs. Average power dissipation is 40 mW per flip-flop, and 1.0-Volt noise margins are typical.

The 800 series also includes six different NAND gate configurations, single, dual, triple and quad; a gate expander, an Exclusive-OR, and a 30 Mc single J-K Binary Element that offers unusually great input logic flexibility.

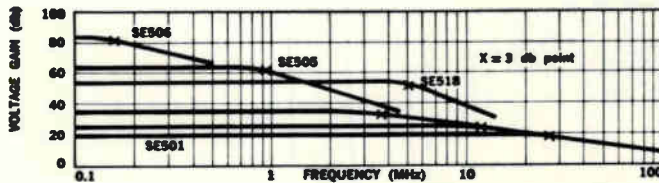
The series is offered in Signetics glass-Kovar 14-lead TO-88 flat package, and is available in two temperature ranges: the SE800 series for -55°C to $+125^{\circ}\text{C}$ application, and the NE800 series for a range of 0°C to 70°C .

800 SERIES TTL

Element Catalog Number	Description	Package Type	Available In 0°C to 70°C Range
SE806	DUAL 4-INPUT EXPANDER	J	X
SE808	8-INPUT NAND GATE	J	X
SE816	DUAL 4-INPUT NAND GATE	J	X
SE825	MASTER-SLAVE J-K FLIP-FLOP	J	X
SE826	DUAL HIGH SPEED J-K FLIP-FLOP	J	X
SE840	EXCLUSIVE-OR GATE	J	X
SE855	DUAL 4-INPUT POWER GATE	J	X
SE870	TRIPLE 3-INPUT NAND GATE	J	X
SE880	QUAD 2-INPUT NAND GATE	J	X

Signetics Data Circle 259

SIGNETICS LINEAR FUNCTION SET



As shown in the accompanying graph, Signetics SE500-Series Linear Function Set provides all of the most frequently required circuit functions over a broad spectrum of gain and bandwidth combinations. The most recent additions to Signetics linear family are the SE506 Differential Operational Amplifier featuring an open loop gain of 17,000 and bandwidth of 170 KHz and the SE518 Analog Comparator which provides 5 MHz bandwidth and an open loop gain of 1700. All SE500 series elements are available in two temperature ranges (-55°C to $+125^{\circ}\text{C}$ and 0°C to 70°C).

Signetics Data Circle 260

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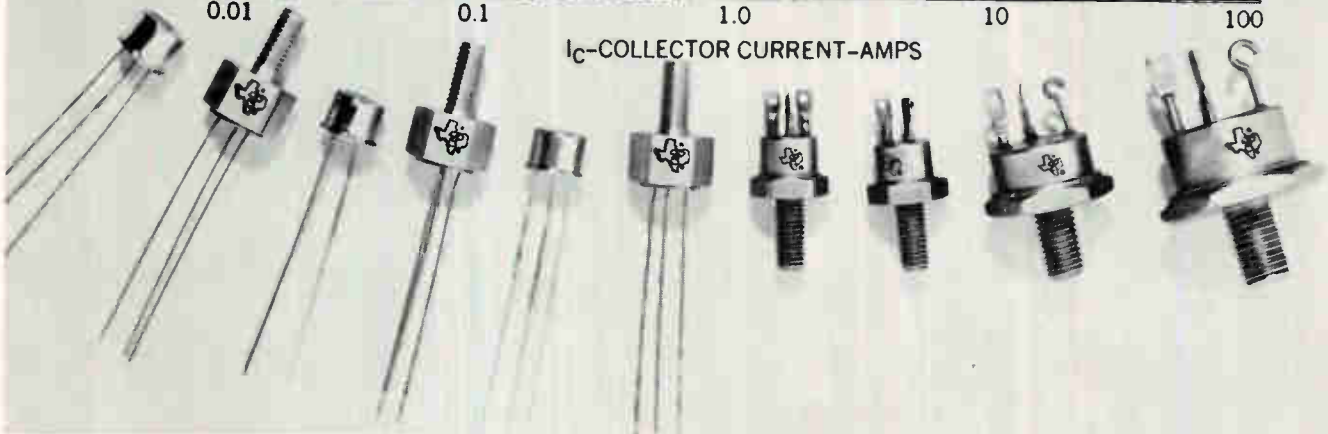
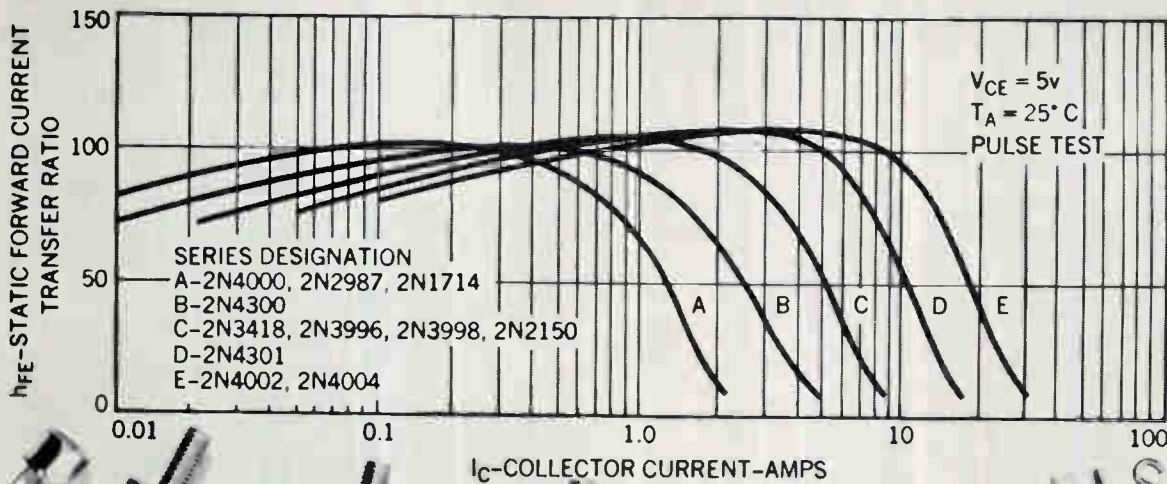
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For further information on the Signetics products discussed in this insert, please circle the appropriate reader service number. For information on the products which use Signetics Integrated Circuits, please circle the reader service number indicated.

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NEW 2-amp 2N4300 This transistor is offered in a high-dissipation TO-5 package rated at 15 watts at 100°C case temperature. A press-on stud is optionally available. Saturation voltage is exceptionally low (0.5 volts maximum at 2 amps), assuring low internal losses for increased circuit efficiency. Gain is linear from 50 milliamps to 1 amp (h_{FE} is typically 70 at both levels), making the device well suited to amplifier applications. Fast switching characteristics ($t_{on} = 150$ nsec, $t_{off} = 1.5$ μ sec typical at 1 amp) make the 2N4300 ideal for high-speed, medium-power circuits and switching regulators.

Typical applications include servo and relay control amplifiers, audio amplifiers, converters and power supply regulators.

NEW 10-amp 2N4301 This new transistor is packaged in a TO-61 case offering a power dissipation of 50 watts at 100°C case temperature. Operating characteristics include extremely low saturation voltage (0.5 volts typical at 10 amps), high gain at high current ($h_{FE} = 30$ typical at 10 amps), and high frequency response ($f_T = 40$ MHz min). Drive power requirements are low ($V_{BE} = 1.2$ volts max at 10 amps), permitting use of low-power driver stages with the possibility of eliminating an intermediate stage.

These transistors are well suited for switching and linear power supply regulators, converters, inverters, servo amplifiers, and linear power amplifiers.

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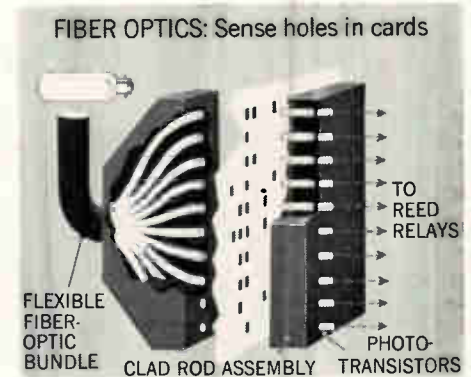
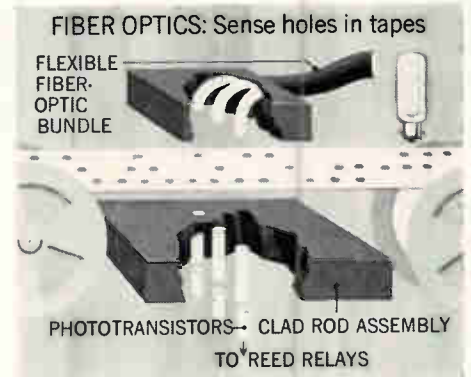
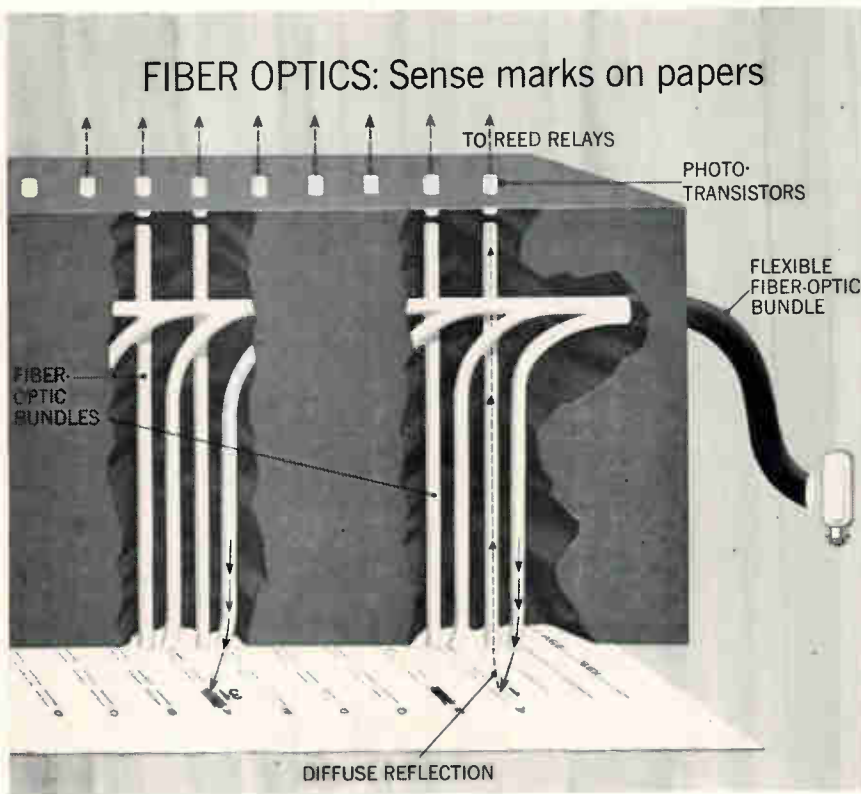


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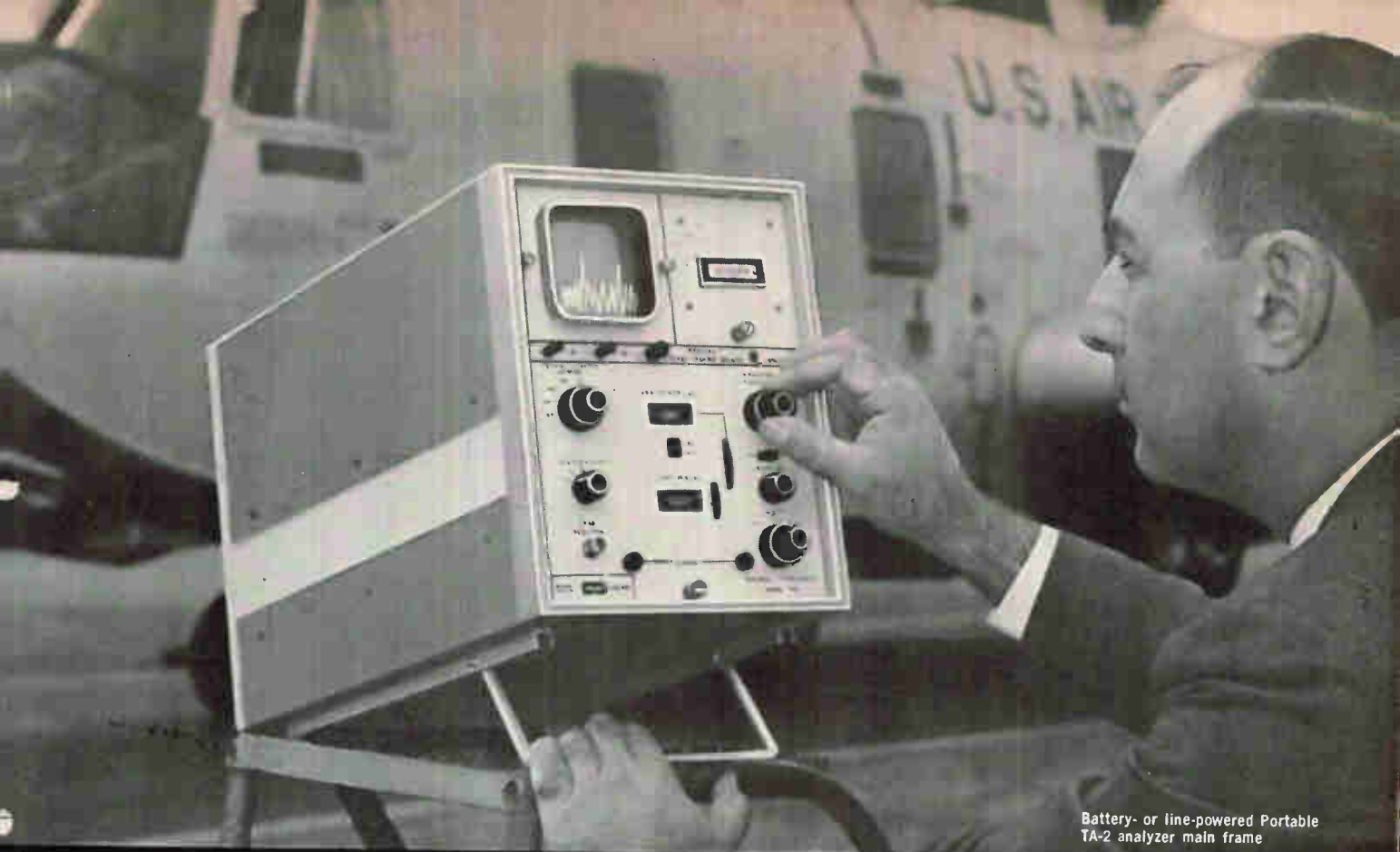
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Marker Spacing	0.02% Accuracy-Fundamentals shown Harmonics Usable			
	2.5 kc	2.5 kc	25 kc	25 kc, 500 kc, 100 Mc

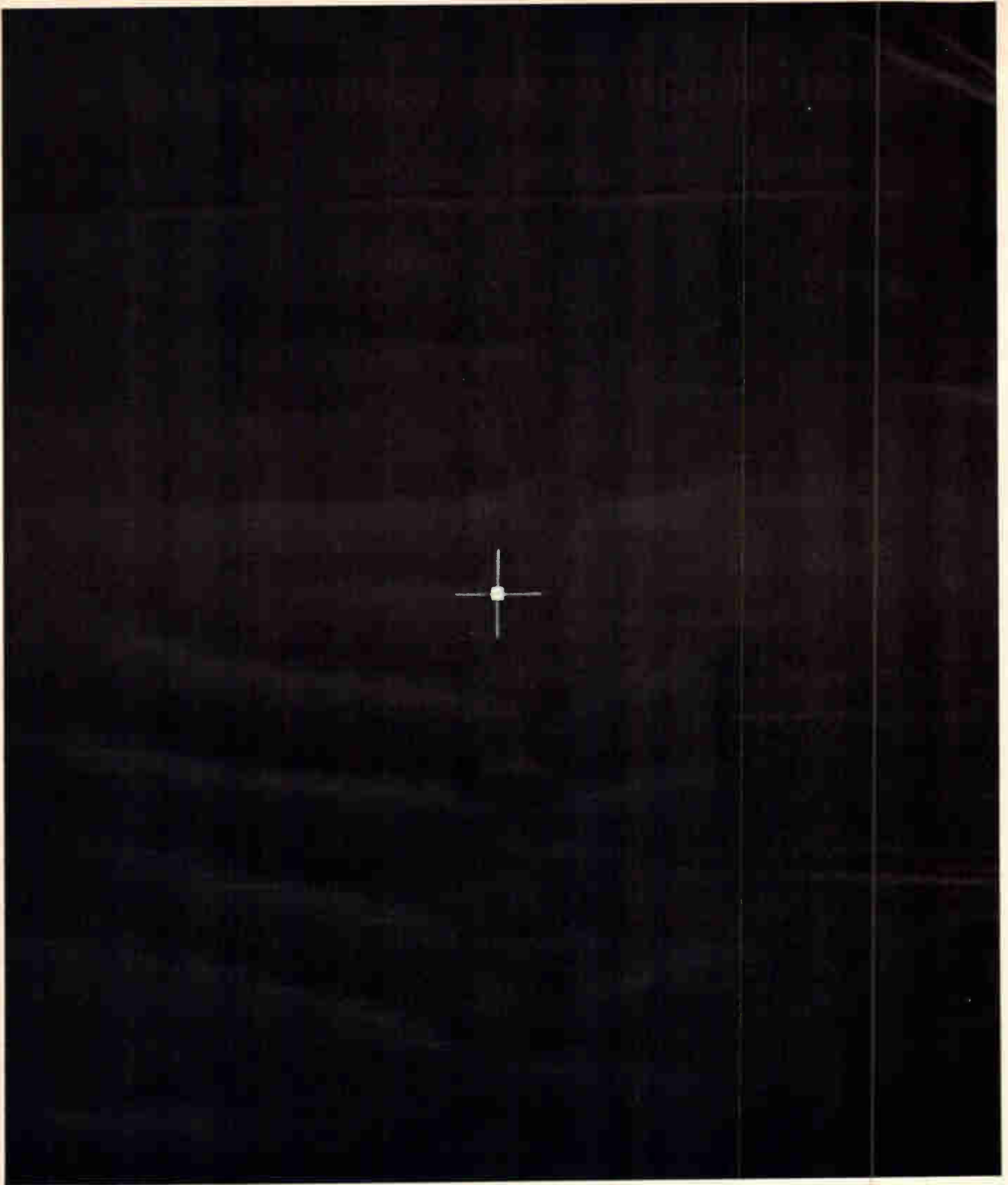
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Probing the News

Government

New standards of operation set for Bureau of Standards

Channeling technology to commerce will help the electronics industry; but lessened emphasis on research could hurt in the long run

By Warren Kornberg

Washington Bureau

The National Bureau of Standards is moving from the ivory tower to the marketplace and the shift is bound to affect the electronics industry.

Traditionally, the bureau has been among the world's best physics and measurements laboratories. But now there is a lot of pulling and tugging between those who think the bureau ought to concentrate on research as a backup to its measurement role, and those who believe its prime mission is the application of technology to realistic industrial problems.

"There's no reason," says Frederick Seitz, president of the National Academy of Sciences, speaking for the scientific community, "that the bureau can't do the other things it's being called on for, and still be an outstanding laboratory."

However, there still is a feeling that if the bureau lets itself get distracted too far from its job of updating the nation's measurement system and the basic physical science to support it, all of American science and industry will be hurt.

Primary role. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, denies that basic research—even as a backup for measurement—ever was the bureau's primary role. And his opinion counts: the bureau reports to him.

"If you look at the history," he



J. Herbert Hollomon says the bureau is 'hipped on being a national physics lab.'

says, "you'll find that the bureau was founded 65 years ago to serve the needs of the economy."

Bureau director, Allen V. Astin, also denies that basic research—once the bureau's strongest arm—has suffered because of the new industry-oriented emphasis.

But research for research's sake, that is, without a definite application in view, is on the way out while Hollomon holds the reins.

Under Hollomon the fastest growing activity of the bureau over the next five years will be the transfer of standards and measurement technology to industry.

He believes the bureau's research capability was vital before the scientific explosion of the past decade. It developed the first guided missile and printed circuits during World War II. But now Hollomon says there are other good sources of first-rate research and the bureau ought to concentrate on measurement technology and channel it to commerce.

For example, Hollomon has serious doubts about the need for a 100-million-volt electron accelerator being installed at the bureau's new \$117 million facility at Gaithersburg, Maryland. The machine is being justified publicly on the grounds that it serves the growing needs of the radiation industry for dosimetry metrology. There is a strong hint, however, that the accelerator is aimed primarily at attracting the physicists the bureau has always needed. Such men are reluctant to go where facilities are not the best.

"They got hipped on being a national physics laboratory," Hollomon says of the bureau. "I've been trying for a couple of years now to help them find out what their job really is."

Hollomon's reorientation policy is evidenced by the recent reor-

ganization of the bureau into three institutes. The Institute for Applied Technology takes over the old engineering standards work. It has responsibility for the computer standards effort, standards for buildings, electronic devices and for tires, seat belts and perhaps later, auto safety.

The Institute for Materials Research assumes the old chemistry and metallurgy functions, providing standard reference materials to industry so that production materials can be precisely identified and written into specifications and reliability testing programs.

The Institute for Basic Standards performs the basic function—refining standards of time, mass, length, temperature and the derived radiation, electrical and other national standards.

A warning. In 1953 and again in 1960, studies by the National Academy of Sciences warned that outside influences were distracting the bureau from its primary role. The studies claimed a "measurement gap" was being created.

"Sure there's a measurement gap," says R. D. Huntoon, director of the bureau's Institute for Basic Standards. "It's somewhat closed, but the explosive growth of technology puts far more demands on us than we can cope with."

But whether the bureau can remain a step ahead of the latest demands of modern industry for metrology, as it has in the past, remains problematic.

Huntoon explains: "Before World War II, we were able to stay ahead of industry. But that's not always the case now. We can't do everything."

I. Assets and liabilities

The electronics industry may feel the pinch of Hollomon's decision to take the accent off research, but it will profit from the bureau's helping hand to industry.

The bureau has fallen behind in some areas. Industry demands for techniques of microcircuit measurement and evaluation are only beginning to be answered. Measurement of semiconductor purity, failure prediction and quality control lags far behind the need. Time standards, refined to accuracies of a second in 30,000 years, still trail



Richard Zipin of the Sheffield Corp. is one of many research associates from industry who work at the National Bureau of Standards. Here, Zipin adjusts a laser used in making interferometric measurements of length.

the needs of the space program. The demands of space and military technology for thrust gauges in the million-pound range are just now being satisfied after a delay of several years. But the need is still outrunning the capability.

However, it would be false to say that NBS has dropped back in all areas. In application of lasers to measurement problems it is in the lead, as it is in materials research, radiation standards and a large number of other areas.

A question of money. An effort is being made to rid the bureau of some of the routine chores it has been saddled with. Hollomon is driving the Computer Research Center out of the hardware business so it can concentrate on standards. The Institute of Applied Technology is getting out of the instrument development business and leaving the job to industry. Huntoon, at Basic Standards, is considering a proposal to certify industry and association laboratories to take over some of the routine calibration work traditionally performed by the bureau.

Seitz adds that these small steps will help, but probably will not be enough. "But the bureau needs more money," he says. This is something Congress appears unwilling to provide.

The bureau will serve industry

through such programs as the Standard Reference Data System (SRDS). It has resumed inviting company engineers to serve as research associates. Another service will be to goad industry into greater effort. Such an approach is the new performance concept where, for example, the accent is placed on what a computer ought to do, rather than on what a computer ought to be. This would leave it up to industry to find the techniques to meet computer standards.

Under the SRDS, information specialists review the measurements, materials properties and other numbers put out by scientists and engineers throughout the world. Good numbers are then circulated by SRDS to the engineers and scientists who need them; questionable numbers are reestablished through contract research.

II. Research associates

The bureau will write performance standards for 30% of the nation's computer market—the Federal government's share. Major computer manufacturers are already negotiating with bureau officials to assign researchers to the Computer Research Center where the standards will take shape and probably set the guidelines for all customers.

Eglin radar nears completion

Replacement is better than original which was destroyed by fire, but no one knows who will have to pay the bill

Robert Stern, director of the bureau's Office of Industrial Service says: "I wouldn't be surprised if we have as many research associates from the industry as we do bureau people on the project."

The electronics industry is taking advantage of the revived Research Associates Program. The associates are industry researchers, on company payrolls, who work at the bureau for a year or two.

Richard Zipin is completing a year's assignment as an associate from the Sheffield Corp., instrumentation division of the Bendix Corp. He did research on the application of lasers to metrology.

"We just didn't know anything about this area," says Zipin. "Lasers work better on long distance measurements than any other light sources; I came here to learn the technology and bring it back."

Zipin won't say his study provides the base for a new laser section at Sheffield, "but at least now we'll know enough to talk about it."

Not ready yet. J.C. French, of the bureau's Electron Devices section, says, "We're not quite ready yet. When you invite people in, you want to have something to offer them. We're not far enough along yet." To make an associate-ship attractive, the bureau must be able to offer frontier opportunities, as it can in laser metrology and is planning to offer in computer standards.

French feels his section has made significant contributions to the technology of solid state materials—especially silicon and germanium. "These are materials industry has spent a lot to develop," he says, "but industry still doesn't know enough."

French's boss, Charles Marsden, adds, "Industry could do the research, but it won't. It's uneconomical, as long as industry can live with what it has."

The bureau contributed to the theory of second breakdown failure in semiconductors—that it involves nonuniformities in current caused by perturbation or small inhomogeneities which create temperature problems. These contributions are being incorporated into industry's rating systems, although the breakdown triggering mechanisms are still not fully understood.

As the finishing touches go on the new 13-story radar that has risen from the ashes of one that burned to the ground 18 months ago at Eglin Air Force Base, Fla. [Electronics, Jan. 25, 1965, p. 101], no one knows who is going to pay for it.

The Bendix Radio Systems division of the Bendix Corp., which has been prime contractor for both the AN/FPS-85 radars, had almost finished the original \$30-million, missile and satellite detection sensor when on Jan. 5, 1965 it lit up the north Florida skies. Now, with the replacement almost finished, the "owner" of the first one is still in dispute. If, as the Air Force contends, Bendix was still in legal possession of the radar when it burned, the firm and its insurance company must bear the loss.

The Air Force points out that the loss doesn't amount to the entire \$30 million, since the contract called for engineering data as well as hardware, and only the hardware was destroyed.

How much this amounts to and how much insurance Bendix had—some say it was between \$10 million and \$15 million—isn't known.

Decision due. The final decision on who must pay the bill rests now with the Board of Contract Appeals in the Pentagon, a quasi-judicial group that was set up to wrestle with contractor-government disputes. According to the board a ruling will be made "in a matter of weeks."

Despite the delay—the radar will be operational three years after the Air Force's original target date—the FPS-85 will still be the first long-range, large aperture array radar in the operational inventory of the United States, and perhaps the world. Opinion is divided on whether or not the Soviet Union has such a system.

The new version will be better than its predecessor. Before the fire, the Air Force had planned to modify the radar gradually. And after the disaster, all the modifications were put into the new radar's design. The version that will be ready in November will handle more targets than the old one, its resolution will be better, and it will have greater protection against the possibility of fire.

More accurate measurement of doppler shift will enable the radar to distinguish between two targets moving at slightly different speeds, such as the Gemini spacecraft and its docking vehicle. And better resolution will be achieved by the use of pulse-compression techniques.

Redundant systems. For improved capacity, and reliability, redundancy has been designed into the computer and signal-processing subsystems.

The radar will be operated remotely by one computer interrogating another computer 1,000 miles away. A Philco 2000 at Colorado Springs will send surveillance instructions to an IBM 360 at the radar site. There will be three computers of the IBM 360 series there: two system computers for on-line and back-up functions, and a different model for compiling programs and other auxiliary tasks.

Other improvements make the radar site less vulnerable to fire. The new radar is compartmentalized with fire walls and equipped with automatic extinguishers.

When the original radar caught fire, there was no way of getting water from nearby wells because the power supply for pumping water—the same used to power the radar—was off. The new system has three 500-kilowatt, quick-start generators which can power the pumps independently of the radar power sources.

Almost everything is under control

Adaptive machine tool controls and learning system to detect oil impress control engineers at international meeting in London

By Derek Barlow
European Editor

The Third Congress of the International Federation of Automatic Control, in London, covered a wide range of newly developed control applications from throughout the world. From Russia and the United States came word of new adaptive machine tool control systems. From Great Britain came a new control design system. And from the oil fields of Russia came word of a learning system being used to detect petroleum.

Some 1,600 engineers from more than 30 nations attending the meeting heard more than 300 papers, with the U.S. and Russia giving the lion's share.

The Russians concentrated on design aspects of nonlinear and adaptive system control, but also revealed a brief description of one of the first practical applications of a learning system—a system the Russians are using with stored geo-physical data to test for oil.

The Russians claimed that in field tests the system has proved

more accurate than human interpretation of oil-bearing strata data, which is wrong about 15% to 20% of the time. In one test of 180 geo-physical layers, the Russians said, the learning machine only misidentified one. Apart from a few operating results, however, little information was given on the system, which was developed at the Institute of Automatics and Telemachics in Moscow.

I. Adaptive control

In machine tool control, two techniques using adaptive controls were described—one American and the other Russian. In one of the systems, developed at the Bendix Research Laboratories, a division of the Bendix Corp., input data is supplied by a tape reader to a numerically controlled milling machine which feeds dimension, speed and inertial position commands to the machine's control system. Position transducers, which operate in a primary feedback loop,

control the actual tool position while a separate adaptive loop monitors the cutting process by sensing the average temperature of the tool-tip, spindle torque and tool vibration.

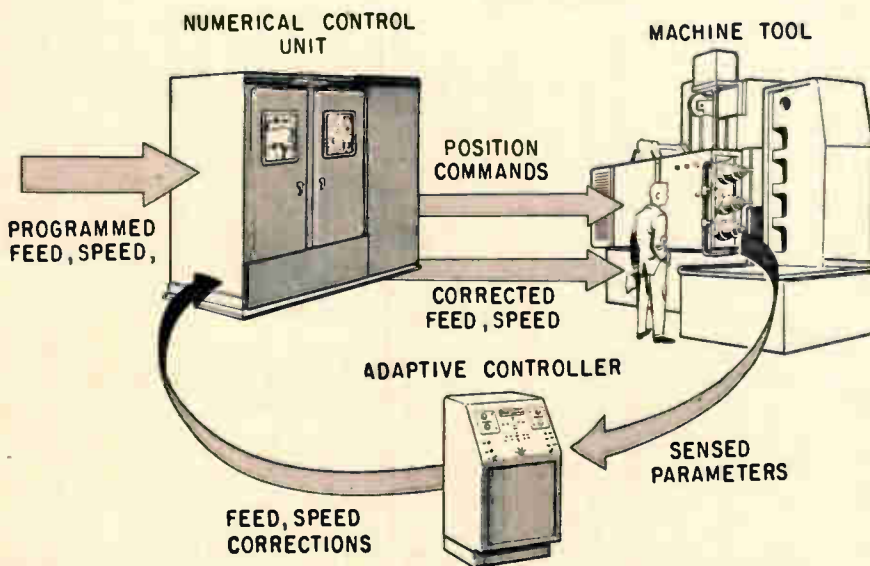
The data is continuously processed to provide a measurement of the productivity of the machining process and to make sure that the parameters stay within limits. Logic circuits provide speed and feed correction signals to give maximum productivity without exceeding any of the limits.

On test machinings, a prototype system cut costs between 5% and 50%, depending on the type of cuts made. The project was sponsored by the U.S. Air Force Materials Laboratory at Wright-Patterson Air Force Base.

The Russian system, used on a 4-spindle program-controlled milling machine for jet engine blades, was designed to eliminate inaccuracies caused by elastic movement of the workpiece. The program, known as Sapcons, measures the deformation of the material under loading conditions; and then modifies the cutter's control program to offset this deformation. The system uses an open-loop stepping-motor positioning system for the tool motion. A measuring sensor mounted close to the cutter detects the blade deformations.

At the conference a Japanese numerical control system using hybrid analog and digital techniques also attracted attention. The system, developed by the Institute of Industrial Science at the University of Tokyo, uses digital techniques for rough positioning, and analog measurements for the fine positions.

Threading a needle. The position detector is a carbon steel screw



with a 2-millimeter pitch rectangular thread operating with a pair of axially mounted detector coils. Rectangular copper wire is wound in two helical grooves of 1-mm pitch which are cut on the outer surface on each coil bobbin. The coils form one-half of an impedance bridge with impedance varying as the coils and the detector screw are moved relative to each other.

Coarse positioning is under control of a digital counter. When the tool is 2 mm away from zero the system shifts to analog operation. The remaining count, still held in the counter at this point, rotates the screw, changing the final null point by shifting the relative positions between the coils and the screw.

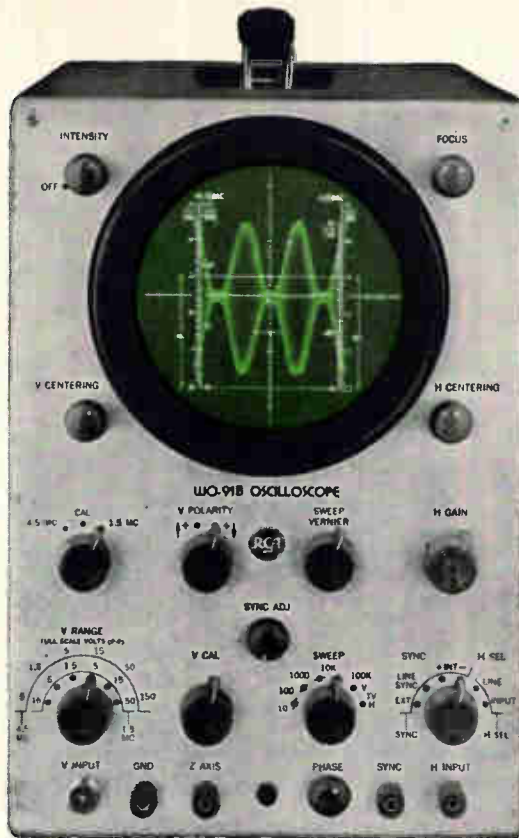
The main servo system follows the motion of the null point and moves to the final position.

II. Railroad computers

Two experimental systems in West Germany and France are using computer systems for direct control of railroad traffic. In the Germany State Railroad system a computer continuously monitors the spacing between trains; the maximum speed limit over a section of track is based on the speed, weight, and retardation characteristics of each train and its position relative to the train ahead. Pairs of line conductors, energized between 30 and 80 kilohertz and placed every 50 to 100 meters, provide position measurement.

The French system is being tried out on an overhead metro track at Chateaufneuf. A central computer tracks the position of each train and controls all the track switches and the train's speed and brakes. The speed is chosen by the computer by comparing the scheduled time with the actual time a train crosses block points. Instructions are sent to the train by an inductive carrier system along the track.

The papers presented at the meeting also covered the automatic design area. Rolls Royce Ltd. reported on a system in which two automatic control concepts—design automation and numerical control—were combined in a production system for producing compressor blades directly from the preliminary aerodynamic requirements. The system telescopes the design time from months to days.



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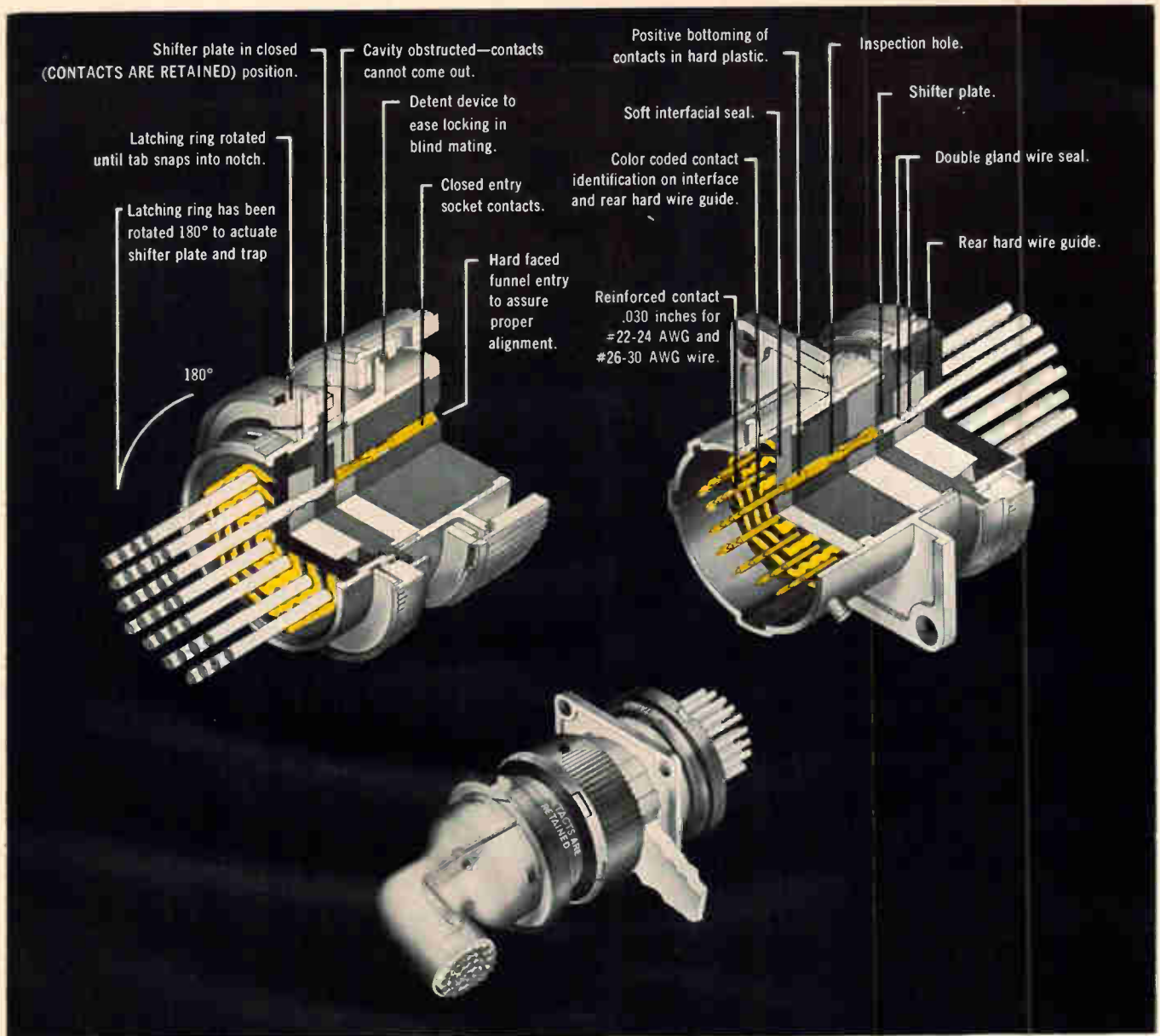
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Compatibility: a worldwide problem

Variety of digital pcm telephone systems being planned around the world will complicate direct dialing from one country to another

By Leonard Weller

Communications Editor

At the communications conference in Philadelphia, a vice president of AT&T completed the first international direct dial call. At the same time, panelists were warning that some agreement had to be reached on telephone systems of the future.

Most major countries are considering digital pulse-coded modulation systems, pcm, as the eventual replacement for the analog systems that are now used. However, in the more than 22 countries that have installed some pcm equipment or are developing it, there are many variations in important system characteristics that make them difficult to interconnect—such as bit rates, number of channels per frame, quantization steps and even synchronizing techniques.

Harry B. Law, a staff engineer at the British Post Office, which runs England's telephone system, claims, "About the only thing that everybody agrees on is that the sampling rate should be 8 kilohertz." This rate reproduces a good quality voice signal from digitally encoded samples.

Many problems. The potential problems with pcm systems were noted at a panel discussion at the Institute of Electrical and Electronic Engineers International Communications Conference in Philadelphia, June 15 to 17. The conference's theme was compatibility in world communications. However, it was apparent that opinions differed on the choice of the best pcm system and there was an indication that countries are designing pcm systems that meet the peculiarities of their own telephone networks.

During a conversation, one Brit-

ish engineer justified this type of telephone nationalism by saying, "It isn't necessarily the case that one pcm system is right and the other is wrong. It could be that our operating conditions are so different that both of us are right."

I. A choice of solutions

Ralph H. Franklin, a staff engineer at the British Post Office, speaking at a conference session, said incompatibilities can be resolved in two ways. "We can remove the cause by standardization, or we can overcome the defect by technical ingenuity." Franklin claimed that standardization was preferable but added, "Inevitably we have been forced to fall back on technical ingenuity."

High stakes. Law said, "In the area of pcm, there is a tremendous potential and amount of money locked up in local telephony." As a result, Law said, "Compatibility begins at home, right in the local market." In general, it was considered that a pcm system, which is a time division system, is cheaper than the frequency division multiplex equipment that exists in almost all national systems.

The company with the largest investment in pcm equipment is the American Telephone & Telegraph Co., which began introducing pcm equipment into its telephone network in 1962. Japan has an operational system similar to AT&T's, but there are differences in signaling techniques—busy signals and dial tones—and in the sampling procedure that would prevent direct interconnection. Britain is now testing three short pcm links for domestic use. Other countries that are studying pcm

include France, Italy and Sweden.

II. A hot debate over technique

In a spirited question and answer period, members of the British and AT&T groups staunchly defended the different methods they have adopted. The discussion was prompted by a paper on synchronizing a pcm system by John Mayo of AT&T's Bell Laboratories at Holmdel, N.J. Mayo discussed a technique similar to the one used in AT&T's pcm system—designated T-1—which eliminates the need for a master clock.

Asynchronous digital inputs representing voice or data are passed through a processor which stuffs pulses into the data stream to make the asynchronous bit rate equal to that needed by the multiplexer.

Law, of the British Post Office, objected to the pulse-stuffing technique because it wastes about 2% of the system's bit capacity. He also indicated that it would not necessarily be a suitable technique if it were passed through a switching exchange that operates with pcm signals. Such an exchange is being considered for the British system.

Mayo countered that pulse-stuffing was useful because it was good at interfacing low-speed and high-speed devices, and that it frees the sampling rates from the line rates so that the pulse-stuffing is divorced from the switching machine. The issue was not resolved, but the discussion ended shortly after Mayo pointed out that the various synchronization schemes could augment each other.

Calling Europe. The problem of interconnecting telephone systems that are not compatible was high-



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Calling Europe. The problem of interconnecting telephone systems that are not compatible was high-

lighted when Lowell W. Wingert, a vice president of AT&T's Long Line division placed the first publicly demonstrated direct dialed call to Europe. Wingert said the simple differences in the way the dials are lettered in various countries represents a problem for a direct dial international system. For example, in England the number and letter "O" are at the same position. As a result, a person in London who wishes to call at MOtt exchange in New York would dial the letters corresponding to the numbers 60; in the United States, however, MO corresponds to 66. To prevent a wrong number, ter-

minal equipment must convert the dialed number 60 to 66.

In addition, there is the need to transmit such things as busy signals that are compatible with the other nations' equipment. Furthermore, because European and U. S. telephone numbers vary in the number of digits, the switching equipment must also be able to accept different length dialed numbers. These problems would also exist in a pcm system, and in addition, because the voice signals are in digital form, it would be necessary to process the digital data to make it compatible with other nations' systems.

System rejects heavy noise, finds signal

An adaptive pattern-recognition system is making possible a signal interceptor that can strain from heavy noise an unknown and irregular radio signal. At Sylvania Electric Products, Inc., a mathematical model showed the system could pick out a correct signal from a signal-to-noise ratio of -23 decibels with a probability of $1 - 10^{-5}$.

Work on the technique was described by S. C. Fralick and G. L. Slenkovic of Sylvania at the conference. Sylvania is a division of the General Telephone & Electronics Corp. The engineers, working at Sylvania laboratories in Mountain View, Calif., set as their goal devising a system that could pick a signal from a wide band even when the signal lasts only a few milliseconds and is sporadic.

They rejected the use of simple filters with narrow or wide bandwidths. Those with narrow bandwidths could isolate the frequency with relatively few encounters, but it would take too long to build up an effective number of encounters. The wide bandwidth filters sweep faster, but noise generates false alarms.

Less noise. To get a fast sweep, the engineers chose a wideband filter. To minimize the noise, they added an adaptive system.

The adaptive system, whose characteristics are classified by the Defense Department, effected a remarkable capability. The false alarm rate—at first high because the system responded equally to noise and signal—began to fall off. The system had learned to reject the noise and zero in on the signal.

On a mathematical model, the engineers found the design should achieve satisfactory results with a noise level 200 times greater than the signal level. However, the hardware they built has not yet achieved those results. The receiver was selective to a level of 0.9 with a signal-to-noise ratio of -6 db. Its operation was limited by internal noise. Development is continuing.

Improved Autovon and Autodin for military communications

Installation of the two worldwide automatic communications networks is progressing at a fast clip, Brig. Gen. James H. Weiner, Chief of Staff, Defense Communications Agency, told the conference. The systems are Autovon for voice, which will use automatic electronic switches and provide direct distant dialing between U.S. military forces throughout the world, and Autodin for teletypewriter and data traffic.

Autovon will have special features such as multiple level preemption, off-hook and abbreviated dialing, preset conferencing and automatic alternate routing. Autodin will use highspeed transmission, code and speed conversion to meet individual user requirements, multilevel precedence and automatic error detection and correction.

Both networks will be fully automatic, using computers to replace the human operators in existing manual and semiautomatic, electromechanical systems. Installation will be completed by 1970, and independent telephone companies are getting in on the construction of the centers where American Telephone & Telegraph Co. isn't entrenched.

The Defense Communications System already is a gigantic network with long lines of 33,000 circuits, composed of over 138,000 channels.

A number of new features in the system were described by R.A. Walsh of Bell Telephone Laboratory.

- **Multilevel preemption.** Five levels of precedence have been determined, with signals that permit a message with higher precedence to break into one of less importance.

- **Precedence in dialing.** All high priority calls originating at a switching center are still handled by an attendant. At the addressee, however, they are switched automatically. There is a helpful, human safety valve, however; if the call is not answered in a specified time, the attendant will be signaled.

- **Precise tones.** The new features for Autovon require unique and uniform information signals for ringing and tone indication to the person doing the calling. Precise tone generators supply dial tone, audible ring, preempt notification tone, line busy, and overflow.

- **Maintenance facilities.** All 4-wire, No. 5 crossbar offices are equipped with a master test frame, an automatic monitor, register and sender test circuit, a toll testboard, and ultimately will have an automatic progression trunk test frame with an automatic transmission measuring system. In addition, standard portable units, such as a frequency counter, and test meters will be available for test measurements.

Cost seen prohibitive for Tacsat

Military communications satellite systems for strategic point-to-point distances received a welcome boost June 16 with the successful launching of the first eight satellites of an interim system, but one scientist doubts that a tactical military system, Tacsat, will follow soon.

R.D. Davis, senior scientist for System Sciences Corp., Falls Church, Va., and a panelist at the conference, cited a number of reasons why such a system would not meet Defense Secretary Robert S. McNamara's cost effectiveness standards—the measuring stick that is intended to determine whether the cost of a system will pay for itself in effective defense.


Power versus cost. The power requirements, Davis argued, for a satellite large enough to transmit to a large number of ground terminals with small antennas would increase the satellite's cost prohibitively.

He said the fact that smaller and less expensive terminals would be used would not save money since more terminals would be needed.

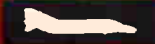

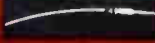


The terminals must also be of advanced design. Unlike many of the ground terminals for the commercial satellite systems, which lock on stationary satellites in synchronous orbits; the tactical ground terminals will have to swing with the satellites as they pass within range. Because of the sophistication required for a ground station to track a fast-moving satellite, the military is still considering a synchronous rather than a medium-altitude system for tactical use.

A moving target. One point in favor of a random system is that it's more difficult for an enemy to knock down. A stationary synchronous satellite—though higher—would still be easier to destroy.

Another pesky problem for all communications satellite developers—particularly military system developers—is multiple access. The military system will have more terminals, including mobile and shipboard compounding the problem.



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-  about antennas for missiles?
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Electronics firms make good at converting ships

Prime contracts for outfitting missile-range ships with complex electronic systems now go to electronics firms instead of shipbuilders

Electronics companies have done well in handling the job of converting five Navy ships to floating instrument stations to track and command the manned Apollo spacecraft on its trip to the moon. So well, in fact, that an important precedent has been set.

Traditionally, shipbuilders have been the prime contractors for converting ships, and electronics firms served as subcontractors and suppliers. But with more and more instrumentation going on these ships, the balance has changed. "When 50% or more of the conversion work involves electronics, prime contractors will more than likely be electronics companies,"

says Capt. Alex. F. Hancock, head of the Instrumentation Ships Project Office for the Bureau of Naval Material.

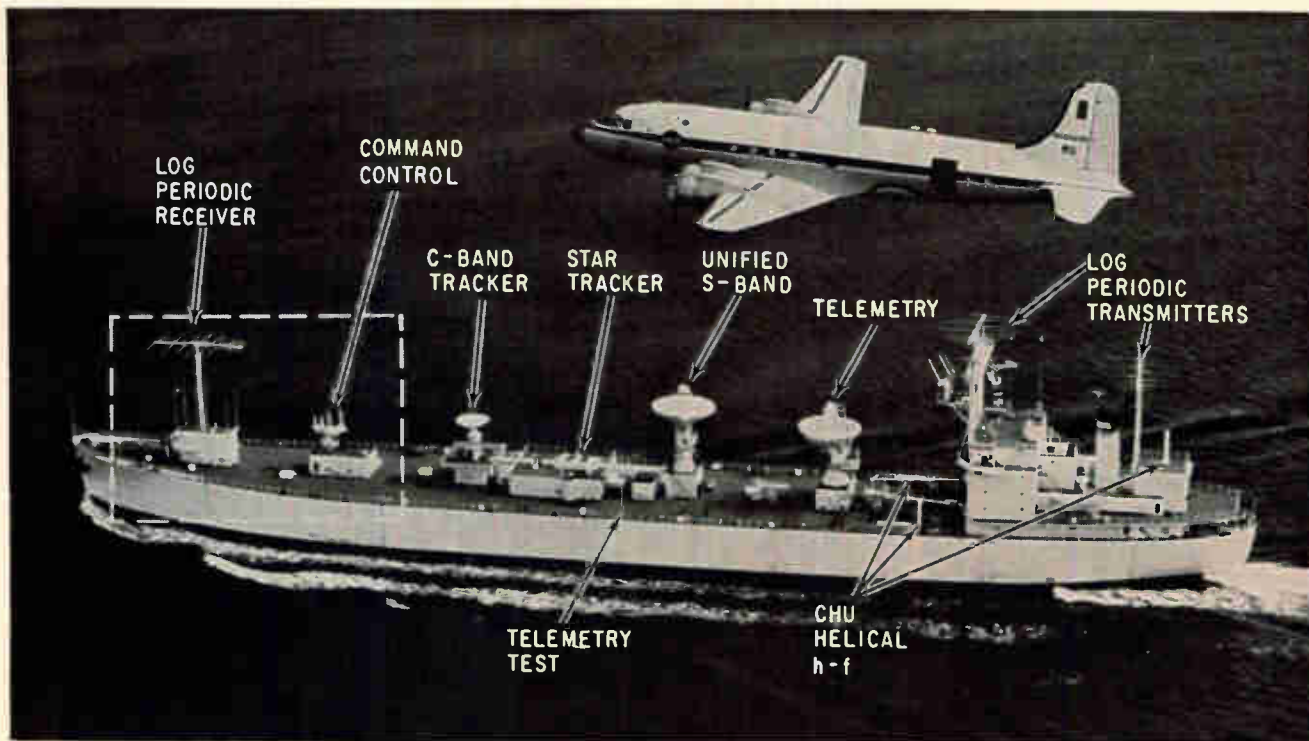
The Apollo Instrumentation Ships Program (AIS) involves lengthening, widening and other changes plus installation of 445 tons of electronic equipment on each ship. Estimated cost of the program is \$175 million.

I. Prime contractors

The first of the five converted ships, the USNS Vanguard, will be delivered to the Air Force next week to begin calibration and compatibility tests at Port Canaveral, Fla.

General Dynamics Corp.'s Electronics division of Rochester, N. Y., is prime contractor for three of the ships—the Vanguard, the USNS Redstone and USNS Mercury. These three converted tankers will have a command and control role. The Range Systems division of Ling-Temco-Vought, Inc., is converting two former victory ships, the USNS Watertown and the USNS Huntsville, which will play a role in reentry. The basic systems on both command and reentry ships are similar, but are tailored to fit their particular functions.

The ships will be manned by civilian crews of the Navy's Military Sea Transport Service. The



Aircraft equipped with all the transmitters carried by the Apollo spacecraft will fly back and forth over the USNS Vanguard tracking ship to calibrate its instrumentation. To tie in with communications satellite, the two small deck houses (inside the dotted rectangle) will be replaced by one large house. The log periodic receiver will be eliminated and its function taken over by one of the log periodic transmitters. The command control will be moved forward and a Satcom antenna installed.

First test for Vanguard in October

Air Force will operate the instrumentation systems, with technical assistance from the National Aeronautics and Space Administration.

The ships form part of a vast communications network which also includes land stations and airplanes. Hancock explains that the ships will perform communications and tracking in areas not covered by land stations.

The Vanguard will send a command to inject the spacecraft into earth orbit; the Redstone and Mercury will insert it into a lunar trajectory, and the Watertown and Huntsville will handle reentry. Vanguard gets its first real workout in October when an unmanned Apollo spacecraft is rocketed into earth orbit.

Four other divisions and a subsidiary of General Dynamics combined to supply the engineering, construction and testing personnel for both the ships and instrumentation systems. Their work includes production of the 30-foot telemetry antennas, developing programs for the central data processing computer, and making communication switchboards, intercommunication and dial telephone equipment.

Government issue. The government furnished General Dynamics with the other subsystems. The Radio Corp. of America built the C-band radar; the Raytheon Co., fashioned the mission control system; the Sperry Gyroscope Co., a division of Sperry Rand Corp., produced the major portion of the navigation systems, and Collins Radio Co., Reeves Instrument Co., Motorola, Inc., and Jet Propulsion Laboratory constructed the unified S-band system.

II. Subsystems

General Dynamics' three instrumentation ships will be equipped with 12 subsystems. In addition to a terminal for communication via the Apollo satellite network, the ships will carry the unified S-band tracking unit, the C-band tracking radar, equipment for ship position and attitude measurement (SPAM), telemetry, communications, acquisition and stabilization, timing, central data processing, command control, operations control and

mission control.

Ling-Temco-Vought's ships will have 11 subsystems. The C-band radar was developed by RCA; the unified S-band system by Collins, Reeves Instrument, Motorola and JPL, and the SPAM system by Perkin-Elmer Corp. and Sperry Gyroscope. Ling-Temco built the acquisition and stabilization network and radiation-hazard warning system. Radio communications were produced by RCA, Ling-Temco and instrumentation communications by Mectron Co., Inc., and Collins. The timing system was made by Metric Corp., the operations control center by Milgo Corp., Metric Corp., and Ling-Temco. Fischbach and Moore Co. was responsible for designing the telemetry system.

The first ship to become operational, the USNS Vanguard, will lack the satellite communications terminal being installed on the other ships. Conversion of the Vanguard was too far advanced in January when the decision was made to include a satellite system in the Apollo complex. The Satcom gear will be added later.

Tracking. The unified S-band system provides the capability to track range, range-rate and angle, and to communicate with two spacecrafts simultaneously. Only one spacecraft at a time can be tracked by the Vanguard. Again, due to Vanguard's being first the ship missed out on later design changes. When it goes out to sea, it will only have a single link system. This may be modified later.

Voice digital commands and ranging signals are sent from the ground to the spacecraft by means of the S-band link. From the spacecraft to the ground more data is relayed: voice, telemetry, television, biomedical data, ranging, emergency voice and emergency key (Morse code).

Telemetry, television and biomedical data sent from the spacecraft to the ground is routed to the telemetry system video patch bays where it can be fed into the pulse code modulated decommutation system for display in the mission control center. Or the data can be recorded.

Downlink emergency voice and emergency key are connected directly with existing communication interphone circuits for distribution to mission operators.

The acquisition antenna of the unified S-band is three feet in diameter, mounted on the periphery of a 30-foot antenna. Beamwidth is 10°. Maximum unambiguous range is 500,000 statute miles—more than twice the distance from the earth to the moon.

Old reliable. The C-band tracking radar is the old missile range reliable, the AN/FPS-16, modified for shipboard use. The modification consists of on-mount gyros and a hydrostatic bearing compensated for horizontal thrust components. Maximum range is 37,000 statute miles.

Accuracy of the tracking sensors is worthless if the ship's own position is not known. This problem is solved by a series of position determining instruments, each checking on the other, and a data processing computer.

III. Instrumentation

Instrumentation is made up of the ship's inertial navigation system, a star tracker, miniaturized data acquisition computer, bathymetric navigation subsystem, MK-19 gyrocompass, loran C navigation system, underwater log, consoles, displays and recorders.

The computer is a Univac 1230—a general-purpose, medium-scale, solid state, parallel, binary device. It has a 32,768-word, magnetic-core, random-access memory. The computer operates before, during and after the mission. Its jobs are numerous—ranging from ocean bottom surveys for the bathymetric navigation subsystem to calibrating and aligning various instrumentation systems in conjunction with balloon or aircraft tracking.

A big job. The job of communications is a big one. The ship communicates with range stations on land, ships and in aircraft. During mission support, the communication system provides the ship with mission status, updating operational directives, target acquisition data and vehicle command signals. The ship feeds the mission control center in Houston and other stations information relating to shipboard instrumentation status, tra-

jectory and telemetry data, voice relay from the spacecraft and transmission of reduced orbital data for target acquisition.

The ship's battery of communications include six high-frequency transmitters and 11 receivers—one receiver that covers the very low and low-frequency bands (15 to 1,600 kilohertz), four ultrahigh-frequency transceivers, two very high-frequency fixed transceivers and six transportable ones. There are a number of teletypewriter facilities and 37 special cryptographic devices.

Satellite terminal. Communications by satellite will be the primary mode of data transfer between ship and shore; this will replace the h-f system that is often unreliable because of atmospheric disturbances.


The satellite system provides for simultaneous transmission and reception of voice and data, patched via the communications and timing center, and relayed through the terminal transmitter system via the satellite and land terminals to the integrated mission control center in Houston. Voice and data are sent from Houston by the same route.

IV. Problems

Radio interference is a problem because so many transmitters and receivers are close to each other and to metallic objects that cause induction currents. These currents not only act as unwanted antennas but can be lethal to anyone who comes in contact with them. Because of so much radiation, nylon rope was strung along the sides of the ship instead of the usual chain railings

On the Vanguard, for example, the 10-kilowatt antennas interfere with the h-f equipment mounted on the bridge. Says Hancock: "If we move them forward they will interfere with the S band, and if we move them away from the S-band gear they interfere with the C-band radar."

No solution has been found, yet, and a decision won't be made on where to put all the gear until the ship is tested at sea. Tests are made by tracking NASA aircraft flying over the ship from horizon to horizon. The aircraft will carry beacons, telemetry transmitters and all the other equipment packed into the Apollo vehicle.



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and it's not etched!

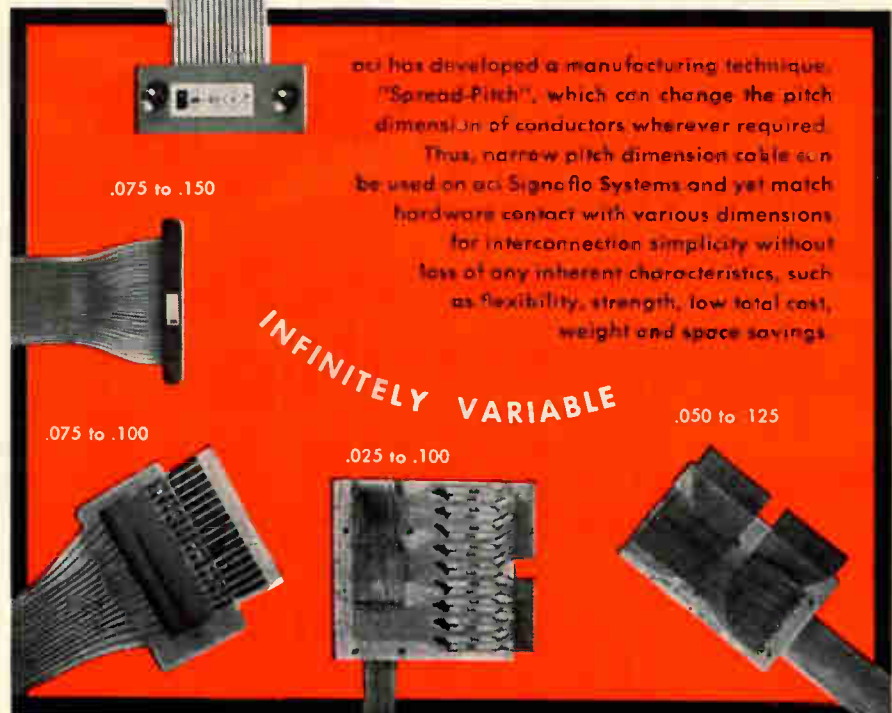
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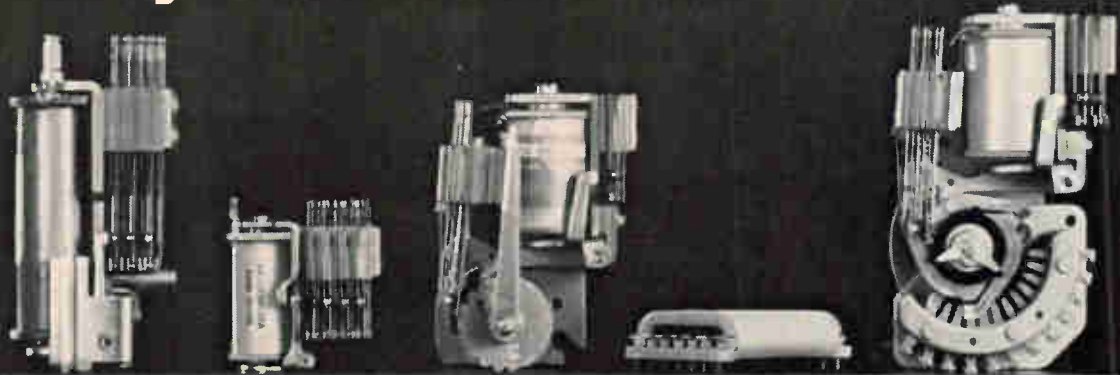


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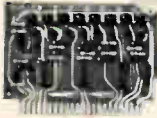
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WHEN DO YOU USE INTEGRATED CIRCUIT LOGIC MODULES?

by Don Tothe, Product Manager



So why design, bread-board, test, de-bug, procure, produce, test, de-bug—well, you know the story. That's why you buy your logic module boards pre-engineered and mass-produced from, we hope, Wyle.

But which type of logic cards do you choose: our new Integrated Circuit or our old-faithful Discrete Component boards? Although the IC uses silicon semiconductors while the discrete usually uses the less-expensive germanium, they both offer the high-level reliability that goes with all-solid-state circuitry. Ninety percent of all logic card applications can be satisfied by Wyle's in-stock modules, and either type can be used in a number of ways.

Which is best for you? If you're already using Discrete Component logic modules—ours, we trust—and you aren't having any problems, why change? The discrete is still your least expensive route. So as long as your functions are being performed satisfactorily, and if your sales are increasing, stay with discretely!



But other considerations may lead you to IC's now. For one thing, our 20 varieties of IC cards can be arranged to carry out most of the functions fulfilled by almost 100 standard discrete types. For another, if you're being pushed for space, or lower power requirements, or faster response time, or performance at 70°C, or want the added prestige of incorporating the most recent development into

your product—then the Integrated Circuit is your baby.

Maybe you can tell we're pretty excited about the new Wyle Integrated Circuit cards. The big point is that they're truly in the forefront of design. They incorporate the industry's design thinking you're becoming familiar with—plus some fresh thinking that, for instance, helps one board do the job for which you previously needed several. And Wyle will give you more engineering assistance than anyone else in the business.



There's quite an alphabet of uses for logic modules so while we're on the subject, let's review some of them.

Binary counting? We've got a 5-bit IC board for that.

Data storage? There's an IC card with eight parallel load storage flip-flops on it. For making data transfer easier, another eight flip-flop card has the required input gating on the same card.

Driving visual readouts? For instance, Nixies, incandescent lamps, neons, or inline projection type displays can all be driven by modules specifically designed for the purpose.

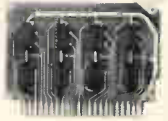
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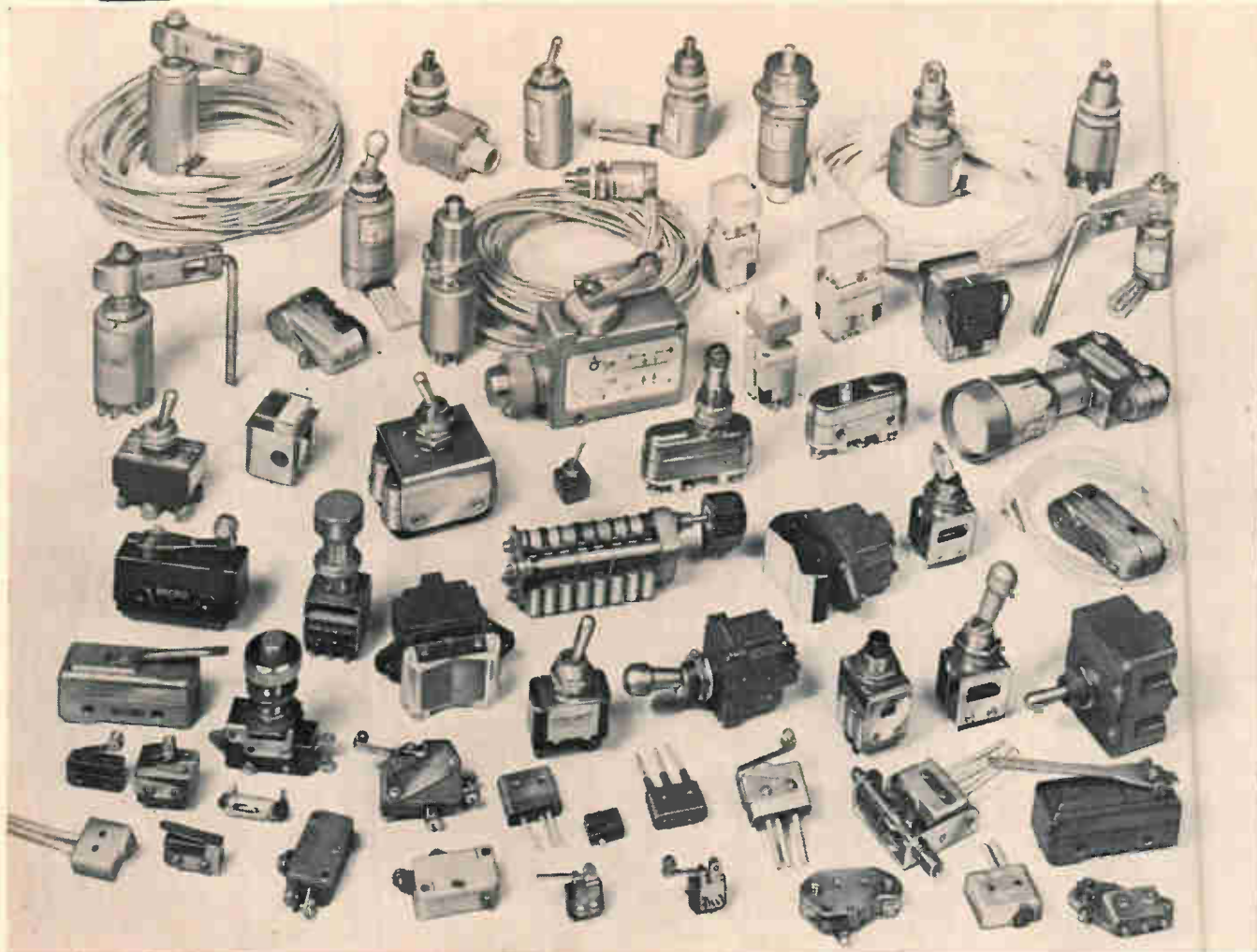
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Circle 145 on reader service card

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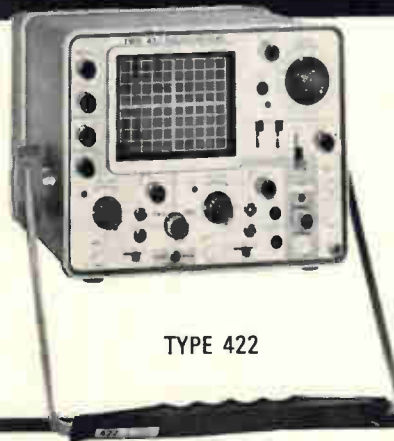
	<input type="checkbox"/> TYPE 453	<input type="checkbox"/> TYPE 422	<input type="checkbox"/> TYPE 321A
Bandwidth	DC-50 MHz	DC-15 MHz	DC-6 MHz
Deflection Factor	5 mV/div to 10 V/div	10 mV/div to 20 V/div	10 mV/div to 20 V/div
Channels	Dual	Dual	Single
Delay Line	Yes	Yes	No
Sweep Delay	Yes	No	No
Size	Height	7 $\frac{1}{4}$	7 $\frac{1}{8}$
	Width	12 $\frac{1}{2}$	10
	Depth	20 $\frac{1}{2}$	14
Weight (pounds)	28 $\frac{3}{4}$	22	14
Power Requirements	AC: 96-137 V or 192-274 V; 45-440 Hz; approx 100 watts.	AC: 115 V or 230 V \pm 10%; 45-440 Hz; approx. 40 watts. DC: 11.5-35 V; approx. 23 watts; accepts Tektronix 24 V battery pack.	AC: 115 V or 230 V \pm 10%; 45-800 Hz; approx. 20 watts. DC: 11.5-35 V; or 10 size D batteries; approx. 700 mA
Rack Mount Available	Yes (7" Rack Height)	Yes (7" Rack Height)	No
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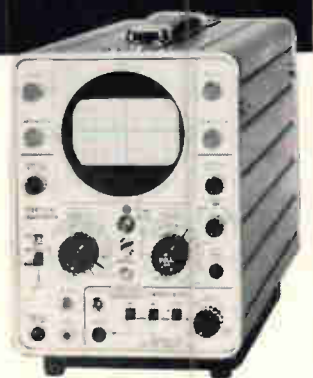
*without batteries



TYPE 453



TYPE 422



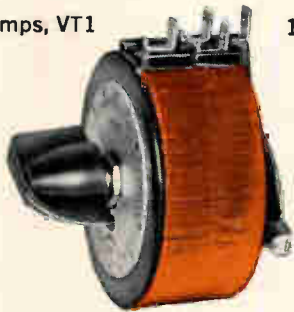
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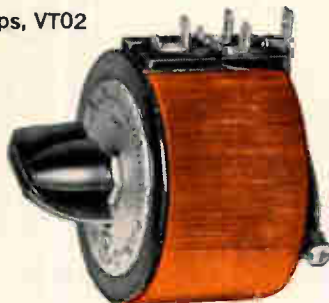
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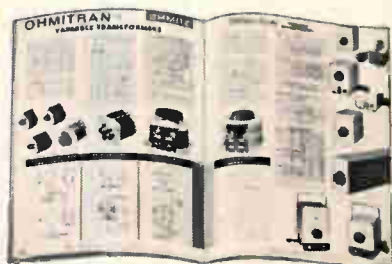
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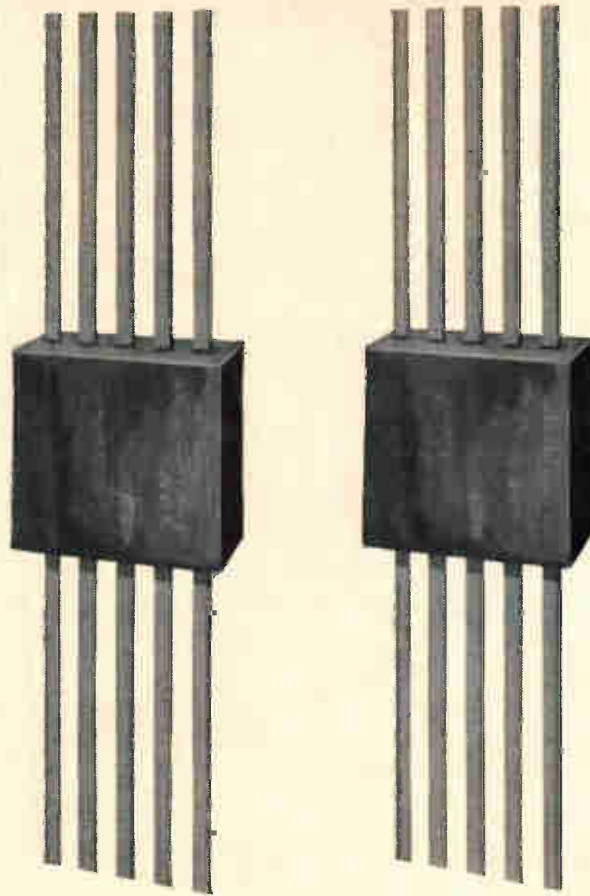
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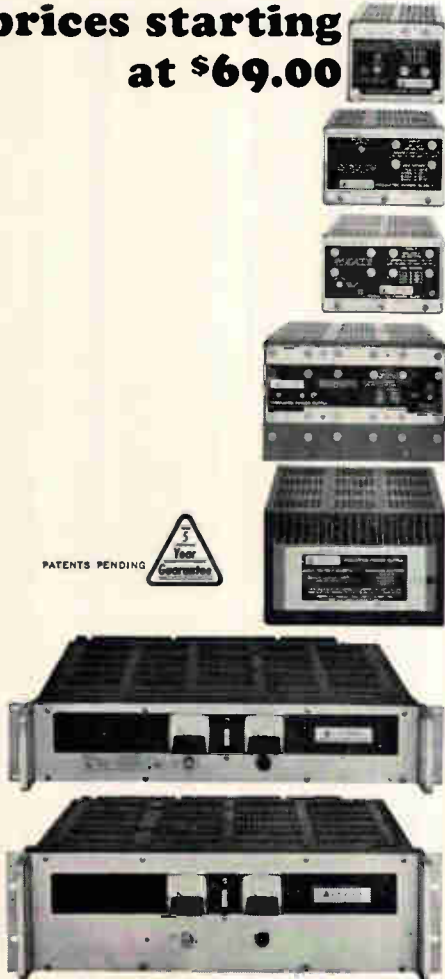
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LM 202	0-7	1.7	1.5	1.4	1.1	89
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LM 257	0-14	0.27	0.24	0.23	0.22	69
LM 203	0-14	0.45	0.40	0.38	0.28	79
LM 204	0-14	0.90	0.80	0.75	0.55	89
LM 258	0-14	1.2	1.1	1.0	0.80	99
LM 259	0-24	0.18	0.16	0.15	0.14	69
LM 260	0-24	0.35	0.30	0.25	0.20	79
LM 261	0-24	0.70	0.65	0.60	0.45	89
LM 262	0-24	0.80	0.75	0.70	0.60	99
LM 263	0-32	0.14	0.12	0.11	0.10	69
LM 205	0-32	0.25	0.23	0.20	0.15	79
LM 206	0-32	0.50	0.45	0.40	0.30	89
LM 264	0-32	0.66	0.60	0.50	0.32	99
LM 265	0-60	0.08	0.07	0.07	0.06	79
LM 207	0-60	0.13	0.12	0.11	0.08	89
LM 208	0-60	0.25	0.23	0.21	0.16	99
LM 266	0-60	0.35	0.31	0.28	0.25	109

Package E 4 1/16" x 7 1/2" x 11 1/2"

Accessory Metered Panels: \$40.00

Model	ADJ. VOLT. RANGE VDC	I MAX. AMPS ¹				Price
		40°C	50°C	60°C	71°C	
LME-0-7	0-7	12.0	10.5	8.5	6.8	\$249
LME-0-14	0-14	7.4	6.4	5.2	4.1	249
LME-0-32	0-32	3.7	3.2	2.6	2.1	249
LME-0-60	0-60	2.1	1.7	1.4	1.1	249

Package B 3 3/16" x 4 1/16" x 6 1/2"

Accessory Metered Panels: \$40.00

Model	ADJ. VOLT. RANGE VDC	I MAX. AMPS ¹				Price
		40°C	50°C	60°C	71°C	
LMB-0-7	0-7	2.8	2.6	2.3	1.5	\$109
LMB-0-14	0-14	1.6	1.5	1.3	1.2	109
LMB-0-32	0-32	0.80	0.70	0.60	0.5	109
LMB-0-60	0-60	0.45	0.40	0.35	0.3	109
LM-217	8.5-14	2.1	1.9	1.7	1.3	119
LM-218	13-23	1.5	1.3	1.2	1.0	119
LM-219	22-32	1.2	1.1	1.0	0.80	119
LM-220	30-60	0.70	0.65	0.60	0.45	129

Package F 3 1/2" x 19" x 16 1/2"

For metered models, add suffix (M) to model number and \$30.00 to the price below.

Model	ADJ. VOLT. RANGE VDC	I MAX. AMPS ¹				Price
		40°C	50°C	60°C	71°C	
LMF-0-7	0-7	25.0	21.0	17.0	14.0	\$425

Package C 3 3/16" x 4 1/16" x 9 1/2"

Accessory Metered Panels: \$40.00

Model	ADJ. VOLT. RANGE VDC	I MAX. AMPS ¹				Price
		40°C	50°C	60°C	71°C	
LM-225	0-7	4.0	3.6	3.0	2.4	\$139
LMC-0-14	0-14	2.2	2.0	1.8	1.5	139
LMC-0-32	0-32	1.1	1.0	0.90	0.80	139
LMC-0-60	0-60	0.60	0.55	0.50	0.45	139
LM-226	8.5-14	3.3	3.0	2.5	2.0	139
LM-227	13-23	2.3	2.1	1.7	1.4	139
LM-228	22-32	2.0	1.8	1.5	1.2	139
LM-229	30-60	1.1	1.0	0.80	0.60	149

Package G 5 1/4" x 19" x 16 1/2"

For metered models, add suffix (M) to model number and \$30.00 to the price below.

Model	ADJ. VOLT. RANGE VDC	I MAX. AMPS ¹				Price
		40°C	50°C	60°C	71°C	
LMG-0-7	0-7	35.0	29.0	24.0	20.0	\$575

Package D 4 1/16" x 7 1/2" x 9 1/2"

Accessory Metered Panels: \$40.00

Model	ADJ. VOLT. RANGE VDC	I MAX. AMPS ¹				Price
		40°C	50°C	60°C	71°C	
LM-234	0-7	8.3	7.3	6.5	5.5	\$199
LMD-0-14	0-14	4.9	4.2	3.4	2.7	199
LMD-0-32	0-32	2.5	2.1	1.7	1.3	180
LMD-0-60	0-60	1.3	1.1	0.95	0.75	239
LM-235	8.5-14	7.7	6.8	6.0	4.8	199
LM-236	13-23	5.8	5.1	4.5	3.6	209
LM-237	22-32	5.0	4.4	3.9	3.1	219
LM-238	30-60	2.6	2.3	2.0	1.6	239

¹ Current rating is from zero to I max. Current rating applies over entire output voltage range. Current rating applies for input voltage 105-132 VAC 55-65 cps. * For operation at 45-55 cps derate current rating 10%. * For operation at 360-440 cps consult factory for ratings and specifications. * ² Prices F.O.B. Factory, Melville, N. Y. All specifications and prices subject to change without notice.

Features and Data Meet Mil. Environment Specs. RFI—MIL-I-16910; Vibration: MIL-T-4807A; Shock: MIL-E-4970A • Proc. 1 & 2; Humidity: MIL-STD-810 • Meth. 507: / Temp. Shock: MIL-E-5272C • (ASG) Proc. 1; Altitude: MIL-E-4970A • (ASG) Proc. 1; Marking: MIL-STD-130; Quality: MIL-Q-9858.

Convection cooled—no heat sinking or forced air required

Wide input voltage and frequency range—105-132 VAC, (200-250 VAC, optional at no extra charge) 45-440 cps

Regulation (line) 0.05% plus 4MV (load) 0.03% plus 3MV; Ripple and Noise—1 MV rms, 3MV p to p

Temp. Coef.—0.03%/°C

RACK ADAPTERS

LRA-3

LRA-3—5 1/4" height by 2 7/8" depth. Price \$35.00

LRA-4—3 1/2" height by 14" depth. (For use with chassis slides) Price \$55.00

LRA-6—5 1/4" height by 14" depth. (For use with chassis slides) Price \$60.00



LRA-5—3 1/2" height by 2 7/8" depth. Price \$35.00

SEND FOR NEW CATALOG ON FIXED VOLTAGE AND WIDE RANGE MODULAR POWER SUPPLIES



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516 BROAD HOLLOW ROAD • MELVILLE, L. I., NEW YORK • 516 MYRTLE 4-4200

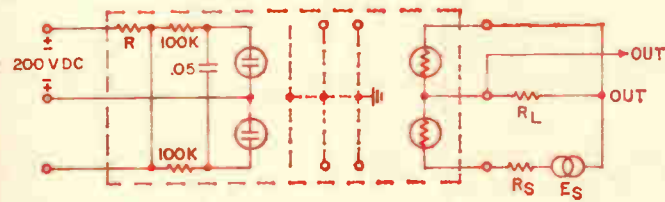
IS A PHOTO-CHOPPER BETTER?

PART NINE of a series on the state of the chopper art

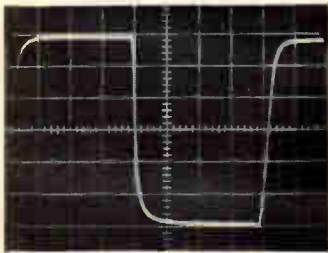
Maybe. Us engineer types never get a decent clear cut decision. Still, if the Old Man said don't use them damn choppers maybe you'd better go photo-chopper. If you just ignore the neon bulbs you could say all solid state and get away with it.

It's like this. You'll get 1500 to 2500 ohms conducting resistance if you leave the neon lamp on. If you switch it at 60 cycles you get maybe 20 K. Dark resistance gets pretty good, about 10^9 .

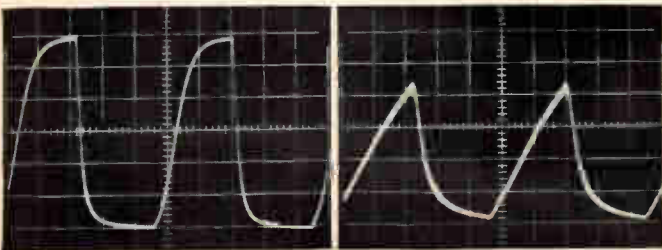
The response time is not so hot. The flaw is turn-off time. The cells turn on quick and off slow. You use two, which helps, one in series with the load, one in shunt.



Type 5514 in a modulator circuit



Output waveform
60 cycle square wave drive



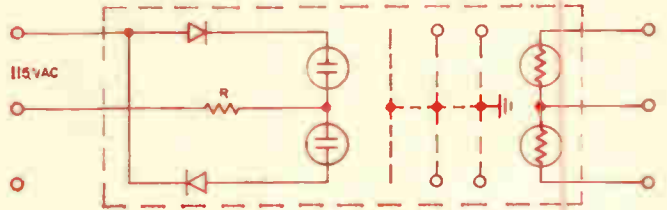
Output waveform
400 cycle square wave drive

Output waveform
1000 cycle square wave drive

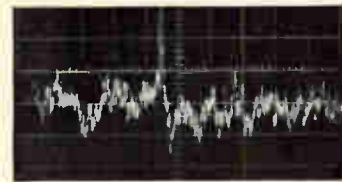
You really need a square wave drive for best performance. Or you can supply DC at about 200 volts and get the neon bulbs to operate as relaxation oscillators. That's Airpax part 5514. The chopping rate will vary directly as the DC voltage.

So — sorry about that. It's still your headache. The life seems pretty good, we dunno how good yet, but it's probably up to the neon bulb if the photo-resistors are any good.

We will cheerfully sell you a couple thousand.

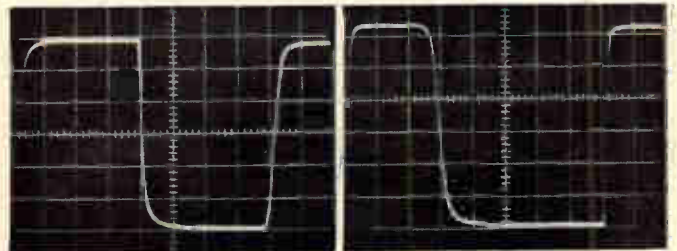
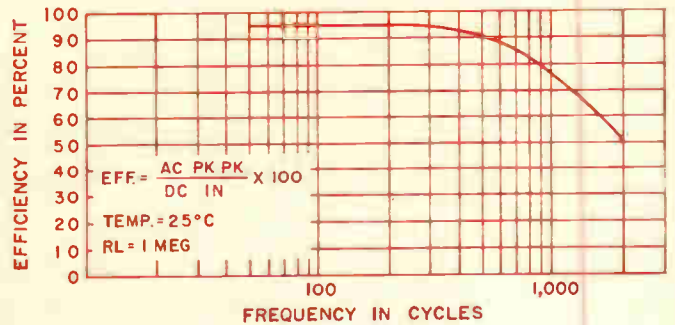


Internal schematic of AC Drive Type 5510
60 to 400 cps. R = Limiting resistor.



3 microvolt RMS, 50 microvolt
peak noise across 1 megohm.

PEAK EFFICIENCY VS. FREQUENCY



60 cps square wave drive
showing maximum efficiency.

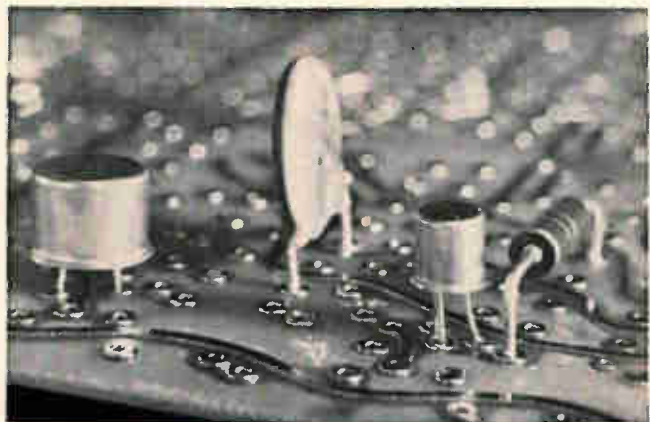
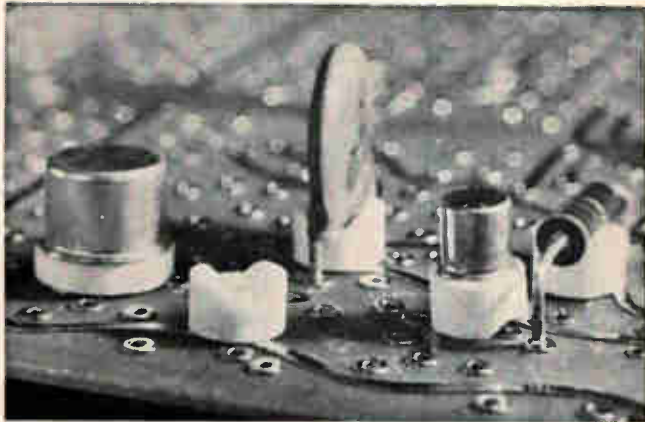
60 cps sine wave drive
showing reduced time efficiency.

AIRPAX ELECTRONICS incorporated CAMBRIDGE DIVISION, Cambridge, Maryland

Phone: 301 228-4600 • TWX: 301-228-3558 • TELEX: 8-7715

Penny candy helps produce circuits

Standoff pads for components of printed circuit assemblies are made with sugar so they rinse away after the circuit is soldered



Now you see them, now you don't. The spacers which raise transistors off the board are notched so they can also be used upside down as pads for axial-lead components and resistors, left. After the pads have buffered the components from the heat of machine soldering, the board is rinsed in warm water, dissolving the pads.

The sweetest solution yet to the problem of protecting components from heat damage during dip soldering are Dissopads. They taste like soap-flavored candy, which is basically what they are. After the tiny standoff pads have done their job, the ingredients—sugar and soap—are rinsed off the circuit board, cleaning up the assembly.

The Bivar Co., a new firm formed by the developer of the pads, is offering them as a low-cost alternative to component-lead crimping and conventional pads. They cost about a penny each, one-third the usual pad price, according to Ron Vielicka, who developed them while working as a mechanical engineer for the Hewlett-Packard Co. That firm gave Bivar a license and is one of its first customers.

Raising components above a printed circuit board by crimping the component leads or placing spacers under them is often needed to thermally and electrically insulate the components from the board. Raising also improves the circulation of cooling air during circuit operation and keeps heat-dissipating components from heating up the circuit board.

Crimping saves pad costs, but stresses the leads and takes time, Vielicka points out, while conventional spacer pads require threading leads into individual holes in the pad.

Dissopads have a single hole in the center and in one operation are slipped like a washer over all the leads of a multilead component, such as a transistor or integrated circuit. Early versions looked like miniature Lifesaver candies. Now, the underside is notched so that the transistor pads can also be used for other components. When the pad is flipped over, the notch becomes a firm seat for diodes, resistors and capacitors, as illustrated.

The pads buffer the heat during fluxing, preheating and machine-soldering of the assembly. They dissolve during the board rinsing normally used to wash off flux residues. Running water warmed to 125°F removes the pads in less than a minute, leaving the board surface clear for detection of solder bridging between component leads, and the leads accessible for parts replacement.

Gone too, Vielicka adds, are the clutter and excess weight of per-

manent spacers and the vibration problems that pads sometimes cause.

The ingredients, he says, are harmless to assembly materials and even can be safely eaten.

Solubility tests were made with pads that were impregnated by fluorescent dyes. Inspection with black light disclosed no trace of the pads after the boards were rinsed. Surface resistivity tests of the washed boards indicated that board areas around the pad positions were cleaner than the remainder of the board, Vielicka reports.

Specifications

Sizes	Corresponding to transistor-package types TO-5 and TO-18
Diameters	TO-5: 0.375 inch, TO-18: 0.250 or 0.290 inch
Center hole	TO-5: 0.225 or 0.250 inch TO-18: 0.125 inch
Notch width	TO-18: 0.125, 0.160 or 0.220 inch
Height	TO-5: 0.075 inch, TO-18: 0.075, 0.130 or 0.150 inch
Price	\$9.00 to \$12.50 per thousand (minimum order of 2,000 in any size)
Color	White (special colors and thicknesses available).

Bivar Co., Inc., 725 Loma Verde, Palo Alto, Calif. 94303

Circle 350 on reader service card

A new twist on handling light-- from Bulova

Now... scan, chop, twist—with a tuning fork!



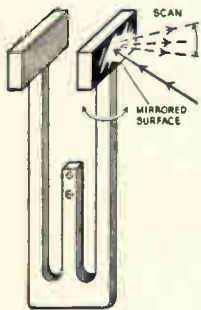
Bulova's American Time Products division has a patent pending on an important innovation in tuning forks: By affixing to the fork's tines a pair of vanes which can be slotted, notched or pierced as desired, the fork can be made to chop light or similar energy beams—making possible optical effects never before achieved.

Bulova fork light choppers offer great advantages over motor-driven types: There are no wearing parts—no lubrication is required—operational life is many times longer! Forks handle light more efficiently. They are smaller and lighter than any other chopper. Example: A 2 cu. inch package can chop 1,000 times per second!

And Bulova keeps coming up with important improvements. Among the latest—forks can now be supplied with peak-to-peak fine excursions of $\frac{3}{8}$ " at 200 cps.

In addition, Bulova has recently patented torsional tuning forks. Each tine twists about its own axis independently, in opposite phase. This eliminates rate change

due to attitude or acceleration, and results in the most constant and uniform movement known. Bulova torsional forks can be used for any number of scanner variations—in spectrophotometers, automatic star tracking units and densitometers. Write for information. Address: Dept. E-19.



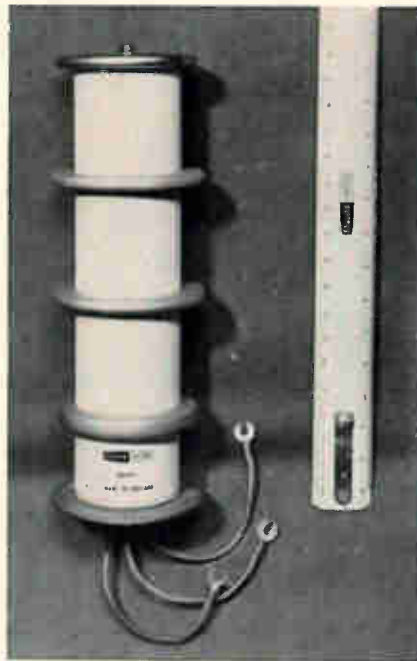
BULOVA

AMERICAN TIME PRODUCTS

Electronics Div. of Bulova Watch Co., Inc.
61-20 Woodside Avenue, Woodside,
New York 11377 (212) DE 5-6000

New Components and Hardware

Small thyratron carries high power



A thyratron only 13 inches high is being made in Britain that, according to its manufacturer, can switch higher voltages and carry higher currents than any other tube now available. The English Electric Valve Co. says its tube can handle repetitive switching of 120 kilovolts peak at 2,500 amperes peak and can carry up to 40,000 amperes peak when triggered every 10 seconds. It is only 3.75 inches in diameter, unusually small for its capacity.

Possible applications are in radar pulse modulators, laser systems and linear particle accelerators. The tube is cooled by standard oil bath immersion techniques.

The CX1171 is a triple-gap tube, with peak anode to cathode voltage of 120 kv equally distributed by a voltage divider network between two intermediate gradient grids which divide the space between anode and cathode. This enables the tube, filled with deuterium and hydrogen, to hold off firing beyond the normal 40-kv breakdown voltage that would occur in a single-gap tube filled with these gases. The inverse voltage, unfortunately, does not divide itself among the gaps.

Therefore the inverse voltage is limited, by external clipping circuitry, to 20 kv within the first 25 microseconds after the pulse. This ensures complete tube recovery and avoids damage to the grids. No large thyratron, though, will tolerate any inverse voltage within the first 25 microseconds after the pulse.

To fire the tube, the priming grid and the trigger grid are pulsed successively with a delay of about 1 microsecond. The priming grid is triggered by a positive pulse with respect to the cathode of 500 volts peak and a plasma is established between the priming grid and the cathode. Because the triggering grid is negative with respect to the priming grid, no conduction takes place. When the delayed pulse reaches the triggering grid, it enables the pulse to fire through and conduction begins.

To establish the plasma, all high-power thyratrons contain a reservoir which releases hydrogen at a rate which depends on the current passing through it. In the new thyratron, the current path is connected in parallel with the tube's heater. Independent current adjustment, usually found in high-powered thyratrons, is not required.

Deuterium gas is mixed with the hydrogen to provide a higher voltage hold-off and the optimum tube recovery time.

The tube's supporting ceramic elements are only 3 inches in diameter. This allows the ceramic section to be joined with thick copper grids. Improved grid dissipation results, enabling the tube to withstand the comparatively high peak inverse spike of 20 kv immediately after the pulse.

The short, direct path of the plasma provided by the tube's design is responsible for its high current-carrying capability, despite its small diameter.

The short plasma path gives a lower dynamic inductance, which tends to inhibit the rise time of the current and reduces the jitter

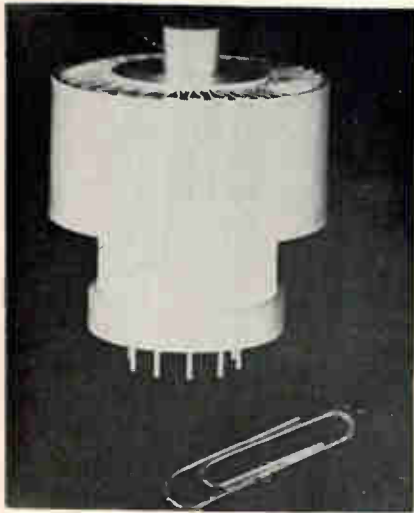
on the leading edge of the current pulse.

Specifications

Peak forward anode voltage	120 kv
Peak inverse anode voltage	120 kv
Peak anode current	2,500 amps
Mean anode current	2.5 amps max
Rate of rise of anode current	5,000 amps/ μ sec max
Anode heating factor	70×10^6 v-a pps max
Peak output power	150 Mw
Cathode heater voltage	6.3 v
Cathode heater current	21.5 amps
Reservoir heater voltage	3.5-6.5 v
Reservoir heater current	7.9 amps
Tube heating time (minimum)	Approx. 15 minutes
Maximum temperature of envelope	200°C
Price	On request
Delivery	5 months

Calvert Electronics, Inc. 200 E. 23rd Street, New York, N.Y. 10010 [351]

External-anode ceramic beam pentode



A ceramic beam pentode with a third-order intermodulation distortion level of at least -40 db at 350 w useful power output, Class AB₁, is designated PL-8583/267. The external-anode tube has a plate dissipation rating of 300 w and is suited for single-sideband or multiplex applications where adjacent-channel interference must be held to a minimum.

The PL-8583/267 has a vane-type suppressor grid and an oxide-coated unipotential cathode. Required filament voltage is 26.5 v at 1.0 amp. Maximum plate voltage is 2,000 v; maximum plate current, 350 ma. Transconductance is 40,-

Electronics | June 27, 1966

Make a Few Gallons of hot, Pure Water do the work of thousands

... with Barnstead microelectronic cleaning equipment

You cut rejects of integrated circuits, transistors, diodes and other semiconductor materials with hot rinses of particle-free, ultra-pure water. You minimize purification expense and usage of heat and water — at the same time!

Instead of dumping used hot, pure water down the drain, Barnstead equipment continually repurifies it, to be used over and over again.

Barnstead makes a variety of microelectronic cleaning stations, including open or cabinetized, dust-free types, and built-ins for clean rooms. They incorporate rinses of 18-megohm water, often combined with chemical baths, ultrasonic cleaners and Freon rinses.

Ask us about this or *any* pure-water need, including stills, demineralizers and associated equipment.



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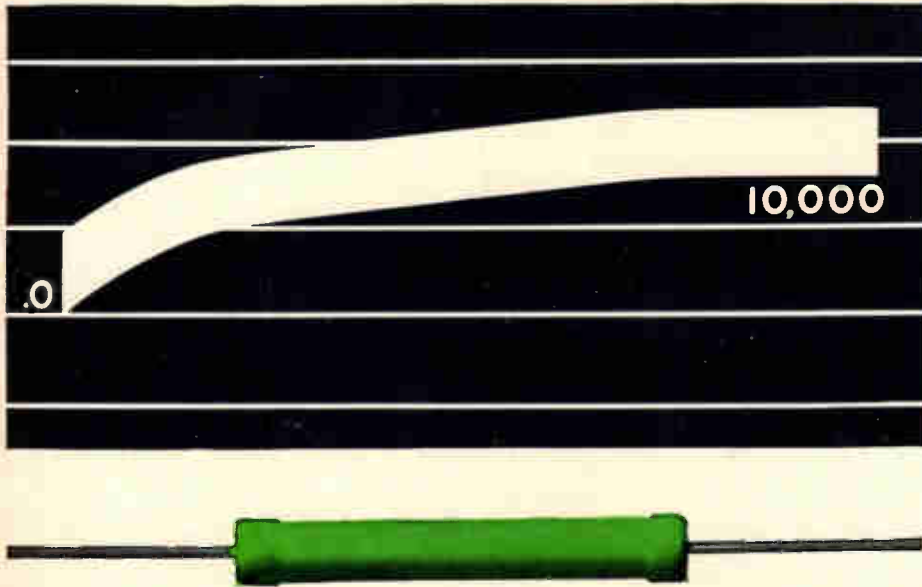
Barnstead

Still and Sterilizer Co.
308 Lanesville Terrace, Boston, Mass. 02131

Circle 155 on reader service card

155

MOL Resistors



STABILITY

... is just one reason why all major TV manufacturers use Mallory MOL film resistors. On 10,000-hour load-life test, resistance changed less than 5%. Other reasons: temperature coefficient of 250 PPM/°C; proved flame resistance, stability in humidity. *Plus* prompt delivery from expanded production capacity. Write for data and quotation. Mallory Controls Company, a division of P. R. Mallory & Co. Inc., Frankfort, Indiana 46041.

50th
ANNIVERSARY

MALLORY

New Components

000 micromhos.

The tube measures 2.16 in. long and 1.75 in. in diameter. At full-rated plate dissipation, the forced-air cooled tube requires an air flow of 8 cfm at a pressure drop of 0.2 in. of water.

Suggested retail price is \$87 each in quantities of five or less.

The Machlett Laboratories, Inc., Penta Plant 312 North Nopal St., Santa Barbara, Calif., 93102. [352]

Twin tetrode features wide-range cathode



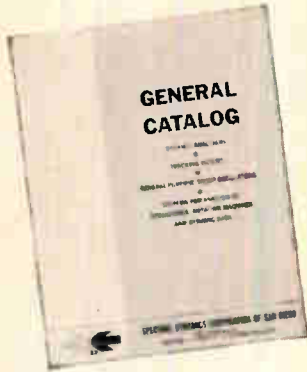
The 8643 is a mobile communications tube incorporating a new cathode designed to be relatively immune to variations in battery power supply voltages. The cathode can deliver 90% of rated power without damage to the tube, even when the battery delivers as much as 16 v or as little as 10 v (all other parameters constant). The cathode has been designed to withstand sublimation at higher voltages, while at the same time, maintaining more than adequate emission for full talk-power.

The tube is the first of a family of twin tetrodes that will incorporate this new cathode. It is an indirectly heated tube, designed for use as an r-f power amplifier, oscillator and frequency multiplier up to 175 Mhz. When rated for push-to-talk-service (maximum duty cycle, 1 minute on, 4 minutes off) at 175 Mhz as a push-pull f-m amplifier, it is capable of pro-

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SD102 DYNAMIC ANALYZER TUNER (DAT)... functions as a tracking frequency multiplier, accepting virtually any type of wave form or pulse and supplying a sinusoidal tuning signal to the SD101A. This enables the SD101A to "track" individual components of a rotating machine as it is speed cycled, filtering out all frequencies except that of the component of immediate interest. The SD102's interchangeable plug-in modules also enable the SD101A to perform a harmonic analysis of the entire rotating machine as it runs at a steady RPM.



SD101A DYNAMIC ANALYZER... original unit in our closely related family of vibration analysis instruments and systems — a frequency-tuned bandpass filter, compatible with all existing shaker console equipment. In its sweep mode, it analyzes complex or random signals as a function of frequency. In its tracking mode, it separates fundamental specimen or shaker response signals from background noise and tracks them over their entire frequency range. The SD101A is especially valuable in Power Spectral Density Analysis, to which it brings new speed and accuracy. (Also available: the SD101AS Single-Channel Slave Unit.)

SD104 LINEAR/LOG SWEEP OSCILLATORS

All-electronic, completely different in concept and operation from previously available oscillators. Three models offer outstanding versatility and flexibility. Features include: Exceptionally flat frequency response from .005 cps to 50 kc... uninterrupted, automatic sweeps over full three-decade range... continuously variable, all-electronic linear and log sweep rates... automatic range switching of front panel meter for unequalled accuracy of frequency indication and resolution... eight simultaneous outputs, including accurate DC analog for direct X-Y data recording without frequency or log converters.



SD105 AMPLITUDE SERVO/MONITOR

...Specifically designed for use with tracking filters and the SD104 Sweep Oscillator to provide automatic, all-electronic control for vibration exciters, including: Continuously varied compressor speed... Preset vibration and compression levels... Automatic, thump-free crossover from displacement, velocity or acceleration to acceleration... Three meters for display of: acceleration; compression; acceleration, velocity or displacement... Wide dynamic range (65 db minimum)... Small size, light weight, minimum down time. (Also compatible with other audio oscillators.)



SD1001



SD1005

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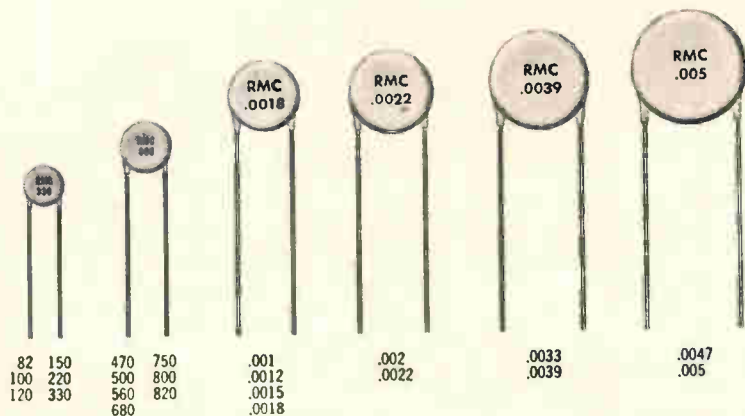
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**MAXIMUM
RELIABILITY
OVER A WIDE
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RMC

**TYPE JL
DISCAPS**



SPECIFICATIONS

CAPACITANCE: Within tolerance @ 1KC and 25°C

CAPACITANCE TOLERANCES: ±10%, 20% or +80 -20%

WORKING VOLTAGE: 1000 VDC

POWER FACTOR: 1.5% @ 1KC

INSULATION RESISTANCE: Greater than 7500 Megohms @ 500 VDC

TEMPERATURE COEFFICIENT: Z5F, Y5F, X5F

FLASH TEST: 2000 VDC for 1 second

LIFE TEST: Per EIA RS-165 Class II

POWER FACTOR AFTER HUMIDITY: 2.5% @ 1KC

INSULATION RESISTANCE AFTER HUMIDITY: Greater than 1000 Megohms @ 500 VDC

BODY INSULATION: Durez phenolic—vacuum wax impregnated

LEAD STYLES AVAILABLE— Long lead—#22 AWG tinned copper—and all types for printed wire circuits.

RMC Type JL DISCAPS exhibit less than a $\pm 7\frac{1}{2}\%$ change in capacitance over the temperature range of -55° to $+85^\circ\text{C}$. They are ideal units for temperature stable compensation and filter network use or other applications where stable circuit parameters are required. Rated at 1000 volts VDC, Type JL DISCAPS offer tangible cost savings over paper or general purpose mica capacitors.

Write today
on your company letterhead
for your copy
of the new RMC catalog.

DISCAP
CERAMIC
CAPACITORS

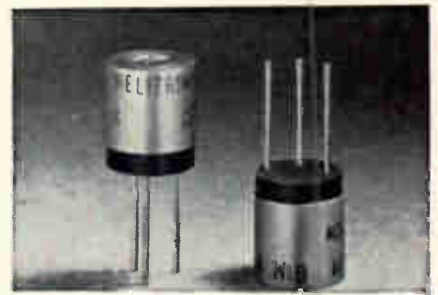


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New Components

ducing 135 watts from less than 4 watts drive. Under periodic conditions, it will produce 123 w from 3.5-w drive power.
Amperex Electronic Corp., Tube division, Hicksville, L.I., N.Y., 11802. [353]

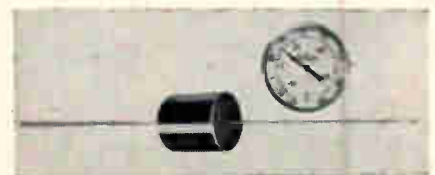
Trimming pots offer 17 standard resistances



Model 61M Helitrim trimming potentiometer is a $\frac{1}{4}$ -in. diameter single-turn unit with pins spaced on a 0.100-in. grid per MIL spec style RJ22. Pin length is $\frac{3}{16}$ in. The unit has sealed housing and meets the immersion test of MIL-R-22097B.

Seventeen standard resistances from 10 ohms to 1 megohm are available. The Cermet resistance element offers essentially infinite resolution and a power rating of 0.5 w at 85°C , derating to 0 at 150°C . Model 61M weighs 0.75 gram and is available in continuous rotation or stop configurations. Helipot division of Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif., 92634. [354]

Temperature-sensitive wire-wound resistor



The Delthistor is a temperature-sensitive wire-wound resistor that may be used in many instances in place of more expensive silicon resistors. It has a temperature coefficient of $+5,800$ ppm/ $^\circ\text{C}$ linear

over a temperature range of from 0° to +125°C at full rated wattage. Wattage is available from 0.04 to 1.0 depending on the type. The Delthistor has a constant rate of change in resistance with a response time of 0.5 to 1.5 seconds. Tolerance is 5%.

Delthistors come in the full range of low-temperature-coefficient-resistor dimensions listed in the manufacturer's catalog. They are hot molded for maximum heat transfer using the same construction technique used in the company's Mil-Spec qualified low-temperature-coefficient resistors.

Prices range from \$2.50 to \$4 for limited quantities, decreasing with larger orders. Delivery is within three weeks.

Riedon Avionics, division of the On Mark Engineering Co., 11728 Vose St., North Hollywood, Calif. [355]

Heavy-duty relay is rated at 5 amps



A semi solid state, heavy duty relay is rated at 5 amps 115 v a-c or 220 v a-c. Known as Reedac, the relay combines the advantages of reed relay switching with solid state dependability. Its rating is either inductive or resistive and will withstand inrush at 10 times its rating for 1 cycle. Reedac is designed to be controlled from a signal of 6, 12 or 24 v.

The device features a life of 500 million cycles, switching speed of 1 msec, extremely low rfi, silent operation, and imperviousness to environmental conditions. It is packaged in a small, rugged housing with turret terminals for line and control connectors and two ¼ in. steel studs for mounting. Its compact mechanical dimensions are 1¾ in. wide x 1½ in. long x 1 in. high.

Grigsby-Barton, Inc., 107 N. Hickory Ave., Arlington Heights, Ill. [356]

VICTOREEN SPARK GAPS

*Firing Time 75 nanoseconds to 1 microsecond
Tolerance ±5% or better*

Victoreen Type VX-96 Spark Gaps now provide creative designers with circuit protection never before possible by simple, economical means. Because of extremely fast firing time, Victoreen Spark Gaps ward off catastrophic effects of pulses, spikes, even transients with extremely steep wave fronts. Available in any desired firing voltage from 150 — 5000 volts \pm 5%. Low interelectrode capacitance enhances use in HF applications where wave deformation cannot be tolerated.

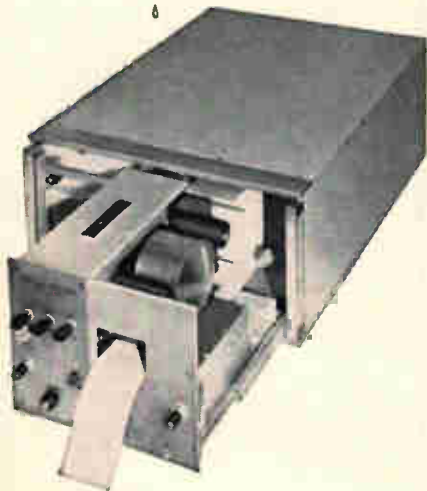
For Ignition Applications, as a "hold-off" device, Victoreen Spark Gaps prevent current flow until circuit voltage has reached breakdown voltage of gaps. Their excellent repeatability and long life enhance operation in continuous duty systems. Ambient temperature range —65° to 125°C, shock resistance to 100g for 11 milliseconds, vibration resistance 10g from 55-2000 cps. Write or wire for full details. Or call Applications Engineering Department, (216) 795-8200, Ext. 306.

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 32 columns



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Apply several drops of oil to the drive-motor shaft-ends each year (or every fifty-million lines). Brush out any accumulated dust or lint. Clean the air filter periodically.

That's the extent of maintenance for a Franklin Model 1000 . . . the only digital printer that offers a printing rate of 40 lines per second (or less) at low, low, OEM prices.

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East Fourth St. • Bridgeport, Pa. 19405
 A Division of the Anelex Corporation

New Semiconductors

Photodiode peaks at 1.5 microns



A high-speed germanium photodiode capable of demodulating the outputs of lasers in optical communication systems operating in the 0.5- to 1.8-micron range has been developed at the Philco Corp.'s Solid State Products Operation in Spring City, Pa. The diode fills out a line of photomixers offering the broadest spectral coverage possible with solid state diodes, according to the manufacturer. The series covers the range from 0.4 to 5.7 microns, with cutoff frequencies extending beyond 20 gigahertz.

The L-4520 diode detects the outputs of laser beams and can also photomix the frequencies of coherent light beams with wavelengths within its 0.5- to 1.8-micron spectral response range. Its most frequent application is anticipated in systems using 1.06-micron neodymium lasers and 1.15-micron helium-neon lasers, according to John Roschen, manager of Philco's sensor and transducer department.

Coherent light outputs at these wavelengths formerly were detected by silicon photodiodes.

These units have peak response in the 0.8- to 0.9-micron range and the response drops off sharply after 1.0 micron. The germanium diode fills this gap: its peak response is the 1.4- to 1.5-micron range.

Its mounting in a standard coaxial connector allows convenient transmission of any output frequency within its operating bandwidth. One end of the package is covered with a transparent window, permitting focusing of the optical energy directly on the active area of the diode. The other end of the package mates with all standard BNC type connectors permitting easy insertion into existing microwave receivers.

Specifications

Operating range	0.5 to 1.8 microns
Peak spectral response	1.4 microns
Light-sensitive area	0.03 sq mm
Cutoff frequency	1.5 Ghz
D-c reverse bias	6v
Typical photon efficiency	30%
Current efficiency	Over 85%
Minimum power detectability	10 ⁻⁶ w
Package	UG-88/U
Price	\$98 to \$135
The Philco Corp., Spring City, Pa. 19475. [361]	

Plastic-encapsulated transistor amplifiers



A line of microminiature, plastic-encapsulated transistors, the silicon Microtab line, includes a high-gain, low-noise amplifier that sells for 85 cents in quantities of 10,000 and a high-frequency amplifier priced at \$1.75 in high volume.

The new amplifiers are designed for hearing aids, instrumentation, hybrid circuits, linear and analog

circuits, miniature operational amplifiers, or any other application where small size is important.

The high-gain, low-noise amplifiers, designated types D26E-1 through E-7, are similar to conventional 2N930 or 2N2484 types. Betas range from 40 to 300. The high-frequency amplifier, typed D26G-1, is similar to the 2N918. It has a beta at 100 Mhz of greater than 6.

The amplifiers are color coded for type number and lead configuration. Package size is 0.07 x 0.07 x 0.085 in. Availability on small quantities of all types is from stock. The General Electric Co., Schenectady, N.Y. [362]

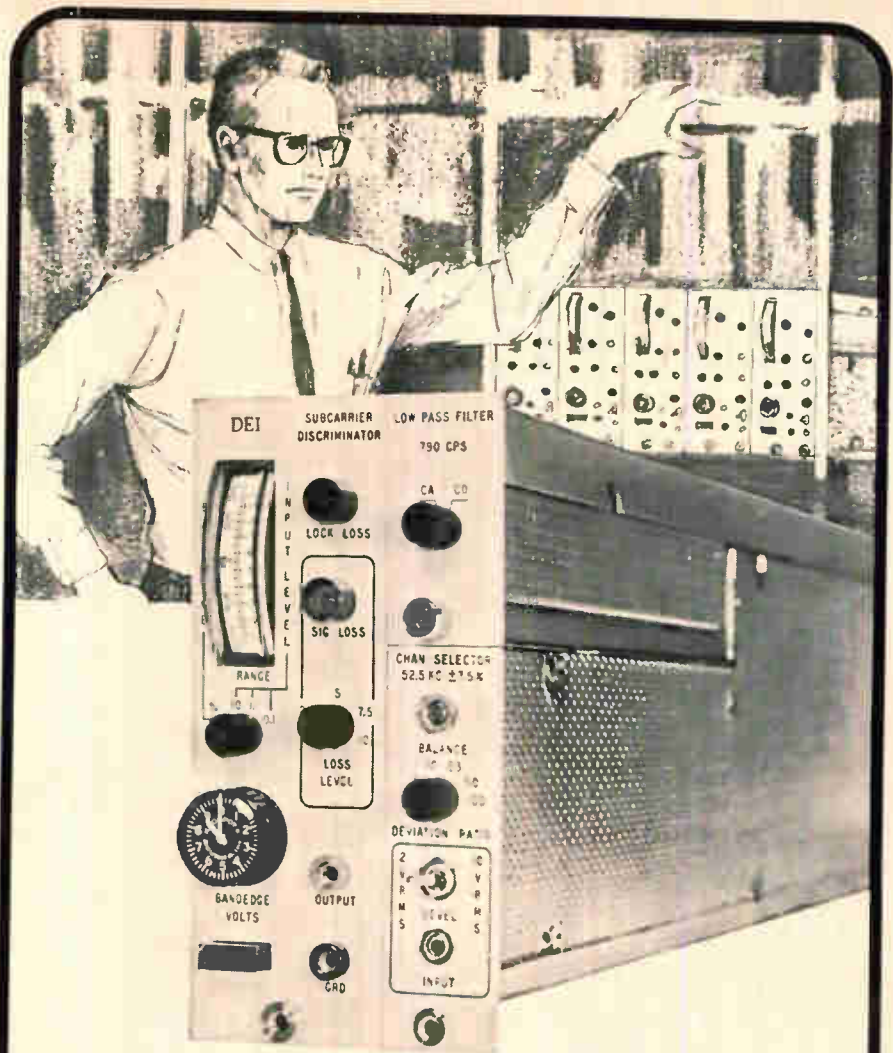
Silicon rectifiers with octal sockets



A series R silicon rectifier has been introduced for use in circuits calling for plug-in modules. Offering compact design and efficient performance, the plug-in rectifiers are available in full wave, half wave, doubler, center tap, open bridge and three phase types. This series of octal-socket plug-ins contain double-diffused, passivated, controlled avalanche junctions in a special cold case configuration designed for high reliability. Used as vacuum tube replacements, the series R silicon rectifiers assure greater reliability and longer operating life.

Electrical ratings for the series R indicate high temperature resistance, low leakage current and low forward voltage drop. Peak inverse voltage ratings range from 50 to 5,000 v and currents from 100 ma to 6 amps.

Edal Industries, Inc., 4 Short Beach Road, East Haven, Conn., 56512. [363]



NEW... MODULAR...

PHASE-LOCK LOOP DISCRIMINATOR

- Acquires lock at S/N ratio of -3 db.
- $\pm 180^\circ$ phase-lock loop; deviations up to $\pm 40\%$.
- Bandpass phase linearity better than 1%.
- Integral power supply: 115/230 v, 47-420 cps.
- Minimum Input of 2 mv rms.
- Isolated Input, output and chassis commons.
- Front panel threshold adjust for signal loss indication.
- High level output: ± 1.0 to ± 10 volts/100 ma.

The SCD-1 is designed for telemetry applications in which an FM multiplex signal is to be demodulated by phase-lock detection. All standard IRIG channels are included, along with AIA channels, plus special channels. Channel selectors have adjustable phase-lock loop bandwidths for deviation ratios of 1, 5, 10, 25, 50 and 100.

Working dynamic range for any selected input is 60 db. Input impedance is 100k minimum. Truly isolated input allows selective grounding of input and output. Output filter is of active element type, with either of two response characteristics.

Standard tape speed compensation results in a minimum of 30 db improvement ratios for speed variation of $\pm 3\%$. The integral power supply has a maximum power requirement of 18 watts.

The design is modular. The size is $2\frac{1}{8}''$ x $5\frac{1}{4}''$ x $18''$ maximum. Low pass filter and channel selector are removable, independent units.

Defense Electronics, Inc.

Rockville, Maryland



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Rockville, Md. (301) 762-5700 TWX 710 828-9783 • Satellite Beach, Fla. (305) 632-5400 • Huntsville, Ala. (205) 881-5139 • Santa Maria, Cal. (805) WA 5-2347 • International, Rockville, Md. Cable: DEIUSA

DIGITAL READOUT resistance thermometer bridge

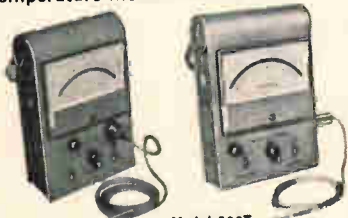


RFL Model 2550 Resistance Thermometer Bridge gives you more accurate resistance readings faster and easier than ever! In-line, six-place digital readout in ohms and these remarkable features make the difference:

- Range of 0 to 1111.11 ohms and 0.001 ohm resolution
- Accuracy of $\pm 0.008\%$ +0.0015 ohms
- Operation as Mueller (3 or 4-terminal probe) or Callander-Griffiths (2-terminal with lead compensation) bridge
- Calibration data traceable to NBS (readings to 25 ppm)
- Accommodation of all base and precious metal probes



Portable, Direct-Reading Electrical Thermometers liquid or surface temperature measurement.



Model 212.
7 ranges: -100°C
to 500°C . 2.5 sec.
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Model 380T.
You choose scale
range. Ultra-fast
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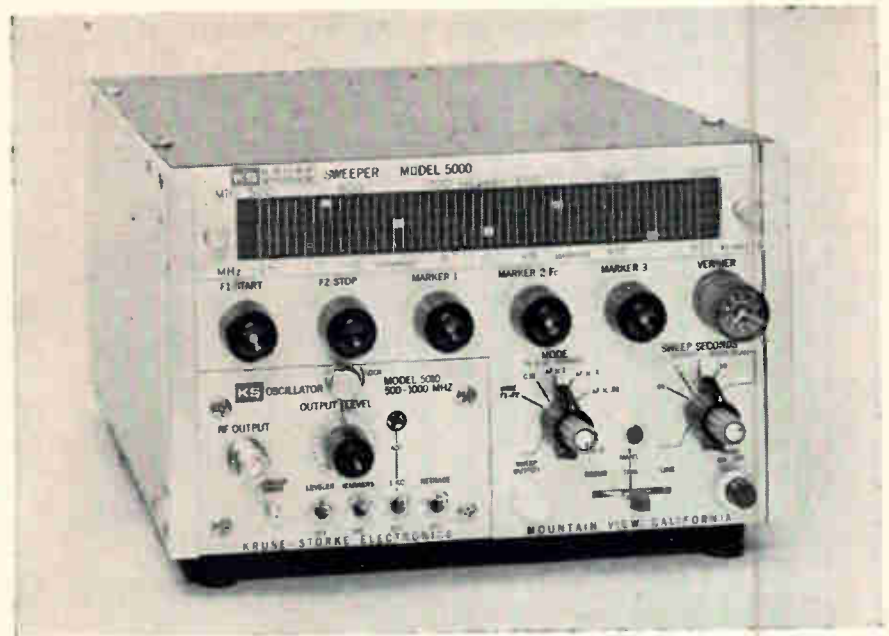
For complete information and specifications, write or call John Carson at RFL (201) 334-3100 or contact your nearest RFL Representative.

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Temperature and Control Division
Boonton, New Jersey 07005 • U.S.A. 62

New Instruments

Solid state sweeper cuts power needs



The first all solid state, wide-range microwave sweep generator is claimed by Kruse-Storke Electronics. Reliability is high, says a company spokesman, since it does not depend on relatively short-lived backward-wave tubes or voltage-tunable magnetrons. Instead, varactor-tuned oscillators provide more than an octave bandwidth in each of four plug-in units which in total cover a frequency range from 250 megahertz to 2.4 Ghz.

With solid state components, size and weight have been reduced to about one-fourth and power requirements to about one-sixth that of a comparable single-unit sweep oscillator.

The instrument has a calibrated vernier dial to make fine adjustments of the frequency settings. Other features include an a-m square-wave output for synchronous detectors and a direct phase-lock control connection to the plug-in oscillators.

A precise graticule dial, which extends across the full width of the instrument, provides frequency readout of high resolution. The dial is calibrated for each plug-in oscillator by an overlay. The settings for the starting frequency, the center frequency and the end-marker

frequencies are controlled by five knobs on the front panel and are displayed on the graticule dial.

Several sweep modes are provided. These include recurrent, manually or externally triggered, line-triggered, manual-scan and external sweeps. Sweep time for all but the manual-scan and external sweep modes is continuously adjustable from 0.01 to 100 seconds. The manual-scan time is controlled by a front panel knob. Switching the instrument puts the generator in the external sweep mode and simultaneously disables the internal sweep circuit. An external signal with a 10-volt peak amplitude will sweep the generator's output over the full frequency range.

Internal leveling circuits with p-i-n diodes keep the oscillators' outputs constant over the entire frequency range of the outputs. The leveling circuits are controlled by signals from external r-f sampler-crystal detectors.

Sweep voltages, concurrent with the sweep r-f output, are provided for connection to oscilloscopes and x-y recorders. Output can be blanked during retrace to provide a zero base line on an oscilloscope display.

The instrument's self-contained

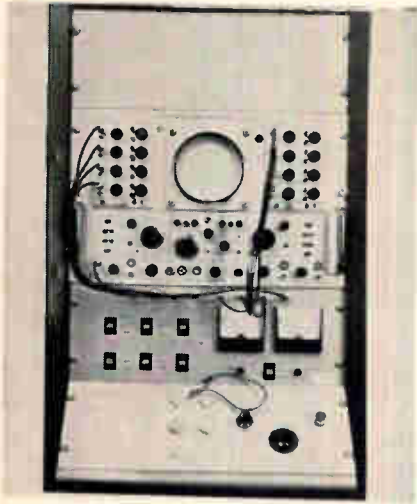
power supplies provide the sweep voltage and current for operating any of the four available plug-in oscilloscopes.

Specifications

Frequency	250 Mhz to 2.4 Ghz in four ranges: 0.25-0.5, 0.5-1, 1-2, 1-4 to 2.4 Ghz
Power output, minimum	20, 20, 10 and 5 mw respectively
Power variation	
Unleveled	6 db
Leveled	±0.3 db
Frequency accuracy at 25 C	±2.5, ±5, ±10 and ±15 Mhz respectively
Spurious signals below rated output	
Harmonic	16 db
Nonharmonic	50 db
Frequency stability (% of output frequency)	
0 to 1 hz	
Temperature change	±0.05%/°C
100% load change	±1%
10% line change	±0.001%

Kruse-Storke Electronics, 790 Hem-meter Lane, Mountain View, Calif. 94040. [371]

Instrument analyzes relay characteristics



A relay signature analyzer gives simultaneous visual displays of all dynamic switching characteristics of any relay up to six pdt. Any conventional oscilloscope can provide display. Custom units are available for visual display performance of relays of eight or more poles.

The analyzer, which has application for both relay consumers and relay manufacturers, is used for design, production, inspection and testing of any a-c or d-c relay. It is available in console, standard

Ballantine Sensitive R-A-P VTVM

(true-Rms) (Av.) (Peak)

Model 321

Price: \$560

Measures True-RMS, Average, or Peak Voltage

Same Accuracy and Resolution over entire Five-Inch Log Scales

Accuracy of 2% of Indication is far better over the lower half of the scale than for a linear scale instrument rated at 1% F.S.D.



THREE INSTRUMENTS IN ONE

Measures Wide Range of Voltages, Frequencies, and Waveforms

Ballantine's Model 321 is an electronic voltmeter designed for accurate measurements of the true-rms, average, or peak values of a wide range of voltages and waveforms. It is *not* limited to measurement of pure sine waves to obtain the specified accuracy, but will measure sine, distorted sine, complex, pulse, or random signals whose frequency components lie within the designated frequency range.

The instrument's five-inch voltage scales make it possible for you to specify uniform resolution and accuracy in % of indication over the entire scale length. This feature is not possible with a linear scale meter.

PARTIAL SPECIFICATIONS

VOLTAGE RANGE

RMS	100 μ V — 330 V
Average & Peak	300 μ V — 330 V
As null detector	to 10 μ V

WAVEFORMS

Sine, distorted sine, complex, pulse, random

Power Requirements: 115/230 V, 50 — 420 Hz, 90 W

FREQUENCY RANGE

RMS	5 Hz — 4 MHz
3 db bandwidth	2 Hz — 7 MHz

ACCURACY, ABOVE 300 μ V, MID-BAND

RMS & Average	0.2% of indication
Peak	0.3% f.s.

Amplifier: 90 db
Mean Square Output (dc): 1 V

Available in portable or rack versions

Write for brochure giving many more details

Member Scientific Apparatus Makers Association

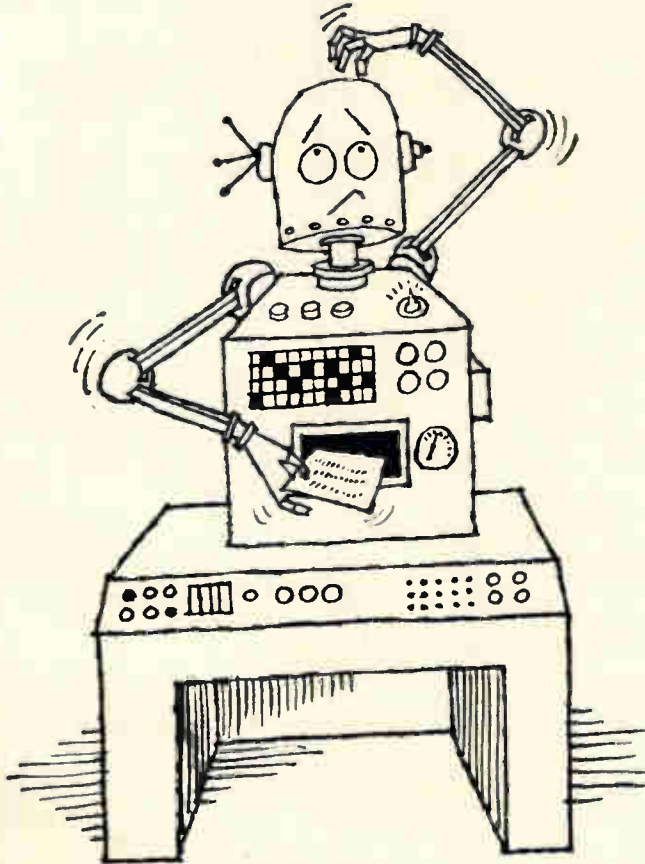


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CHECK WITH BALLANTINE FIRST FOR DC AND AC ELECTRONIC VOLTMETERS/AMMETERS/OHM METERS, REGARDLESS OF YOUR REQUIREMENTS. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC LINEAR CONVERTERS, AC/DC CALIBRATORS, WIDE BAND AMPLIFIERS, DIRECT-READING CAPACITANCE METERS, AND A LINE OF LABORATORY VOLTAGE STANDARDS FOR 0 TO 1,000 MHZ.

Who puts the "gray matter" in computers?



The "brains" responsible for the fantastic capabilities of today's electronic computers are actually small coils called "bobbins" or "memory cores." They're made of ultra-thin Moly-Permalloy foil wound on bobbins. Metallurgical quality must be precise; dimensional specifications extremely rigid—.000125" thin by 1/8" wide.

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Check with Hamilton Precision Metals on your electronic metals requirements for precision strip, foil or wire. Write today for a completely new brochure giving full information about our capabilities as well as detailed properties of over 100 metals.

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New Instruments

rack or portable field models.

The instrument can also be used in comparison testing of different relays; and to provide displays of relays operating under such environmental testing as high and low temperature, humidity, shock and vibration. The unit can be used for applicable phases of Group A testing per MIL-R-5757.

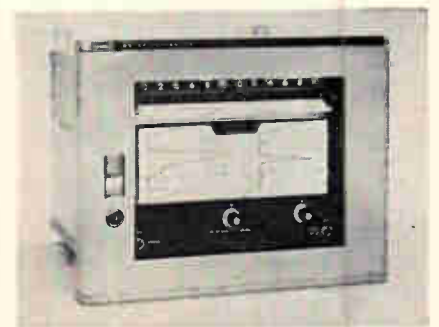
Such characteristics as pull-in and drop-out voltage, operate and release time, bounce and overtravel are visually given on the oscilloscope. The only requirement is that the scope have one more channel than the number of poles on a relay. The extra channel is for coil current.

The laboratory model signature analyzer has the following parameters for displaying all dynamic switching characteristics of relays: coil supply voltage, 0 to 150 v, a-c or d-c; 2 amps at 28 v, any or all contacts; dry circuit at 40 mv and 20 μ a; contact resistance at 400 ma and 2 amps; automatic coil voltage sweep for photographic record of pull-in/drop-out; manual or auto coil voltage polarity reversal; manual or auto selection of coil on 2-coil relay; automatic reset on polarized relay; external input for other types of contact test; and external input for other types of coil voltages.

Base cost of the lab model is \$4,500. A production line model is also available.

Electro-Tec Corp., Suite 407, 2009 North 14th St., Arlington, Va., [372]

Servo recorder has 1/8-sec response



A two-channel, wide-chart servo-recorder is available with 1/8-sec

full-scale response in each of the side-by-side 4½-in. channels. The Speed Servo features two unique shuttle servomotors, each of which has only one moving part. These servomotors have no drive cords to break or gears to wear.

Also new is an automatic chart drive that enables users to dial instantly any one of 15 chart speeds including ½, 1, 2, 4 and 8 inches per second, minute or hour. Single-speed, 2-speed, and 10-speed drives can also be ordered. None of the drives requires gear change, motor or screwdriver adjustments.

The two-channel Speed Servo features source impedance of 100,000 ohms, off balance input impedance of 50,000 ohms, conductive plastic feedback potentiometers which last thousands of hours longer than wire-wound pots, modular amplifier and a writing surface.

An optional feature is adjustable zero adjustable span (AZAS). Any calibrated span from 1 to 100 mv full scale can be measured without changing range cards or internal connections. Zero is continuously adjustable from 0 to ±100 mv. A chart tear-off bar is a standard feature.

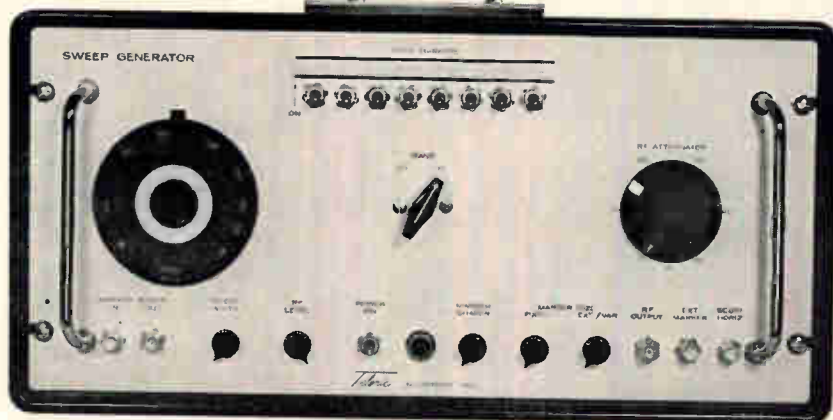
Modular construction of the recorder provides easy access to all components. Both chart frame and recording mechanism frame swing out 180°, which makes them readily accessible from both sides and also exposes all electronic components and connection terminals.

Dimensions of the wide-chart Speed Servo are 17¾ in. wide, 13½ in. high and 15 in. deep. Esterline Angus Instrument Co., Inc., P.O. Box 24000, Indianapolis, Ind., 46224. [373]

A-c voltmeters offer high input impedance

The latest of the 400-series a-c voltmeters, 400F and 400FL, have 100 μv full-scale ranges, and 10-megohm input impedance. An a-c output produces 1 v rms for full-scale meter deflection, regardless of range and use; on the 100-μv range, the amplifier has 80-db gain with less than 5-μv noise. Frequency range of the instrument is 20 hz to 4 Mhz. Accuracy, in the range from 100 hz to 1 Mhz, is ±0.5% of full-

SALE!
ONLY
\$1.12/MHz



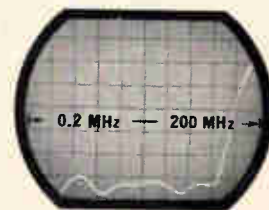
TELONIC HD-1A SWEEP GENERATOR

Here are all the benefits of swept frequency instrumentation at a price under \$1000.00. Telonic's HD-1A Sweep Generator covers a wide range of frequencies, 1 MHz to 900 MHz, with the convenience of a built-in frequency marker system, and performance factors par excellence.

LESS TIME—MORE DATA The extra wide sweep, covering video to UHF, makes the HD-1A an ideal instrument for frequency response testing of amplifiers, tuners, networks and similar circuits. The use of swept techniques in such applications saves valuable test time and provides a complete response curve. Instead of isolated point by point measurements.

The HD-1A marker system permits the use of up to 8 plug-in markers of specific frequencies or harmonics covering the entire 1 to 900 MHz range. The instrument is fully documented to DOD, Air Force, Signal Corps, and Navy specifications. Federal stock no. is 6625-063-4492.

SPECIFICATIONS	LOW RANGE	HIGH RANGE
Center Frequency	1 - 400 MHz	390 - 900 MHz
Sweep Width	200 KHz - 200 MHz	0.06 - 10%
Output	0.25v r.m.s.	0.50v r.m.s.
Source VSWR	Normally below 1.3:1	
Impedance	50 ohms	
Flatness	± 5%	



APPLICATIONS Telonic's Sweep Generator Application file is yours on request. This folder contains a number of application notes covering conventional and unique uses of sweep generators. Your name is also automatically placed on the mailing list to receive copies of new application notes as they are published.



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Is the Spectrol Model 140 really so great ?

No, it just acts that way!

This precision pot is priced like a trimmer, and yet it outperforms many higher priced models.

Here's a half-inch, single-turn, precision potentiometer with rear terminals for optimum packaging density...a new type mechanical stop that provides exceptionally high stop strength...and a unique wiper design that assures positive contact under severe conditions of shock and vibration per MIL-R-12934. Also, here's a miniature pot with high "specability!" From our standard data sheet, you can choose from more than 100 mechanical and electrical options, in addition to resistance ratings from 50 ohms to 70K ohms.

On second thought maybe it really is so great! Why don't you find out for yourself? You'll find the standard Model 140 (with stops) stocked at your local distributor. Want more data? Send for the 140 data sheet and ask for our new Short Form Catalog, too. The Model 140 comes from a great family.

spectrol

Spectrol Electronics Corporation
17070 East Gale Avenue
City of Industry, Calif. 91745

New Instruments



scale $\pm 0.5\%$ of reading for the 400F, and 1% of reading for the 400FL. Model 400F presents a linear voltage scale uppermost, while the 400FL presents a linear db scale uppermost.

The new meters will measure voltage gains up to 144 db over 5 decades of frequency range. Internal noise, referred to the input, with 100-khz bandwidth, is typically only $3 \mu\text{V}$; thus, signals as low as $10 \mu\text{V}$ can be measured with 10% accuracy. A front-panel control engages a 100-khz, low-pass filter to eliminate the error-producing effects of high-frequency voltages when low-frequency measurements are being made. The company says the built-in filter is an exclusive feature in this class of instrument.

The instrument is especially useful as a calibrated high-gain pre-amplifier for oscilloscopes, bridge detectors, and other devices, according to the manufacturer. In acoustical measurements, the sensitivity enables direct connection of a calibrated microphone to the input terminals.

The Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif., 94304. [374]

Accurate and stable d-c voltage standard



This d-c voltage standard provides voltages from 0 to ± 1222.2221 volts in three decade ranges. Model

326 supplies d-c voltages having an accuracy within 0.003% of setting with an output current capability of 50 ma. The stability of the output voltage is within 0.0015% for 7 days and within 0.0025% for 6 months. Output noise and hum is less than 20 μ v rms on the lowest voltage range. Source resistance is less than $(0.00025 + 0.00005 E_{out})$ ohm.

Features include in-line readout of output voltage with automatic, illuminated decimal placement; isolated, four-terminal output; current-limit control; over-current and over-voltage protection with manual and automatic reset; and provision for self-checking the linearity of the output voltage. The output current may be limited within the range of 5 to 50 ma by a front-panel control.

Stability of operation is provided by a low drift, wideband, high-gain amplifier system; a highly stable reference voltage; and precision range and decade resistors. The reference voltage is provided by a solid state circuit which utilizes a constant-current preregulator housed in an electronically controlled oven. To ensure stability, the unit undergoes more than 1,000 hours of aging and testing before it is shipped.

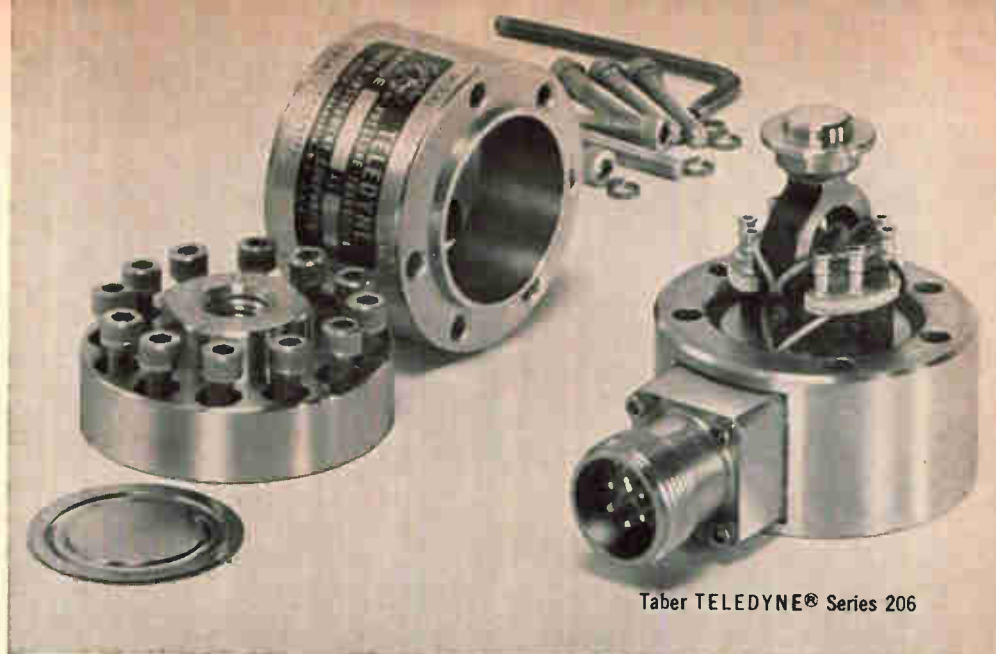
Designed for production-line and laboratory use, the 326 is available with the following options: slides, rear terminals, and tabulated data of the instrument's stability history. Price, without options, is \$2,490. Cohu Electronics, Inc., Box 623, San Diego, Calif., 92112. [375]

Compact, wide range signal generator

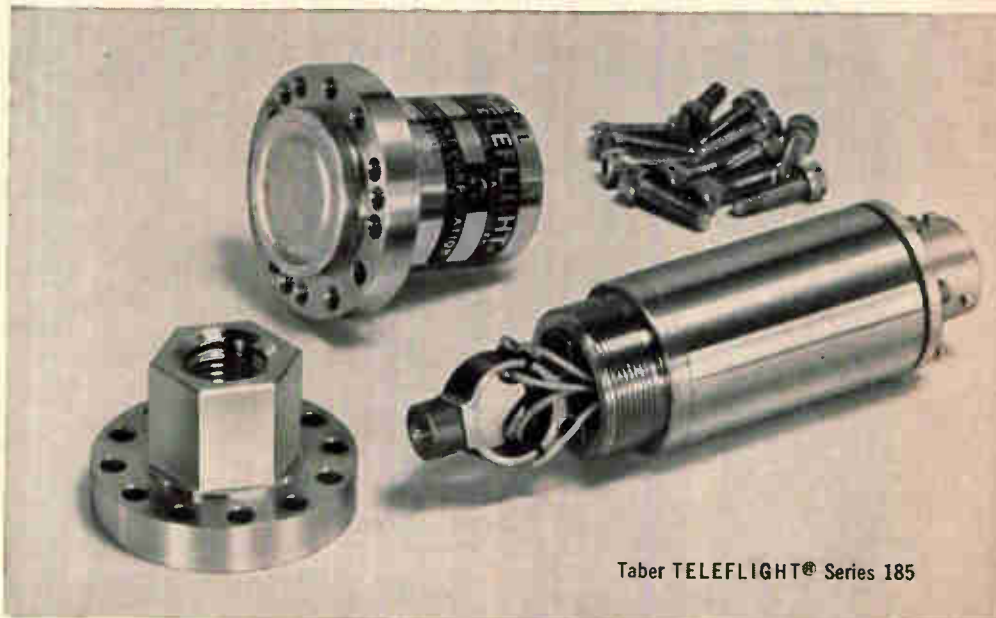


Model 102 signal generator, designed for 225- to 400-Mhz range, offers deviation calibration accu-

Circle 167 on reader service card →



Taber TELEDYNE® Series 206



Taber TELEFLIGHT® Series 185

the inside story of Taber quality

All of Taber's TELEDYNE® and TELEFLIGHT® Electrical Pressure Transmitters feature ruggedness, accuracy, and dependability. The illustrations above demonstrate several good reasons why this is true.

The most obvious, of course, are the clean design and careful construction. Close examination of the precision sensing elements, the meticulous wiring, the beautifully machined surfaces proves that Quality is the principal ingredient of Taber products.

For example, Taber uses only Ni-Span C* for the sensing element rings because it's the only constant modulus alloy. With 42.2% Ni, Ni-Span C is tough to machine and to heat treat, but Taber's vast experience with the alloy has permitted standardization on it for most models in the line.

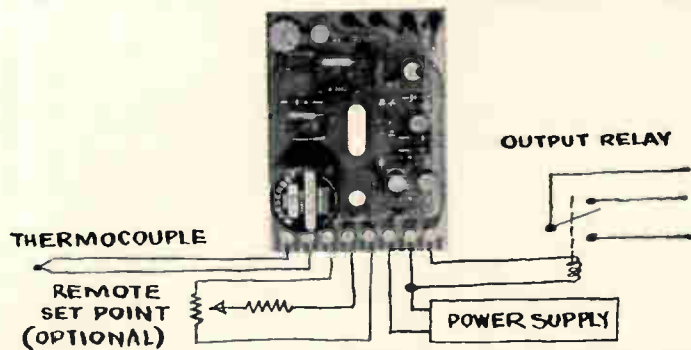
Behind what you see when you look at a Taber TELEDYNE Pressure Transducer are hundreds of skilled hands... of the girls who bond the sensing elements, the machinists who produce the parts, the assemblers who fit the parts together, and, at every stage in the manufacture, the hands of the inspectors who make sure that every sensing element, wire, connection, mating surface, diaphragm, thread, even every screw meets Taber's stringent requirements.

Yes, there's more than meets the eye in a Taber instrument... even if you scrutinize each part. To get that "more", be sure to specify Taber. For more information about Taber's full line of pressure transducers, signal conditioners and indicators, write: Taber Instrument Corporation, Section 158, 107 Goundry St., North Tonawanda, N. Y.



*Ni-Span C is a registered trademark of The International Nickel Company.

NOW...
control **TEMPERATURE**
and get cold junction and
copper compensation automatically



MAGSENSE® 73 ALARM/CONTROLLER

CONNECT A THERMOCOUPLE to one side of the MAGSENSE Model 73 and a relay, solenoid or annunciator to the other. It's just about that simple to control or alarm directly from thermocouples *without pre-amplifiers*. Latching or non-latching options for alarming applications, and differential gap or proportional control action for the controller applications, are offered in the standard Model 73. Output options include either solid state ground leg switching or pulse outputs suitable for driving S.C.R.'s. Excellent common mode rejection (typically 120 db at 60 cps). Set point may be programmed with the board-mounted pot or remotely.

BRIEF SPECIFICATIONS FOR MODEL 73

- INPUTS:** 0 to 50 mv from Type J or K thermocouples of 24 ohms.
- POWER REQUIRED:** 12 V DC or 28 V DC $\pm 10\%$. Less than 2.0 Watts dissipated exclusive of load.
- OUTPUT:** Latching or non-latching, two ranges of 100 ma and 500 ma maximum—with load returned to up to +30 V DC.
- REPEATABILITY:** $\pm 0.15\%$ of full scale maximum for line voltage variation of $\pm 1\%$. For ambient variation of 0° to 50°C, $\pm 1\%$ of full scale maximum.
- M. T. B. F.:** 228,000 hours.
- SIZE:** 3" x 4" x 1 1/4"
- WEIGHT:** 3 oz. maximum
- PRICE:** \$76 with quantity discounts. Some options slightly higher.

CASH-IN ON YOUR CREATIVITY

Describe an interesting application for versatile MAGSENSE alarm/controllers and you can win \$100, \$50 or \$25. It's easy and simple. Application can be either actual or theoretical. Get full contest information by contacting your MAGSENSE representative listed in EEM or by circling reader service number below.

FOR INFORMATION about the complete line of MAGSENSE products for military and industrial applications, circle the inquiry number below or contact MAGSENSE Products, Dept. 161, La Jolla Division, Control Data Corporation, 4455 Miramar Rd., La Jolla, California (Area code 714, 453-2500)

CONTROL DATA
CORPORATION

4455 Miramar Road, La Jolla, Calif.

New Instruments

racy of $\pm 0.1\%$ of full scale at 300 Mhz, and $\pm 0.5\%$ at any other frequency. Measurements are made with 1-khz modulation.

The unit, which has been approved as Class A for the Minute-man test planning program, offers 25 ppm frequency stability per hour, and less than 1% modulation distortion at 150-khz deviation, with 1-khz modulation. Compact (10 1/2 x 19 x 12 1/2 in.) and lightweight (35 lbs), the signal generator is available for rack or bench mounting. Marcon Electronics Corp., 201 Devon Terrace, Kearny, N.J. [376]

Automatic counter measures to 12.4 Ghz

A counter/plug-in system makes automatic and direct-reading measurements in the range from 500 Mhz to 12.4 Ghz. The 5 1/4-in.-high portable instrument consists of a basic 50-Mhz or 100-Mhz counter and three interchangeable ACTO plug-ins that progressively extend the automatic measuring range of the counter from 500 Mhz to 12.4 Ghz.

When installed into the front plug-in area of the basic counter, the ACTO plug-in accepts an input signal, phase locks an harmonic of an internally swept oscillator and automatically adjusts the counter time base to achieve direct readout—everything from input to readout occurring within milliseconds.

Measurements that until now required tedious, time consuming calculations and numerous instrument adjustments that could only be performed by highly trained technical operators, can now be made by unskilled personnel. Operator errors are thus completely eliminated, and measurement time has been drastically reduced.

Frequency range for the model 1253 ACTO plug-in is 500 Mhz to 3,000 Mhz; for the model 1254, 2.96 Ghz to 8.2 Ghz; for the 1255, 8.2 Ghz to 12.4 Ghz. Prices are \$975; \$1,950; and \$1,975, respectively. Systron-Donner Corp., 888 Galindo St., Concord, Calif. [377]

Low-cost way to solid state



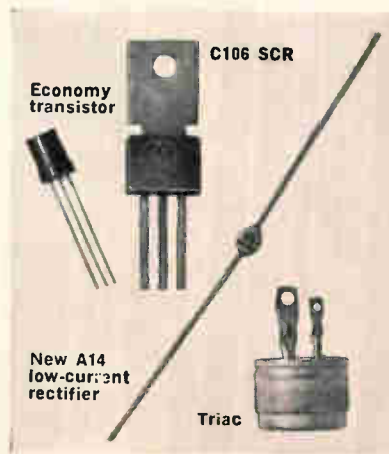
G-E economy line semiconductors

■ Today, low-cost solid state is a reality for dozens of applications never before thought possible. The reason: G-E economy line semiconductors.

Now, for under \$2.00, a single G-E Triac can control a 600-watt load. Yet, less than 10 years ago, it would have taken two \$145.00 SCR's.

G-E economy transistors cost as little as 15¢ each. Many high-sensitivity SCR's, less than half a dollar.

And today you can buy one kind of rectifier to perform a number of different functions. New G-E A14 rectifiers will work almost anywhere you



Actual size General Electric economy line semiconductors

need dependable, low-power rectification.

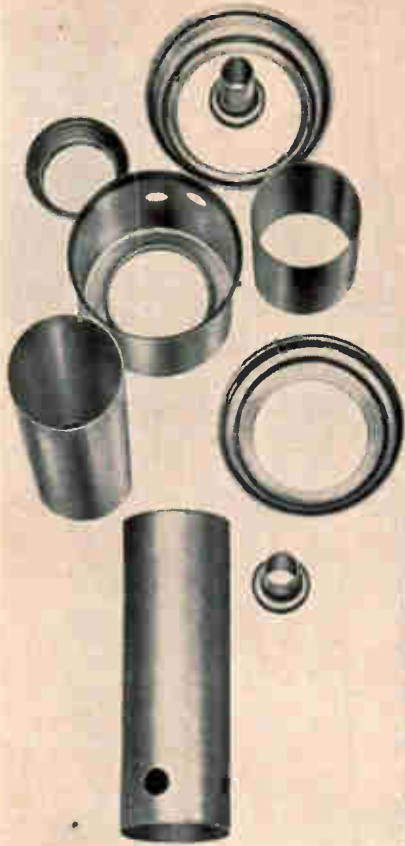
Surely you have at least one application problem that ought to be solved by low-cost solid state. Ask your G-E engineer/salesman or semiconductor distributor about it . . . and the application experts they can call on to help you.

Or write to Section 220-32, General Electric Company, Schenectady, N. Y. In Canada: Canadian General Electric, 189 Dufferin St., Toronto, Ont. Export: Electronic Component Sales, IGE Export Division, 159 Madison Ave., New York, N. Y.

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New Subassemblies and Systems

Phase shifters for i-f applications



A series of i-f variable phase shifters has been introduced for frequencies from 1 Mhz to 200 Mhz. The units are suited for phase control applications such as phased-array antenna steering, phase-coded secure communications equipment, as well as test and circuit applications in phase altering, balancing and restoration.

Designated series PSE, the phase shifter incorporates a completely reactive circuit featuring lumped element devices. Voltage-variable capacitors are employed to control desired phase shift electronically.

Three standard models at various center frequencies are available from stock: PSE-3-30 (30 Mhz), PSE-3-60 (60 Mhz) and PSE-3-70 (70 Mhz). Other frequencies up to 200 Mhz can be obtained on special order.

The phase shifters have typical bandwidths of 10% and can be biased to shift over the entire range from 0 to 180° (over insertion phase shift). Control voltage required to sweep the full 180° phase variation is 40 v (bias voltage). Rate of control is approximately 4.2° per volt with reasonable linearity.

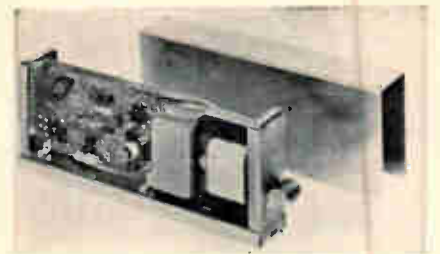
The impedance of standard PSE series is 50 ohms at each port with vswr discontinuities at less than 1.5:1. Impedance levels from 10 ohms to 200 ohms are readily available due to the flexibility of construction. Insertion losses are less than 1 db.

Standard units are terminated with two standard BNC connectors, but other connectors can be pro-

vided on request. All PSE series are housed in cases and standard packaging measures approximately 1 in. x 2 $\frac{5}{16}$ in. x 1 $\frac{7}{16}$ in. Miniaturized packages can be supplied at additional cost.

Merrimac Research and Development, Inc., 517 Lyons Ave., Irvington, N.J., 07111. [381]

Audio amplifier with FET design



The T-1108 audio amplifier is claimed to be the first professional device of its type to incorporate a field effect transistor. The unit, designed primarily as a microphone preamplifier, also doubles as a booster or line amplifier.

Use of an FET semiconductor in the input stage results in an exceptionally low noise figure (equivalent to an input of -124 dbm). The all solid state design also results in very low power drain, compact circuitry, and a high level of reliability. Other transistors in the amplifier are of the silicon-planar type, allowing the T-1108 to operate within specifications at temperatures up to +195°F.

The amplifier retains the envelopmental equalization concept pioneered by the company's 1008 amplifier. Envelopmental equalization is achieved by electronically enclosing an external passive equalizer within an active feedback loop of the amplifier; this allows the operator to boost or attenuate the T-1108 output at both high and low frequencies without loss or gain. In many cases, this feature of the T-1108 eliminates the need for an additional booster amplifier.

Another add-on accessory for the T-1108 is a plug-in unit that allows the input level to the first stage to be remotely adjusted when the am-

Soliton

announces

325_v

300_v

250_v

225_v

200_v

V_{CEO} (SUS)



*in a 10 Amp. NPN Silicon
Planar Power Transistor
Plus*

50 mcs ----- 150 pfs

Type Number	Pkg. Size	DESIGN LIMITS						PERFORMANCE SPECIFICATIONS					
		T _J	θ	P _T	BV _{CEO}	V _{CEO} (SUS)	BV _{EB0}	h _{FE}		V _{BE} (sat)	V _{CE} (sat)	I _{CBO}	f _T
		°C	°C/W	Watts	Volts	Volts	Volts	@I _C = 5A V _{CE} = 5V		Volts	Volts	μA	mc
		Max.	Max.	Max.	Min.	Min.	Min.	Min.	Max.	Max.	Max.	Max.	Min.
MHT7801	TO-61	200	2	50	225	200	8	20	60	1.2	0.50	1.0	50
MHT7802	TO-61	200	2	50	250	225	8	20	60	1.2	0.50	1.0	50
MHT7803	TO-61	200	2	50	275	250	8	20	60	1.2	0.50	1.0	50
MHT7804	TO-61	200	2	50	325	300	8	20	60	1.2	0.50	1.0	50
MHT7805	TO-61	200	2	50	350	325	8	20	60	1.2	0.50	1.0	50

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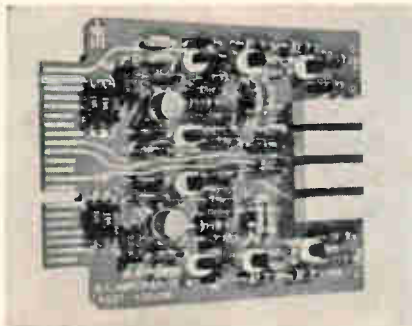
New Subassemblies

plifier is used with high-level sources, such as capacitor microphones. No pads are required to protect against overloads.

The T-1108 is only $1\frac{1}{2}$ in. wide, permitting it to be mounted in line with conventional vertical faders. Height of the unit is 3 in. and depth is $9\frac{1}{4}$ in. The unit is provided with a dust cover and is normally mounted in an accessory tray provided with a printed-circuit connector.

Universal Audio Products, 11922 Valerio St., North Hollywood, Calif. [382]

D-c amplifiers with 0.1% linearity



The DCA-10 d-c amplifier, priced at \$135 per pair, employs all-silicon semiconductors mounted on a single 3 in. x 5 in. etched circuit card. It has numerous applications as a summing amplifier, integrating amplifier or buffer amplifier in computer and system circuitry. Both inverting and noninverting inputs are available at the connector, which mates with Burndy connector PB4D2D22-1. The amplifier input node is available at the connector for use as a summing node.

Linearity of the DCA-10 is 0.1%. Open-loop gain is approximately 60 db. Closed-loop frequency response is 5 Mhz (1:1 gain). Input impedance is 10,000 ohm; the summing node allows a choice of other input resistances with a proportionate decrease in closed-loop response.

Slewing rate is 10 v per $0.2 \mu\text{sec}$, with a settling time, to 1%, within 300 nsec. Temperature drift is only 2 mv per $^{\circ}\text{C}$ over an operating temperature range from 0 to $+55^{\circ}\text{C}$.

The output level of the DCA-10

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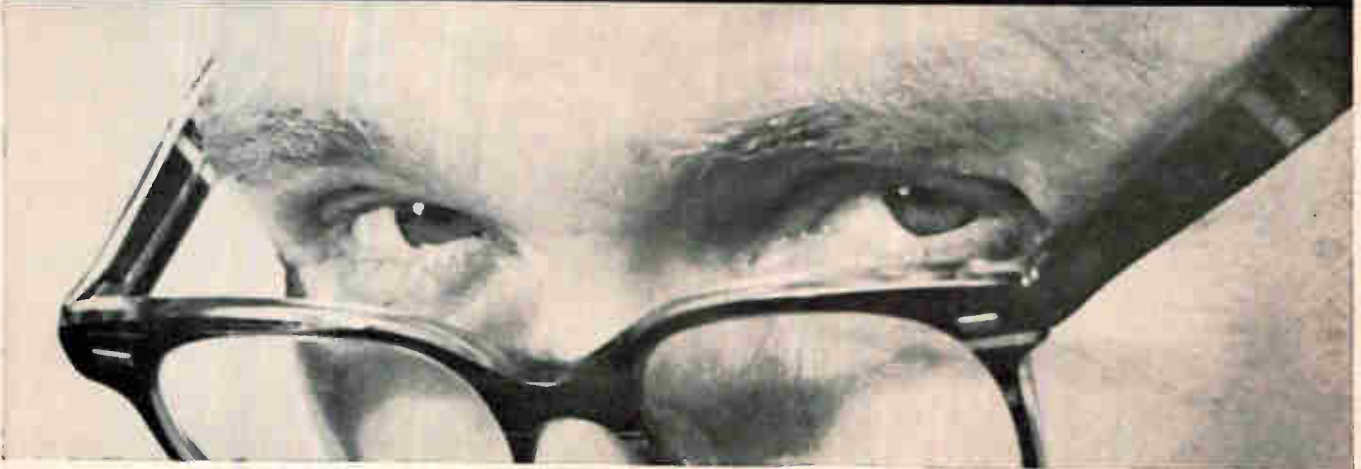
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New Subassemblies

is a 20-v swing, from +10 v to -10 v. Output is 20 ma at 10 v. Offset and gain are both screw-driver-adjustable; offset from +4 to -4 v, gain from ± 1 v to ± 10 v. Elpac Systems division, Elpac, Inc., 3760 Campus Drive, Newport Beach, Calif., 92660. [383]

Constant current power supplies



Miniaturized, programable constant current power supplies have been announced. There are four units in the series, and they can be programmed remotely to fulfill the need for constant current applications from 100 μ a to 1 ampere.

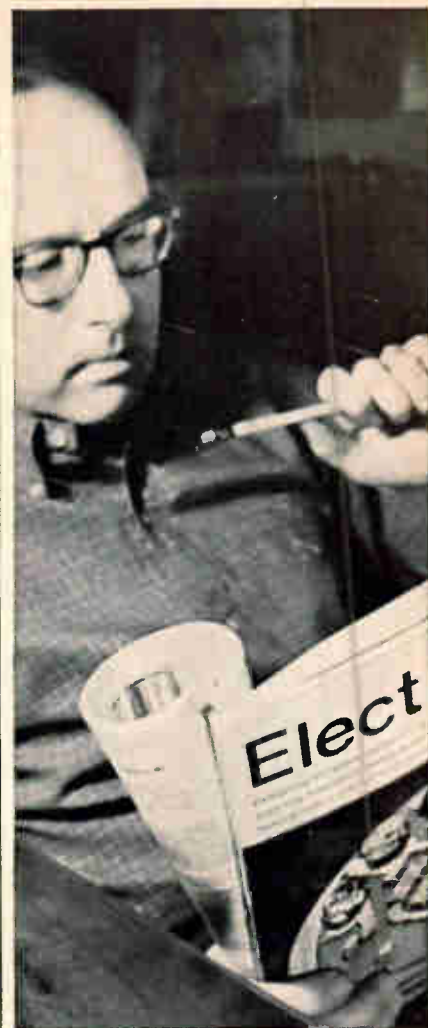
The power supplies employ unique solid state circuit principles, according to the manufacturer, to provide constant currents programable with external resistances to the desired level. The high stability of the units insures drift-free operation.

Designated CCP series, the supplies have been employed in systems to provide the stimulus for measuring resistance to 0.04% accuracy in a fraction of the previously required space.

Sparton Southwest, Inc., P.O. Box 1784, Albuquerque, N.M. [384]

Power supplies offer minimum ripple

A series of low-cost power supplies has been introduced in 13 standard sizes. The LX series units were designed to replace conventional ferroresonant power supplies now widely in use. An important feature is the 1% load regulation characteristic which is of particular significance in microelectronic circuit applications requiring large cur-



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home

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Electronics

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Electronics | June 27, 1966

rents at low voltages (4 to 5 v d-c). Crowbar over-voltage protection is available as an optional feature.

The units are frequency insensitive over a range from 47 to 63 hz and have an output voltage adjustability of $\pm 3\%$. At 6.3-v output the units have a ripple of 150 mv rms, less than one-half that of competitive supplies, according to the manufacturer.

Input frequency regulation is $\pm 2\%$ compared to $\pm 12\%$ for other units. Line transient response is 50 μ sec, which is 1/500th the response time of typical ferroresonant supplies.

The LX power supply series measures approximately 4 in. x 6 in. x 13 in. and weighs 14 lbs. Single units are priced at \$125; quantity prices are lower. Delivery is immediate.

Wanlass Electric Co., 2189 South Grand Ave., Santa Ana, Calif. [385]

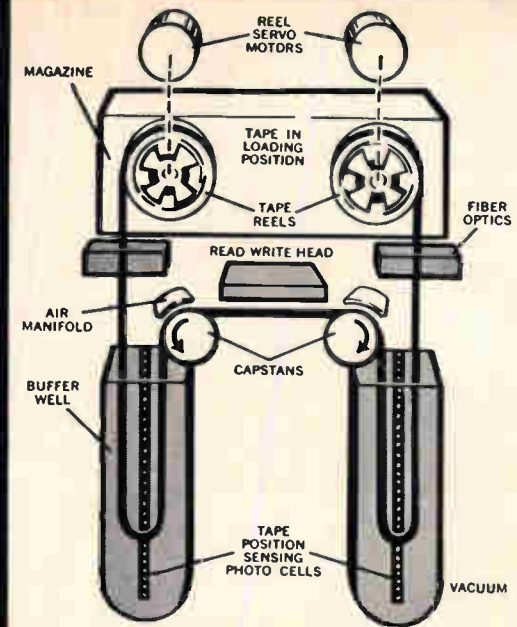
General-purpose discriminator/trigger



The T101 discriminator/trigger has been added to the M100 modular counting system. This general-purpose, direct-coupled module can operate at duty factors up to 100%. It has dual complementary output, as well as dual normal outputs, to facilitate veto logic.

The new module has a scaler output and an operation light which flashes for a minimum of 200 nsec for each triggering and glows steadily at rates above 5 pps. EG&G, Inc., 35 Congress St., Salem, Mass., 01971. [386]

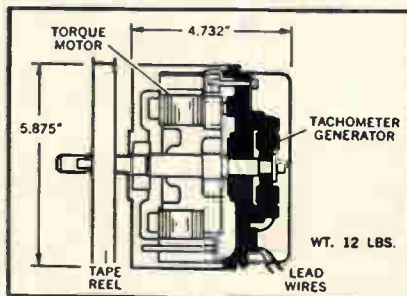
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Inland's Standard DC Direct-drive Torque Motors Solve MOBIDIC Tape Transport Problems

Faced with meeting the rugged requirements of military operation, Sylvania's Electronic Systems Division of General Telephone & Electronics Corp.



turned from conventional tape transport designs and developed a unique militarized system capable of optimum tape handling without damage or distortion. This modern, miniaturized design provides rapid reversal (less than 6 milliseconds) so programming is not restricted, high controlled acceleration and deceleration, (empty reel: 570 rad/sec², full reel: 270 rad/sec²), wide dynamic speed ranges (1000/1).

Sound impossible? Not to Inland Motor. Inland's standard Model TT-4005,

tachometer generator-torque motor combination surpasses these performance requirements. Featuring a peak torque output of 3.5 lb.-ft., the DC direct-drive torque motor, with damping enhanced by a DC directly-driven tachometer generator, furnished the linear speed/torque characteristics required over these ranges. Easily controlled by current limiting, it also provided the desired acceleration. Dynamic braking assisted the quick reversal. Since it was direct-drive, the operation was smooth and back-lash free.

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New Microwave

Varactor multipliers cover broad band



Broad, instantaneous bandwidth, from 3 to 15% over a frequency range of 300 Mhz to 6 Ghz, is an outstanding characteristic of these solid state stripline varactor multipliers. Conversion loss is held to a minimum. Typical values are 2.8 db at 5%, 3.5 db at 10%, and 7 db at 15% bandwidth.

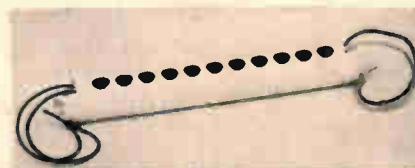
Spurious oscillations are held to an absolute minimum. With a clean input signal within the multiplication band of these components, spurious signals are typically -27 to -30 db.

Each varactor multiplier is internally biased and fixed tuned, so that installation consists only of inserting the r-f input and obtaining twice the frequency at the output, with trouble-free operation and no significant degradation of electrical characteristics during years of continuous duty.

Stripline construction with a durable epoxy finish, withstands extreme vibration, shock and other severe environments.

Microwave department, Elpac Systems division, Elpac, Inc., 3760 Campus Drive, Newport Beach, Calif. [391]

Traveling-wave tube provides 28-db gain

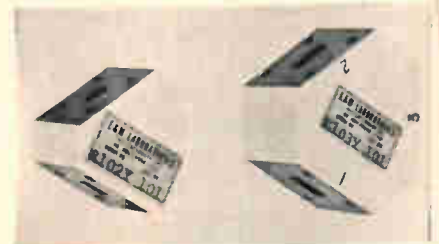


The MA-2028 traveling-wave tube covers a full octave from 450 to 900 Mhz. It provides 28-db gain in a 13 in. x 1.8 in. package. Saturated

power output is 10 watts.

Other features of this twt include a hollow electron beam, advanced mechanical and thermal design and precise solenoid-controlled beam, providing reliable and efficient performance in an extremely compact package. The tube is adaptable for operation as a driver in broadband electronic countermeasure systems and as an amplifier in test equipment. Microwave Associates, Inc., Burlington, Mass. [392]

Waveguide circulators span 20 to 36 Ghz



Waveguide circulators are available covering the frequency range of 20 to 36 Ghz. Three models are offered in both RG-53/U and RG-96/U waveguide. Featured are 2 Ghz bandwidths with 20-db minimum isolation, 0.5-db maximum insertion loss and 1.20 maximum vswr.

Designed primarily for use in solid state duplexing and parametric amplifier systems, these models can also be supplied modified for use as low-loss terminated circulators and switches.

Price is available on request. Delivery is 30 to 45 days after receipt of order.

E&M Laboratories, 7419 Greenbush Ave., North Hollywood, Calif. [393]

Microwave amplifier uses transistors

The TA1300-15 is a compact, lightweight, microwave transistor amplifier that can handle higher power than available low-noise microwave amplifiers, according to the manufacturer. It can be easily packaged

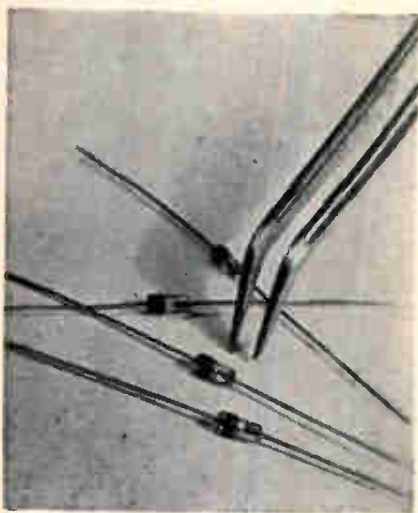


with a small mixer preamplifier for a complete miniature low-noise receiver.

Center frequency is 1.3 Ghz; bandwidth, 300 Mhz; and noise figure, 4.0 db maximum. Input signal 1 db compression level equals -25 dbm. Size is 7/8 x 2 x 3 in. Connectors are standard coaxial.

Additional specifications include: gain, 15 db; input-output impedance (nominal), 50 ohms; d-c power, ± 12 v; and current, 20 ma. International Microwave Corp., River Road, Cos Cob, Conn., 06807. [394]

Microwave diodes offer fast switching



A series of fast-switching microwave silicon diodes is designed to meet the requirements of high-speed, low-loss switch applications at frequencies up to and including Ku band.

Model MO2800A of the 2800 series features a forward switching time of 1 nsec maximum, total capacitance of 0.10 pf maximum, voltage breakdown of 80 v minimum, and dynamic forward impedance of 3 ohms maximum.

The package style of this model

microwave acoustic delay lines a practical reality from MEC



S band delay line

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For example: In L and S bands 1000 MHz bandwidth is "real world" at MEC.

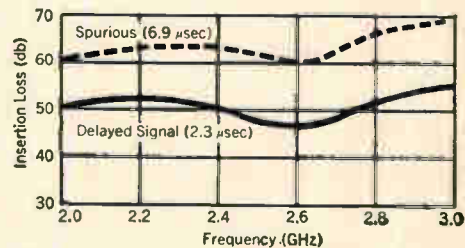
Fixed delays between .5 and 5 μ sec. can be specified in L, S, or C band.

Insertion losses of less than 70 db are standard in C band; in other ranges the loss is correspondingly less. Across 10% of L band losses are 25 db or lower.

Applications? Some of our customers have used them in altimeters, ECM systems, radar ranging systems, and for standard two-port memory and signal delay.

Whether you want octave bandwidth in L band, or wide-band coverage at higher frequencies, call MEC. We've got the capability and experience to talk microwave acoustics, and the data to back it up.

Exceptional opportunities on our technical staff for qualified engineers and scientists. An equal opportunity employer.



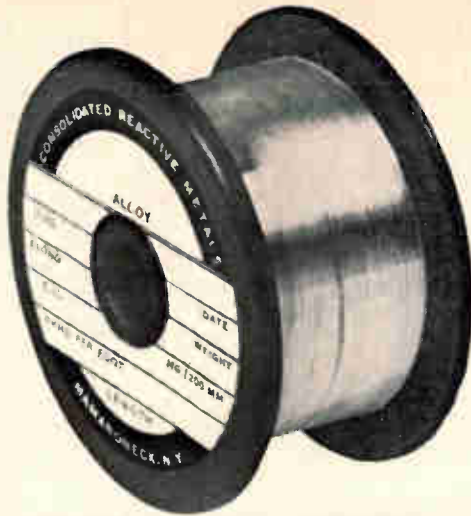
S band performance characteristics, M7032



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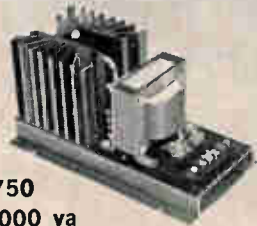
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Alpha Industries, Inc., MicroOptics di-
vision, Newton Upper Falls, Mass.,
02164. [395]

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Other models are available to
dissipate 10, 100 and 500 watts
continuously.

Electro Impulse Laboratory, 208 River
St., Red Bank, N.J., 07701. [396]

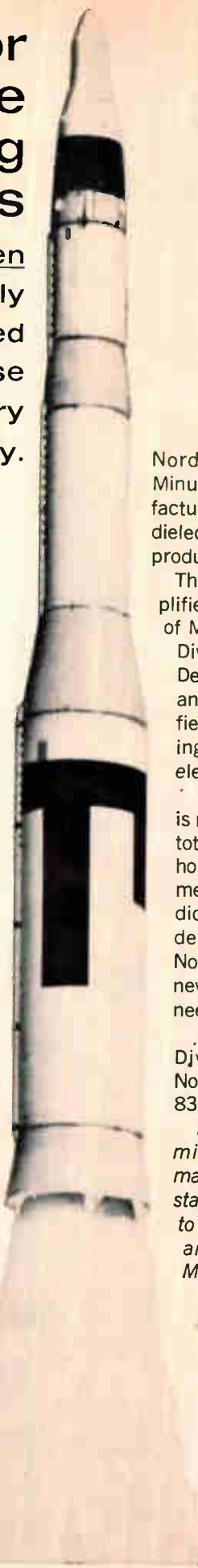
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Because of its growing role in the microcircuitry field, Norden has many openings for qualified solid state engineers. Send your resume to Personnel Department, Norden, an equal opportunity employer, M&F.

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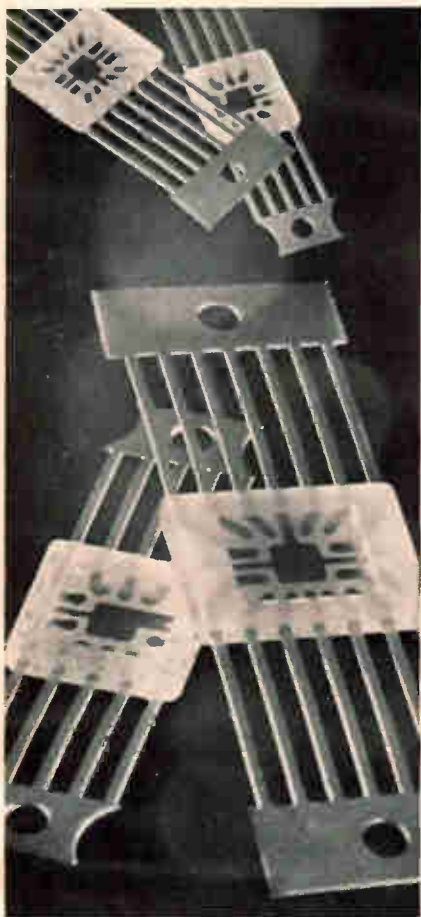
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Norden — supplier to the Minuteman
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The shape of tomorrow, today

For more than 20 years, Ultra Carbon consistently has provided industry with advanced graphite technology. "F" purity graphite for the AEC... semiconductor crystal crucibles, boats, headers and fixtures made from *Ultra purity* graphite—these are typical of our past contributions to the electronic industries.



ULTRA/FGP® flat glass packs for integrated circuits in 14 lead $\frac{1}{4} \times \frac{3}{8}$ inch and 10 lead $\frac{1}{4} \times \frac{1}{4}$ inch are now in production. Write Ultra Carbon Corporation, Box 747, Bay City, Michigan 48709.

New Production Equipment

Ultrasonic device cleans components



In a clear example of serendipity, Bausch & Lomb Inc., is marketing an ultrasonic device to clean electronic switches, diodes and semiconductors. Because its customers, opticians and ophthalmologists, were seeking a low-cost, efficient method of cleaning eyeglasses to replace manual cleaning, Bausch & Lomb asked the Crest Ultrasonics Corp. of Trenton, N. J. to solve the problem. Crest came up with a unit called the "Balsonic" that costs \$124.50 and Bausch & Lomb is now offering it to the electronics industry.

The machine can also be used to clean dies, molds, and small instruments and tools.

According to Crest this is the first small-size ultrasonic cleaner with simultaneous multiple-frequency output. It has six frequencies; the lowest 20 kilohertz, the highest 90 khz.

E. G. Cook, president of Crest, explains there are two reasons why the multiple-frequency feature is desirable. The first is low cost; the unit is simpler than a single-frequency cleaner that requires a filter (the Balsonic has only 12 basic components). The second reason is that simultaneous multiple frequencies clean better than one because the higher ultrasonic frequencies produce very small (microscopic) cavitating bubbles which penetrate small cracks and crevices. The lower frequencies

produce larger, but still microscopic, bubbles with more power to blast away the dirt loosened by the smaller bubbles. For most objects, all these bubbles do their work in less than a minute.

The Balsonic is encased in a tough, durable plastic and has a $7\frac{1}{2}$ by $3\frac{1}{2}$ by $2\frac{1}{2}$ -inch stainless steel tank. Chlorine-solution solvents aren't recommended, and the unit cannot be used to clean carbonous materials which need an acid bath.

The fully automatic machine has a simple on-off switch and warms up in 20 seconds.

Specifications

Power input	115 v, 50-60 hz
Rated output	About 50 w
Delivery	Immediate in the East. A few weeks in Midwest and West

Optical Machinery Dept., Bausch & Lomb Inc., Rochester, N.Y. 14602 [401]

Hand-operated device bends component leads

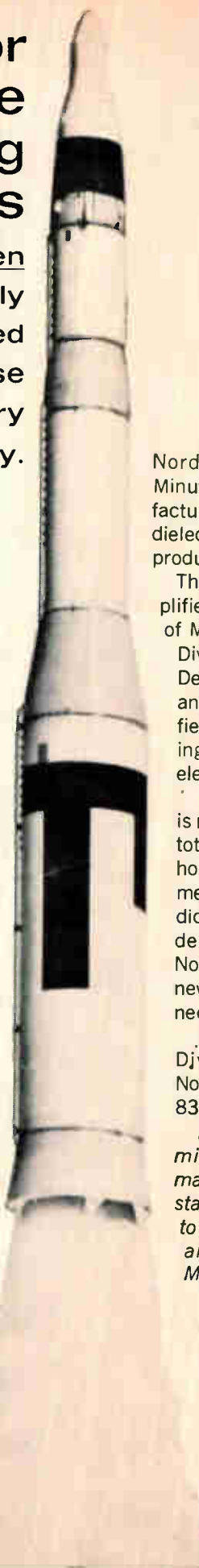
Model 100B is a hand-operated device designed to produce extremely accurate bends in multiple lead components. The machine will handle up to 600 components per hour including flatpacks, reed relays, diodes, miniature electrolytic capacitors and other components. Components as long as 1 in. and with virtually any number of leads can be accommodated. The lead bender is designed to fill the gap between simple hand bending and highly automated machine bending.

Adjustable and interchangeable dies are available to perform bends on virtually any center-to-center spacing. Dies for Military and NASA type and commercial bends are stock and considered standard. Custom bends and dies for special spacings can be supplied to customer specifications.

D. Vel Research Laboratories, Inc., 555 Bedford Rd., Bedford Hills, N.Y., 10507. [402]

For the big programs

... only Norden
can supply
advanced
special-purpose
microcircuitry
routinely.



Norden, a qualified supplier to the Minuteman program, is the first manufacturer of integrated circuits to supply dielectrically-isolated units on a routine production basis.

These units are general purpose amplifiers used in the electronic systems of Minuteman missiles by Autonetics Division, North American Aviation. Designed to increase performance and reliability, these unique amplifiers resulted from new manufacturing techniques which isolate active elements on the integrated circuits.

Our leadership in manufacturing is matched by our ability to produce totally new circuitry in a matter of hours—by converting design requirements into hardware with master dice breadboards. Computer-aided design techniques developed by Norden are another guarantee that new circuitry will match your exact needs for advanced equipment.

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FIG. II

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PART NO.	A	B	C	E	F
35 5054	HI	547	.422	2	100
35 5253	HI	671	945		180 170 972
35 5081	H	1.043	872		120 250 781 1.375
35 5111	HI	1.000	830		18 225 290 612 1.18

This is a typical sheet from Latronics new catalog on Ceramic and Glass-to-Metal Seals.

SEND for Latronics Catalog 100-266-1.

Latronics Corporation

995 Lloyd Avenue, Latrobe, Pa. 15650 • Phone 412-539-1626 • TWX 412-594-7857

Circle 455 on reader service card

New Microwave

coupled, is 18 in. long, and weighs 6 lbs. It operates with depressed collector in MIL-E-5400 Class II environments, and will deliver rated performance with heat sink temperatures up to 100°C.

The vacuum envelope is of metal-ceramic construction, and the integral ppm focusing assembly is magnetically shielded. Versions of these tubes can be supplied for air, liquid or conduction cooling.

The tube was developed to satisfy requirements for high average-power microwave tubes in military electronic warfare systems, microwave communications systems, or laboratory power amplifiers.

Microwave Electronics, 3165 Porter Drive, Palo Alto, Calif., 94304. [397]

Continuously variable coaxial attenuator

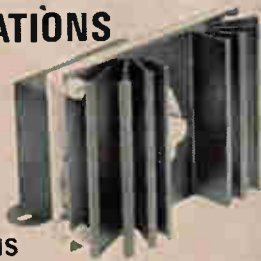


Model 3704-10B coaxial variable attenuator will withstand up to 100 w average power and 10,000 w peak. It will provide continuously variable attenuation for high-power transmitters. This device obviates the need for couplers, high-power terminations, mechanical switches, lengths of lossy cable, and other equipment that up to now has been utilized to vary transmitter power in discrete steps, at higher cost, while using much more space.

Frequency range is 1.35 to 1.45 Ghz; attenuation range, 0 to 10 db minimum; attenuation vs frequency, flat to within ± 0.25 db; maximum insertion loss, 0.6 db; maximum vswr, 1.50. Connectors are type N female. The unit measures 5 in. in diameter.

Models are also available in other attenuation values and fre-

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NOW... TRUE 0.5% RMS LINE-LOAD REGULATION WITH 50 MICROSECOND RESPONSE AND 47-63 CYCLE OPERATION

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quency bands. Prices range from approximately \$500. Delivery is 6 to 8 weeks.

Antenna & Radome Research Associates, Inc., 27 Bond St., Westbury, N.Y., 11590. [398]

Single reversal twt amplifier

The WJ-403 is a low-noise, single-reversal, permanent magnet twt amplifier for the 8 to 12-GHz range. The tube, a rectangular, easy-to-stack package, marks a departure from the cylindrical shape of the company's twt amplifiers in the past. Features include integral power supply and simple connection to any power outlet.

Guaranteed specifications include 9-db maximum noise figure, 25-db minimum gain (small signal), 13-dbm minimum power output and 2:1 maximum vswr (input and output). Primary voltage is 115 ± 3 v a-c. Dimensions are 10.5 x 3 x 3 in., and weight is 8 lbs.

Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. [399]

Turret attenuator covers 0 to 50 db

A wide-range turret attenuator, model RA-54, covers a range of 0 to 50 db in 1-db steps. The unique dial arrangement digitally displays the total attenuation.

The RA-54 is a miniature, dual-concentric, rotary attenuator. Each of the dual rotors is adjustable independently. One rotor provides 0 to 40 db attenuation in 10-db steps, while the other rotor provides 0 to 10 db in 1-db steps for a total of 50 db.

The new attenuator measures $1\frac{1}{8}$ in. in diameter x $3\frac{3}{4}$ in. long, and weighs less than 14 oz. It provides an accuracy of better than ± 0.5 db at 500 Mhz, ± 1 db at 1 Ghz, and ± 1.5 db at 1.5 Ghz. Vswr is less than 1.25 and insertion loss is less than 0.3 db at 1 Ghz.

The unit can be supplied with BNC, TNC, or type N connectors and is priced at \$165. Delivery is two to three weeks.

Texscan Corp., 51 South Kowebe Lane, Indianapolis, Ind. [400]



Mark II Series 300 and Series 350

SIZE DOWN. PERFORMANCE UP!

Our new one-inch 6PDT and 4PDT relays give you established dry-circuit reliability

Electro-Tec's wedge-action contact mechanism* has been proving itself in conventional 6PDT operations for 9 years. It's established an outstanding dry-circuit confidence level of 90% based on a failure rate of .001% per 10,000 operations. Now we've put wedge-action to work in two 1" x 1" miniature relays, the Series 300 (6PDT) and Series 350 (4PDT). The Series 300 will replace three half-size crystal-can relays in approximately the same space while giving you the advantage of a proven reliability factor. Wedge-action, precious metal contacts combine long contact wipe area with high contact force. Results? Low, low contact resistance, stable over operating life. Extreme shock, vibration, and acceleration immunity. Performance exceeds all MIL-R-5757/1 and /7 requirements. Competitively priced, with in-house testing to your high-rel specifications.

*U.S. Patent No. 2,866,046 and others pending.

CHARACTERISTIC PERFORMANCE DATA

Contact Rating: Low-level to 2 amps
Operate and Release Time: 10 ms max. @ 26.5 VDC and 25°C
Contact Bounce: 1 ms max. even at low-level loads
Shock: 100G—11 ± 1 ms Vibration: 30G up to 3000 cps



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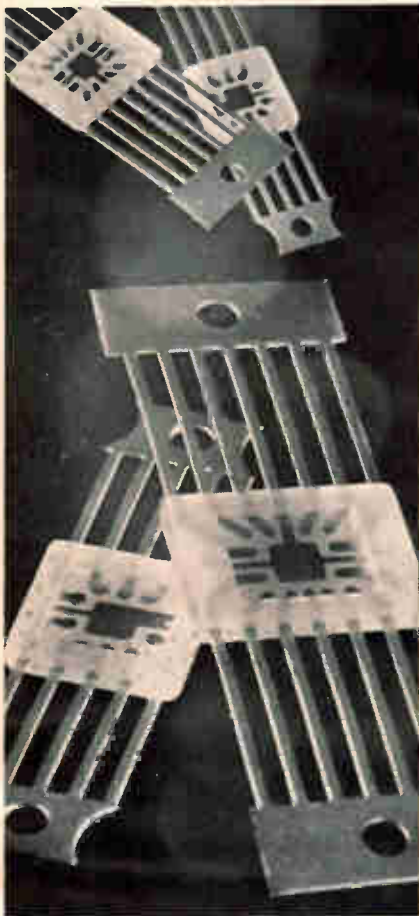
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(904) 677-1771 • TWX 810-857-0305

Manufacturing facilities: Ormond Beach, Fla. • Blacksburg, Va.



The shape of tomorrow, today

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Optical Machinery Dept., Bausch & Lomb Inc., Rochester, N.Y. 14602 [401]

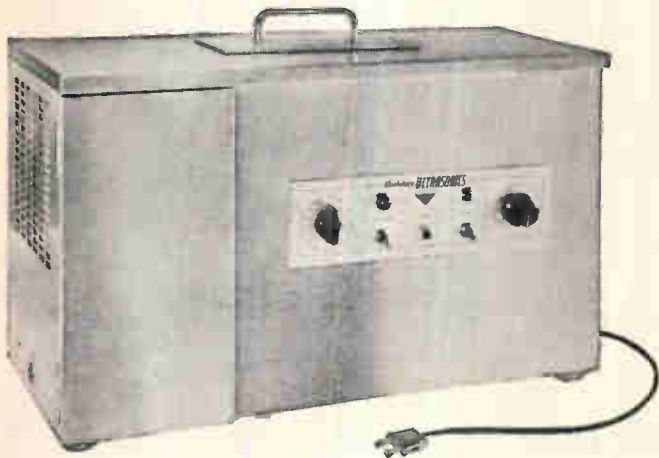
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D. Vel Research Laboratories, Inc., 555 Bedford Rd., Bedford Hills, N.Y., 10507. [402]

It's easy to put vapor rinse and ultrasonic cleaning at every work station.



All it takes is 110 volts and Blackstone's new VRO.

Just plug VRO into the handiest outlet. It's at the worker's elbow ready to clean each subassembly that passes the work-station.

VRO requires no water, no drains, no hoods because it has its own built-in refrigeration system. And it can't waste solvent because the cooling system condenses the solvent and returns it to the tank. And it can't waste time while parts are trotted to central cleaning stations.

You get ultrasonic cleaning, followed by jet spray rinsing, followed by rinsing in pure distilled solvent vapors. And VRO does it all without special maintenance. It gets along on a dipper-full of solvent and conserves that by constantly filtering and re-distilling it.

Look at it this way. If you're making something that can be ultrasonically cleaned at 21,000 cycles, in a tank 4" x 4" x 3" deep, in any of the DuPont "Freon" Solvents, with particulate matter controlled down to 1 micron... then the Blackstone VRO can probably save you production time and white room space.

VRO's tank and exposed housing areas are 316L stainless steel; it uses a new high efficiency lead zirconate titanate transducer with an extremely reliable method of metallurgical attachment to the tank, guaranteed against failure; provides 0 to 100% power control, automatic timers and thermostatically controlled heaters.

Any other questions about VRO or any of the many other kinds of ultrasonic cleaning equipment Blackstone makes? If so, ask us. We'll be glad to hear from you.



BLACKSTONE ULTRASONICS, INC.

1400 Howard Street • Sheffield, Pa.

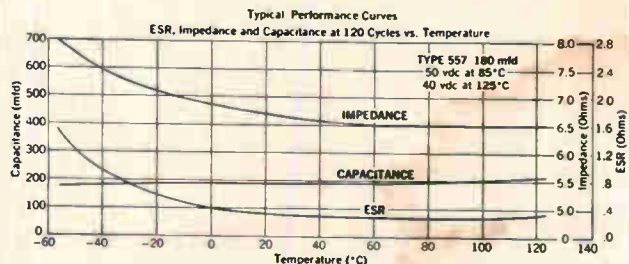
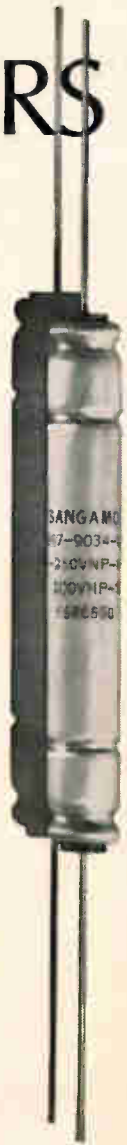
Circle 454 on reader service card

NEWS FOR DESIGNERS

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The new, wider range is accomplished by vacuum impregnating the capacitor with an exclusive Sangamo electrolyte. Built in accordance with MIL-C-39018, Type 557 provides these additional benefits:

- Voltage ratings up to 250 VDC at 85°C or 200 VDC at 125°C. ■ Both positive and negative leads and tab connections are welded to prevent open circuits and high contact resistance.
- Electrical characteristics comparable to tantalum foil capacitors.



Write for Bulletin 2240 detailing Type 557 specifications.

SANGAMO ELECTRIC COMPANY
Pickens, South Carolina



EC66-3

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Typical CAPITRON* CRT regulated high voltage supply. Other sizes available.

Outstanding performance from a dual output supply. Modularized solid state circuitry for efficient, continuous operation in a minimum of space. Rugged construction meets military vibration, shock, and altitude tests.

Specifications in brief: Input — -18 VDC $\pm 1\%$; Output 1 — +14 KVDC, 400 μa , 0.1% max. pk-pk ripple; $\pm 0.1\%$ regulation 0 to full load; Output 2 — +500 VDC, 1.0 ma, .05% max. pk-pk ripple; $\pm 0.1\%$ regulation 0 to full load; Size — 7" x 5" x 4"; Weight — 8 lbs.

AMP's CAPITRON Division is a leading producer of custom-engineered high voltage and low voltage power supplies, airborne radar systems and components, and high voltage lead assemblies and wafer capacitors.

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AMP INCORPORATED

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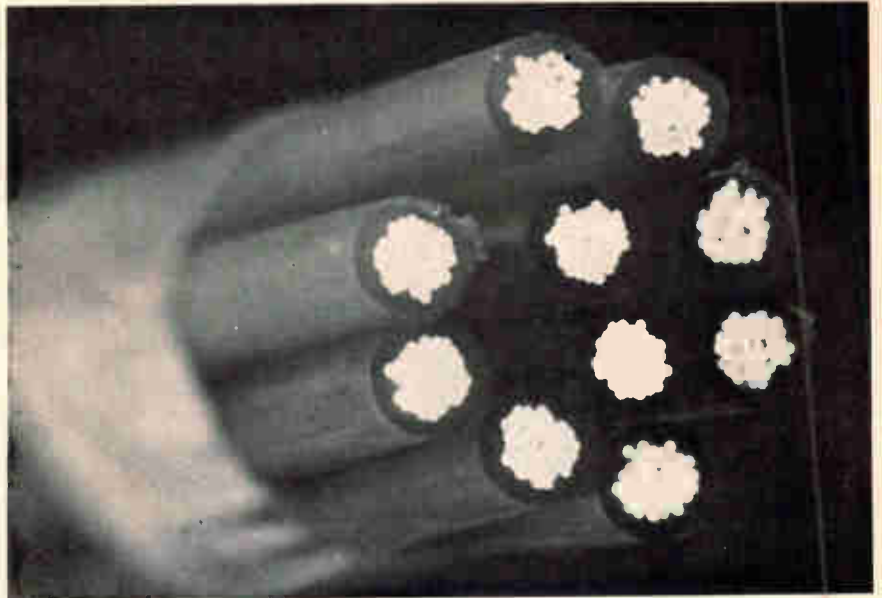
155 Park St., Elizabethtown, Pa. 17022
TWX: 717-330-4560 Phone: 717-367-1105

CAPITRON products and engineering assistance are available in Canada through Aircraft-Marine Products Ltd., Ontario, Canada

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New Materials

Plastic pipes cut cost of bending light



Plastic light pipes said to be tougher and more flexible than comparable glass counterparts have been developed by E.I. du Pont de Nemours & Co. The light guides, called Crofon, can be made in almost any length, and processed by automated manufacturing equipment.

The plastic pipes will make their commercial debut in the dashboard lighting systems of some 1967 General Motors Corp. cars. Other applications could include low-level illumination in relatively inaccessible areas, and sensing, signaling and monitoring in appliances, vending machines, toys, communications and medical equipment.

In all optical fibers, light is confined to a zigzag path within a transparent core by internal reflections from a surrounding medium with a lower index of refraction. Du Pont's fibers have a core of Lucite, a polymethyl methacrylate, and are sheathed with another plastic that the company is keeping secret. Each fiber is 10 mils in diameter and they are bundled together in units of 16, 32, 48 and 64, and surrounded by a jacket of polyethylene resin called Alathon. Direct cost comparisons between

the plastic light pipes and their glass counterparts are not possible because Du Pont sells only the light guides while most manufacturers of glass optical fibers sell complete assemblies. Du Pont claims, however, that Crofon's adaptability to automated processing will open up areas of applications previously barred by the high cost of glass fiber assemblies.

Crofon is currently available in limited quantities, with commercial production expected in 1967. The minimum order is 200 feet, and all sizes in quantities under 1,000 feet cost 50 cents a ft. Prices range from 10 cents a ft. for 16-fiber bundles in quantities of 50,000 ft. or more to 24 cents a ft. for a 1,000-ft., 64-fiber bundle.

Specifications

Operating temperature range	-40° to 175° F
Breaking strength	
16-fiber	22 lb.
32-fiber	42 lb.
48-fiber	56 lb.
64-fiber	70 lb.
Bending radius	
16-fiber	1/4 in.
32-fiber	3/8 in.
48-fiber	1/2 in.
64-fiber	3/4 in.

E. I. du Pont de Nemours & Co., Wilmington, Del. 19898 [406]

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Allen Frequency Sources Types C and P (plug-in type)

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Allen Toroids

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Utilize latest developments in solid-state technology. They demonstrate characteristics normally associated with such circuitry (compact design, low heat dissipation). High sensitivity, conservatively rated.

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Circle 452 on reader service card



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Both Type CMM and Type CLL motors are available with a high quality planetary geartrain offering 83 ratios from 4:1 to 46,656:1 with torques from 3.0 to 1000 oz. in. Motors and gearmotors operate on 6 to 75 v.d.c. Request Bulletin CMM-CLL.

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Dayton, Ohio 45404, U.S.A., Tel.: 513 222-3741

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subminiature toggle switches (one of the smallest made in America!) provide maximum reliable performance in a tiny but precisely fabricated component!

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subminiature toggle switches will meet high reliability standards in a wide range of ground/aero-space applications where the utilization of small space is a positive requirement!

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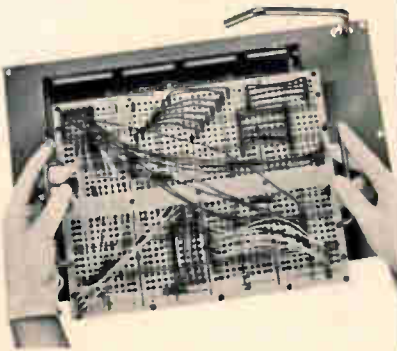
Circle 185 on reader service card

185

VECTOR

Pre-Programming PATCHBOARDS

save switching seconds



Single Lever Control switches up to 1200 contacts in under 5 seconds.

■ Hundreds of uses for these handsome low cost units. On test and control equipment, digital and analog computers, data processing equipment... wherever large numbers of contacts must be quickly changed.

■ A size for every need — Standard units have 204, 300, 450, 600, or 1200 contacts. May be ganged or stacked for added capacity.

■ Sleek, modern design enhances the appearance of any equipment. Patch panels fit into frame recess for flush mounting. Rugged frame and precision manufacture assure perfect alignment of removable panel and frame.

■ Low noise contacts — Plugs are forced against the beryllium gold-plated contact springs with 6 to 14 ozs. of pressure, assuring positive contact reliability.

■ Solderless slip-on lead connections speed backboard wiring. Leads may also be soldered or wire-wrapped.

■ Free! Patch panel PROGRAM PLANNING SHEETS, suitable for reproduction, available without charge.



■ New! Stackable cords for greater programming versatility. Full line of single and multiple, color-coded cords are available.

■ Lower cost fixed panel boards also available in seven standard sizes from 10 to 300 contacts.



For complete information contact:

Vector 

ELECTRONIC COMPANY, INC.
1100 Flower Street, Glendale, California

New Books

Semiconductors

Space Charge Conduction Solids
R.H. Tredgold
American Elsevier Publishing Co.,
143 pp., \$10

An author who tries to write a useful theoretical book in a developing field where an adequate theoretical approach does not yet exist faces an insurmountable task. It isn't too surprising then that this book is more like an annotated bibliography than a textbook. The book, however, does compile the existing theory in an attempt to explain conduction of unneutralized charges through insulators and large-gap semiconductors.

In the preface, the author states that he has "done [his] best to avoid the air of omniscience which it is fashionable to affect in much of the current literature." To the engineer who possesses a background equivalent to that of the author, (but then—why buy the book?), this fact will be appreciated. To the less initiated, it may appear to be the book's chief fault.

Little advance warning is given of the importance or relevance of each topic, and frequently there is no conclusion regarding the usefulness of a given procedure. A succession of possible theoretical explanations is given (generally prior to presenting the relevant experimental data) with relatively equal emphasis; therefore, the book cannot be scanned or read selectively.

The author also has complicated the problem for the reader by heavily referencing his own and other authors' works on complex materials, such as cadmium sulfide and barium titanate, with little attention to the elemental materials such as germanium and silicon, where reasonable correlation with theory has been obtained.

Little emphasis has been given to the early work of Shockley and Prim, Dacey and Larabee on germanium. The bibliography is approximately one and one-half years old, except for the author's references to his own work. This means that important later works are missing, such as Mayer et al on double injection in silicon and Gregory

and Jordon (Physical Review, 1964) on silicon.

In the first chapter, the author discusses in detail a number of explanations for the low conductivity of semi-insulating materials, including possible reasons for very low mobility and/or a reduction in carrier density due to autocompensation of impurities. The author indicates that in many cases the explanations are not satisfactory or that the results are not applicable. He then notes the unpredictable effects of work functions, surface states and impurities on the potential barrier at the contact-insulator surface.

In the remainder of the text, the author presents a number of mathematical models describing increasingly complex variations of space-charge limited current with material constants, voltage and temperature. Starting with the simplest situation involving a semiconductor with electron conduction only, solutions are derived, first, for the case where the current is governed solely by the applied field; and, second, where both the field and the minority-carrier diffusion are active. Separate results are also obtained for cases involving shallow and deep donors and acceptors. Predicted current and voltage characteristics are given for barium titanate and cadmium sulfide. The important theoretical work of Lambert, as well as that of numerous other authors, is considered throughout.

Experimental results for barium titanate, cadmium sulfide and anthracene are presented midway through the book along with references to studies of several other materials. The more practical-minded reader will be more likely to persevere through the earlier portions of the book if he reads these sections first.

In subsequent chapters, consideration is given to the case where both kinds of charge carriers are present, with electrical, optical or thermal injection. This model is related to observations in p-i-n diodes in gallium arsenide, silicon and germanium, as well as cadmium sulfide layers having different

cathode and anode materials. A solution to the problem involving current flow under pulse conditions is also given.

In the conclusion, Tredgold provides a brief description of practical areas where space-charge conduction is believed to be an important mechanism. These include breakdown effects in insulators, the possibility of constructing a solid state analog of a thermionic diode, solid state luminescent lasers, and various kinds of amplifiers, including the Weimer triode which has been considered for use in microelectronics. The information adds practical interest to the rest of the book but should not be considered more than a superficial source of information on these topics.

For the many researchers in semiconductors and closely related fields, this book provides a consolidation of many of the essential results obtained to date. The mathematical developments are concise and logically presented, and the bibliography, up to the middle of 1964, appears to be reasonably complete. It should not be considered as a textbook except at the higher graduate levels and then only with considerable supplementary guidance, and it is not a book for the engineer hoping to augment his general knowledge of the field with a brief reading.

C.G. Thornton

Philco Corp.
Lansdale, Pa.

Recently published

Computer Programming, Ivan Flores, Prentice-Hall, Inc., 395 pp., \$16

Progress in Biocybernetics, Vol. 3, edited by Norbert Weiner and J.P. Schade, American Elsevier Publishing Co., 258 pp., \$15.75

Sequential-Circuit Synthesis: State Assignment Aspects, Research Monograph No. 31, Donald R. Haring, the M.I.T. Press, 348 pp., \$12

Heating with Microwaves, H. Puschner, translated from the German by E. Grubba, Philips Technical Library, Springer-Verlag New York Inc., 320 pp., \$10.80

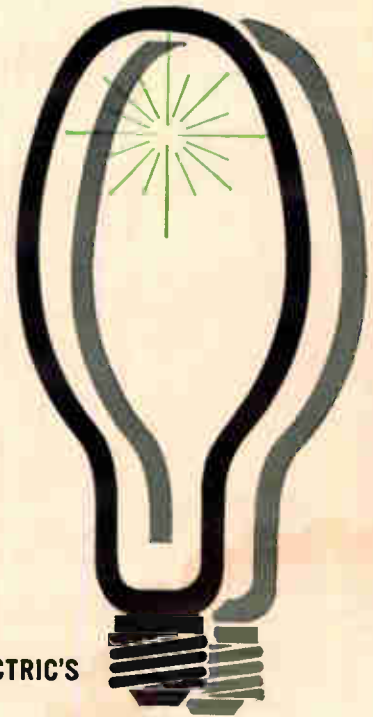
Modern Technical Writing, Second Edition, Theodore A. Sherman, Prentice-Hall, Inc., 418 pp., \$10

Statistical Association Methods for Mechanized Documentation, Symposium Proceedings, Washington, 1964, edited by Mary Elizabeth Stevens, Vincent E. Giluliano and Laurence B. Heilprin, National Bureau of Standards Miscellaneous Publication 269, U.S. Government Printing Office, 261 pp., \$2.75

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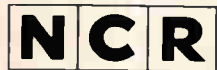
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Semiconductor testers. American Electronic Laboratories, Inc., P.O. Box 552, Lansdale, Pa., has published a technical bulletin on the models 259 and 259C in-circuit semiconductor testers. Circle 420 on reader service card

Repeat cycle timers. The A.W. Haydon Co., 232 North Elm St., Waterbury, Conn., 06720. Series 42400 low-cost repeat cycle timers are described in product information sheet No. 128. [421]

Core memories. The Ampex Corp., Mail Stop 7-14, 401 Broadway, Redwood City, Calif. Description, applications and specifications of the model RF core memories for computers are in brochure C004. [422]

Solder terminals. The Penn Engineering & Mfg. Corp., Box 311, Doylestown, Pa., 18901, offers bulletin ST-166 describing a complete line of self-clinching solder terminals. [423]

Pulse circuits. The Micro Switch division, Honeywell, Inc., 11 W. Spring St., Freeport, Ill., 61032. Bulletin ED contains data on microsecond, millisecond, and untimed pulse circuits and push-button assemblies. [424]

Semiconductor parameters. The General Electric Co., Schenectady, N.Y., 12305. A 60-page illustrated catalog contains major parameters of the company's semiconductor line. [425]

Coaxial switches. Microwave Associates, Inc., Burlington, Mass., offers two technical bulletins describing a new series of electromechanical coaxial switches. [426]

Solder alloy selection. Alpha Metals, Inc., 56 Water St., Jersey City, N.J., 07304, has released a technical bulletin that presents a logical method for considering all the parameters involved in the proper selection of a solder alloy. [427]

Copper-clad laminates. The Taylor Corp., Valley Forge, Pa., 19481. Glass base, epoxy resin, copper-clad laminates for printed circuits are described in data sheet No. GB-2. [428]

H-v energy-storage capacitors. The Sprague Electric Co., 35 Marshall St., North Adams, Mass., 01247. Data on 14 high-voltage energy-storage capacitors made by British Insulated Cables Ltd. is given in engineering bulletin No. 2144. [429]

Switch selector guide. The Cherry Electrical Products Corp., Highland Park, Ill., 60035, offers an illustrated, pocket-size switch selector guide for design engineers. [430]

Recording system. The Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif. Bulletin 5510 describes an eight-channel, thermal writing-recording system that combines the reliability of solid state electronics with the versatility of preamplifier plug-in modules. [431]

Ruggedized oscillograph. Century Electronics and Instruments, a subsidiary of the Century Geophysical Corp., 6540 E. Apache St., Tulsa, Okla., 75114, has available a brochure describing the model 414 ruggedized recording oscillograph. [432]

Bit synchronizer/signal generator. The Systems division, Elpac, Inc., 3760 Campus Drive, Newport Beach, Calif., 92660, has released a four-page data sheet covering its Spectra Sync II, an addressable pcm bit synchronizer/signal generator. [433]

Broadband balanced mixers. Microwave Associates, Inc., Burlington, Mass. Bulletin 3004 provides complete specifications for four new mixers that cover the frequency range of 8.2 to 40 Ghz in waveguide bandwidth steps. [434]

Shorting levels. C.P. Clare & Co., 3101 Pratt Blvd., Chicago, Ill., 60645. Three types of shorting levels, which increase the total capability of the company's 20- and 26-point telephone-type stepping switches, are described in data sheet No. 651-1. [435]

Digital electronic thermometer. Gulton Industries, 212 Durham Ave., Metuchen, N.J. Bulletin DS20 deals with a digital electronic thermometer designed for precise measurement of temperature in laboratories and the field and for use as a secondary standard. [436]

Analog-to-digital conversion. The Theta Instrument Corp., Saddle Brook, N.J., 07663, has released a 10-page engineering catalog describing a new method of analog-to-digital conversion. [437]

High-speed diffusion pump. The High Vacuum Equipment Corp., 2 Churchill Road, Hingham, Mass., 02043, has issued a data sheet on the HVEC model FPS-4500 high-speed, 10-inch fractionating diffusion pump. [438]

Digital logic modules. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass., 02138. Published to aid design engineers in implementing logic circuits, catalog 80 makes it easy to select the right logic module for use in digital industrial systems, process-control computers, digital communications and data processing. [439]

Reliability testing

Reliability testing—application to RCA time division data link testing program
W.J. O'Leary
Radio Corp. of America, Moorestown, N.J.

Field experience with an airborne digital communications system has shown that mean times between failures (mtbf) determined during factory testing several years ago correlate well with actual mtbf's. The tests were conducted on more than 200 time-division data link systems produced for the Air Force's Sage early warning system. Thus, the methods which were developed to design the factory test procedures have been verified.

This tutorial paper presents a series of curves and formulas that were used in planning the reliability test. The techniques are of general interest, since they can help the reliability engineer strike a balance between theoretical limitations of the test problem and practical considerations. The practical aspects include the amount of risk that the customer and producer are willing to assume and the amount of time that can be spent on testing.

The curves presented can be used to design sequential sampling plans that determine mtbf when there is a Poisson distribution of the failures. The advantage of sequential sampling is that, on the average, it requires 50% less testing time than fixed-time sampling plans. Testing, under the sequential technique, stops when the number of failures—plotted against time—is unacceptably high or acceptably low. Otherwise, it continues until a decision can be reached. The plot is divided into three regions which define these conditions. The sampling plan must be able to differentiate among these and indicate whether the product is satisfactory.

The ability of the sampling plan to accomplish this is described by an operating characteristic curve that relates the probability of acceptance to an mtbf level. Curves are normalized to apply to all levels of mtbf. The curves are based on earlier work in statistical analysis

and life-acceptance procedures, but changes have been made in normalizing test time and in defining the discrimination ratio between the lowest acceptable mtbf and the specified mtbf. This allows the slope of the sequential-decision curves to be plotted and calculated.

Curves and equations are given for determining such factors as the probability of acceptance, the average time required to reach a decision and truncation policy. Truncation refers to the time at which testing should terminate, considering the trade-offs between maximum test time and the risks involved in a lesser test time. The recommended cut-off time is twice the average time for testing equipments having the specified mtbf.

The author illustrates the use of the test-design curves with two examples.

Presented at the Seventh Annual IEEE New York Conference on Electronic Reliability, New York, May 20, 1966.

Contactless switching

An optoelectronic Pax
G.H. Taylor,
Plessey Ltd.,
Beeston, England

A small private automatic exchange (Pax) has been developed to show the feasibility of using photoconductive relays as substitutes for reed relays. Except for the contacts in the telephone instruments, the exchange requires no moving parts. The unit is suitable for a small business office because it is completely silent and requires almost no maintenance. At this time however, switching speeds are not fast enough for a large commercial exchange.

The photoconductive relay consists of four cadmium sulfide cells that are switched from their high-resistance state (20 megohms in darkness) to their low-resistance state (30 ohms under illumination) by means of a small tungsten lamp. In operation the unit acts like a four-pole, single-throw relay. Its operating time is 50 milliseconds and its release time—defined as the time for the resistance to reach 100,000 ohms—is 200 milliseconds.

Although these switching speeds are much slower than a reed relay, it does not severely limit the speed of the Pax, because many operations within the exchange overlap. As a result, the inherent time delays were not noticed by people using the exchange.

The life of the relay is limited by lamp-life, but is suitable for about five million switching operations. It is believed that a semiconductor light source will eventually be developed extending the life almost indefinitely. In addition, research is continuing to increase the dark resistance, and reduce the illuminated resistance.

Photoconductive relays together with transistor and diode circuits are employed as logic elements to determine the state of the circuit and to select alternate routes across the exchange. The relays are also used as crosspoints that connect the various paths across the exchange.

The Pax is designed for operation with 30 lines and permits four calls to be in progress at one time. Facilities for increasing the number of lines to 48 and the number of calls to six are included in the present circuit. Push-button phones or conventional dial phones may be used without modification.

In general the calling party has control of the system. If the calling party hangs up, the called line receives a dial tone and can dial immediately. If the called line hangs up first, the calling extension receives a busy tone. However, if the calling party has intrusion facilities that allow him to have priority on any line, he has complete control of the clearing operation.

Since economy and ease of servicing are important in such an exchange the unit uses only four different panels and carries lights on all panels to indicate the state of the circuit.

The insertion loss of the exchange is about 2.5 db at 300 hertz and the crosstalk is about 70 db below the desired signal at 3 kilohertz. The size of the unit is 2½ feet square by 19 inches deep.

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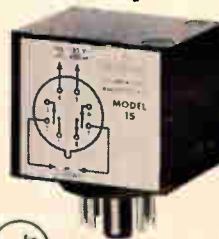
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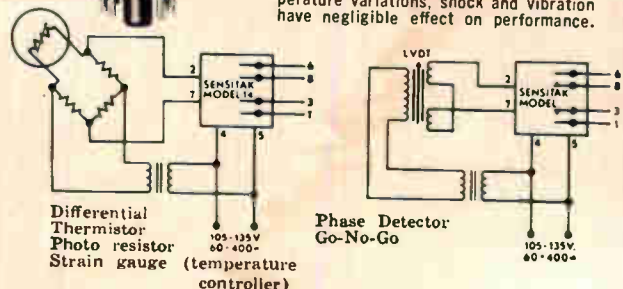
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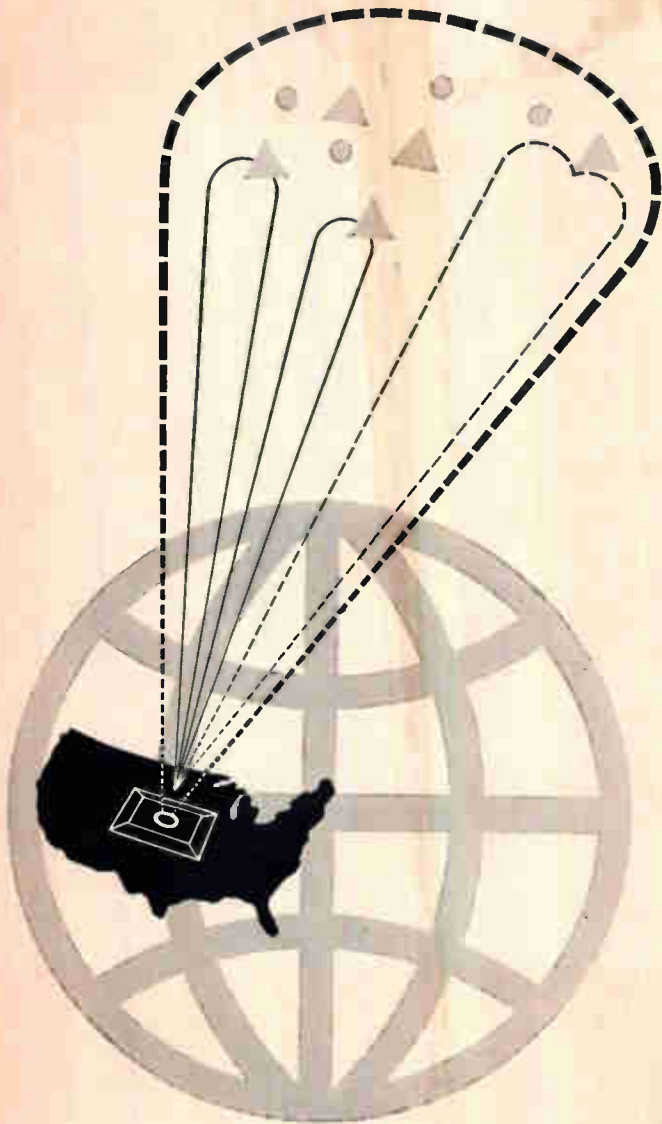
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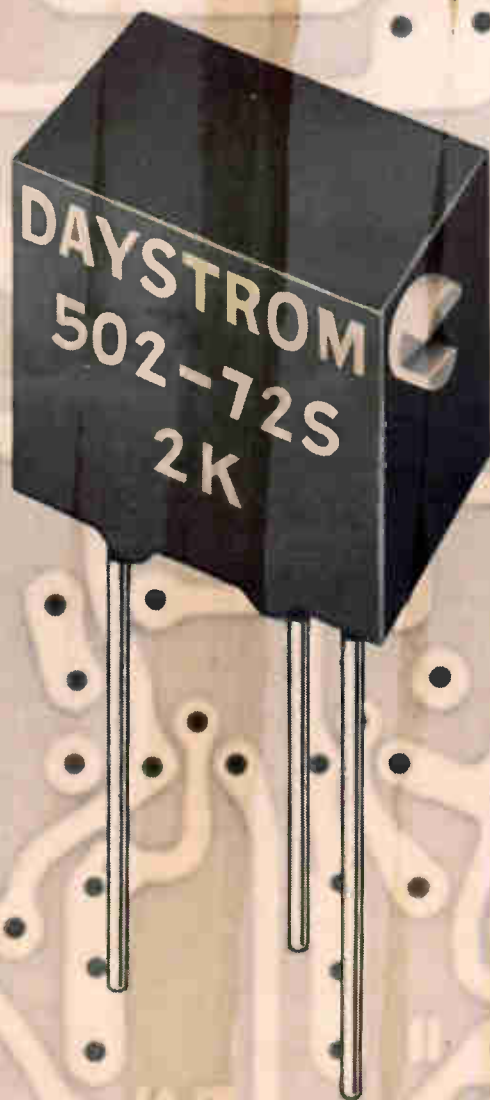
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Electronics Abroad

Volume 39
Number 13

Japan

East meets West

Many an American semiconductor specialist has heeded Horace Greeley's advice and headed West to find fortune. Perhaps none has followed the precept more wholeheartedly than 41-year-old Bernard Jacobs. He went West from New York as far as the Far East to found, along with five Japanese component makers, Kyodo Electronics Laboratories Inc., Japan's newest and smallest semiconductor manufacturer.

Although it's at the tail end of the list right now in sales and size, Kyodo may well turn out to be the industry leader in exports of computer-grade silicon devices to the United States. By late summer, Kyodo's plant in the Yokohama suburb of Sagamihara will be geared up for a monthly output of about 500,000 discrete transistors and diodes plus some 30,000 integrated circuits—both monolithic and hybrid. That puts Kyodo in a position to tap the U.S. market, where a shortage of sophisticated semiconductor components is building up because of the war in Vietnam.

The leading semiconductor makers in Japan, on the other hand, aren't in a position to push sales of computer-grade devices in the U.S. All are also equipment manufacturers and have their hands full supplying themselves and domestic customers.

Already U.S. customers account for about a quarter of Kyodo's sales, which Jacobs says will hit a rate of \$1 million yearly this fall. And Jacobs wouldn't be surprised if by the end of the year deliveries to the U.S. outnumbered deliveries in Japan, the only other market Kyodo is tackling for the moment. Jacobs hints there's a whopping order in the offing from one of the



Bernard Jacobs stands to collect a handsome payoff for the know-how he has brought to Japan, where he joined with five component makers and set up a company to produce computer-grade silicon semiconductors.

American companies he's now dickering with.

Specialized. Kyodo so far has concentrated on nonlinear planar epitaxial silicon devices. Its bread-and-butter products are epoxy-sealed high-speed transistors and diodes, diode arrays, and hybrid sense amplifiers for computer memories.

The hybrid sense amplifier, in fact, may turn out to be a best seller for Kyodo. It combines cermet and semiconductor passive components, along with planar transistors, to form a differential amplifier and a strobe. Gain of the amplifier is either 20 or 40 decibels with bandwidths of 7 or 15 megahertz. This integrated circuit, Jacobs says, has been incorporated in the design of upcoming Japanese high-speed computers along with the woven-wire memory of Toko Inc., one of the partners in the semiconductor venture. Kyodo, though, isn't limiting sales of the sense amplifier to Toko.

Along with the hybrid circuit, Kyodo has gone into production on a line of monolithic transistor-transistor logic circuits compatible

with the Series 54 units of Texas Instruments Incorporated. For these IC's, Kyodo starts with one basic wafer circuit, a dual four-input NAND gate. By dicing the wafers so that each chip has two circuits on it, Kyodo can get four different configurations from the basic circuit—for two, three, four or eight inputs.

Still another key new product in the lineup is an npn memory core driver. It handles collector currents up to 1 ampere and has a collector-base breakdown voltage of 80 volts. It is designed to switch 500 milliamperes with base currents of 50 ma and collector voltage of 30 volts. Rise, storage and fall times are all 30 nanoseconds or less.

Sealed. To hold the line on costs, Kyodo has stuck to epoxy encapsulation for all its devices. Jacobs says that a passivation process perfected by Kyodo eliminates migration of sodium ions through the protective silicon-oxide layer and onto the semiconductor surface. This migration is the major cause of degradation of planar epitaxial transistors, especially pnp types. Except to say it's a process similar

to one used by a leading U.S. semiconductor manufacturer, Jacobs won't disclose how the passivation layer is grown.

Although he's convinced that epoxy devices are as reliable as hermetically sealed ones, Jacobs is well aware that many a U.S. computer maker won't touch them. As a result, Kyodo plans to offer hermetically sealed transistors at about the same price as its epoxy units. Instead of metal cans, the packages will have alumina headers and cover plates. The lead configuration will be the same as that of the TO-18 package, but the package itself will be slightly smaller. Jacobs doesn't class the package as a startling breakthrough in design. Nonetheless, Kyodo won't put its hermetically sealed units on the market until there's enough stock built up to discourage larger companies from rushing into production with copies.

Payoff. Just 18 months after it was founded, Kyodo seems poised for a payoff in profits. Well before the end of the year, Jacobs estimates, the company will be operating in the black.

And Jacobs will then be on the way to Oriental affluence. For the semiconductor know-how he brought with him to Japan, Jacobs gets a fixed royalty for the first five years of the company's existence. Jacobs, who holds a doctorate in physical chemistry from New York University, acquired his competence in a 13-year stint of semiconductor development at companies such as the International Telephone and Telegraph Corp., the Radio Receptor Corp., the General Transistor Corp. and the company that took it over, the General Instrument Corp.

In addition, Jacobs holds 24% of the stock in Kyodo and the corporate title of vice-president, although as general manager he actually runs the company. Other major investors in the venture are Toko Inc., the Nippon Chemical Condenser Co., the Kodan Electronics Co., the Alps Electric Co., and the Pioneer Electronics Corp. The latter two manufacture consumer electronics products.

Eastern Europe

Computer craze

In the capitals of Eastern Europe, economists believe that the shortcomings of Socialist planning could be corrected if only they had electronic computers. In the factories, plant manufacturers say production could be made more efficient if they had computers. And in the research institutes, engineers and scientists are complaining that the advance of technology is being slowed because they don't have enough good computers.

The interest in computers in the countries of Eastern Europe is approaching mania. An official of the International Business Machines Corp., who has studied the market, estimates that Poland, Czechoslovakia, Rumania, Bulgaria, Hungary and the German Democratic Republic will need 10,000 to 12,000 computers during the next five years.

To satisfy even a part of this craze, the Socialist countries will have to turn to Western Europe or the United States.

Handmade. There is almost a void in computer technology—both in the design of the machines and their application — between the eastern border of West Germany and the western frontier of the Soviet Union. Rumania, for example, has fewer than 30 machines, most of them are handmade by the men who run them in research institutes. In the German Democratic Republic, the Carl Zeiss plant has stopped making the slow, vacuum-tube machine it called ZRA-1. A new machine has been designed at another plant but it is a small one.

At the Poznan International Fair this month, the only Socialist country able to demonstrate a working computer was Poland. The Elwro factory at Wroclaw has designed two machines—the ODRA 1013 for scientific use and the ODRA 1204 for commercial data processing. But Elwro's production is far too small to satisfy very much of Eastern Europe's demand or even Po-

land's. Last year, Poland was able to export only three machines, worth a mere \$140,000.

Transistor troubles. Both of Elwro's machines have to be rated technologically behind most Western-designed computers because the Polish machines use germanium transistors. So far, no Socialist country has been able to make silicon transistors that are faster than germanium ones. Poland's Tewa plant in Warsaw has started making three types of silicon mesa transistors—for pulse amplifiers, low- and medium-frequency amplifiers and signal generators—but the work is still mainly developmental. East Germany's semiconductor plant at Potsdam has produced silicon devices on a pilot basis; Rumania's Baneasa semiconductor factory will not be in a position to produce silicon transistors before 1967.

All this meant heavy traffic for the U.S. exhibit at Poznan, where IBM, Control Data Corp. and The National Cash Register Co. had computers on working display. None of the U.S. machines was the latest offered by its maker, but all were designed for the kinds of scientific and industrial uses the East Europeans are talking about.

The NCR 500, a medium-sized data processor, was shown for the first time in Poland. IBM's 1410 also had its Polish debut after having been introduced at the Czechoslovakian computer fair earlier this month. Control Data showed its 160 computer built for solving engineering and scientific problems.

Striving. The run-away interest in computers has turned Eastern Europe into a bitter competitive area. Computer salesmen are treading on each others' heels. In addition to the three U.S. companies at the Poznan fair, Honeywell Inc. is also actively seeking business, mainly through its Italian subsidiary. At least three English firms—English Electric Co., International Computers and Tabulators, Ltd., and Elliott-Automation, Ltd., which has a licensing arrangement with NCR—are on the scene. Also in the sweepstakes are France's

Bull-General Electric and Compagnie des Compteurs, and West Germany's Telefunken A.G.

One factor that has slowed sales is that most of the Eastern European countries would like to trade their goods for computers instead of paying cash. So far, only NCR has shown a willingness to do business this way. Last year, it delivered an NCR 315 data processor in Poland and received sewing machines and central-heating radiators in payment.

Great Britain

On the rocks

Those ambitious computer printed-circuit cards that have learned so many unskilled jobs now may force a lot of analytical chemists to hang up their white jackets and head for the nearest employment office.

An idea of what chemists face comes from the experience of Elliott-Automation Ltd., a leading British process-control computer manufacturer. Two years ago, Elliott went on the market with pre-packaged quality-control systems

that tied together computers and analytical instruments, such as chromatographs, moisture meters, and mass spectrometers. Sales of these systems soared to \$3 million last year. Elliott expects its quality-control systems sales to rise to \$6 million this year, with 90% of the orders from outside Britain.

Run of the mine. Much of the growth will come from computer-controlled installations that analyze ore content by X-ray fluorescence. Elliott has several in the works.

One will help an Australian iron-ore mine meet the tough contract conditions laid down by the Japanese steel plant it supplies. The pact calls for payment at the full contract price only when the concentration of iron in the ore runs higher than 70%. Limits are laid down, too, for silicon and alumina content. And the Japanese get a lower rate if the phosphorous content runs above a fixed limit. What's more, the supply contract calls for a sampling and analysis of content on each 125 tons of ore delivered. At the 2,500 ton-per-hour output of the mine, that means a complete analysis every 3 minutes.

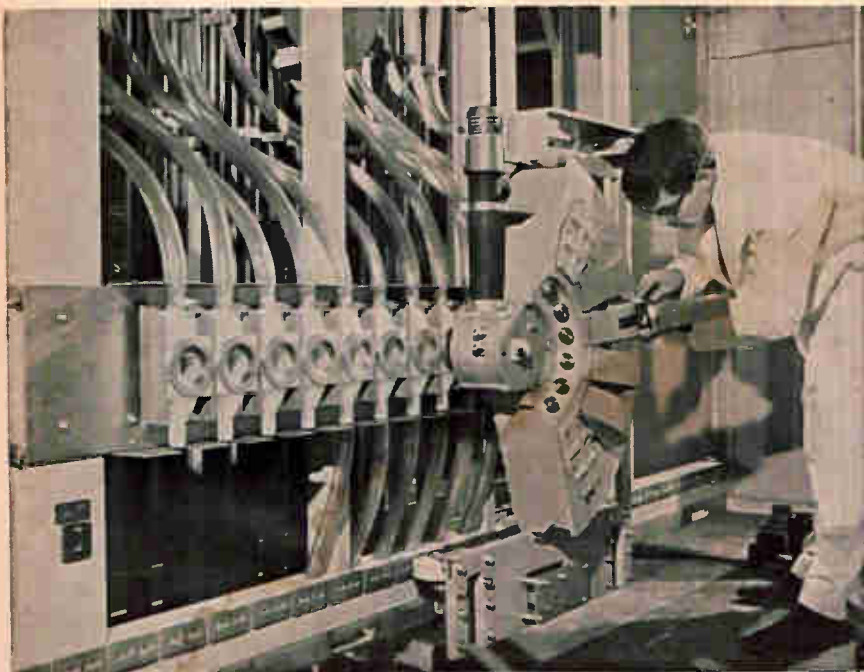
The system Elliott will deliver later this year operates at that rate. Forty-pound samples from the

main stream of the slurry are diverted through an X-ray analyzer. Secondary irradiation from the elements in the slurry is picked up by scintillation counters; the counts go to an Arch 1000 digital computer, which converts them into a percentage analysis of the ore content. The system can detect traces of phosphorous down to 0.02%, silicon to 0.4% and alumina to 0.23%.

While checking ore content, the Arch 1000 controls stockpiling. When there's no ship available to pick up the ore, the computer stores data on the location and analysis of each pile of ore. When a ship comes in, the computer calculates the optimum mix—one that meets the contract limits on ore content but doesn't give the customer an inordinate bonus in iron.

More control. Even more complex is an X-ray fluorescent analyzer going into an ore-dressing plant in Northern Sweden. It continuously checks the content of five slurry streams in a floatation separation process. An Arch 9000 digital computer calculates from the scintillation counts the ore's copper, lead, zinc, arsenic and iron content.

Along with analysis data, the computer cranks out signals used to control, in part, the processing plant itself. A small analog computer tied into the system also spots trends in the change of ore composition. This is part of a long-range program to determine how far the operators can go toward complete plant automation. As suitable mathematical models are built up, more and more ore extraction will be put under computer control.



Quality-control systems like this X-ray fluorescent analyzer have won worldwide markets for Elliott-Automation Ltd.

France

Hold that line

President Charles de Gaulle long has sought to bolster the French electronics industry, which is important to his design to free France from dependence on the United States in defense and diplomacy. To De Gaulle's annoyance, Ameri-

can companies in recent years have carved strong market positions in France, especially in computers and semiconductors. All along, De Gaulle's government has kept all the pressure it could on French companies to join forces and stay competitive.

Now the government has added to the merger pressure the potent persuasion of research and development funds, which the government is dangling before companies that pool research efforts. The combination could eventually restructure French electronics.

Togetherness. A major move in that direction came this month when two major French companies decided to go it together in semiconductor research. The decision may lead to a full merger of the component-producing affiliates of the two companies, CSF-Compagnie Générale de Télégraphie Sans Fil and Compagnie Française Thomson-Houston.

The affiliates involved in the joint research are the CSF subsidiary Compagnie Générale des Semiconducteurs (Cossem) and the Société Européenne des Semiconducteurs (Sesco), controlled by Thomson-Houston. Sesco rates as the leading French-controlled semiconductor producer, with sales last year of \$13 million; Cossem was right behind with a figure of \$11 million.

With a combined research program, the pair stands to pick up a substantial piece of the \$20 million the De Gaulle government has earmarked for electronics research over the next five years.

As it stands, American companies wind up with most of the orders for IC's, even for French military applications. Texas Instruments Incorporated, Fairchild Camera & Instrument Corp., Motorola, Inc., and the General Electric Co. all are involved in semiconductor production in France. GE, in fact, has a 49% holding in Sesco. This could be a stumbling block for an outright merger of Cossem and Sesco.

Computer tie-up. The combination of pressure and persuasion also brought together this month the two largest French computer makers free of foreign—notably

Yankee—influence. Although it's not certain whether there'll be an outright merger or just a close working arrangement, Compagnie Européenne d'Automatisme Electronique (CAE) and Société d'Electronique et d'Automatisme (SEA) plan to market by late 1968 a range of medium-size computers competitive with U.S. third-generation machines.

To finance development and production of the computer, the government plans to spend anywhere from \$60 million to \$100 million over the next three to five years. The two companies figure their investment will be even greater—\$100 million to \$150 million. But they expect a substantial payoff. The new computer will win the preference of government agencies and scientific institutes—and the preference of industrial companies that want to stay in the government's good graces. CAE and SEA, in fact, have set a 1970 sales target of \$60 million annually.

This, though, shouldn't much bother the American giants, particularly the International Business Machines Corp., that dominate the French business computer market. The new French computer is destined primarily for industrial and scientific applications.

Like the togetherness in semiconductors, the computer tie-up De Gaulle has wrought involves two heavyweights in French electronics—CSF and Compagnie Générale d'Electricité. Between them they own, fifty-fifty, a holding company called Citec, which in turn owns CAE. SEA is owned by the powerful Empain-Schneider industrial group.

Pierre Edrom, industrial manager of Citec, says the CAE-SEA association won't shut out other companies who want to join the effort to keep at least a part of the French computer market in French hands. But for the moment, the regrouping has stalled plans for a French-British tie-up [Electronics, Aug. 9, 1965, p. 219]. "We need a year to pull ourselves together," Edrom explains, "and then when we go to Britain we'll have some cards in our hands."

International

Nadge verdict

A consortium headed by the Hughes Aircraft Co. has all but sewn up the contract for the North Atlantic Treaty Organization air-defense network. The award announcement is expected this week.

In a second round of bids, called after all bidders went over NATO's \$300 million ceiling in the first round last January, the Hughes group was low with \$230 million, some \$15 million less than its only other competitor, a consortium headed by Westinghouse Electric Corp. International Telephone & Telegraph Corp. bid for the contract in the first round but offered only specifications the second time.

To pin down the award, Hughes has to work out final details with each of the nine countries involved in the project before the end of year. France is one of these, but apparently won't be a stumbling block although French president Charles de Gaulle has pulled out of the NATO integrated command structure. Insiders at NATO maintain the De Gaulle government plans to go along with Nadge.

The network that the Hughes group will build will pick up enemy aircraft approaching the NATO perimeter and feed interception instructions semiautomatically to defense bases. The hardware involved in the network is a NATO secret, but Nadge presumably will have 38 control centers equipped with Hughes computers and linked up through microwave links and telephone lines. To hold the line on costs, Nadge program managers reportedly cut down the number of radar installations.

Some \$70 million of the \$300 million earmarked for Nadge already has been spent for preliminary installations.

Principal foreign companies aligned with Hughes for the Nadge project are Compagnie Française Thomson-Houston, Telefunken A. G. of West Germany, Marconi Co. Ltd. of Great Britain, and Selenia S.p.A. of Italy.

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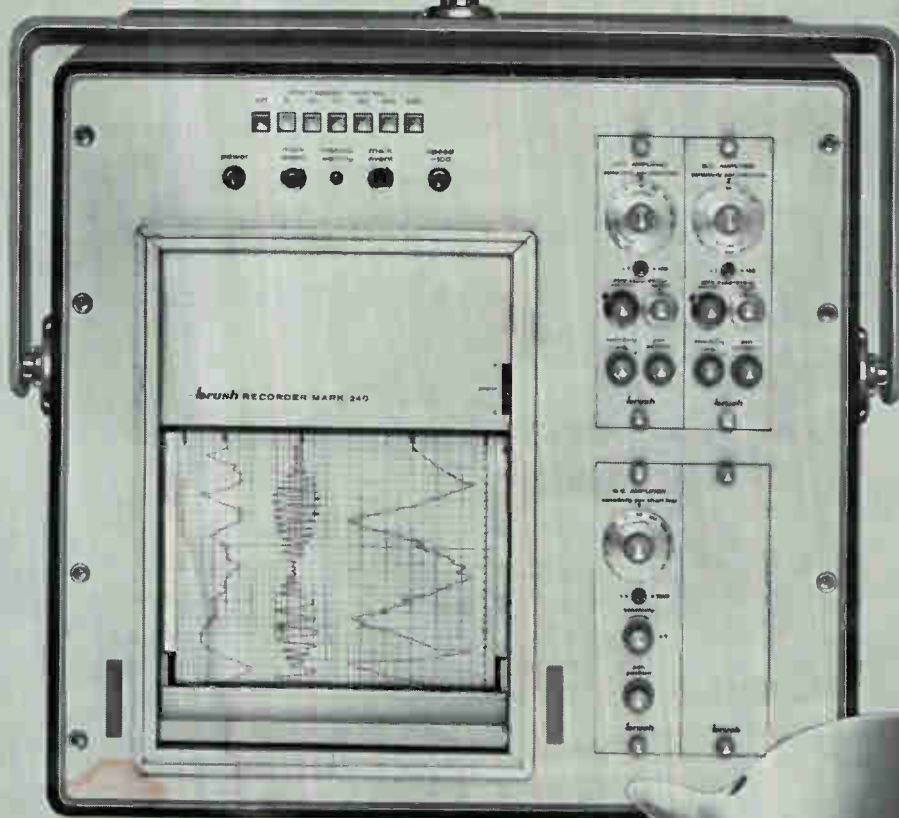
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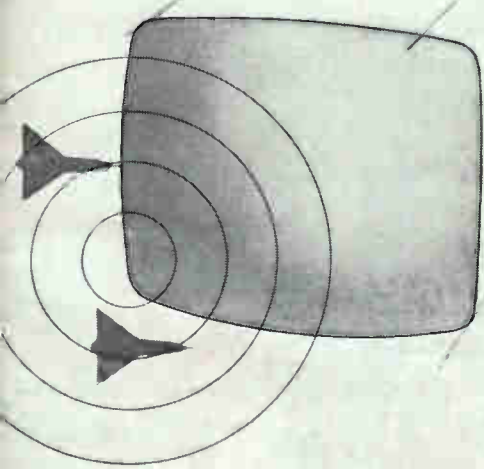
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