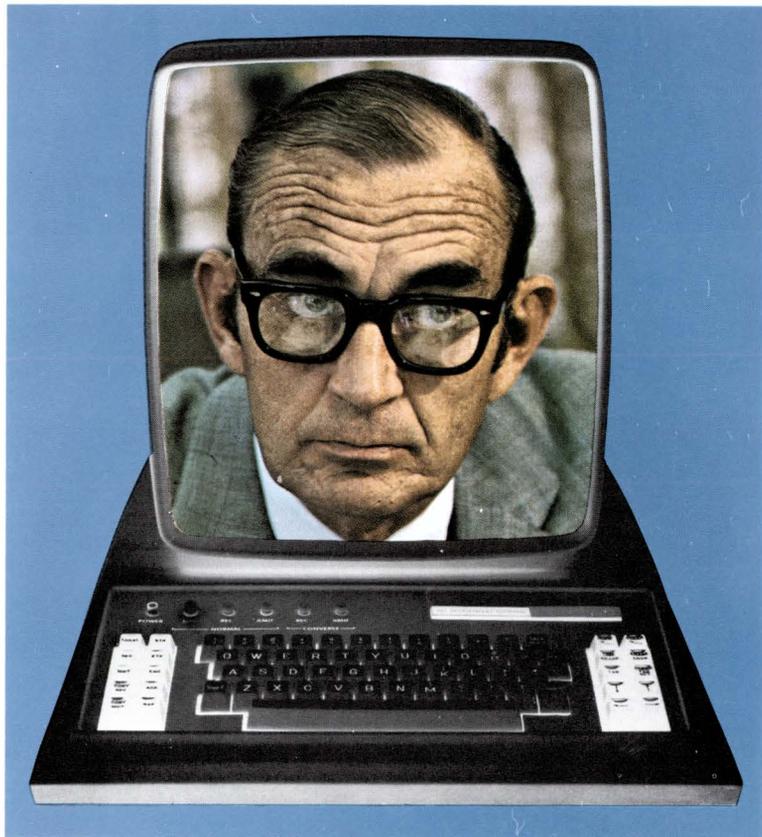


VOL. 29 NO. 11  
NOVEMBER 1970

# CHILTON'S **THE** **ELECTRONIC** **ENGINEER**



FCC Chairman Dean Burch faces tough decisions for data communications

**MOS course examination**  
**Special report:**  
**data terminals & communications**

SAMPLING

REAL-TIME

STORAGE

ECONOMICAL

18 GHz  
250 MHz  
100 MHz  
500 kHz



HEWLETT **hp** PACKARD

OSCILLOSCOPE SYSTEMS

**What's new in HP Scopes?** 18 GHz, dual-channel sampling! New, faster HP diodes now extend sampling capability through 18 GHz. For the first time, you can directly view and measure 18 GHz CW signals (or 20 psec risetime pulses).

But there are more new scope innovations from HP. There's the new, easy-to-use, 250 MHz real-time scope... and new, direct read-out TDR with 1/4" resolution... and new variable persistence and storage scopes for measurements up to 100 MHz... and a whole new series of low-cost 500 kHz scopes.

AND, *there are more eye-popping*

*scope ideas just around the corner!*

Next time you see your HP field engineer, ask him what's new in scopes. You'll be surprised by all that's happening to give you better, more economical scope measurements. One thing, we bet you'll get a new (and better) answer, every time you ask!

Are you thinking about a new scope? Are you wondering whether you should continue down the same old road? Or is it time you took a look

at another manufacturer? The HP road means going with the demonstrated leader — maker of performance champs.

Call your HP field engineer, right now, if 18 GHz sampling is your interest. Complete 18 GHz sampling system available with delayed sweep, or w/o delayed sweep. If you already have an HP 12.4 GHz sampling system, add the new 18 GHz HP 1430B remote sampler. Write Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

080/6

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# URGENTLY NEEDED: RELIABILITY

## Accidental Electrocutions Claim 1200 Patients a Year

Fairchild News Service  
At least three patients in United States hospitals are accidentally electrocuted each day. The total number of electrocutions annually is about 1200. According to Dr. Paul W. Wight, a surgeon at Holy Spirit Hospital, Sydney, who supplied the figures, most of

condition but were undergoing "routine diagnostic tests," or "routine treatment."

Dr. Wight's figure on accidental electrocution quoted last week at a Symposium held in London at a session of the Medical Instrumentation Society.

search Council, Canada, said: "Internal electric shock is a subtle hazard that has often escaped recognition. As a result, many deaths were attributed to natural causes."

patients a year are electrocuted during hospital treatment in the U.S.A."

In a telephone interview last week, Dr. Wight said he received the figures from an actuary for a national United States insurance company's computer study.

NEWS

## The tiny flaws in medical design can kill

Errant currents from faulty electronic equipment are reported imperiling patients in certain cases

Ronald Gechman  
West Coast Editor

aware that small electrical currents applied to the human body can be fatal.

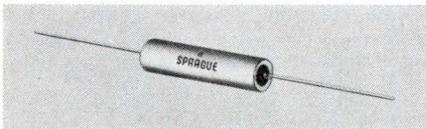
Reproduced from: *Electronic News*

Reproduced from: *Electronic Design*

# FROM SPRAGUE: RELIABLE CAPACITORS

Sprague Electric has long been aware of the crucial importance of reliability . . . particularly in medical electronics, where failure can be fatal. The capacitors shown on this page are designed for utmost reliability . . . not merely to meet existing standards, but to be as failure-free as the present state of the art will permit.

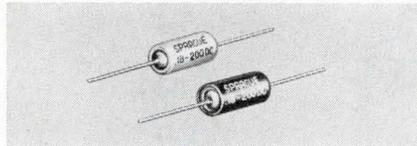
### HYREL® Capacitors



Manufactured under climate- and dust-controlled conditions in factory space used solely for high reliability production. 100% tested for optimum quality control. Exceed military and industrial standards for shock, vibration, moisture resistance, life. Reliability documented by extensive test data. Applications now include cardiac pacers and coronary care units. One 4-year user reports *no* failures. Available in following types:

- Type 350D HYREL® ST Solid Tantalum  
6 to 75 WVDC, .0047 to 330  $\mu$ F
- Type 351D Non-Polar HYREL® ST Solid Tantalum  
6 to 50 WVDC, .0023 to 160  $\mu$ F
- Type 309D HYREL® GT Sintered-Anode Tantalum  
6 to 150 WVDC, 1.7 to 1200  $\mu$ F
- Type 330D HYREL® GT Sintered-Anode Tantalum  
4 to 100 WVDC, 1.7 to 1200  $\mu$ F
- Type 195P HYREL® Q Subminiature Paper  
200 to 600 WVDC, .001 to 1.0  $\mu$ F
- Type 168P HYREL® PQ Subminiature Paper  
50 WVDC, .001 to 1.0  $\mu$ F

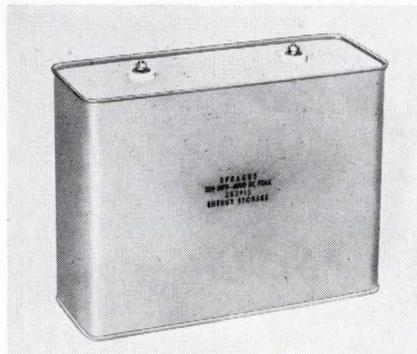
### Type 118P Subminiature DIFILM® Metallized Capacitors



Unmatched for reliability at 125C by any other metallized paper capacitor. Higher insulation resistance than that of any other metallized paper design. Unique dielectric combines metallized paper and polyester film impregnated with special high temperature mineral wax. Hermetically sealed.

200 to 1000 WVDC, .001 to 12.0  $\mu$ F

### Heart Defibrillator Capacitors



True energy-storage capacitors expressly developed for heart defibrillators. Charged in milliseconds and discharged in a fraction of a millisecond.

Three case sizes available.

Each rated 16  $\mu$ F, 7500 WVDC.

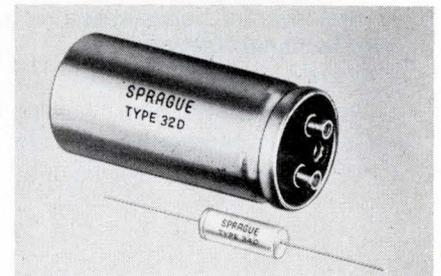
### Type 260P METFILM® 'K' Film Capacitors



Exceptional versatility and superior electrical characteristics in small physical size. Metallized polycarbonate-film dielectric provides high insulation resistance, high capacitance stability, low dielectric absorption, low dissipation factor. Hermetically sealed.

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### COMPULYTIC® Aluminum Electrolytic Capacitors



Power supply filter capacitors with low leakage currents, low ESR, long shelf life. Feature the most reliable seal yet developed for aluminum electrolytics.

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2.5 to 450 WVDC, 35 to 200,000  $\mu$ F

Type 34D—Tubular with axial leads

2.5 to 450 WVDC, 1 to 13,000  $\mu$ F

4SC-0119

For technical literature on any of these capacitors, or engineering assistance without obligation, write or call Mr. John Moynihan, Sprague Electric Company, 233 Marshall Street, North Adams, Mass. 01247. Telephone (413) 664-4411

**THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS**

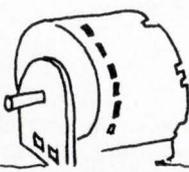


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# LOW-COST, SOLID STATE AC RELAYS

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SOLENOIDS



LIGHTS



HEATERS

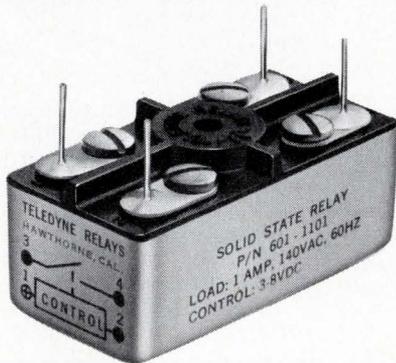
etc.

ETC.

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- 1 - 10 AMPS at 140 V RMS or 280 V RMS
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- PC board or screw terminal mounted



**PART NUMBERING (Economy Line)**

INPUT (CONTROL) VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT (LOAD) CURRENT RATING & PART NUMBERS				
		1 AMP	3 AMP	5 AMP	7 AMP	10 AMP
3-10 VDC	140 VAC	601-1001	601-1002	601-1003	601-1004	601-1005
	280 VAC	601-1006	601-1007	601-1008	601-1009	601-1010
6-32 VDC	140 VAC	601-1011	601-1012	601-1013	601-1014	601-1015
	280 VAC	601-1016	601-1017	601-1018	601-1019	601-1020
15-45 VDC	140 VAC	601-1021	601-1022	601-1023	601-1024	601-1025
	280 VAC	601-1026	601-1027	601-1028	601-1029	601-1030
20-75 VDC	140 VAC	601-1031	601-1032	601-1033	601-1034	601-1035
	280 VAC	601-1036	601-1037	601-1038	601-1039	601-1040

NOTE: Add "P" to P/N for printed circuit (pin) mounting only.

**ECONOMY LINE PRICE / QUANTITY (Typical)**

LOAD	QUANTITY		
Amps @ 140 VAC	10 - 24	100 - 249	1000 - 2499
1	\$12.20	\$ 8.75	\$ 6.65
3	13.50	9.70	7.35
5	15.30	10.60	8.10
7	16.60	11.55	8.80
10	18.45	12.80	9.75

**PART NUMBERING (Zero Voltage Turn-On)**

INPUT (CONTROL) VOLTAGE RANGE	OUTPUT VOLTAGE RATING	OUTPUT (LOAD) CURRENT RATING & PART NUMBERS				
		1 AMP	3 AMP	5 AMP	7 AMP	10 AMP
3-8 VDC	140 VAC	601-1101	601-1102	601-1103	601-1104	601-1105
	280 VAC	601-1106	601-1107	601-1108	601-1109	601-1110
7-85 VDC	140 VAC	601-1111	601-1112	601-1113	601-1114	601-1115
	280 VAC	601-1116	601-1117	601-1118	601-1119	601-1120
90-280 VAC	140 VAC	601-1121	601-1122	601-1123	601-1124	601-1125
	280 VAC	601-1126	601-1127	601-1128	601-1129	601-1130

**ZERO VOLTAGE TURN-ON LINE PRICE / QUANTITY (Typical)**

LOAD	QUANTITY		
Amps @ 140 VAC	10 - 24	100 - 249	1000 - 2499
1	\$21.60	\$15.00	\$11.40
3	22.95	15.94	12.11
5	24.30	16.88	12.83
7	25.65	17.81	13.55
10	27.45	19.06	14.50

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# CHILTONS THE ELECTRONIC ENGINEER

November 1970 Vol. 29 No. 11

**Cover:** The Federal Communications Commission may well be standing at a crossroads and Dean Burch will have to be the man to pick the right road. Burch and the FCC face the on-rushing advance of technology in such diverse approaches as CATV, specialized common carriers, domestic satellite communications systems, and allocating the electromagnetic spectrum. How the Chairman and his fellow Commissioners treat these and other problems will have far-reaching effects on electronics. Story on page 22. (Photo by John DiJoseph, Jr., Remi Studio.)

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## 22 HOUR OF DECISION AT THE FCC By John McNichol

The quickening pace of telecommunications technology means a more crowded docket at the FCC. Here's an inside look as Dean Burch's FCC and some of the problems confronting it.

---

## REPORT ON DATA TERMINALS AND COMMUNICATIONS following page 32

### D3 CREATIVE DOODLING MADE EASY: CRT TERMINALS By W. H. Sass and H. S. Rasmussen

From helping you to design a circuit to ensuring that your seat will not be taken when you board your flight, the CRT terminal is everywhere. The latest ways to achieve man-machine interface and overcome that "communications gap" are given.

### D9 REVIEW OF INTERACTIVE CRT TERMINALS Editorial Staff, Instruments and Control Systems.

A comprehensive survey of commercially available CRT computer terminals can guide you in your selection of these interactive units.

---

## 51 IC IDEAS

**Man-machine interface circuit** by Alphonso H. Marsh Jr.

**Circuit performs up/down counting and shifting** by Ken Erickson

**Versatile triangle wave generator** by Adrian Moses

**Oven temperature controller** by S. W. Billingsley

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# KEPCO TALKS POWER SUPPLY TECHNOLOGY:

## FERRORESONANCE... *the key to simple stabilization*

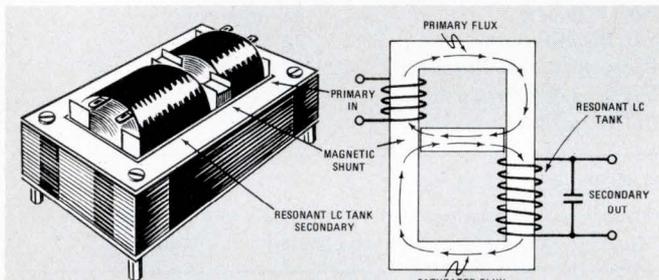
In this age of high gain, solid-state integrated feedback circuit, it is easy to overlook the simpler ways of controlling voltage and current. The ferroresonant flux-oscillating power transformer, used as the control for a d-c power supply, provides an extremely simple—therefore reliable—stabilizer that suffers no risk of the overvoltage danger to which so many loads are so vulnerable.

A ferroresonant system consists of two coils on a common core separated by a magnetic shunt. The primary coil is permitted to function linearly, while the secondary is paralleled with a resonating capacitor to excite its iron into saturation on alternate half-cycles. The shunt provides a flux path for the secondary so that the primary is not saturated.

The voltage waveform across the tank has a roughly square aspect because the iron transition from unsaturated to saturated state is a rather abrupt phenomenon triggering a rapid discharge from the capacitor (whose energy then builds the flux in the reverse direction).

When rectified, this square waveform presents a much smaller peak/average ratio to a capacitor input filter, resulting in a much lower output impedance and smaller ripple amplitude than would an equivalent sinusoid.

Because the tank's voltage, which controls the output is independent of the driving source amplitude, the load voltage is entirely a function of the magnetic structure with about 30 dB or more isolation from source changes.



THE FERRORESONANT POWER TRANSFORMER WITH ITS TANK CAPACITOR STABILIZES A d-c OUTPUT WITH A MINIMUM OF FUSS AND BOTHER; AND A MAXIMUM OF RELIABILITY

The ferroresonant approach, in addition to providing stabilization versus the source, and a reduced load effect, through lowered impedance, is also self-protecting for overloads. Short the output and the lowered tank "Q" causes the tank oscillations to diminish and cease. This provides a current limiting effect which protects both supply and load.

Power Supplies with the Kepco ferroresonant transformer, Flux-O-Tran®, range from 60 watt modules to 300 watt supplies in single and dual output configurations. The Kepco PRM Series has 58 models in all from 4.5V d-c to 240V d-c, easily tailored to your application. Check out their advantages in *your* circuit. Get Kepco Catalog B-703.

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November 1970

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## Not to help is to hurt

If the U.S. consumer was ready to buy color TV sets in 1961, he had to wait until *American* electronic companies developed receivers at a low enough cost. He had to wait, because low-cost TV sets couldn't have come from any other country—in 1961, that is.

If U.S. banks and insurance companies were ready for business computers in 1961, or if the process control industry was ready for small computers a couple of years later, they had to wait until *American* computer manufacturers brought the cost of those computers down to a price low enough. They had to wait, because in those years no other country in the world had the resources, the brainpower or the technology to produce computers in quantity.

How about today? Are there any products or services which the consumer, business or industry in the U.S. (as well as in many other countries) need from the electronics industry? Of course there are. The consumer is ready for low-cost **video recorders** and video records; businesses need electronic **calculators**; computer users want **data terminals**; the communications industry needs low-cost **microwave** equipment to transmit data between terminals and computers; hospitals must have the aid of **medical electronic equipment**; schools all over the world are yearning for low-cost **electronic teaching machines** to relieve the short supply of teachers.

These new markets for the 70's are as ready today as the previous ones were ready in the early 60's. There is, however, one important difference between now and last decade: if American electronic manufacturers do not develop low-cost products for those markets immediately, the markets will not wait for them—there are plenty of manufacturers in Japan (and, also, in Western Europe) with both the technology and the resources to fill the gap, as they did with transistor radios in the late 1950's, and are already doing now with calculators.

Don't we have the technology and brainpower to develop those products? We do, but we lack the commitment. While more than ten thousand electronic engineers have been idled by the cutbacks in aerospace and defense contracts, these engineers cannot find work in industry because the manufacturers interested in making those products are wrestling with the high operating costs and short supply of money which affect our economy today.

That's why we are sounding an alarm. That's why we are enlisting the cooperation of other electronic magazines, and of industry associations, to convince our government that the electronic industry needs help. Help of the same sort that Japan, as well as other countries, gives *their* manufacturers.

In Japan, the Ministry of International Trade and Industry (MITI) carefully selects those industries which can help improve its trade balance (and electronic industries rate tops in that list), and makes available to them not only trade assistance, but also loans at unbelievably low rates. Even closer home, the Canadian Province de Quebec attracts electronic companies (especially those making computers and peripherals) with cash grants of up to 25% of investment, and with low-rent land sites.

We believe American electronic manufacturers can and must develop the products for the 70's. We believe American electronic engineers do not need to depend on defense contracts for work—a healthy industry can and needs to occupy them. But the industry cannot do it without the same help from our government that foreign competitors get from theirs. And not to help, is to hurt—not just our industry, but the future of the whole country.

*Alberto Socolovsky*  
Editor

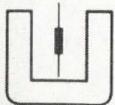
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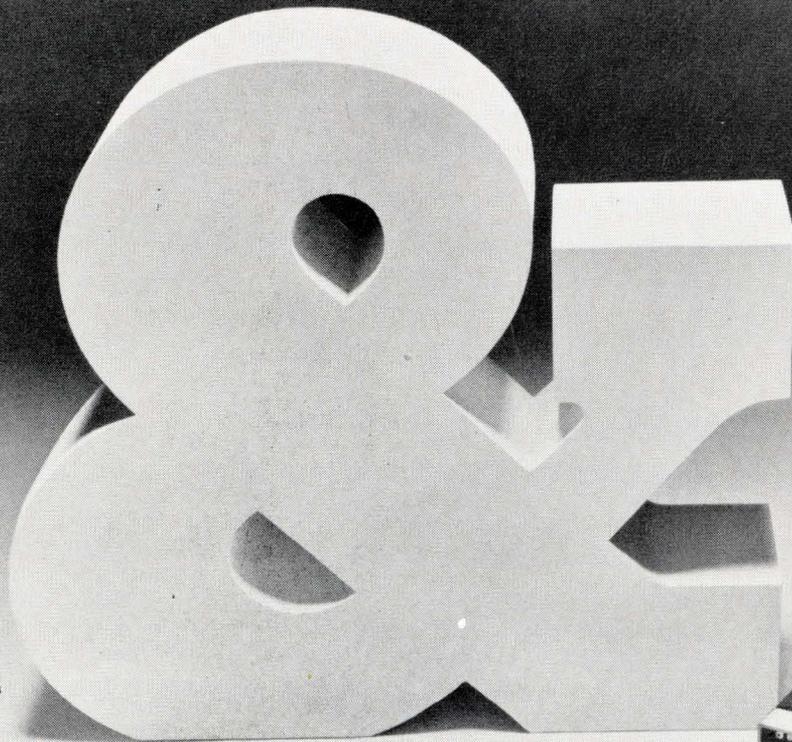
Please send Φ-line zener samples in  1 watt,  5 watt rating with complete specifications.

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## Bell & Howell & Recording & How

It's done with oscillographs. We have a bunch, but let's talk about these two. They can handle on-line or off-line test and measurement of any physical happening you might have in mind. From pulse flutters during surgery to whether or not you're refining that crude the same way today as last year.

The one on the bottom is the 5-134. It does everything but talk. It writes to 25,000 Hz. (But with all that speed, it has a data accuracy to  $\pm 1/2\%$ .) And can flip into any one of 10 different servo-controlled speeds.

It's modular, of course, with special refinements. Like the timer, servo control board and galvo all plug in. Individual input connectors as standard. An extremely quiet operation. That type of thing.

Here's a couple more exclusives. You don't have to write out timing line rates. With us, that's taken care of automatically. With a timing ID marked on the edge of the paper. Not only that, the rate can be manually selected or can be automatically synced with paper speed.

And it's got a "jog" feature that allows you to move the paper short distances for initial set up—one hold-down button for on/off.

The smaller box is the 5-135. It weighs in at 35 pounds (a real portable) as compared to the other's 50 pounds. Both boxes share pretty much the same components. It's just that the 5-135 has broader application by more industries across the board because it's not quite so fancy (9 channels versus the 5-134's 18, for instance). Even though it's smaller, it doesn't skimp on performance. It has the largest range of input power options of anybody going. And all that at a lot less money. Not bad, huh?

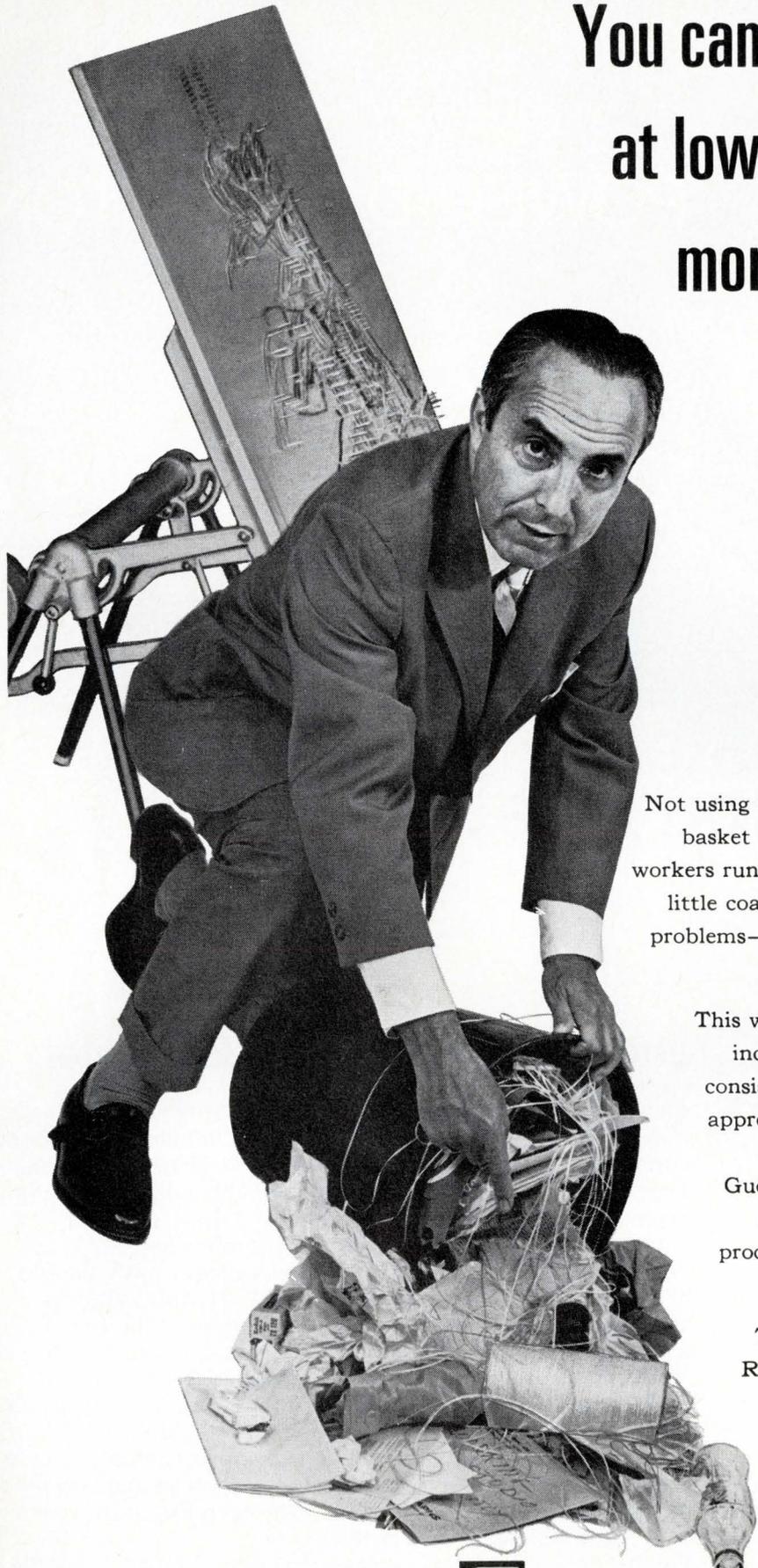
And one more thing. Just in case you're building a system, we've got a range of other new goodies to complement these graphs: 1-172 amplifier, 8-114 bridge excitation/signal conditioner and the 23-111 paper processor.

If anything here piques your curiosity, you can get the full package of specs by writing Bell & Howell, Instruments Division, 360 Sierra Madre Villa, Pasadena, California 91109.

INSTRUMENTS DIVISION

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# You can buy "lacing tape" at lower cost... why pay more for Gudebrod's?

(Maybe your waste  
container will explain!)

Not using Gudebrod Lacing Tape? Then your waste basket contents may be revealing! When harness workers run into tape having coating build up, or too little coating—or other irregularities causing tying problems—they'll often bury it in the waste basket.

Yards and yards of tape will be wasted!

This won't happen with Gudebrod Tape. Every inch has exactly the same uniform finish—it consistently makes tight knots—workers really appreciate it. Naturally Gudebrod Tapes meet applicable MIL Specs. Save money with Gudebrod Lacing Tape—*not on the tape*—but at the harness board where faster production, high quality harnesses with fewer rejects count up in real dollar savings.

Talk this over with a Gudebrod Technical Representative—you'll be glad you did! He has a wealth of unique harness lacing experience.

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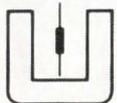
**integrated switching  
circuits  
cost you less...**

**and make your work a lot easier.**

Unitrode's new industrial 10 Amp silicon planar NPN Darlington transistors offer you the advantages of a monolithic two transistor circuit for less than the price of comparable discrete devices. They're ideal for high gain switching applications such as print hammer drivers, solenoid, servo and lamp drivers and for amplifying applications such as motor controls and linear amplifiers. They're available in two hermetically sealed metal packages — a lead-mounted TO-33 (U2T101) and a chassis-mounted TO-66 (U2T201). Both utilize overlay (multiple emitter) techniques on driver and output transistors. Saturation voltage is 1.5V max. @ 5A and current gain is 2000 min @ 5A. Collector-Emitter voltage ratings are available up to 150 volts. U2T201 has a power dissipation rating of 25W @ a case temperature of 100°C. For whatever Darlington application you have, Unitrode ϕ-Line Darlington are more efficient and less expensive than any other method of performing the function. Why not make us prove it? (U2T101 is \$2.75 ea. in lots of 100.)

For fast action, call sales engineering collect at (617) 926-0404  
Unitrode Corporation,  
Dept.11D, 580 Pleasant St., Watertown, Mass. 02172

**Free samples on request.**



**UNITRODE** quality takes the worry out of paying less.

Circle 7 on Inquiry Card

# UP-TO-DATE

**Bremsstrahlung production . . .** The Department of Health, Education and Welfare (HEW) has conducted a search of published literature on Bremsstrahlung production. The literature survey indicated a severe deficiency in the present knowledge of Bremsstrahlung, emphasizing the urgent need for a research program. An understanding of the Bremsstrahlung production is basic to the understanding of X-ray radiation from electronic products, and is, therefore, of importance to engineers. And as you all know, this is becoming more and more prominent in "news" from Washington.

**Product safety . . .** Richard O. Simpson, Deputy Assistant Secretary of Commerce for product standards, claims a vast number of consumer standards for safety—perhaps 10,000—need to be developed. At the average of three man-years per standard, this would require 30,000 man-years of effort. Obviously, new approaches are needed. Simpson states that one very promising work-save may be to concentrate on general standards. By this he means a standard which would deal with a common characteristic of a large group of products. One example would be to introduce a standard covering shock protection in all 117-V, 60-cycle electrical appliances.

**Stop breaks . . .** IBM scientists have found that adding 4% copper to aluminum greatly increases the use of aluminum connection lines for integrated circuits. The addition of copper substantially retards electromigration which causes many electrical opens in ICs. Electrical opens are one of the chief causes of failure in ICs.

**Fly with this . . .** The RCA Aviation Equipment Dept. has developed several new products for general aviation use. These include an 80-mile weather radar, a 200-mile weather radar, a 300-mile weather radar, an airborne digital DME system, and a "Hi-Rel" ATC transponder. The radar sets a unique flat-plate antenna array. The antenna is said to be so good that it will be used by some commercial airlines with their existing weather radars.

**Connect with these specialists . . .** The Electronic Connector Study Group, with headquarters in Philadelphia, wants to hear from interested connector specialists who are willing to serve as consultants. This group plans to establish a group of qualified specialists and distribute their names to any engineers having specific connector problems. Those interested in becoming specialists should write to the Electronic Connector Study Group, P. O. Box 3104, Philadelphia, Pa., 19150, stating interest and qualifications.

**Invasion of privacy . . .** The keynote speaker at the Association of Computing Machinery conference held in New York was Ralph Nader. With the widespread use of computers, Nader stressed a need for an "information Bill of Rights." "Otherwise," he stated, "we risk the threat of computers creating a mass antipathy on both public and private sources." Nader has the same concern as the rest of us with the invasion of privacy via computers. He even prophesized that this will become a political issue in the near future.

**Solidly together . . .** The Electronic Industries Association (EIA) and the National Electrical Manufacturers Association (NEMA) have jointly formed an engineering organization to develop standards on microelectronic and semiconductor devices. The new group will be known as the Solid State Products Engineering Council of the Joint Electron Device Engineering Council. The new council is a combination of the former JEDEC Semiconductor Council and the Microelectronic Engineering Panel.

**It'll cost you . . .** Subscription TV has been approved by FCC for the Zenith Corp.'s Phonevision®. This system is for over-the-air subscription TV (STV). Basically, a scrambled TV signal is transmitted over the air to a special decoding unit at the receiver end. A charge is collected through rental of the decoding unit.

**Fruitful confinement . . .** With a goal to qualify trainees for a variety of unfilled jobs, Sylvania is now using a \$98,000 grant to set up a rehabilitation program with the Massachusetts House of Correction. Inmates will be instructed for unfilled jobs in such areas as electronics, water treatment, and servicing consumer products. Three 16-week courses are aimed at helping about 400 inmates. The Sylvania-trained graduates will be placed in jobs through state-operated employment and service agencies, Chambers of Commerce, and universities.

**Wanna' bet . . .** The New York City Off-Track Betting Corp. is negotiating a 5-year contract for the design and development of the first totally automated wagering system. Access to off-track wagering will be through 100-200 branch offices and a telephone deposit betting exchange. The data processing system will provide a short betting-to-payoff cycle, allow for cash turnover of increased betting volume, and cover all wager types and combinations, such as parlays. For telephone betting, each machine provides the operator with an instant display of the bettor's account balance and enters new bets if the account balance is sufficient.



# locate point-to-point

## New Gardner-Denver *Wire-Wrap*<sup>\*</sup> Terminal Locator with .001 accuracy.

Electronic production schedules up to one million wires per year can be wired with this new 14YN Wire-Wrap Terminal Locating Machine recently announced by Gardner-Denver Company. Positioning rate is adjustable from 120 to 360 inches per minute, and position resolution is .001 on both axes. Wrap area is 36" on the "X" axis and 24" on the "Y" axis.

Machine can be used with twisted wire pairs, as well as a wide range of wire gauges. Standard equipment includes the Terminal Locator, a lighted wire bin with 32

tubes, and a Gardner-Denver solid state tape reader and numerical control. Write for further information, or ask your Gardner-Denver Wire-Wrap Specialist about specifications and assistance in your wiring requirements.

**GARDNER-DENVER**

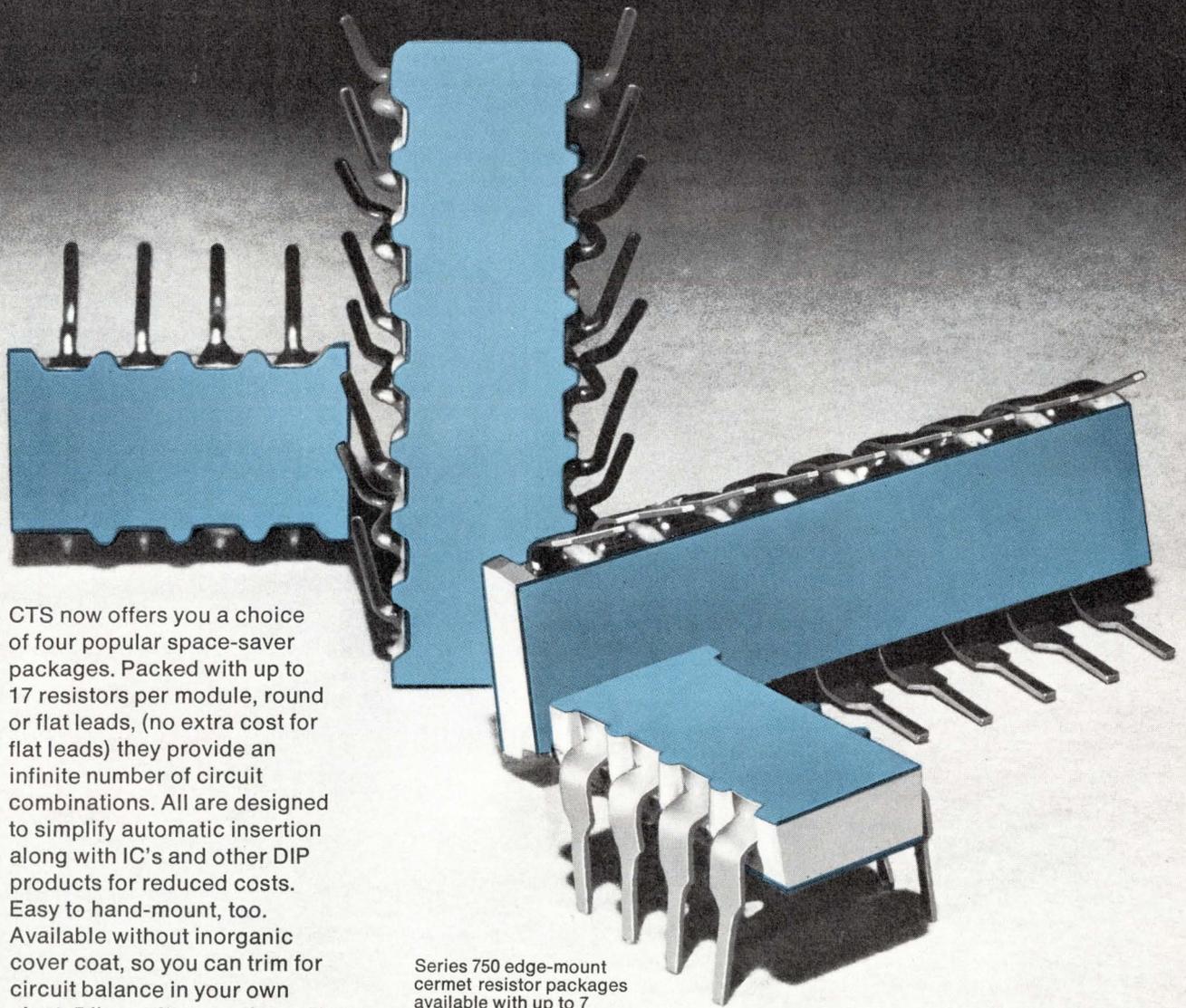
Gardner-Denver Company, Quincy, Illinois 62301

<sup>\*</sup>Wire-Wrap is a registered Trademark of Gardner-Denver Company



# *We packed even more circuitry into CTS cermet resistor networks.*

*New 8 and 18-lead styles added to 14 & 16-lead  
Series 760 Dual In-Line Packages.*



CTS now offers you a choice of four popular space-saver packages. Packed with up to 17 resistors per module, round or flat leads, (no extra cost for flat leads) they provide an infinite number of circuit combinations. All are designed to simplify automatic insertion along with IC's and other DIP products for reduced costs. Easy to hand-mount, too. Available without inorganic cover coat, so you can trim for circuit balance in your own plant. 5 lbs. pull strength on all leads; .100" lead spacing; rated up to 2 watts on 18 lead style.

CTS of Berne, Inc., Berne,  
Indiana 46711. (219) 589-3111.

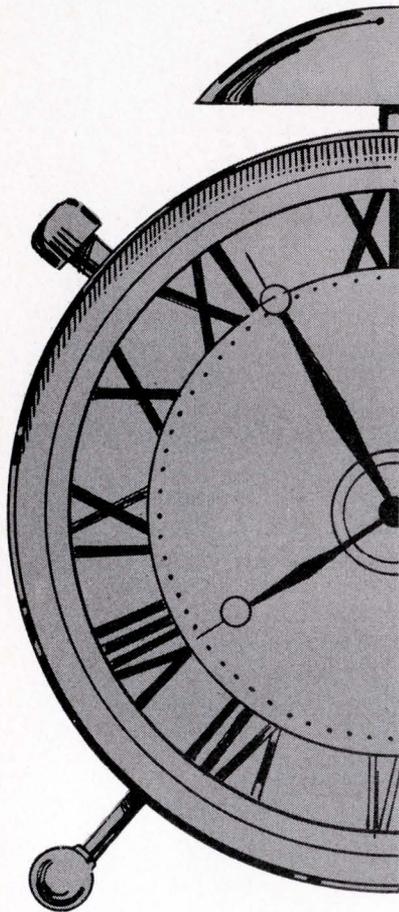
Series 750 edge-mount  
cermet resistor packages  
available with up to 7  
resistors per module in  
9 package configurations.

**CTS CORPORATION**  
Elkhart, Indiana



YOUR CTS ANSWER  
MAN will be glad to  
work with you to pack  
maximum circuitry  
into your compact  
design with this  
expanded line of dual  
in-line packages.

# up-to-date "clocking" solves your advanced LOAD TIMING/CONTROL PROBLEMS



Precision timing and control of high current (mercury displacement) load switching requires advanced, reliable components and circuitry. Where nanoseconds, seconds, minutes, or even hours must be controlled, precision solid-state circuitry must be employed to insure maximum dependability. ADLAKE now offers two new timing devices, plus a unique solid-state bistable relay designed for precise and reliable control. These versatile products will find applications in circuits ranging from the most simple electro-mechanical apparatus to highly sophisticated computers.

## PULSE LATCH

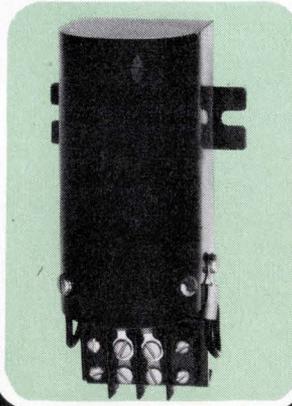
The **Pulse Latch** is a solid-state bistable relay of advance design which controls loads in excess of 3 amps (8-200 Volts). Positive input pulses as narrow as 100 usec. to the same terminal will alternately latch the two outputs. Switching rates as high as 2 kHz are attainable, depending on output loading.



The **Pulse Latch** is unaffected by shock or vibration and is internally suppressed against voltage transients. Many standard models are available. **Pulse Latches** to accommodate your particular load, voltage, and switching parameters can be built on special order.

## HYBRID TIMER

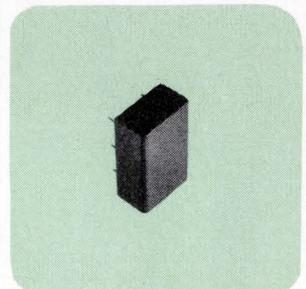
For the first time, an economical timer to handle 35 amp loads for the full timing period (no derating necessary). No need for a costly additional driven relay for high currents. Inputs up to 220 VAC and/or 200 VDC are time delayed from 50 msec. to over 2 minutes.  $\pm 5\%$  accuracy under all load conditions in an operating temperature range from  $-30$  to  $200^\circ\text{F}$ . Fixed or adjustable timing periods in excess of 15 minutes available special. Wide variety of combinations of "On", "Off", "Delay", "Instant Close or Open", with N.C. or N.O. switching.



## DC-DC TRANSFER TIMER

Provides positively controlled, delayed dc output from dc input — timing interval is 10 msec. to 10 minutes. Timing period can be fixed (external resistor) or adjustable (external potentiometer).

Output timing accuracy is within  $\pm 2.5\%$  at recycle times as low



as 20 msec. Operating temperature range is  $-30$  to  $170^\circ\text{F}$ .

Selection of screw-type, PC, or quick connect-disconnect terminations minimize your production line problems. N.O. delay operate mode standard; N.O. quick operate-delayed release on special order. Solid-state AC or input/output isolation available special.

Specify ultra-reliable solid-state ADLAKE Timers and Control components for critical timing and heavy current load switching applications.

**Won't you let us help you?**

Our engineering applications specialists have modern answers to your most frustrating power timing and switching problems.

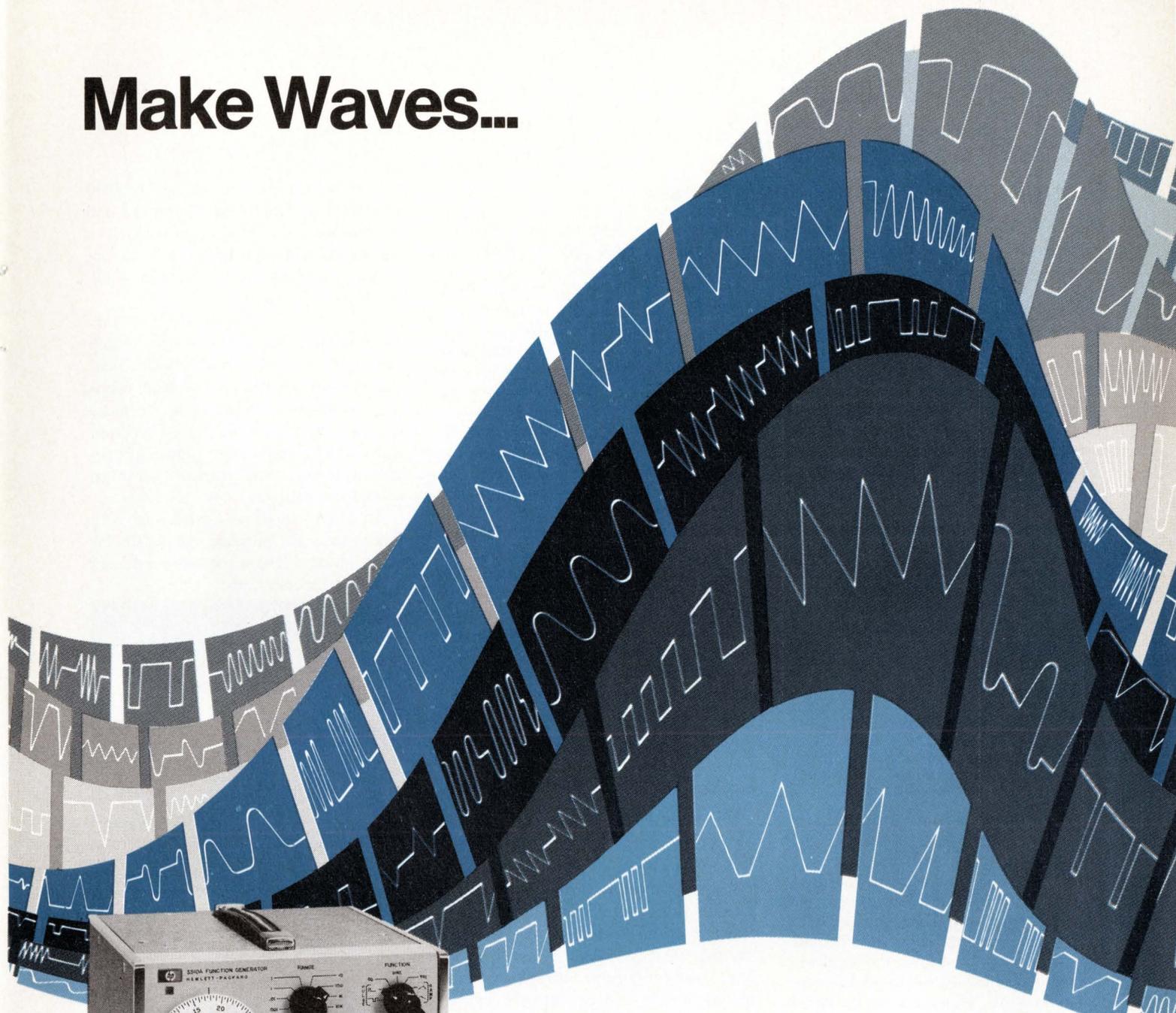


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# Make Waves...



## just about any waveform you can imagine

HP's 3310A is the function generator that gives you seven different waveforms—in three different modes—in one inexpensive package.

In its basic form, the 3310A gives you a continuous output of square waves, sine waves, and triangle waves — plus positive and negative ramps and pulses—for only \$595.

By adding HP's new Option H10 (only \$140), you can generate each of these seven waveforms in two other modes—single-cycle and multiple cycle "bursts." These "bursts" can be triggered either manually or

by an external oscillator; starting-point phase can be varied by  $\pm 90^\circ$ .

With or without Option H10, the 3310 gives you a choice of ten frequency ranges—from 0.0005 Hz to 5 MHz—and an output voltage range from 15 mV pk-pk to 15 V pk-pk into 50  $\Omega$  load. Dc offset of  $\pm 5$  V into 50  $\Omega$  load is also standard.

With Option H10, the 3310A can be used in frequency-response and transient-response testing, as a waveform converter, for generating phase-coherent waveforms, and as a frequency multiplier or divider,

among other things. Applications include testing television and communications systems, radar systems, and analog or digital circuits.

For further information on the 3310A and Option H10, contact your local HP field engineer, or write to Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

090/41

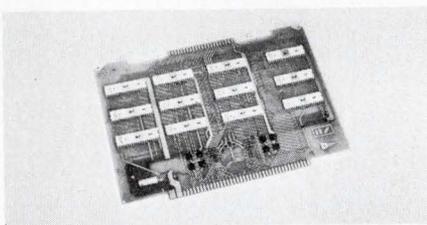
HEWLETT  PACKARD  
S I G N A L   S O U R C E S

Circle 13 on Inquiry Card

## Computer-on-a-chip—well almost

Since the advent of large-scale integrated circuits there have been predictions of a computer-on-a-chip. Well, we aren't there yet but Four-Phase Systems Inc., Cupertino, Calif., has shrunk the central processing unit of its new System IV/70 computer to one printed circuit card—12 MOS/LSI chips.

Of the 12 chips, six are read-only-memory chips which store the instruction set for the machine. These ROM's with 48,000 bits of storage contain the complete set of 120 machine instructions for the new computer. Of the six other chips, three are random logic arrays and three are byte-slice chips.



This circuit card contains the entire CPU for the System IV/70 computer. The 12 MOS/LSI packages contain logic which represents over 10,000 digital gates, or 75,000 components.

The new system consists of up to 32 video display terminals connected and controlled by an integral computer. The System IV/70 computer, which in turn, communicates with the central computer facility, guides you through the data entry steps, pre-processes and formats the data, stores it on disc for local use and/or transmits it directly to the central data base. However, the terminal can handle most of the typical data processing problems before it is necessary to access the central computer.

Peripherals include line printers, card punches and readers, discs, IBM-compatible magnetic tape, and paper tape.

Designed for data entry and retrieval to and from data bases and computer systems, the new computer and terminal display system uses semiconductor memories exclusively. According to the



Up to 32 video displays may be connected to, and controlled by, a System IV/70 which, in turn, communicates with a central computer facility.

company, the system has the computing power of an IBM 360/30. And, you would also have the display system.

System IV/70 interfaces with IBM 360/370 systems locally or remotely—and with unmodified IBM software through a System IV/70 foreground communications package. A subset of this package completely simulates an IBM 2848/2260 data station complex.

The machine has no software yet (it will be available at a later date), but it is capable of using IBM's software (for the 360 and 370 lines), which is, of course, immediately available.

During normal system operation, display and communication operating overhead is only 10 to 20%, leaving 80 to 90% of the system's time available for user background programs such as data validation, error checking, formatting, and local processing and storage before transmission to the main computer.

The desk-top unit sells for only \$7,500.

## Mesa passivation

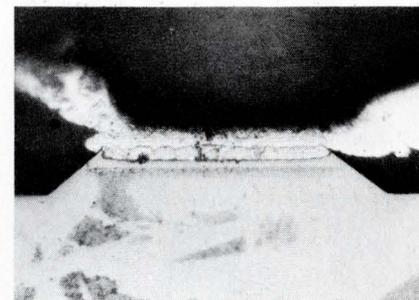
Most semiconductor devices and monolithic ICs are made by planar process. This process, by its nature, affects total protection of the sensitive diffused junctions during, as well as after, various process steps. Mesa devices have many desirable advantages over planar devices and can achieve special performance characteristics not possible with the planar process. However, the mesa process results in exposed junctions, and no practical passivation method fully protects the junctions.

A new process is the combination of the mesa and planar, incorporating the advantages of the two processes. This process is given the acronym SIMTOP for the Silicon Nitride ( $\text{Si}_3\text{N}_4$ ) masked, thermally oxidized, post-diffused mesa process. Procedure is basically as follows: A thin layer of  $\text{Si}_3\text{N}_4$  is deposited onto a silicon wafer. The  $\text{Si}_3\text{N}_4$  is etched to form a desired geometry using photolithography and the appropriate etchants. The mesa is then formed by etching the silicon. The resulting mesa will have smooth crystallographic planes if the silicon material is  $\langle 100 \rangle$  orientation and is etched using an anisotropic etch. Then the silicon is

thermally oxidized to a thickness of 8000 to 10,000 Å. The  $\text{Si}_3\text{N}_4$  is removed and the p-n junction formed by diffusion. The metallized contacts are formed by evaporating or plating the appropriate metal, Al, Ni-Au, Cr-Au, etc.

The post-diffusion feature of this mesa process results in devices which have high reliability, uniform electrical and physical characteristics, and fabrication simplicity. In addition, the mesa structure eliminates the curved junction and lateral space-change widening, providing lower capacitance and high breakdown voltages.

An Impatt diode was fabricated with this process to illustrate the feasibility of the process. The work was conducted at MIT's Lincoln Labs.



A new processing method incorporates the advantages of both planar and mesa fabricated devices. Here is a cross section of a device made with the SIMTOP method.

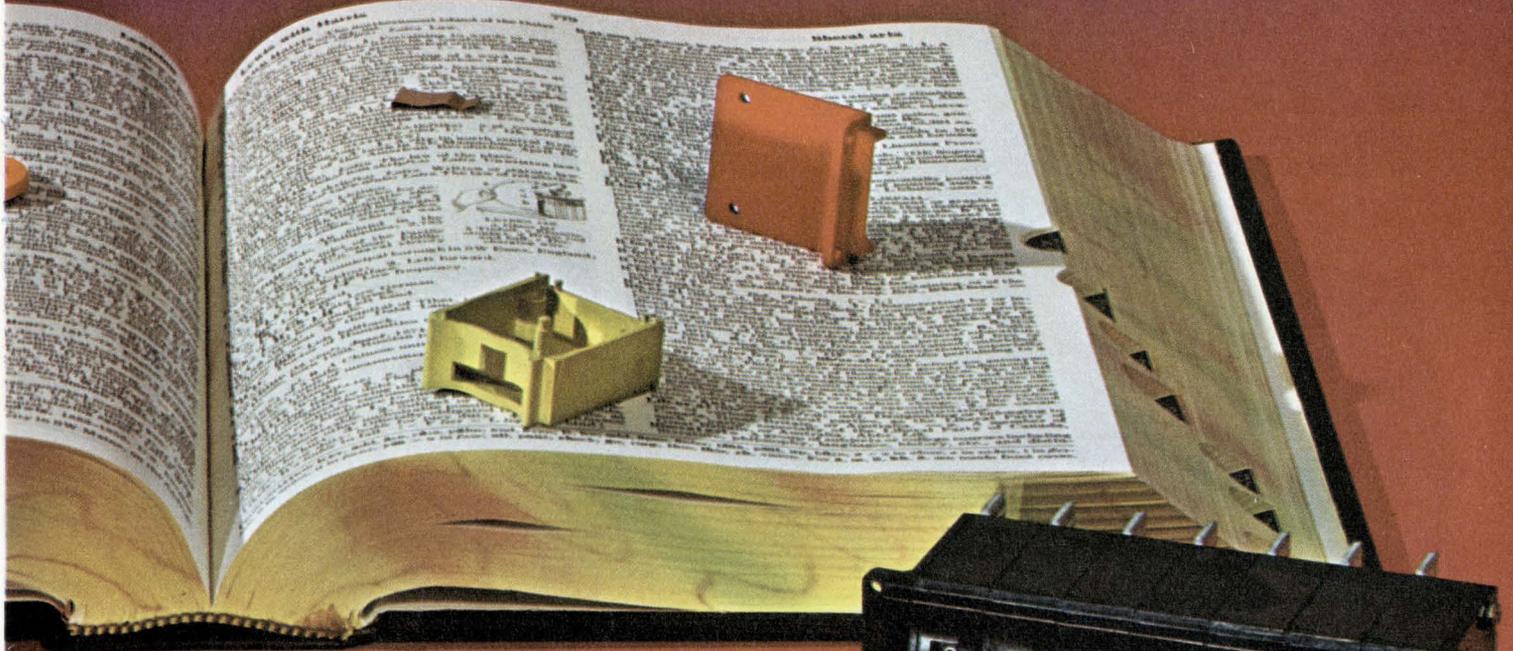
## Insulation won't cook

A new electrical wire coating can withstand heat as high as 700°F without degradation or danger of fire. The material, which can seal wire against the effects of moisture and air, as well as repel heat, was developed for the Air Force Materials Laboratory by Hughes Aircraft as a coating for "hook-up" wire in high-temperature applications.

The material is a combination of a polyimide film and a new polymeric coating. The latter is applied in a solution form to the polyimide film and then dried and cured.

A commercially available polyimide tape that is used to insulate electrical wire is coated with a polymer adhesive substance. The coated tape is then wrapped around the wire on a wire-wrapping machine.

# lev-er-wheel

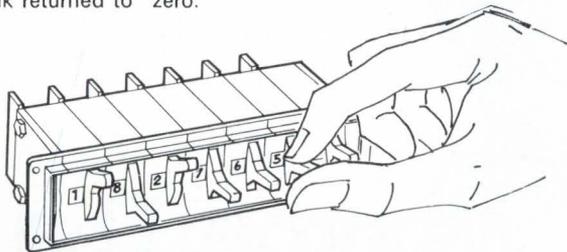


... so new  
you can't look it up  
in your Funk & Wagnalls

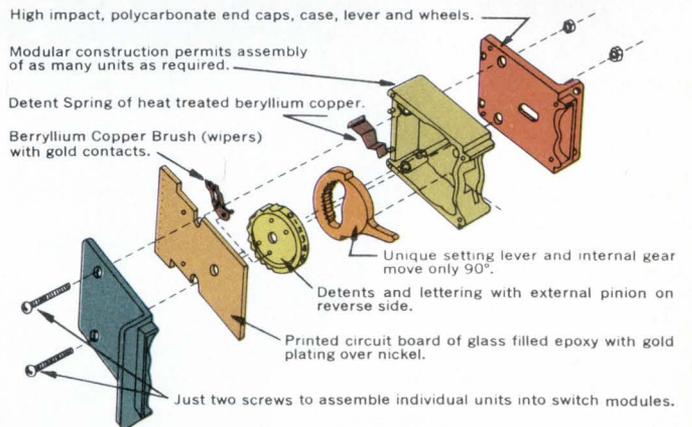
## LEVERWHEEL SWITCH ... a brand new concept ... Thumbwheel Lever-Action by CHERRY

**FASTER SETTING:** A single movement of the Leverwheel setting lever through its 60° arc is all that's necessary for a complete 10-Position cycle. (Compare *that* to plunking through the 360° rotation on conventional thumbwheel!)  
**Instant reset** at no extra cost: A simple sweep with the hand and all levers return to home position with every switch in the bank returned to "zero."

Instant reset at no extra cost: A simple sweep with the hand and all levers return to home position with every switch in the bank returned to "zero."



Cherry has new standard thumbwheel switches, too! Like the unique new Leverwheel, Cherry thumbwheel switches are available in miniature and subminiature sizes, totally-interchangeable with other leading thumbwheels.



SEND TODAY for our new 44-page full line catalog . . . which includes complete data on Cherry Leverwheel and Thumbwheel Switches.



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Programming: 128 steps for linear or conditional branching operations.

Automatic special functions:  
 $a^x$ ,  $\log_{10}/\log_e$  SIN/COS,  
 $\text{SIN}^{-1}/\text{COS}^{-1}$ ,  $\times!_{1/x}$ ,  
radians to degrees,  
single key  $\Sigma x$ ,  $\Sigma x^2$ , N,  
rectangular to polar conversion.  
Automatic entry  
of values for e and  $\pi$ .

Ten independent, directly addressable storage registers.

Special punch card system allows programming without tying up the calculator.

Dynamic range of  $10^{-99}$  to  $10^{+99}$ .  
Decimals displayed in either Autopoint or scientific notation.



Model 1655 shown.  
All MOS/LSI circuitry.  
Weight: 12 pounds  
Size: 13" x 13½" x 6½"  
Available with or without programming.

Accessory card reader for automatic entry of program data, special functions and decision-making capability not shown on keyboard.

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\*In Connecticut: 800 942-0655

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Calculator  
Company**



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# About MIL-temp-range, clockless, TTL-loving RAM's, ROM's, and other MOS improbabilities.

There are any number of people making MOS devices these days.

But not so many people using them.

And we know why.

Almost all MOS devices are power hungry.

Most of them don't get along easily with DTL and TTL.

And almost every one carries a 65°C or 85°C maximum-temperature limitation around its neck.

That's why ours are so improbable.

They all interface directly with worst-case DTL and TTL levels.

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And the RAM's use about half the power that most of the others require.

Our new off-the-shelf 256 x 1 RAM, for instance.

It's fast (<1  $\mu$ sec access time); low power (1 mw/bit); and it interfaces with DTL and TTL without pull-up or pull-down resistors. Our special field-inversion protection keeps those specs stable at 125°C and at circuit voltages well in excess of -20 volts.

That's not a "someday we'll do it if you pay for the tooling" promise. Our stock list already includes 64 x

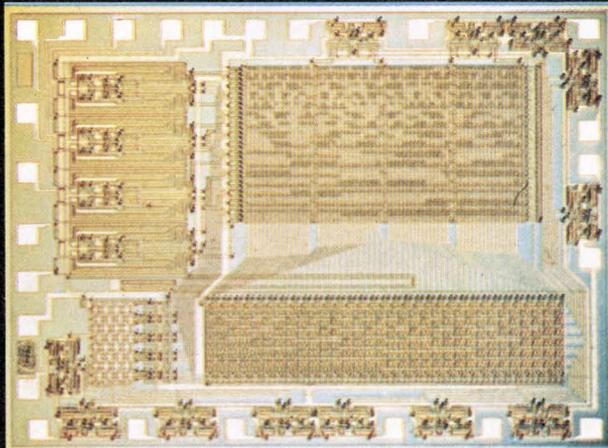
4 and 256 x 1 RAM's; 1024-bit, 2048-bit, 3072-bit, and 4096-bit ROM's; and a new 2240-bit character generator; not one of which has a clock or needs a clock driver. More—like a 1024 x 1 RAM—are on the way.

What's your pleasure? Call and tell us what you want and you'll have one in 72 hours. Write, and we'll have data in the next mail.

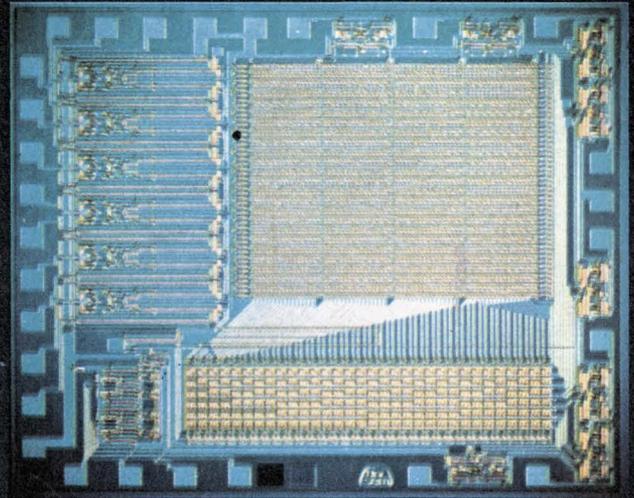
Special problem? Ask for our MOS problem-solver, John Kitzrow.

Unisem Corporation  
Street Road, Trevoze, Pa. 19047  
(215) 355-5000

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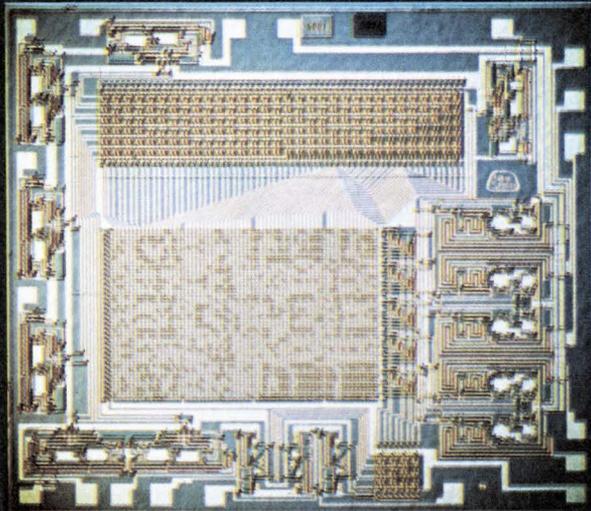


UA2548/3548 2048-bit ROM

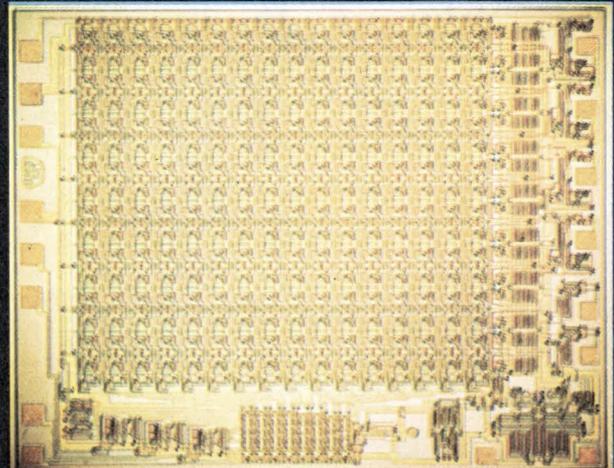


UA2572/3572 3072-bit ROM

UA2540/3540 2240-bit character generator



UA2556/3556 256 x 1 RAM



**Unisem**  
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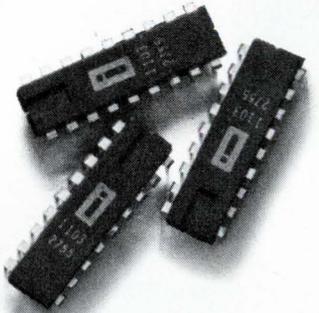
**U  
A.**

THE

END

CORES LOSE  
PRICE WAR  
TO NEW CHIP

ASK INTEL FOR  
PROOF



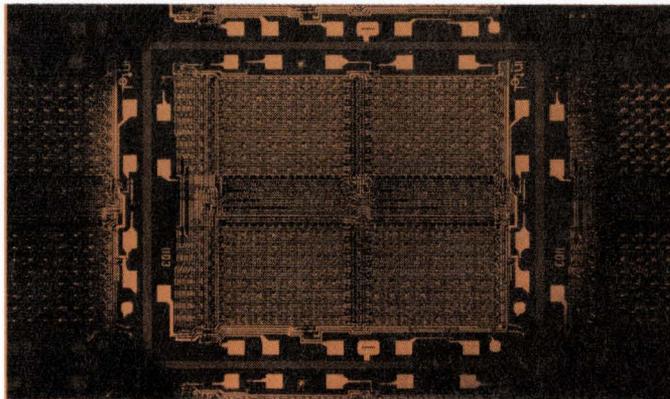
Intel introduces Type 1103, a history-making 1024-bit RAM made by our silicon-gate MOS process at such high yields that the cost dips below cores.

Just tell us what core memories cost you, and we'll tell you how to build operational Type 1103 memories for less cost in any size from 50,000 bits to 10,000,000 bits.

The Intel 1103 makes a fully assembled memory system that has a maximum access of 300 nanoseconds and a total cycle time of 600 nanoseconds. The chip is fully decoded and dissipates only 100 microwatts per bit, permitting dense packing in compact configurations.

For proof of the cost advantage, phone your Intel representative or call us collect at (415) 961-8080. For immediate delivery phone your local Intel distributor, Cramer Electronics or Hamilton Electro Sales. If your distributor isn't stocked, call Intel collect for immediate same-day shipment.

Intel Corporation is in high-volume production at 365 Middlefield Road, Mountain View, California 94040.



intel<sup>TM</sup>  
delivers.

# HOUR of DECISION



**A busier schedule and more complex technology have combined to make decision-making at the FCC a much harder task.**

DEAN BURCH  
of the Federal Communications Commission



# at the FCC

By John McNichol, *Assistant Editor*

The Communications Act of 1934, which created the Federal Communications Commission, requires the Commissioners of the FCC to meet once a month. Until not too long ago, when August came, they did just that. They would gather on the first Wednesday of August, and take the rest of the month off—not unlike the French government. Today, the Commission no longer has an 11-month year—it's much too busy for that.

The reason for the Commission's busyness is implied in the progress of technology. Photography, which was invented in 1727, did not become available to the public until 1839—an 112 years lapse. The lag was halved by the time the telephone (1820-1876) came—56 years. We had to wait 35 years for the radio (1867-1902) and 15 years for radar (1925-1940), while television was manufactured in 1934, 12 years after its invention in 1922. From concept in

1939 to awesome reality in 1945, the atomic bomb took six years. The most recent inventions on our list, the transistor (1948-1953) and the integrated circuit (1958-1961), took only five and three years, respectively.

Because of modern technology and the expertise with which it is applied, the lead-time between invention and execution of that invention is rapidly declining. And that's not an unmixed blessing when your job is to regulate and decide on the future functions of these technologies. Although only three of the inventions on the list are governed by the FCC, that is precisely the position that the Commission will increasingly find itself in.

## Can of worms

The man who inherited this electronic can of worms is Dean Burch, Chairman of the Federal Communications

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## THE FCC AND DEAN BURCH

The direction taken by much of the enormous potential of telecommunications technology in the United States is ultimately decided by seven men—none of them a scientist or an engineer. These seven men, the Commissioners of the Federal Communications Commission (FCC), are responsible "for regulating interstate and foreign communications by radio, television, wire and cable." Created as a result of the Communications Act of 1934, the FCC, an independent government agency reporting directly to Congress, "provides for orderly development and operation of broadcasting services and rapid, efficient nationwide and worldwide telegraph and telephone service at reasonable rates. It promotes the safety of life and property through the use of wire and radio communications and employs communication facilities for strengthening national defense."

To aid the Commissioners who have been appointed by the President for a period of seven years, there is a staff of 1500, relatively small as Washington agencies go. Each Commissioner may have at least three personal aides (administrative, legal, and technical). Approximately half of the 1500 are professionals, such as engineers, attorneys, accountants, economists, librarians, etc. The technical staff consists of 350 engineers and 100 technicians, based both in Washington and the field. Because of the smallness of the staff, the Commission is forced to go outside itself when making a large study. It will go to such groups as NASA, or the Stanford Research Institute (as in the case of the "Interdependence of the Computer and Communications Service and Facilities" inquiry), or the National Academy of Sciences for the "Interconnection" report, etc. In addition, as Dean Burch, the Chairman, says, "The Commission places a great deal of dependence upon the advice and assistance of industrial and professional groups. Frankly, without them we could not function effectively in our present form. Industry coordinating committees render a tremendous

amount of assistance to the Commission by easing the problems associated with frequency assignments to land mobile, aeronautical telemetering, and operational fixed stations, for example.

"There are any number of special committees and national associations established to deal with communication problems associated with aviation, marine services, broadcasting, manufacturing, etc. to which we often turn for advice in their particular specialty."

These Commissioners, (three Republicans and three Democrats) and their Chairman, Dean Burch, meet once a week to consider questions in the following areas:

□ Regulation of broadcasting—The FCC has jurisdiction over a-m and fm, uhf and vhf television (both commercial and educational), pay television, and CATV (Community Antenna Television). It also regulates aviation, ship, amateur, and various form of business and citizens' radio services. It considers applications for construction permits and licenses for all classes of non-government radio stations. The Commission also assigns frequencies, sets operating power, designates call signs, inspects transmitting equipment, and regulates its use. The Commission authorizes license renewals and changes in ownership of radio and television broadcasting stations.

□ Common carrier operations—This includes telephone, telegraph, cable, microwave, and satellite communications, where the FCC sets regulations, supervises charges, practices, and classifications of service. It also licenses radio-telephone and radiotelegraph circuits and assigns frequencies for their operation.

□ International matters—The FCC is responsible for the domestic administration of telecommunications provisions of treaties and international agreements. In addition to participating in international communication conferences, it licenses radio and cable circuits from the United States to

Commission. Since 1969, he and his colleagues have considered or made decisions on such diverse matters as CATV, domestic satellites for communications, microwave special service common carrier systems, spectrum reallocation, and others, besides the workaday routine of regulating broadcasting and telephony in this country. (For a more complete description of the FCC's responsibilities, see box, "The FCC and Dean Burch.")

While the FCC oversees communications matters that affect the public, President Nixon's recently created Office of Telecommunications Policy, headed by Dr. Clay T. Whitehead, is charged with a similar function for the government (see CHALLENGE, "Innovating for the 21st centu-

## THE FCC AND DEAN BURCH (continued)

foreign points and regulates operating companies.

On November 3, 1969, Dean Burch was sworn in as Chairman of the FCC, making him responsible for the general administration of the internal affairs of the agency. (Unlike the other Commissioners, the Chairman's responsibilities extend for a term determined by the President.) In addition he presides over the weekly meetings of the other Commissioners. Son of a guard with the Federal Bureau of Prisons, Burch was raised in such places as Norman, Oklahoma; Leavenworth, Kansas; and Alcatraz Island. After graduation from high school in 1940, Burch enlisted in the Army. He now is a Lieutenant Colonel in the Judge Advocate General's Corps reserve. Leaving the Army, he entered the University of Arizona where he received his college and law degrees in 1948 and 1953, respectively. Entering the backstage of politics, the Chairman was appointed assistant to the Attorney General of Arizona in 1953, and then Senator Barry Goldwater's legislative and administrative assistant until 1959 when he returned to private practice in Arizona. Between 1964 and 1965, he was Chairman of the Republican National Committee.

Surrounded by signed black and white pictures of southwestern Indians and flowers photographed by his old friend, Barry Goldwater, the affable Chairman seems not at all intimidated by the implications of the FCC's responsibilities. And to this point, management of electronic companies has been pleased with Mr. Burch's stand, which has been to encourage competition in decisions such as CATV, domestic satellite systems, and specialized transmission systems. In another action, Burch is striving to make the FCC self-sufficient; the Commission has proposed a 500% raise in the fees to broadcast or to operate telecommunication facilities. This would bring in an additional \$20 million a year, almost equalling their \$25 million budget. In a very difficult position, Dean Burch has a tough row to hoe.

ry," *The Electronic Engineer*, July 1970, p. 33). As Burch sees it there is no conflict between the two offices. "On the contrary," he says, "the FCC must get the best thinking it can from any source, and the fact that it comes from the Administration obviously is a consideration. On the other hand, they do not, in my opinion, want to dictate our decisions. Tom Whitehead and I can work together, so I really see no problem. Of course, this arrangement is in the fetal stage and it's rather difficult to see how well it will finally work out."

## A flexible spectrum

Burch does not foresee any possible reallocation of the spectrum in "a comprehensive sense. For instance, the Table of Frequency Allocations, incorporated in the FCC's rules, is a dynamic structure that undergoes change several times a year in response to the changing needs of existing services and to accommodate new radio services. During the past few months, to give you some examples, we changed the Table to permit limited land mobile service access to uhf TV channels 14-20 in certain parts of the country; we reallocated outright the upper 14 uhf TV channels (70-83) to the land mobile service; and we're now in the process of establishing a band for land mobile telemetering. In addition, major changes in the national Table can be expected as a result of decisions to be taken up by the World Administrative Radio Conference on Space Telecommunications (WARC-ST) to be convened on June 7, 1971 in Geneva, Switzerland by the International Telecommunication Union (ITU)."

As an example of the intensive use of the spectrum, and of how technology improves to meet demand, he points to the last six ITU Conferences. In 1927, the upper limit was established at 23 MHz (except for amateurs and experimental stations); 1932—28 MHz (with the same exceptions); 1938—200 MHz; 1947—10.5 GHz; 1959—40 GHz; and 1963, also 40 GHz. "Our proposals for the forthcoming WARC extend up through 265 GHz," he says. "Also, we will intensify usage in presently allocated bands. During the past 15 years, the spacing between assignable frequencies at 150 MHz in the land mobile service was reduced from 120 kHz to 60, then 30, and finally, to 15 kHz. The maritime mobile vhf has undergone similar changes as will the vhf aeronautical band. Additionally, as congestion increases in the microwave fixed bands (e.g., 4, 6, and 11 GHz) around major metropolitan areas, more and more interest is being shown in the millimeter range by potential users looking for relief.

"Some people," Burch stated, "suggest that we need a super-duper computer to come up with an ideal solution to

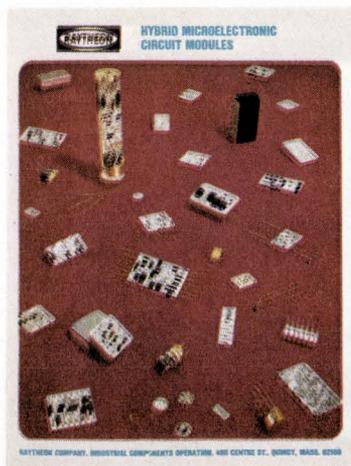
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this question of reallocation and reassignment. But I don't think that this is a purely technical question. I don't conceive in the near term any sort of ideal reallocation of spectrum space where everybody lives happily ever after. It's just not in the cards. Since the spectrum is finite and the uses infinite, we will always have a problem. I do, however, realize that the spectrum, although finite, can stretch, and your readers, the electronic engineers, are responsible for much of the stretching of that finite band."

## **Pie in the sky**

Since the Communications Satellite Act of 1962, there have been a series of milestones in space communications technology:

- Establishment of the Communications Satellite Corp. (Comsat) in 1963.
- The international agreement establishing interim arrangements for a global commercial Communications Satellite System in 1964.
- Operation of the first commercial communications satellite (Early Bird) in 1965.
- Achievement of global coverage by the Intelsat system in 1969.

The FCC has been an active participant, with the now defunct Office of Telecommunications Management, the Department of State, and NASA, in coordinating and maintaining what growth has been made in this exciting medium.

The Chairman is quite candid about the Commission's delay in setting up rules for domestic satellites. "Both Administrations (Johnson and Nixon) have let the matter be held up, so that the President's Task Force could study the overall question of communications with domestic satellites as part of the possible solution. Our approach has probably been slower than if we designated one carrier, authorized users, and demanded so many channels for TV, industry, etc. In effect, we have opened up the whole question to industry and said, 'Submit your proposal. Do you want specialized or common carriers? Should there be more than one carrier? Should anyone with the money be allowed to get into the business?' We don't honestly know what we're going to come out with. All we're asking is that the systems consider Hawaii and especially Alaska (Alaska is desperate for satellite services)."

December 1 has been set as the cut-off date for the filing of applications to own and operate domestic communications satellite systems, with the exception of the ABC, NBC, and CBS television networks, which will receive an extra 15-day grace period. Besides Western Union, which

has already filed, AT&T, Hughes Aircraft Co., Teleprompter Corp., Comsat Corp., RCA Global Communications, Inc., Datran, General Telephone & Electronics Corp., MCI, and the TRW Systems Group of TRW, Inc., may file by the deadline.

## **CATV**

Speaking before the National Cable Television Association (NCTA) convention in June, Dean Burch declared, "In my opinion, the time is now for a breakthrough in your industry." And for the CATV market, which the Electronic Industries Association predicted has the potential to do the same amount of business in the next 10 years that the computer market did in the past 10 years, prospects never looked brighter. (Quantum Sciences Corp. has predicted the future as \$4.4 billion for CATV by 1980.)

In July, the FCC proposed the "Public Dividend Plan," so called because CATV companies would be required to pay 5% of their gross sales to the non-profit Corporation for Public Broadcasting. One interesting sidelight on the overall proposal is the requirement that the design be flexible enough to incorporate two-way communications in the future, opening the way for the "wired city."

## **New carriers**

Probably the area that has raised the most furor, if not necessarily the most significant, is that of the specialized common carriers. (Read the box, "Common and not-so-common carriers.") When the FCC ruled permitting the Carterfone, a product made by a small Texas company, Carter Electronic Corp., to be attached to AT&T's lines, it eased the door open for potential special service common carriers. One such, Microwave Communications Inc., was authorized to build a microwave link between Chicago and St. Louis in 1969. This is the first step towards constructing a national network of such links—after six years of waiting and hoping. A later applicant to the FCC has been University Computing Co.'s Data Transmission Co. which proposes a microwave common carrier network for digital data, differentiating it from MCI, which will carry any form of material. Another difference is that Datran will offer a switched network, while MCI will offer a series of channels across the country. At the moment, Datran is on tenterhooks awaiting the FCC decision; one encouraging note from their standpoint has been the release of a staff report, a very rare event when a decision is pending, which stated that the Datran system should be considered separately from the other applicants. At the same time, AT&T

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## COMMON AND NOT-SO-COMMON CARRIERS

Exhibiting more claims and counterclaims than TV soap commercials, the communications carrier field can be extremely complex. In addition to the communications common carriers, such as AT&T and Western Union, there are other classes of carriers, such as CATV, mobile radio-telephone, and radio paging services. Another type is the so-called special service common carrier, exemplified by Microwave Communications Inc. (MCI). The special service common carrier (SSCC) differs from the common carrier in three ways:

- An SSCC will provide service on an inter-city trunk, which can be customized for individual subscriber requirements, and not on an end-to-end basis.

- Almost no tariff restrictions exist on the interconnection of private communications systems with the SSCC or against the shared use of the special service common carriers.

- A single mode of carrier facility, such as microwave, would be used for the inter-city communications channel.

Microwave transmission technology was developed during World War II by Bell Telephone Labs and what was later to become the MIT Lincoln Laboratory for anti-aircraft radar. After the war it found its way into carrier systems because of its low unit cost and highly expandable channel capacity. Some of the applications were to increase the capacity of Bell's and Western Union systems, private railroad and pipeline systems, and CATV.

Probably the single most important event in the growth of the specialized microwave common carriers had no direct involvement with the system. In June 1968, The FCC ruled that a carrier (such as AT&T) could not apply discriminatory tariffs against a "foreign attachment" such as the Carterfone. For the first time, a product not made by Western

Electric and not sanctioned by Ma Bell could be connected on AT&T's lines. Thanks to this ruling, modems not available from Bell can be built directly into computers.

In 1963, a very determined businessman, John D. Goeken, filed with the FCC to allow his company, MCI, to build a microwave link between Chicago and St. Louis. Some \$400,000 in legal fees and six years later, the FCC licensed Goeken to build such a link, the first of a nationwide network. Offering a wide choice of bandwidths (ranging from 200 Hz to 900 kHz) and the attendant greater speeds, MCI claims their prices will be lower—in some cases—94% less than those of AT&T. The MCI system will carry not only data, but also facsimile, radio, TV, or voice. Being an SSCC, however, MCI's lines will not reach the small user—they will simply operate microwave channels between cities.

During Goeken's long legal ordeal, University Computing Co. of Dallas, Texas, set up a subsidiary, Data Transmission Co. (Datran), which plans a completely digital microwave common carrier for data transmission in categories of up to 150, 4800, 9000, or 14,400 bits/s. An ambitious undertaking, estimated to cost \$375 million at completion, the Datran system differs from MCI's in that it transmits only digital information. Also, since it reaches small subscribers, it is switched—any Datran subscriber can communicate directly with any other subscriber.

Although the FCC has not formally ruled on Datran, a staff report, in an unprecedented action, was released in mid-July by the Commissioners that stated: "We think Datran's proposed system should be considered separately. It alone has proposed a switched, occasional use, all digital and end-to-end network devoted exclusively to data transmission. The other applicants have proposed to provide a variety of private line, point-to-point, specialized services,

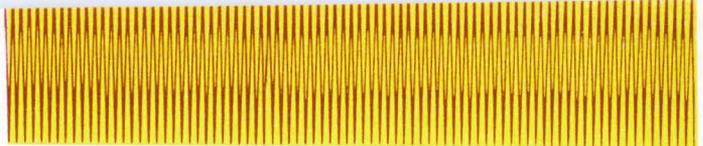
contends that the proposed systems can offer cheaper rates because they are interested in the most populous areas.

### Items

The FCC, in order to keep up with the explosive growth of communications, must continue to inquire into, and to commission studies, for future areas to expand. Some, past and present, are listed below:

- An inquiry to provide a perspective on 1980 for cables, satellites, and other facilities used in overseas communications. The inquiry mentioned cables with a capacity of 800 voice circuits (3 kHz), new satellites with 5000 voice circuits to be operating by 1971, and increased use of new overseas services such as TV and real-time data.

- The so-called "Interconnection" study. Since the Carterfone decision in 1968, a number of products such as modems and switchboards have appeared in the market, and the telephone companies have complained that the connection of these products to telephone lines could be "harmful" to other subscribers. The National Academy of Sciences studied the matter for the FCC, and agreed that "uncontrolled interconnection . . . would be harmful." NAS defined harm as "cross talk, loss of privacy, increase in circuit noise, excessive wrong numbers, and physical harm to the personnel or equipment of a carrier or to a third party." To prevent such problems, the Academy recommended certification of equipment, and of installation and maintenance personnel.



which may include data transmission but are primarily aimed at offering subscribers flexible, low-cost communications channels adaptable to their own particular needs and requirements."

On the basis of this and other statements, Datran has issued approximately \$7 million worth of contracts for a system integration program. Collins Radio Corp., Martin Marietta Corp., Raytheon Co., and Comset will work on areas of the three elements of the digital transmission network—a transcontinental microwave trunk system that employs time division multiplexing and digitized transmission, computer-controlled switching centers, and local distribution systems that may use a combination of low-power microwave, optical, and cable techniques. The FCC has shown a particular interest in this phase, according to Edward A. Berg, Datran vice-president.

□ Collins Radio Corp.—a digital modulator for the trunk systems.

□ Martin Marietta Corp.—integrate a time division multiplex (TDM) system for the trunk network which, when used with the digital modulator, will permit simultaneous transmission of over 4000 digital channels, each with a 4800 bits/s rate. The company will also refine an optical transceiver to be used in the local distribution system; this project will include studies on IR and laser solid-state optical systems.

□ Raytheon Co.—overall systems integration of the local distribution system, stressing the need to conserve frequency and reduce interference.

□ Comcet—further integration on computer-controlled switching system. Initially, Comcet will refine specialized hardware, supply a supervisory console and early software

outlines, and consult with proposed switching matrix vendors.

Datran is testing a new optical system developed by Computer Transmission Corp. for the local distribution of their system. Designated Optran, the system so far has pleased Datran. According to Berg, "The test results are just beginning to come in, but it looks like the system will operate at extremely high degrees of reliability in the normal, short hop situation."

All this activity in data transmission has brought over 1800 applications from some 30 new common carriers before the FCC. As Commissioner Robert E. Lee has said, "I regard this as one of the most important issues we have ever considered in the common carrier field. . . . I believe that the decision (MCI) has resulted in the almost 2000 conflicting applications now on file which give rise and urgency to the problems before us."

Not so ironically, the two firms that have most vehemently fought the MCI-Datran proposals, AT&T and Western Union, have developed data transmission systems not unlike those of the new applicants. (The Stanford Research Institute's study undertaken for the FCC on "Regulatory and Policy Problems Presented by the Interdependence of Computer and Communications Services and Facilities," stated that, by 1980, data transmission will be between 10 and 50% of the common carrier's workload. On the other hand, AT&T has contended that by the same time data transmission will be 10% of the business, at the most.) No matter who is right, the lure of the estimated \$20 billion market by 1980 is hard to resist, even if it's not all your ballgame.

### A losing battle?

Burch has been characterized as a man who does his homework. But handicapped by a small staff and a small budget, he may have a problem that just plain hard work cannot overcome. Although a Republican Commissioner has said that AT&T's problems alone require at least 500 people, Burch contends, "We are not a hardware organization and we shouldn't try to be. . . . The FCC has generally felt that they were not obligated, nor was there a need, for them to be an innovator in technology. . . . We couldn't gather the kind of staff that GE, Motorola, or IBM has."

Even with such advantages as the cooperation of the President's Office of Telecommunications Policy, his own qualities, and the best efforts of the other Commissioners

and Commission staff, Chairman Burch may find the inexorable progress of telecommunications technology outrunning the Commission's best efforts, as it is presently constituted. However, the undeniable achievement of Burch's tenure at this time has been to open up competition to the telecommunications marketplace as never before. As Burch sees it, "Although we're a regulatory agency and *laissez-faire* capitalism just doesn't exist today, we are certainly willing to encourage competition, which, eventually becomes a classic form of regulatory device."

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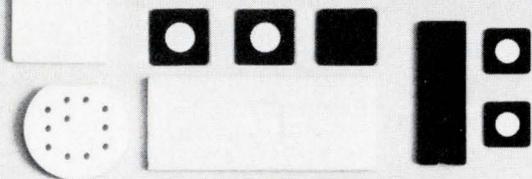


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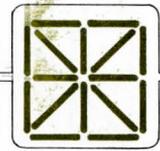
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**optical memory systems**





# creative doodling made easy: CRT terminals

by WILLIAM H. SASS and  
HAROLD S. RASMUSSEN  
IBM Corporation, Kingston, N.Y.

**Whether you use it to  
design a circuit or to  
save your seat on an  
airplane, here's how the  
CRT terminal lets you  
"talk" with a computer**

While you may have trouble getting through to your teen-age son occasionally, you have no idea of what a real communications gap is until you try a two-way conversation with a computer. Computers are marked by massive memory, super fast computational ability, selective recall and an extremely limited vocabulary. Couple this fact with the rapidly growing list of computer applications and you have an apparent need for a sophisticated means of direct man-machine interaction.

Traditionally, communication between man and machine has favored the machine. Man has been obligated to translate his problem into "word" descriptions. These words are then fed into the machine via such means as keyboards and punched cards. Output results from the computer must be extracted from voluminous tabular listings which have to be then converted into some more easily comprehensible form such as graphs or tables. Although some attempts have been made to plot results on line printers or typewriters they have been usually less than satisfactory because of the limited resolutions of these devices. Off-line plotting and film recording equipment have helped man in his attempts to understand the machine. In general, however, these devices lack the ability to input to the

computer which is necessary for truly conversational operation.

At present, the best solution to this problem is the CRT display terminal. Combined with suitable auxiliary equipment, the CRT terminal can provide graphic output plus the required input capability.

## Hardware organization

All computer-controlled CRT terminals basically consist of the CRT and its associated deflection circuits, analog and digital control cir-

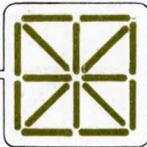
cuits, and data storage.

The CRT which is usually a standard television envelope, uses long-persistence phosphors to maximize the amount of information which can be displayed without excessive flicker.

The control circuits accept commands from the computer, interpret image data and control information from storage, and initiate computer actions in response to operator requests.

Except for storage-tube displays, all of today's CRT display systems must be continuously refreshed to maintain the image on the screen. The system must, therefore, have the image data available in a continuous stream. Usually this function is accomplished by having the computer set up the image data in storage and equipping the terminal to fetch the data as needed. This storage may be part of the general computer memory, or a separate storage device that, after being loaded by the computer, is devoted entirely to maintaining the display image.

We can divide CRT displays into two broad types, raster displays (see box) and vector displays. As an interface device, the CRT can graphically display the output from the computer. The raster type of CRT lends itself to simple drawings or



## RASTER CRT'S

We can compare the raster type of CRT display to a conventional TV tube. The CRT beam is swept in a raster of lines by applying synchronized voltage ramps to the X and Y deflection circuits. The system forms an image by modulating the beam intensity (Z-axis) with a video signal at appropriate times during the raster sweeps.

Typical commercial TV video is essentially a continuous analog signal which exhibits about 10-20 different grey levels. In order to minimize storage and bandwidth requirements, digital raster systems use only two levels of the grey scale, on and off.

A video signal can therefore be presented to the CRT as a stream of 1's and 0's, representing beam-on and beam-off, respectively. The image is made up of a sequential series of dots (and no dots) interpreted as lines, characters, etc.

Raster displays are characterized by

- Simple deflection circuitry
- Simple digital logic
- Inexpensive regeneration storage (bit-at-a-time serial)
- Constant flicker rate, independent of the amount of information displayed.
- Difficulty in using a light pen with a raster display because of the disassociation of image elements
- Required storage for blank areas of the screen
- Quadrupled storage to double resolution
- Doubled resolution reduces the display rate to one-fourth, or else the circuit speed must be increased by a factor of four
- Cumbersome image preparation (for non-alphanumeric displays) for conventional digital computers to perform.

images of a regular nature, such as character displays and halftone pictures. On the other hand, a vector-drawing display system can handle complex line drawings more efficiently. Furthermore, the digital logic of a vector system can perform many graphic operations faster and better than could a general purpose computer. For this reason, most computer terminals today use the vector type of CRT.

### Vector displays

A program (a sequence of positioning and control "orders") controls image generation in a vector display. The orders, which are executed one at a time by the terminal are similar to the instructions in a CPU program. Because the order execution rate is high, the display cycle (time to execute all orders of an image) can be faster than the decay time of the phosphor on the CRT face plate. The picture thus appears

to be steady. If a great many orders must be executed, the cycle time increases and the picture "flickers." While this flicker is objectional aesthetically, it does not prevent creative work.

The display area on the CRT screen is divided into a number of equally spaced horizontal (x) and vertical (y) Cartesian coordinate reference positions. A reference grid is defined by the intersections of these x and y positions. Typical displays in use today have 1024 separate points on each axis to cover approximately 12 x 12 in. of usable image area on a 20 in. (nominal diagonal) CRT. Such a reference grid contains over one million addressable points. Other displays have employed grids with 512, 2048 or 4096 (squared) positions.

Each positioning order specifies a reference x and y address as well as beam-on or beam-off control. When the terminal receives an order, it di-

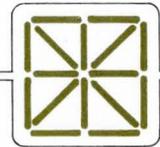
rects the beam to go in a straight line from wherever it was previously to the new grid position specified, and to draw (beam on) or not draw (beam-off) while moving.

We said that the positioning orders cause the beam to be deflected in a straight line between the old position and the new one. When the change of position involves only one axis, straight lines are fairly simple to achieve. However, when the magnitude of change in one axis differs from the change of the other axis, it is rather difficult to produce a truly straight movement.

One solution for this problem consists of breaking up the movement into a series of arbitrarily short vectors (dots) and metering deflection steps to each axis proportionally. This produces a close approximation of the desired straight line. The amount of time required to accomplish a given movement is roughly proportional to the length of the line. The circuitry required, however, is relatively complex.

Another solution to the problem is to design a variable velocity deflection system. In this scheme, all vectors are drawn in the same amount of time, but the deflection velocity of each axis is proportional to the total change for that axis. With this method, beam velocity is proportional to the length of the vector. This scheme has the disadvantage that short vectors are brighter than long vectors because the electron beam impinges on a given area of phosphor for a longer time. While adjusting the beam current can correct this shortcoming, this system has another disadvantage. With this technique it takes just as long to draw short vectors as it does for the longest vector.

Some hybrid systems automatically subdivide very long vectors into a series of shorter vectors. Each of these short vectors is handled by a variable-velocity circuit. These systems exhibit most of the advantages of both constant and



variable velocity deflection without requiring the great amount of hardware usually needed in a single-mode design.

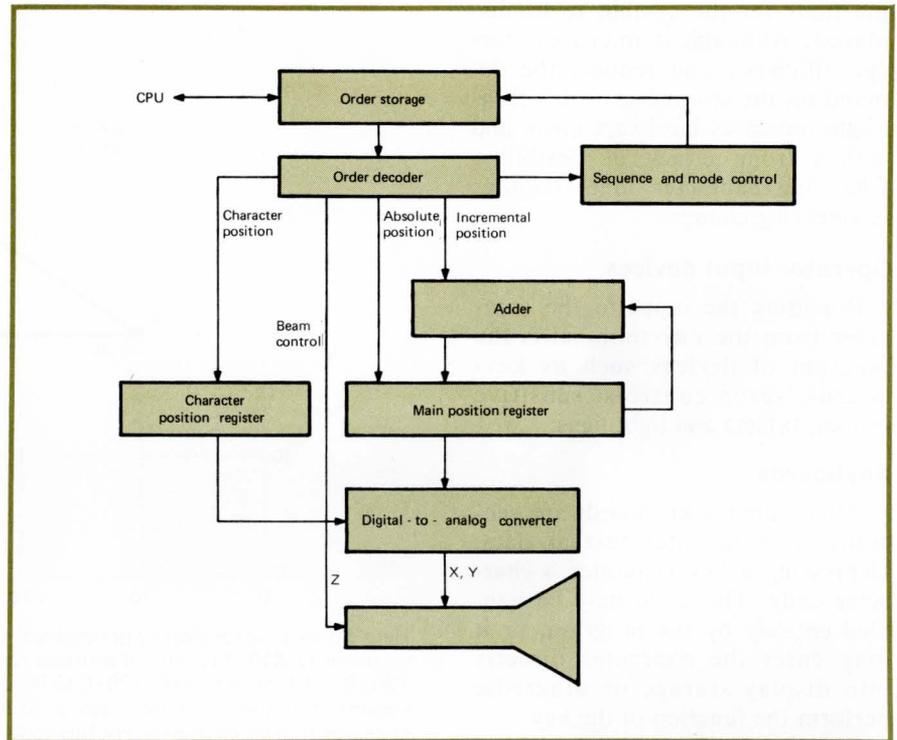
### Character generation

In vector displays, subroutines may be used to generate characters and other often repeated shapes. This technique, however, usually requires a great deal of time and many memory accesses during each regeneration cycle. The result is a significant reduction in the total amount of information which you can display without objectionable flicker. For this reason, considerable work has been done on other methods for the rapid generation of characters.

One early approach was beam shaping. Here, the CRT beam was routed to the screen through a special mask plate which contains a number of apertures. The beam then takes on the shape of the aperture as it passes through. This scheme is not very popular today because of the relatively high cost of these special CRTs and because of the fixed, inflexible character size and shapes.

Typical character generators in today's vector displays use an additive deflection method. Here, small excursions about the primary beam position, in effect, superimpose a small reference grid about the beam, regardless of its position. These small excursions are obtained by such methods as injecting measured amounts of current in the main deflection system, low-reactance, high-speed auxiliary deflection yokes, or electrostatic plates. This secondary deflection system draws "strokes" as opposed to "vectors" of the main deflection system.

The size and spacing of the secondary grid can be varied and does not necessarily have any relationship to the spacing of the primary grid. Therefore, a single set of strokes can produce many different sized characters by simply selecting the secondary grid scale factor. If



System organization of a typical vector-type CRT terminal.

bias is applied to offset the secondary grid with respect to the main deflection, you can form sub- and superscripts. Because the secondary grid covers little of the screen area, relatively fast deflection speeds can be realized when drawing strokes.

During a typical operation, an order will cause the main deflection system to place the beam at some specified position. All following orders for a complete character will then be directed to the secondary deflection circuit. When the character is complete, control will then be switched back to the main deflection circuit and the beam will be moved to some new location.

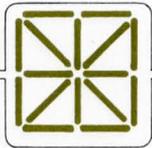
Several techniques are possible to improve storage and execution efficiency. The most obvious is the use of subroutines. Another approach is to design the hardware logic to automatically reset the secondary grid and move the main deflection

one character space as each character is completed.

Because of the numerically small reference addresses of the secondary grid, the stroke orders can be efficiently packed to conserve storage requirements.

It is not necessary to directly interpret stroke orders to generate secondary deflection value. For example, if character codes form the secondary orders, a subroutine link can be simulated in hardware to fetch the stroke orders from storage. Although this technique imposes a slight execution-time penalty, it usually results in at least a two-fold improvement in storage space over direct order subroutine linkages.

Another variation on this general theme creates strokes from a pre-wired logic unit or read-only memory. This method of character generation interprets the 8-bit character



code and creates the series of stroke positions for the symbol to be displayed. Although it improves storage efficiency and reduces the demand on the storage unit, this technique increases hardware costs and suffers from a lack of flexibility. Changing character fonts requires engineering changes.

### Operator input devices

Providing the input to the computer from the CRT terminal is the function of devices such as keyboards, servo controls, sensitive probes, tablets and light pens.

### Keyboards

Alphanumeric keyboards are generally used to enter textual data. Depressing a key generates a character code. This code may be handled entirely by the program, or it may enter the character directly into display storage or otherwise perform the function of the key.

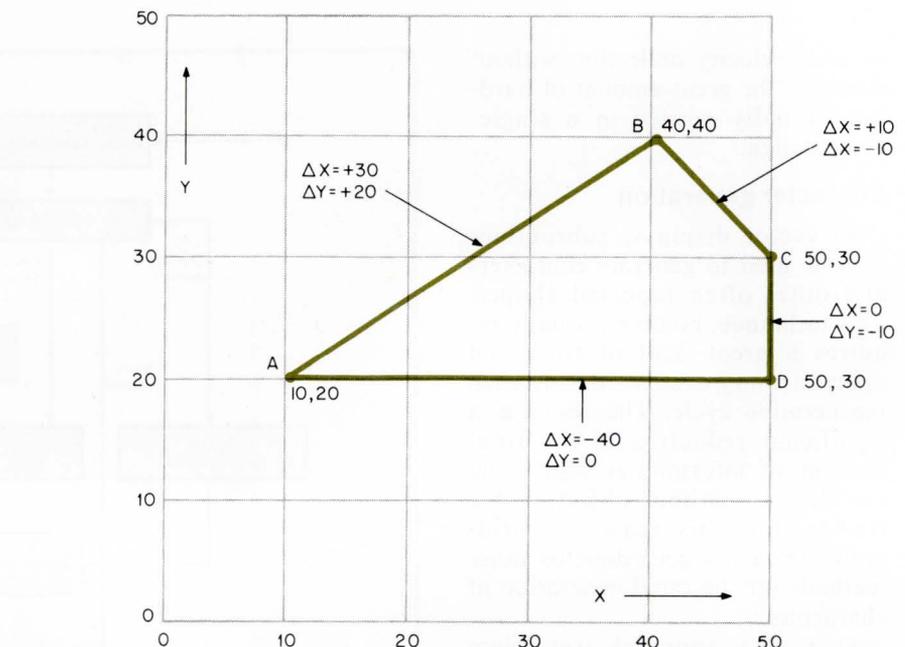
Function keyboards allow the operator to enter program-interpreted commands for controlling such image characteristics as selection, scaling, positioning, additions, deletions, etc. They have also been used for control of such non-graphic functions as job initiation, or sign-off, and data sorting and retrieval.

### Servo controls

Servo controls usually operate with some variation of a "joy-stick." With the joy-stick the operator can direct some marker spot or pattern to be moved about on the screen. In operation, the man becomes an integral part of the servo loop which includes the stimulus (joy-stick), the display control program and the display. Servo control has been used effectively to create, modify and select image elements as well as control display and non-display program flow.

### Sensitive probes

A voltage-sensitive probe operates in conjunction with a transparent, electrically conductive layer on the outside of the CRT faceplate.



Here's how a vector display generates the image that you see. The sequence of orders is: move to X10, Y10 (initial position to A); draw to X40, Y40 (A to B); draw to X50, Y30 (B to C); draw to X50, Y20 (C to D); draw to X10, Y20 (D to A).

Assume that the computer uses a 16-bit word and that the CRT has 1024 reference position on each axis. For this case, it takes two words for each beam movement (10 bits for X, 10 bits for Y and one for beam on/off). You can achieve storage and execution time savings by eliminating those coordinate values which do not change. The sequence in this case would be: move to X10, Y20 (2 words); draw to X40, Y40 (2 words); draw to X50, Y30 (2 words); draw Y to 20 (1 word); draw X to 10 (1 word).

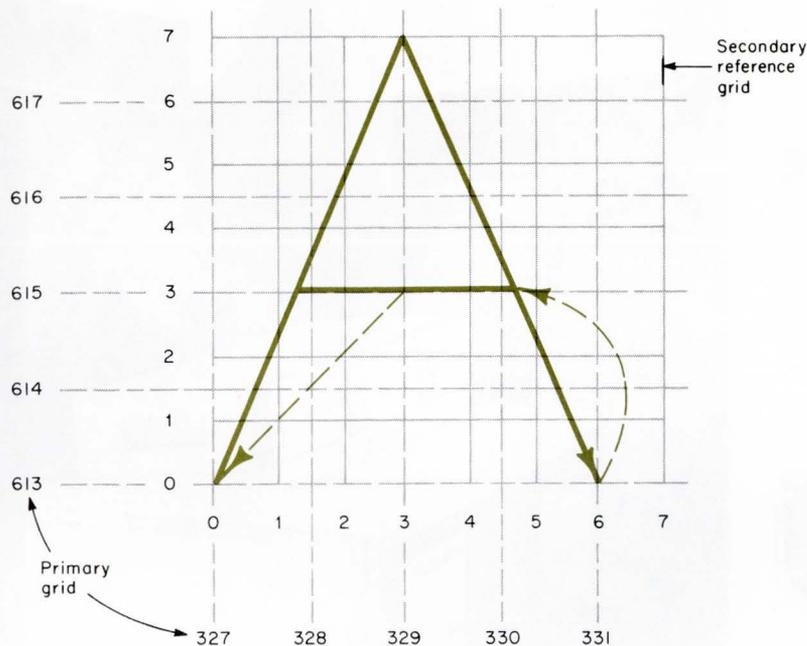
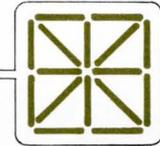
A low voltage applied to opposite sides of the faceplate creates a uniform voltage gradient across the faceplate. When the probe contacts the faceplate, it senses a voltage which is proportional to the distance from the edge. This voltage is then converted to x-y position by some A/D method.

The principal advantage of probes over light pens is that you can use them even when there is no image displayed. The probes, however, have several design and operating disadvantages when compared to light pens. The circuitry required is more complex and programs must perform a rather difficult correlation between an absolute screen position and an image which may have been formed from many intricate, incrementally positioned subroutines. Also, false positions are often reported because of irregularities in the voltage gradient caused by

scratches in the coating, fingerprints or even differences in the operator contact pressure. Because the A/D and D/A conversions are performed by different sets of circuits, the input values are only an approximation of the displayed x-y position intended and a significant programming problem results.

### Tablets

The tablet devices are a variation of the sensitive probe method in which a writing surface other than the CRT face is used. The tablet devices provide a grid surface and a pencil which the operator holds. When the pencil is placed near a grid intersection, the program is presented with the x-y position value. A piece of paper containing information may be placed on the tablet surface and traced into the computer. The CRT display generally provides visual feedback.



To draw the character A on a vector-type CRT with secondary deflection system the sequence is: move to X329, Y615 (main deflection); enter character mode (control to secondary); move to X0, Y0; draw to X3, Y7 (left leg); draw to X6, Y0 (right leg); move to X5, Y3; draw to X1, Y3 (cross-bar); move to X3, Y3 (restore to main position); leave character mode.

### Light pens

The light pen operates by detecting the light emitted when the CRT beam passes within its field of view. Since the image is created from line segments which are sequential in time, one (and only one) segment is illuminated at any instant. When a detection occurs, the display hardware contains the information which uniquely identifies the particular line segment "seen" by the pen.

Often the specific line segment detected is in itself of little importance to the program, and must be related to a higher level image element. For instance, consider the displayed control message "SAVE IMAGE." It may have been written from a series of character subroutines. Now suppose the light pen detects the stroke which creates the crossbar of the "A." The program

which will act upon the control request really is not concerned with which stroke of which character within the message was detected. All it needs to know is that some part of this particular message was detected.

Hardware "detect storage" logic allows a program technique called "bracketing of entire image elements." This bracketing simplifies the problem of relating a detected line segment through a hierarchy of subordinate image elements to the significant element. The detect storage is reset by the program at the beginning of the image element and is interrogated after the element is completed. Using the information that a detect either did or did not occur during the drawing of an element, appropriate program action can be taken.

Since the light pen needs active images for operation, you might ask

how a line can be created where no image exists. The answer is to provide an image. A special image element known as a "tracking pattern" is used. The simplest tracking pattern is a small square, slightly larger than the field of view of the light pen. If the pen is positioned so that it detects an edge of the box, the program moves the box toward the detected edge until no detection occurs. Thus, the program centers the box on the light pen no matter where the pen takes it on the screen.

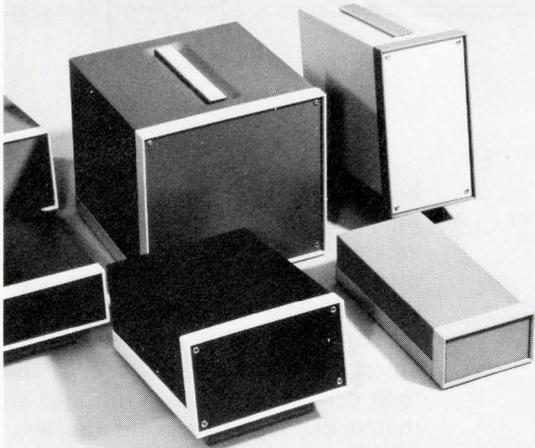
Since it is possible to move the pen more rapidly than the box position can be updated, the tracking pattern can be lost. Self-adjusting, variable-speed tracking can solve this problem. Here, the program adjusts the magnitude of tracking pattern movement according to the outermost box detected of several concentric boxes.

The "enter x-y coordinate" function can be performed at high speeds (using the light pen) by grid detection instead of tracking. The operator may move the pen as fast as he desires, missing detects on many gridlines. As the pen comes to rest, a single detection of an x and a y line updates the current x-y position. This time/rate independence is especially important for a shared system as it eases the real-time service requirement.

### Windowing

The CRT display can manipulate very complex images by programming an expansion and shift, commonly called "windowing" or "scissoring." The window provides an enlarged, detailed view of a portion of the full image. Adjacent image areas are viewed by moving the window (using a different x-y shift value). The areas of the image that lay outside of the window are not displayed. Any of the previously mentioned input devices can direct the computer placement, sizing and movement of the window. Modern computation techniques permit rapid windowing, even when the display is attached to a small computer.

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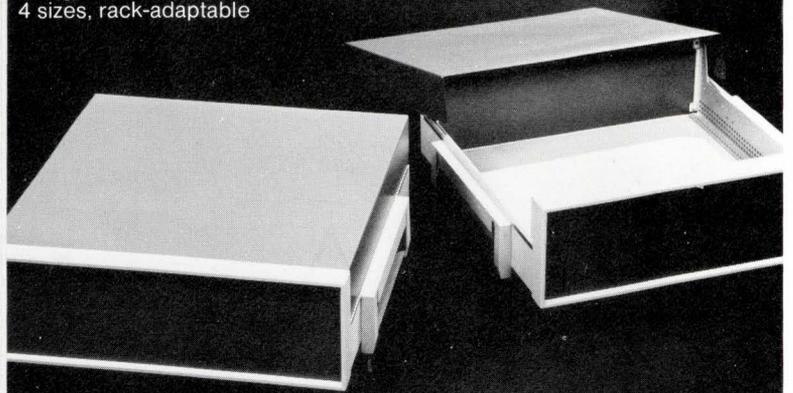
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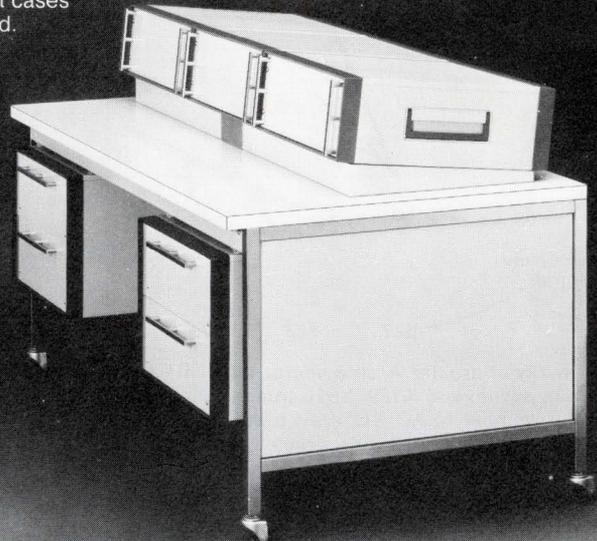
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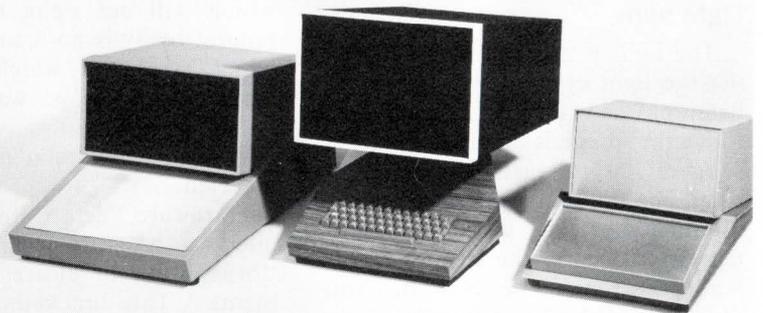
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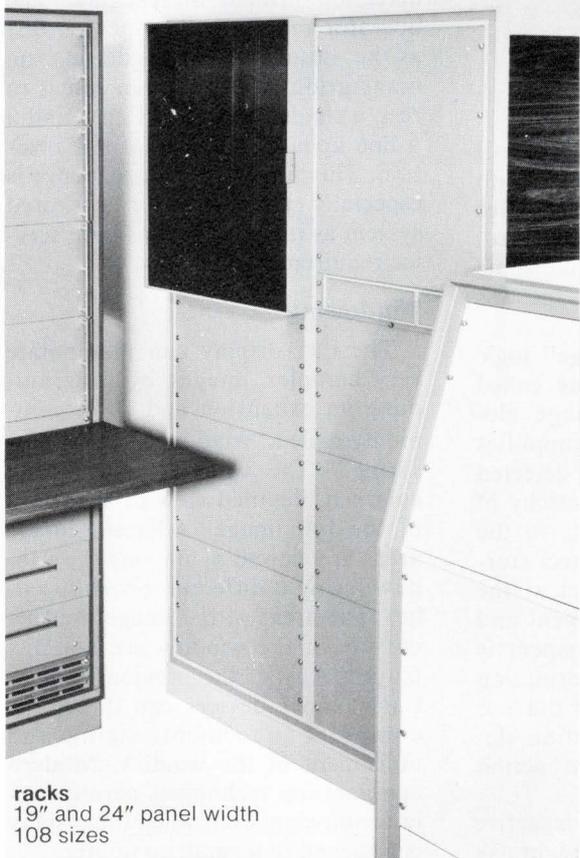


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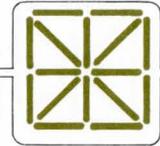
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# review of interactive CRT terminals

EDITORIAL STAFF

Instruments and Controls Systems

Interactive terminals are employed as links for on-line communication between users and computers. CRT devices provide particularly powerful and flexible interfaces, because considerable data in a variety of formats can be presented and altered virtually instantaneously.

Systems have become common in commercial applications for transmission of sales or marketing information. However, engineering uses are increasing, and CRT devices are appearing as terminals for time-sharing computation, computer aided design, process control, and system simulation. The display becomes a working surface for an operator, in which memory and manipulative advantages of paper and pencil are combined with direct electronic access to data, computational algorithms, and signal transmission. Actual communication is between man and computer, but in well-designed configurations the terminal acts as the system.

Cathode ray terminals may require the associated central processor to perform display generation functions such as plotting, editing, and refreshing. However many terminals contain dedicated processors or storage capabilities to relieve the central computer of these tasks.

Systems are available for providing alphanumeric and graphical information. In shaped-beam tubes or monoscopes, the electron beam is directed through a mask, on which symbols are stamped. The beam is then deflected electrostatically to the desired position on the display. High speeds and high character quality are inherent. Disadvantages are the limited range of character sizes on one mask and a fixed character repertoire.

Selective scanning may utilize stroke or programmed dot techniques. In the former an intensity modulated beam following series of short segments can produce a large symbol repertoire. Arbitrary graphics are also possible, but may require considerable software effort. In the programmed dot technique, characters are formed as a beam is sequenced to positions on a 5 x 7 or 10 x 14 dot matrix. The method is inexpensive, and standard software packages are available offering large character sets and limited graphics.

In raster scanning, a beam is continuously moved over the screen and characters are generated by selective intensification. This method is slower than selective scanning but hardware is simple and costs are generally low. Wide bandwidths and fast scan rates are necessary to compete in speed with stroke generating systems.

Other techniques are available, including conversion of computer outputs directly to voltage to drive the CRT along X and Y axes, and ramp generation where the display is driven between specified end points. In any of these systems, there is a trade-off between functions which can be performed by hardware or software at the terminal and those which must be performed by the central computer. The considerable cost of the former may be justified by the potential burdens imposed by the latter.

A number of input devices are used. Alphanumeric or fixed format information is usually entered from a keyboard or function switches, while graphical data are supplied with devices such as light pens, joysticks, tracking balls and data tablets (Refs. 1,2). Combinations of these devices are often used to provide flexibility.

Alphanumeric keyboard entry devices begin at about \$2000 for a simple terminal and at \$8000 for units with minimal storage and editing capabilities. Graphic terminals start at about \$5000, but prices from \$20,000 to \$50,000 are most common, depending on the display generation or dedicated processing hardware included. Primary costs of software-operated systems tend to be low, but generally require expenditures for user-generated or vendor supplied programs.

This review is intended as an aid in the selection of interactive CRT computer terminals. Products offered by cooperating manufacturers are summarized. However, descriptions do not necessarily represent the complete line, and vendors should be contacted directly for more detailed information. Readers service numbers are provided for convenience, but addresses and telephone numbers are supplied for future reference. Please refer to this review when making inquiries.

## REFERENCES

1. NASA SP 5049, Visual Information Display Systems, A Survey, 1968
2. Dennis, L. P., "Digitization of Graphical Analog Records" *Instruments and Control Systems*, October, 1970

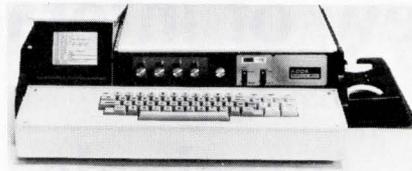


**ADAGE AGT** display generation hardware provides vectors and characters, as well as three-dimensional windows and capability of adjusting beam intensity as an aid to depth perception. Display generators may also be obtained with matrix multiplier subsystems, so that coordinate transformations can be provided for dynamic displays with minimum recourse to the central computer. Operator facilities include the console and CRT, as well as graphic I/O elements such as joysticks and data tablets. AGT/10 is designed to handle two-dimensional displays containing as many as 5000 line segments. AGT/30 and AGT/50 are configured for applications involving dynamic display of three-dimensional images. Such images can be rotated, translated, and scaled with picture changes made from frame to frame. **Adage Inc., 1079 Commonwealth Ave., Boston, Mass. 02215 617/783-1100. Circle No. 350**

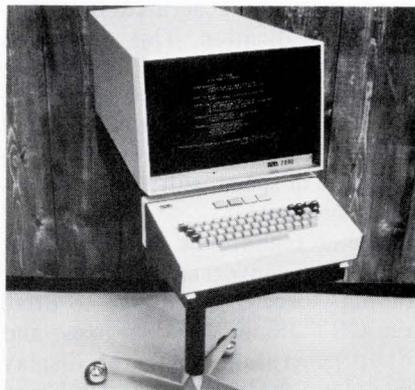


**APPLICON DESIGN ASSISTANT** allows a user to develop computer representations of circuit masks. The unit produces data describing completed mask levels, which can be used for automatic artwork generation and design documentation. System hardware includes a Comutek storage tube display, a keyboard and data tablet, and an IBM 1130 computer. No user programming is required and software interfaces are available for standard artwork generation equipment. User interaction involves arbitrary symbols drawn free-hand on the data tablet with an electronic stylus. These symbols give commands to the system and indicate positions of elements and com-

ponents. **Applicon Inc., 83 Second Ave., Burlington, Mass. 01803 617/272-7070. Circle No. 351**



**APPLIED DIGITAL DATA SYSTEMS** terminals utilize standard EIA 525 line TV raster scanning. Model MRD-200 is a modular alphanumeric unit designed as a display sub-system for on-line applications. Units offer a choice in numbers of lines displayed, characters per line, I/O interfaces, and blink/protected capability. ENVOY 600 and 640 portable terminals utilize 5-inch TV monitors which can display 16 lines of 32 or 64 black characters on a white background. A keyboard, acoustic coupler, and coaxial connector for large screen slave monitors are also supplied. CONSUL series free-standing terminals have 80-character by 24-line capacities, and are offered with a variety of interfaces. **Applied Digital Data Systems, Inc., 100 Marcus Blvd., Hauppauge, N.Y. 11787 516/231-5400. Circle No. 352**



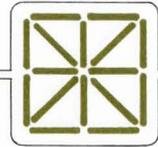
**ATLANTIC TECHNOLOGY** ATC 2000 displays up to 1920 curvilinear stroke characters on a 15-inch screen. In addition to several standard edit and control functions, the unit offers optional graphics, a program-controlled blink function, and true lower case. Other available features include function keys, a hard

copy printer, a serial distributor, and a keyboard with numeric inset. Maximum line width is 120 characters. The terminal is compatible with many computers including IBM 360 and 370 systems. OEM models exclude specific interfaces, and can be adapted to most existing machines. **Atlantic Technology Corp., Somers Point, N.J. 08244 609/646-6300. Circle No. 353**

**BEEHIVE CRT** terminals are modular alphanumeric units. Model I is the basic building block, and contains the wiring harness, card cage, power supply, TV monitor, and keyboard configuration needed for all expanded systems. The unit can display 40 characters/line, with 80 characters/line and a parallel interface optional. Model II adds tab capability, along with line and screen erasure and block transfer. Adapter for remote printers and cassettes are available. Model III offers format and line or page edit functions. Model IV is a stand-alone terminal, containing all necessary logic, buffering, and memory. An adapter provides program and hardware interfacing with up to 24 Model IV terminals. **Beehive Electrotech Inc., 1473 South 6th West Ave., Salt Lake City, Utah 84104 801/487-0741. Circle No. 354**

**BENDIX ICD-1100** graphics display for the IBM 1130 computer unit is FORTRAN programmable and compatible with plotter software. A high-resolution 10-bit display is provided, with all interactive functions performed through a two-speed joystick. Alphanumerics in the \$5,500 unit must be software generated. **The Bendix Corp., Communications Div., East Joppa Road, Towson, Md. 21204 301/823-2200. Circle No. 355**

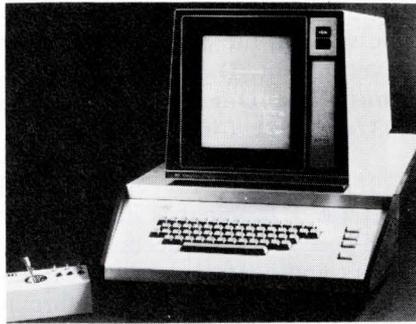
**BUNKER-RAMO BR-90** offers random positioning as well as formatted text modes. The former, utilized for symbols, circles, plotting points, and vectors, provides positioning resolution of one part in 1024. A cursor symbol, controlled



by a hand-operated ball, allows the operator to position elements on the display surface. The standard formatted text mode accommodates 44 lines of 64 characters. In either mode, the display is refreshed at a 60 Hz. Editing or message generation is available, and a 30-key variable function keyboard can be easily modified. A light gun input is also available. **The Bunker-Ramo Corp., Defense Systems Div., 8433 Fallbrook Ave., Canoga Park, Calif. 91304, 213/889-2211. Circle No. 356**

**BURROUGHS B9351** has the capacity to present up to 24 lines of 80 characters on a 9 x 12 inch display. Characters are generated using up to 12 strokes, and are refreshed at 60 frames/sec. The memory, which is not spatially related to the screen, consists of 1024 characters of high-speed magnetic core. Up to 9 controllers, each having from one to four monitors and keyboards, may be directly interfaced with a single computer through a common cable. Hard copy capability, editing functions, and format tabs are available as options. **Burroughs Corp., 6017 Second Ave., Detroit, Mich. 48232, 313/875-2260. Circle No. 357**

**COMPUTER DEVICES** alphanumeric interactive terminals utilize 5 x 7 dot matrix characters. Model 2100 is a compact teletype-compatible unit providing portable data communication or fixed operation at 1200 baud. The 3 x 12 inch screen presents 12 lines of 80 characters. Model 2300 is a large teletype-compatible display with full-page editing features including line and character insert or delete, cursor controls, page up and down, erase, and clear. The screen provides a flicker-free display of 40 lines of 80 characters. **Computer Devices, Inc., 10 Sonar Drive, Woburn, Mass. 01801 617/729-7436. Circle No. 358**



**COMPUTER DISPLAYS** ARDS terminal can display over 4,000 characters in either a horizontal or vertical format. The screen matrix contains 1,081 x 1,415 resolvable and addressable points, with a window size of 4,096 by 4,096 locations. Graphic input data can be achieved through a variety of devices including tablet, mouse, joystick and keyboard. Units are ASCII and RS232C compatible, and software support is available. **Computer Displays Inc., 223 Crescent St., Waltham, Mass. 02154, 617/899-0480. Circle No. 359**

**COMPUTER TERMINAL** Datapoint 3300, developed specifically for time-sharing purposes, includes a keyboard, CRT, refresh memory, communication interface, and power supply. Standard transmission is at 110, 150, 300 or 600 bits/sec, but 1200, 2400, and 4800 bits/sec are possible with an optional speed buffer. The display consists of 25 lines of 72 ASCII characters. A magnetic tape cassette with 800,000 data character capacity is optional. **Computer Terminal Corp., 9725 Datapoint Drive, San Antonio, Texas 78229 512/696-4520. Circle No. 360**



**COMPUTEK** Series 400 CRT graphic terminal can be used with a dedicated computer or implemented

as self-contained remote unit. Upgrading capability is provided by modular mechanical and electrical interchangeability. Other features include display-labeled function keys and a storage CRT module that maintains over 800,000 points of flicker-free information. A curve generator, vector generator, and segmented character generator are included, and interactive devices such as data tablets and joysticks are available. **Computek Inc., 143 Albany St., Cambridge, Mass. 02139 617/864-5140. Circle No. 361**

**CONRAC** 201 alphanumeric display terminal is a free-standing system adaptable to a variety of communication environments. The standard configuration interfaces to a computer through a standard data set. Options are available for direct communication through a two-wire interface. The system is available in a horizontally-oriented display with up to 80 characters per line, or a vertically-oriented display with up to 40 characters per line. Either a 5 x 7 dot matrix or a starburst character font can be provided. **Conrac Corp., 600 N. Rimsdale Ave., Covina, Calif. 91722 213/966-3511. Circle No. 362**

**CORNING** 904 terminal utilizes 5 x 7 dot matrix to present 64 lines of 72 characters. A photochromic storage CRT with a slide overlay system is used for the display. A complete software support package is supplied, including subroutines and programs for cartesian, semi-log, log-log, and polar coordinate data plotting, circle or arc drawing, polynomial fitting, function plotting, and vector generation. Keyboard, mouse, and joystick inputs can be obtained. **Corning Data Systems, 3900 Electronics Drive, Raleigh, N.C. 27602 919/876-1100. Circle No. 363**



**DATA 100** model 73 terminal can provide black-on-white or white-on-black displays. In on-line operation, characters are entered from the keyboard and transmitted to the computer and back to the terminal for storage and display. In the edit mode, keyed characters are stored directly in the buffer and displayed. Data may be changed using the entry marker and keyboard controls. Options provide up to 1920 displayed characters, 72 or 80 on each line. **Data 100 Corp., 7450 France Ave. S., Minneapolis, Minn. 55435 612/920-8800. Circle No. 364**

**DATA DISC** system can display over 4000 alphanumeric characters as well as any graphical representation of up to 262,000 points, on 16 different terminals. Each display has its own dedicated refresh memory, equivalent to 32k bytes of storage. Alphanumeric graphic generators simplify computer software requirements for bar graphs, histograms, annotated graphs, and continuous or discontinuous functions. TV monitors can be used to provide displays, or monitors with separate keyboards can be supplied. Trackball or joystick cursor control is optional. **Data Disc Inc., 1275 California Ave., Palo Alto, Calif. 94304 415/326-7602. Circle No. 365**

**DATA INPUT DEVICES** Series 70 Term-Mite key-to-cassette terminal is designed for off-line data entry. The 25-lb unit features a 5 in. CRT displaying up to 100 ASCII characters. The integral cassette can store up to 1200 80-character records. Alphanumeric, numeric and keypunch keyboards are standard, with key-verify and left-zero in-

sertion available as options. An on-line version, the Series 80, is under development. **Data Input Devices, Route 28, Derry, N.H. 03038 603/434-4551. Circle No. 366**

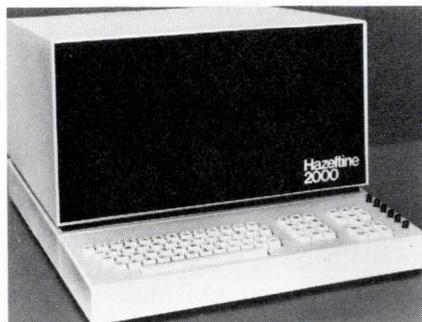
**DELTA DATA SYSTEMS** DELTA 1 terminal is designed for high-speed on-line access to computers and control devices. The integral controller displays information on any standard TV receiver or monitor. An MOS read-only memory is used to generate the 5 x 7 dot matrix for alphanumeric characters, and to generate and store the graphics data in a 128 x 60 dot matrix. Up to 24 lines of 40 characters can be represented, and serial or parallel data transmission is possible. A 1k core memory is included to refresh the screen. The standard terminal features editing, line drawing, and format functions, and has optional 4-color capability. **Delta Data Systems Corp., Woodhaven Industrial Park, Cornwells Heights, Pa. 19020 215/639-9400. Circle No. 367**

**EVANS & SUTHERLAND** LDS-1 is a modular three dimensional line drawing system. When interfaced to a scientific computer, the unit relieves the central processor of tasks such as transforming, scaling, rotating, and structuring. Dynamic perspective of generalized graphic constructions is provided, for use in computer-aided-design of three-dimensional systems and aerospace simulations. Options include multiple consoles, variable word lengths, character generators, and data tablets. **Evans & Sutherland Computer Corp., 3 Research Rd., Salt Lake City, Utah 84112 801/322-5847. Circle No. 368**

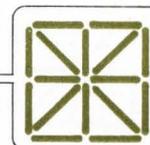
**FOTO-MEM FOTO-VISION** is a low-cost keyboard-entry alphanumeric display. Standard ASCII code is used to maintain compatibility with general purpose computers, mass memories, and standard information storage and retrieval systems. Characters are generated in a 10 x 14 dot matrix, and up to 20 lines of 72 characters can be

accommodated. Text editing is accomplished one character at a time, with appropriate spacing and automatic line change to maintain the display format. Line roll is also under operator control. Options include blink for calling attention to specified characters, and I/O interfaces for hard copy and remote control. **Foto-Mem Inc., 6 Strathmore Rd., Natick, Mass. 01760 617/655-4600. Circle No. 369**

**GENERAL ELECTRIC DATA-NET-760\*** consists of an EKB 761 keyboard and a DMU 761 video display monitor. A two-field interlaced raster scan system provides a 60 Hz refresh rate. Horizontal and vertical lines may be generated, as well as upper case letters, numerics, punctuation and mathematical symbols. Up to eight keyboard/display terminals or read-only display monitors may be connected for shared input and display. **General Electric, Information Devices Dept., 4000 N. W. 39th Expressway, Oklahoma City, Okla. 73112 405/W16-5421. Circle No. 370**



**HAZELTINE 2000** displays up to 1998 alphanumeric characters in 5 x 7 dot matrix format, using a standard 525 line TV raster. Thirteen editing operations are available from the keyboard, with eight more under program control. Units cost under \$3000 and can be supplied with a magnetic tape cassette, hard copy printers, and a remote monitor. **Hazeltime Corp., Industrial Products Div., Little Neck, N.Y. 11362, 212/423-4800. Circle No. 372**



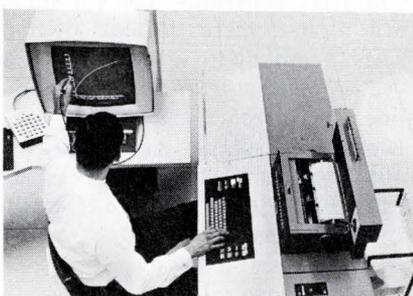
**HEWLETT PACKARD 2600A** terminal displays 25-lines of 72-characters in a 5 x 7 dot matrix format. Data transmission rates from 110 to 2400 baud are switch selectable. Keyboard-controlled cursor permits alteration or deletion of characters or lines. Units are interchangeable with HP 2000 System Time-Share terminals and can be interfaced directly to HP computers by means of specially-provided interface cards and software. **Hewlett Packard, 1501 Page Mill Road, Palo Alto, Calif. 94303, 213/877-1282. Circle No. 373**



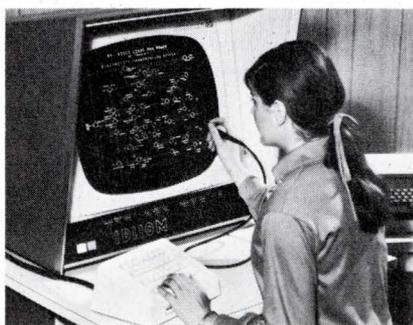
**HONEYWELL 2300 Series VIP** Systems allow multiple display stations to communicate simultaneously with a Series 200 central processor. Single-station units include alphanumeric keyboards, 12-inch CRTs, and controllers. Tab capability and line erasure and deletion are provided, along with display of multiple query/response sequences. Multi-station systems feature selection of either a horizontal (12 lines of 80 characters) or vertical (24 lines of 37 characters) display, with image and optional upper/lower case capability. **Honeywell Inc., Electronic Data Processing Div., 60 Walnut St., Wellesley Hills, Mass. 02181, 617/235-7450. Circle No. 374**

**HUGHES** data displays utilize TV monitors with local character generation and refresh memory. The 512-character systems can be interfaced to keyboards, data sets, and custom controls. Systems for conversion and storage of analog information are also available. Options include custom controls, gray scales and driving circuitry for writ-

ing, storage, erasure, and display of graphic and alphanumeric data. **Hughes Aircraft Co., 2020 Ocean-side Blvd., Oceanside, Calif., 92054 714/757-1200. Circle No. 375**



**IBM 2250** presents alphanumeric and graphic information. Display area is divided into a 1024 x 1024 grid, providing over 1 million program-addressable positions. Two character sizes may be generated in a format of 52 lines by 74 characters. Points may be plotted directly, and vectors may be drawn between two addressable grid points. A programmed function keyboard and light pen are provided for operator interaction. Model 2265 display station for alphanumeric manipulation is also available. Both can be directly interfaced to IBM 360 and 1130 systems. **IBM Corp., 112 East Post Road, White Plains, N.Y. 10601, 914/949-1900. Circle No. 376**

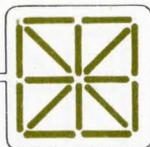


**IDI IDIOM** graphic display system includes a general-purpose 4k (expandable to 32k) 16 bit computer, vector generator, 64 symbol character generator, and circle generator. Interactive input devices include a keyboard, light pen, and function switches. Character size,

line structure, intensity level, and character rotation are programmable. Software support with documentation is available. Model E1 provides the same hardware features, for integration with a customer-supplied computer or OEM use. **Information Displays, Inc., 333 N. Bedford Rd., P.O. Box 688, Mount Kisco, N.Y. 10549 914/241-1000. Circle No. 377**

**IMLAC PDS-1** programmable display system is designed to unburden CPU facilities in time-sharing and data processing environments. The unit is programmed to duplicate communications characteristics of existing terminals, while providing additional flexibility. Four stroke-generated character sizes are available including upper and lower case characters, numerals, and special symbols. Combinations of characters and graphics can be displayed, and insertions, deletions or changes can be readily made. A standard text and graphics editing program allows the use of light pens or data tablets. **IMLAC Corp., 296 Newton St., Waltham, Mass. 02154 617/891-1600. Circle No. 378**

**INFORMATION INTERNATIONAL** Model 1060 provides a common display processor for 12 remote keyboards and display consoles. The equipment is designed to minimize computer load, yet provide simultaneous operation of all stations. Writing capacity at 30 frames/sec is 5610 characters, 1400 two-inch vectors, or 2600 quarter-inch vectors. The display has 1024 x 1024 addressable points, a spot size of less than 0.020 inch and a resolution greater than 50 lines/inch. Light pen, modified typewriter keyboard, and function keyboard are available, as are interfaces to time-sharing computers such as the PDP-6 PDP-10, SDS 940, Sigma 2, and Sigma 7. **Information International, 89 Brighton Ave., Boston, Mass. 02134 617/787-4700. Circle No. 379**



**MEASUREMENT SYSTEMS** computergraphic input devices include track balls as well as potentiometer and force-operated joysticks. Optional pulse rate, up-down counter, D/A converter, and other circuit cards are matched to the input transducers to form the man-computer interface. A miniature force-operated joystick, the size of a single keyboard switch, allows positioning to 1 part in 1,000 on 2 axes in less than 3 seconds. A digital cursor simulator is also available, which uses a 7 x 9 inch high-resolution storage CRT. This includes target-generating and error-measuring circuitry for human factors tests. **Measurement Systems Inc., 523 West Ave., Norwalk, Conn. 06850 203/838-5561. Circle No. 380**

**MEGADATA SYSTEM V-50** video annunciators utilize color or black and white TV sets for display. Systems permit over 50 stations to display up to ten different messages simultaneously. The operator controls and up-dates all information from a single keyboard. Formats of 20 lines by 20 or 40 characters are available; a 400 x 400 graphic pattern matrix is also supplied. **Mega-data Computer & Communications Corporation, 151-8 West Industry Court, Deer Park, N.Y. 11729, 516/667-2900. Circle No. 381**

**MONITOR 8100** provides high-resolution alphanumeric or graphic computer output. The system consists of a refresh computer, a display processor, special purpose function generators, and one or two CRT consoles with associated I/O light pens, function switches, and keyboards. Standard software in-

cludes an assembler, FORTRAN compiler, debugging routines, diagnostics, operating system and a multi-purpose library. Alphanumeric text editing, grid generation and scaling, and light pen processing subroutines are also provided. The character generator forms a standard alphanumeric in one of four sizes, from up to 20 strokes. The vector generator forms continuous line anywhere in the display area. **Monitor Displays, An Aydin Co., 401 Commerce Drive, Ft. Washington, Pa. 19034, 215/646-8100. Circle No. 382**

**NCR 795** data display terminal can display 256 to 1024 continuous stroke characters. Alphanumerics and symbols may be written at any of over 2000 locations, arranged in 32 lines of 64 characters. Data are refreshed 46.5 times/sec to ensure flicker-free operation. A split screen option enables two NCR 795 keyboards to share the same display screen. **National Cash Register, Dayton, Ohio 45409, 513/449-2000. Circle No. 383**

**OPTICAL ELECTRONICS** displays provide three-dimensional monocular images based on light-pen inputs. Modular hardware permits customization to match OEM system requirements, and allows the use of computing time to generate the image and its depth cues, and to provide manipulation capabilities. **Optical Electronics Inc., P.O. Box 11140, Tucson, Arizona 85706, 602/624-8358. Circle No. 384**

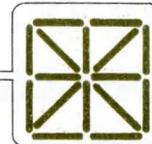
**PHILCO Model D-30** can be obtained as an accessory to a Philco-Ford computer, or can be added to an existing digital system. The symbol repertoire is capable of both alphanumeric and special diagrammatic presentations. Limited graphics and dot matrix alphanumerics are also displayed, in any of four colors. The refresh memory has the capacity for simultaneous display of 3456 characters without degradation. A light pen and a trackball may be used to select any character position on the

CRT screen. The indicated coordinates are automatically made available as an input to the computer controlling display electronics. **Philco Ford Corp., 1002 Gemini Ave., Houston, Texas 77058, 713/448-1270. Circle No. 385**

**PRINCETON ELECTRONICS** PEP-400 terminal is designed for graphics applications requiring storage of random input X-Y information with selective erase and write capabilities. Readout can be either at TV or slow scan rates, for display or raster printout. A complete video frame can be stored in 1/30 sec. with ten logarithmic shades of gray, and either 800 or 1200 line resolution. Continuous refresh for 15 minutes with gray scale or 60 minutes with black and white images is possible. Units are priced from \$3,750 and \$4,250. **Princeton Electronics Products Inc., P.O. Box 101, North Brunswick, N.J. 08902, 201/297-4448. Circle No. 386**

**RCA** video data terminals are linked to processor and random access storage over voice grade lines, with transmission speeds from 120 to 2400 characters/sec. Units afford direct access to a central file through a standard typewriter keyboard. The terminals display up to 1080 monoscope-generated upper and lower case characters on 20 lines. Editing is performed by positioning a movable cursor under the copy on the screen and making the correction. Data may be inserted and a hard copy printout obtained through a teletypewriter. Formats stored in the computers are displayed and held on the screen for tabular data entry. **RCA Computer Systems Div., Cherry Hill, N.J. 08034, 609/424-2385. Circle No. 387**

**RAYTHEON DIDS** CRT terminals feature integral monoscope-generated characters and delay line buffers. Up to 1472 alphanumerics can be displayed on a 14-inch screen with a 60 Hz refresh rate. **DIDS-402** is a stand-alone self-contained unit. A controller is required for the



DIDS-401. The standard controller can accommodate up to 64 displays or printers, but a compact controller is also available for up to 12 displays. Standard editing features are offered, and communication rate is usually 2400 baud. **Raytheon Company, Communications and Data Processing Operation, 1415 Providence Highway, Norwood, Mass. 02062 617/762-6700. Circle No. 388**



**SANDERS ADDS/900** is a general-purpose interactive graphic terminal. The integral display processor has a 1.8  $\mu\text{sec}$  cycle time and a 16-bit memory of 8k to 32k words. The display generator can provide character, symbol, and line vector information under control of the display processor. Typical character generator time is 2.4  $\mu\text{sec}$ , and vector generator time is 40 sec for a full screen axis. The unit may be operated in a stand-alone configuration or interfaced to a large computer and data base. Operator data entry devices include a proprietary light pen, function keyboard, trackball, joystick, alphanumeric keyboard, data tablet, and cursor. **Sanders Associates, Inc., Daniel Webster Highway, S., Nashua, N.H. 03060 603/885-2816. Circle No. 389**

**SPIRAS** alphanumeric terminals feature continuous characters and a variety of EDP and control-oriented options. Systems display 1025 upper and lower case characters on a 2500 character field. Up to 32 lines of 80 characters are possible on the 12 inch non-glare screen. Alphanumerics are generated by a high-resolution monoscope with a refresh rate of 60 Hz. Models offer several edit-

ing options as well as expanded control and position functions. Response is made through standard keyboard and interfaces are available for coupling the unit to all major computer models. **Spiras Systems Inc., Affiliate of USM Corp., 332 Second Ave., Waltham, Mass. 02154 617/891-7300. Circle No. 390**

**STROMBERG DATAGRAPHIX** terminal employs a shaped-beam CRT to present alphanumeric data. Displays are offered as stand-alone units which interface to existing computers, but may be provided with programmed controllers which operate multiple terminals. Up to 1030 characters can be presented in a 2800 position field, with up to 32 lines of 80 characters. Format control can provide split screen capabilities. **Stromberg Datagraphix Inc., General Dynamics Subsidiary, P.O. Box 2449, San Diego, Calif. 92112 714/283-1038. Circle No. 391**

**SLI** video T-6 uses a data input/output format with 10 switch-selectable transmission rates from 110 to 2400 baud. Capacity is 128 upper and lower case and control characters, typically presented as 20 lines of 80 characters. Custom keyboards, parallel data transmission, and hard copy unit interfaces are available. **Sugerman Laboratories Inc., 295 Northern Blvd., Great Neck, N.Y. 11021 516/466-0080. Circle No. 392**

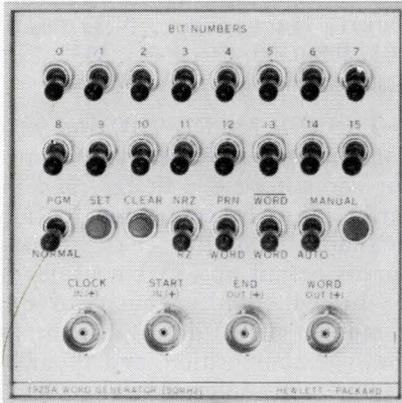
**SYS** alphanumeric interactive terminals can perform editing functions prior to data transmission. Editerm 100 can be interchanged with ASR 33 and 35 teletypes. Memory locations are not assigned to fixed screen positions, so the format is variable and the display window can be moved back and forth over the memory. Editerm 200 is a general-purpose terminal, which operates in a page mode with upper and lower case letters and a fixed format of 24 lines of 80 characters. Both models have blink, tab, and format capabilities, and are provided with a variety of editing controls. Terminals use the SYS micro-

processor as the controlling element, and can be connected to teletypes, typewriters, line printers, channel magnetic tape units, card readers, and paper tape units. **SYS Computer Corp., 17-75 DiCarolis Court, Hackensack, N.J. 07601 201/488-0300. Circle No. 393**

**TASKER** Models 9200 and 9210 consoles were specifically developed for computer-aided design, and interfaces can be configured for any available computer. Fast writing speeds permit up to six consoles to be linked simultaneously to one computer in real-time with editing, message composition, and program control accomplished on-line. Outputs consist of individual interrupt lines for light pens, typewriter keyboards and function keyboards. A deflection amplifier eliminates hysteresis, and yields increased linearity and high vector accuracies. Displays utilize a constant-line drawing rate for all vector and symbol presentations, such that line intensity is always uniform. Character and symbol generation are accomplished by a stroke-writing, at an average of 4  $\mu\text{sec}/\text{character}$ . Standard repertoire is 64 symbols, but special characters are available. **Tasker Industries, 4561 Colorado Blvd., Los Angeles, Calif. 90030 213/246-6761. Circle No. 394**

**TEC** Series 400 **DATA-SCREEN** terminals offer a repertoire of 68 dot-matrix characters in a variety of formats. Up to 1536 characters can be presented on a standard TV monitor. Available in single or multi-station configurations, units offer editing, page formatting and fixed message display. A Plexiglas filter provides sharp character contrast. Series 400 options include a choice of three keyboards, software-controlled fixed message displays, backlit indicator positions on the front panel, selective blinking, a hard copy adaptor, and a variety of interfaces. **TEC, Inc., 6700 South Washington Ave., Eden Prairie, Minn. 55343, 612/941-1100. Circle No. 395**

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**TEKTRONIX** Type T4002 terminal is a self-contained display which provides complex graphics capability. Data input is achieved through a solid-state keyboard, while output is presented through a direct-view storage tube. A character generator provides high-density alphanumeric and complex graphics without flicker or drift. The screen will accommodate up to 35 lines of 80 alphanumeric characters. Two standard character sizes are available under program control. Space is provided in the terminal cabinet for an auxiliary expansion module. Standard interfaces are available for coupling to PDP-8 computers or communication data sets. **Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005, 503/644-0161. Circle No. 396**

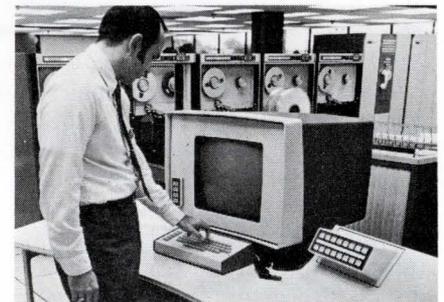


**ULTRONIC** Videomaster 7000 stand-alone display station interfaces directly to an IBM 360/30 with transmission speeds of 1200 or 2400 bits/sec. The serial I/O interface conforms to EIA Standard RS-232B, so the unit may be interfaced to a wide range of computer systems. The display consists of up to 960 5 x 7 dot matrix alphanumeric characters at 64 or 80 characters/line. Edit logic provides full operator cursor control. **Ultronic Systems Corp., Data Communication Products Div., Mt. Laurel Industrial Park, Moorestown, N.J. 08057, 609/235-7300. Circle No. 397**

**VIDEO SYSTEMS** terminals have switchable data transmission rates up to 1200 baud, with multi-

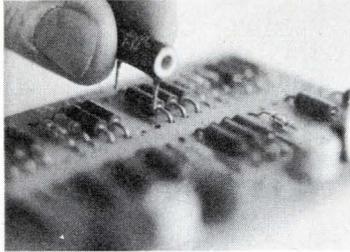
page capacity. Systems utilize standard teletypewriter keyboards with accessory ten-key numerical boards. The CRT presents standard 5 x 7 dot matrix symbols in a 18-line 36-character format. Units are priced from \$4470, with a 72 character line format and standard ASCII printer available at extra cost. **Video Systems Corp., 7300 North Crescent Blvd., Pennsauken, N.J. 08110, 609/665-6688. Circle No. 398**

**WYLE COMPUTERMAL** Model 80 displays up to 960 5 x 7 dot matrix characters in an 80-character 12-line format. An optional 10 character/sec printer is available. The unit is functionally identical with IBM 2260 and 2265 terminals, and therefore requires no software modification for substitution. Interfaces are available for several other computers. **Wyle Computer Products, 129 Maryland St., El Segundo, Calif. 90245, 213/322-1763. Circle No. 399**



**XEROX DATA SYSTEMS** model 7580 graphic and alphanumeric interactive displays are designed for XDS Sigma computers. Consoles contain a CRT, display electronics, two keyboards, action switches, and a light gun. The CRT has a nominal 10 x 10 inch display area, accommodating 1024 divisions along each axis. Five hardware generators are provided, including two vector, one character, one dot, and one raster unit. The raster generator eliminates tracking algorithms, conserving memory and central processor time. The light gun can be pointed at a blank portion of the screen to obtain coordinates. Characters are formed by a stroke generator with software changeable character set. The 7580 is supported from the XDS Graphic Display Library software package. **Xerox Data Systems, 701 South Aviation Blvd., El Segundo, Calif. 90245, 213/772-4511. Circle No. 400**

Ohmite PC-58 radial lead resistors are a special breed. They eliminate tedious lead forming when manually inserting resistors on small to medium PC board runs. This means you can improve your production efficiency for manual insertion by as much as 28% over axial lead types.



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Built-in stand-offs maintain proper clearances between the resistor and the printed circuit board for complete air cir-



ulation. And, you don't have to worry about positioning the resistor to read the markings. The radial leads automatically position



the markings on top for quick determination of the resistance value.

PC-58's are available with vitreous enamel or Ohmicone® silicone ceramic coatings in a wide range of resistance values. Write for catalog 120 or check with your local Ohmite Authorized Distributor. He has PC-58's in stock for all standard resistance values in both the 3 watt and 5 watt sizes.

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# OHMITE

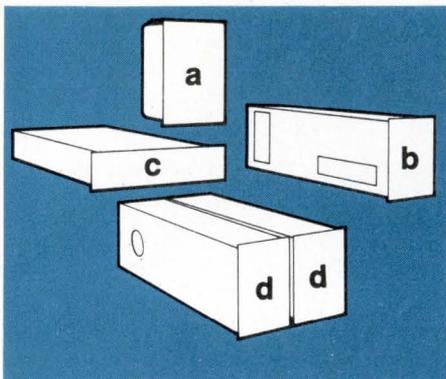
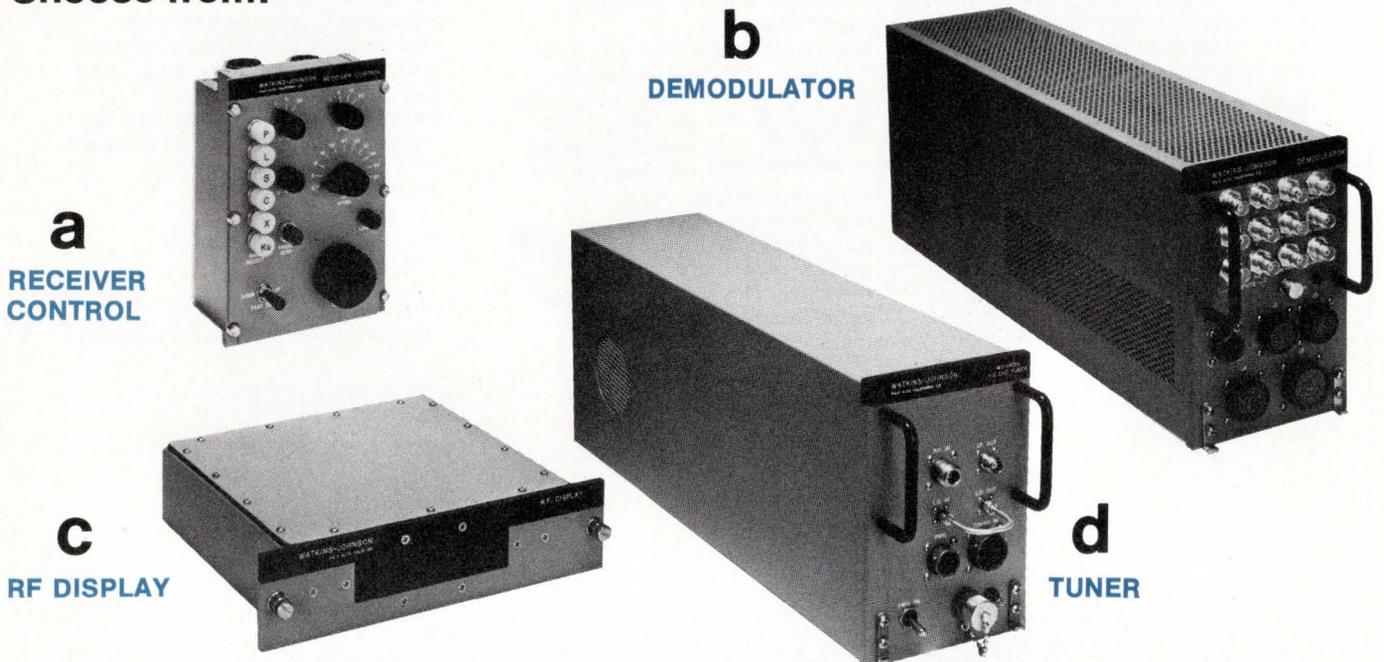
A NORTH AMERICAN PHILIPS COMPANY

## A little stand-offish.

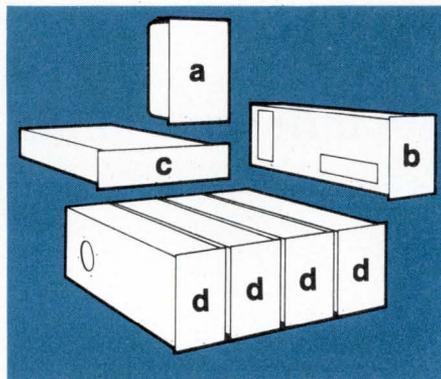


# Plan-It-Yourself Kits for MICROWAVE RECEIVING SYSTEMS

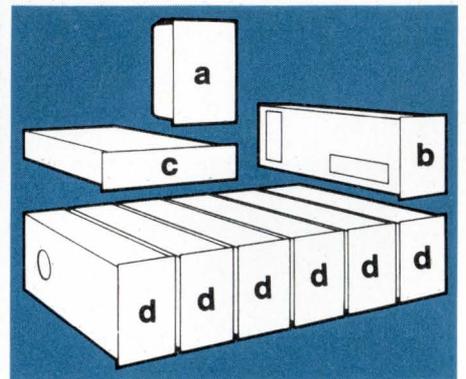
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**VOTE** for the one you like best  
 Write the number of the Idea you like best in the box  
 on the inquiry card and send it to us.

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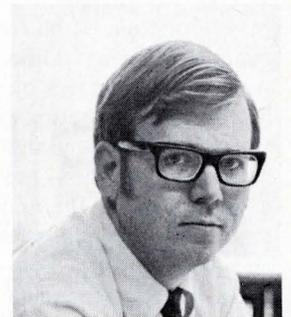
**SEND** us practical, reproducible ideas that are original with you  
 and have been implemented with linear or digital ICs.  
 If we publish your idea, you win a check for \$25.00.  
 If our readers vote yours the best of the issue in which it appears,  
 you have your choice of a Simpson 270 or Triplet 600 multimeter.  
 After 12 issues, our readers will vote on the best idea for all 12 issues.  
 The winner gets his choice of either a Hewlett-Packard 1206A or a Tektronix 3104A oscilloscope.

Submit your IC Ideas to:  
 Alberto Socolovsky, Editor  
**THE ELECTRONIC ENGINEER**  
 Chestnut & 56th Sts.  
 Philadelphia, Pa. 19139

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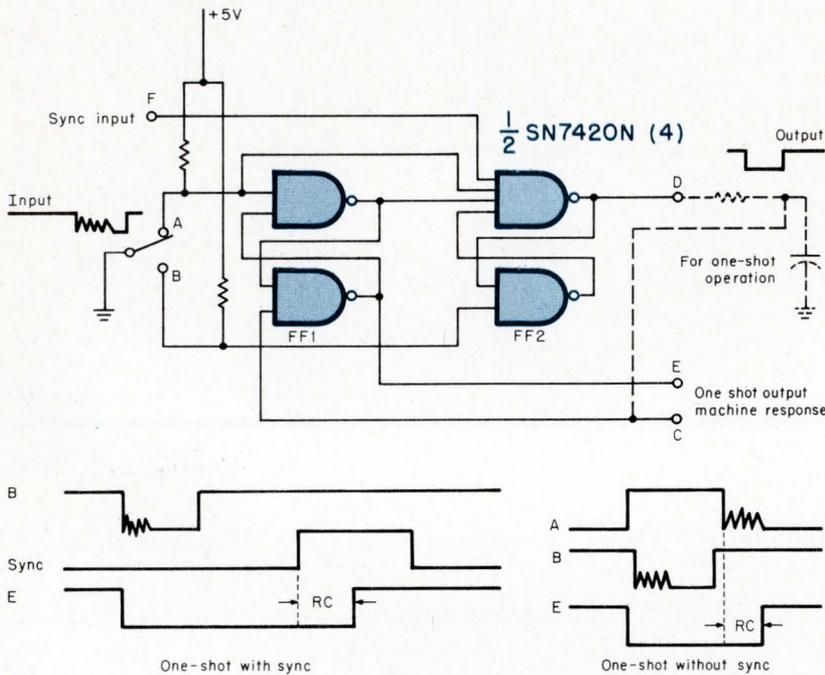
**HOW YOU VOTED**  
 The winning Idea for the June 1970 issue is  
 "Super-simple square-wave generator".

Paul Franson, our prize winning author, is the Director of  
 Technical Publicity for Teradyne, Inc. in Boston, Mass.  
 Mr. Franson has selected the Triplet 600 TVO as his prize.



## 933 Man-machine interface circuit

Alphonso H. Marsh Jr. Raytheon Co., Sudbury, Mass.



Here's a man-machine interface circuit that has the added advantages that you can operate it as one-shot and it can be synchronized to any arbitrary timing.

The circuit is simply two cross-coupled NAND gate flip-flops. Initially FF 1 and 1 FF 2 are set (output high) by the 0 input at terminal A. When the switch is activated, terminal A goes high and FF 2 remains set until terminal B is changed from a 1 to a 0 by the switch. Flip-flop 2 resets until the machine responds by changing terminal C from 1 to 0. This resets FF 1 which sets FF 2. When the switch pole returns to terminal A, FF 1 is also set.

For operation as a one-shot, an external RC network is connected as shown, either with or without the external sync timing.

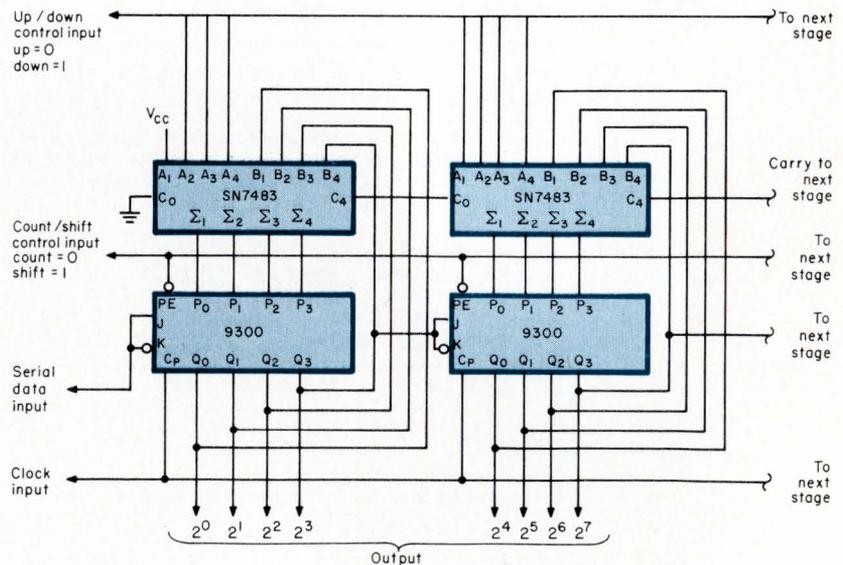
## 934 Circuit performs up/down counting and shifting

Ken Erickson Interstate Electronics Corp., Anaheim, Calif.

You can build this 8-bit up/down counter by combining adders and registers as shown. The circuit has one input to control whether the circuit counts or shifts and another input to determine whether to count up or count down.

The circuit simply adds one to the previous contents of the 9300 registers to count up. A down count is performed by subtracting one (adding 2's complement).

You can lengthen the counter by adding one 4-bit register and adder for each additional 4 bits. As many 4-bit stages may be added as desired, but the maximum clock frequency for counting is limited by the sum of the  $C_0$  to  $C_4$  propagation delays of the adders. Using the newer counters with look-ahead carry will give you the maximum counting frequency.

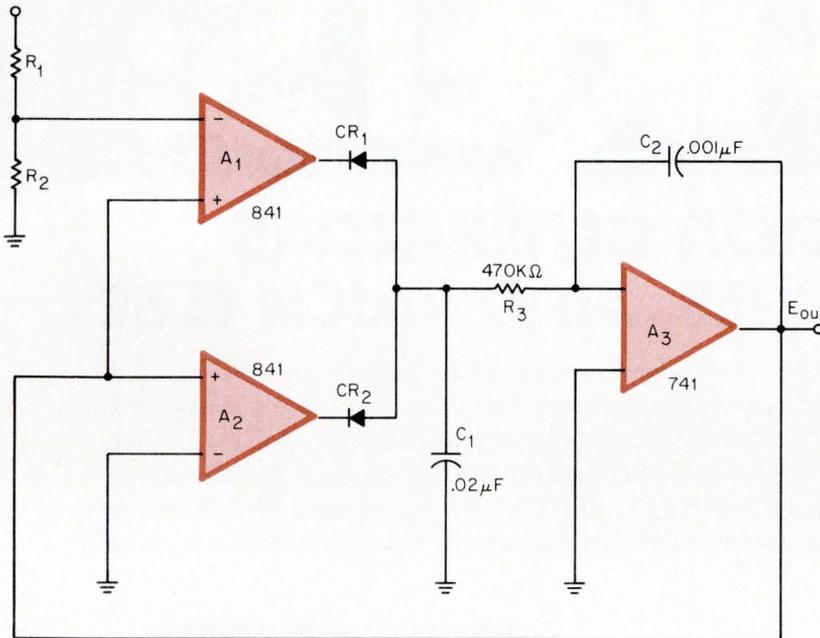


You can easily modify the circuit for other counts such as counting by two's. In this case, the  $A_2$  and  $A_1$  inputs of the first stage

adder would be connected to  $V_{cc}$  and ground respectively. The remaining A inputs would be tied to the up/down control.

## 935 Versatile triangle wave generator

Adrian Moses Lear-Siegler, Inc., Santa Monica, Calif.



This circuit uses two op amps as positive and negative peak detectors letting you set the amplitude anywhere within the range of the power supplies.

The voltage at the junction of  $R_1$  and  $R_2$  determines the amplitude of the output. The circuit shown gives you 0 to +8V, but you can make it -8 (or any selected value) to +8 by putting a negative voltage on the inverting input of amplifier  $A_2$ .

The circuit has good linearity and the amplitude is stable over a wide temperature range. The combination of  $R_3$  and  $C_2$  determines the frequency of the output. The ratio of  $C_1$  to  $C_2$  should be about 20:1. The values in this circuit give you 1 kHz with the inverting input of  $A_1$  at +8V. Op amps  $A_1$  and  $A_2$  are 841's and  $A_3$  is a 741 as shown.

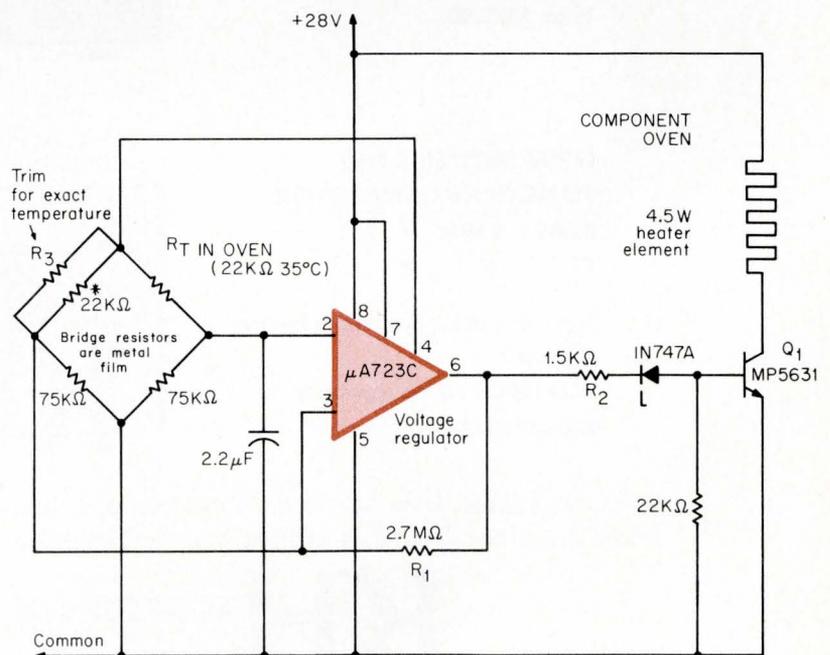
## 936 Oven temperature controller

S. W. Billingsley NASA, Goddard

Frequently, components such as oscillator crystals and Zener diodes require active temperature control. Here's a circuit that provides accurate control and you can build it for less than \$10 in small quantities.

The circuit will control the temperature of an oven within  $\pm 1^\circ\text{C}$  over an ambient swing of  $-50^\circ\text{C}$  to the temperature of the oven. In addition, if you select  $R_2$  to provide adequate drive to  $Q_1$ , the input voltage can vary from 10 to 37 V. Because transistor  $Q_1$  is saturated when on, no heat sink is required.

Resistor  $R_1$  sets the trip-point hysteresis at  $2^\circ\text{C}$  with the circuit values shown. If the heater current is less than 150 mA, you can supply it directly from the  $\mu\text{A}723$  by connecting the element between pin 6 and common.



# FROM THE WAVE MAKERS:

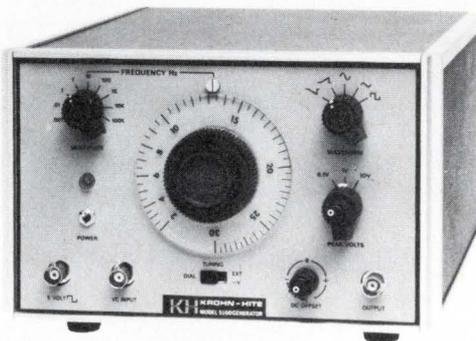
## FUNCTION GENERATORS FOR SQUARES...AND MUCH ELSE

And much less expensive, to boot. Krohn-Hite's new line of function generators give you solid versatility, performance, and operating convenience. Two brand new models covering the frequency range of 0.002 Hz to 5 MHz. Each gives you wavemaking capability for sine, square, triangle, plus and minus ramps, and additional simultaneous square wave outputs. Ultra-fast risetimes. Provision for external V.C. of 1000:1 over the full range. D-C offset control. Adjustable symmetry on square wave for pulse operation. Best of all, we do everything with fewer components.

### NEW MODEL 5100 FUNCTION GENERATOR, 0.002 Hz, to 3 MHz



Simultaneous auxiliary square wave  
VCO 1000:1 sweep capability  
Price: \$375.00.



### NEW MODEL 5400 FUNCTION GENERATOR, 0.002 to 5 MHz



Symmetry offset provides pulse and  
sawtooth  
VCO 1000:1 sweep capability  
Price: \$550.00



If you would like to know much more about much else, drop us a line: The Wavemakers, Krohn-Hite Corporation, 580 Massachusetts Avenue, Cambridge, Mass. 02139



OSCILLATORS / FILTERS / AC SOURCES / FUNCTION GENERATORS / AMPLIFIERS

OVERSEAS SALES OFFICES: BELGIUM, C. N. Rood s. a.; DENMARK, SC Metric A/S; FRANCE, Antares; GERMANY, Nucletron Vertriebs-GMBH; HOLLAND, C. N. Rood n. v.; ITALY, Dott. Ing. Mario Vianello; SWEDEN, Teleinstrument; ISRAEL, R. D. T. Elect. Eng. Ltd.; JAPAN, Shoshin Shoji Kaisha, Ltd.; AUSTRALIA, Sample Electronics (Vic.) Pty., Ltd.; G. B., B & K Inst. Ltd.

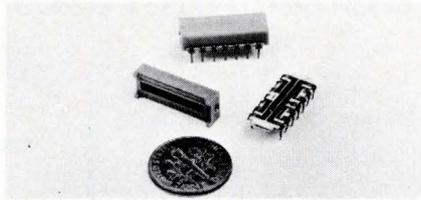
Circle 25 on Inquiry Card

# NEW PRODUCTS

## Trimmers, resistors matched in new network

Many of you have had occasion to match, as closely as possible, all of the resistive components in your circuit from a TCR standpoint. However, you probably found it difficult to accomplish, since you may have had to match a resistor with a negative  $\tau_c$  with a trimmer with a positive  $\tau_c$ . Thus, you had a problem when you attempted to predict what the circuit would do under average conditions and to compensate for induced errors.

So, what was your solution? You probably matched them as closely as possible and accepted the shifting as a fact of life. But, this enforced philosophical approach is no longer necessary because you can now purchase a trimming resistive network whose elements drift only slightly with respect to temperature change, and drift together in a predictable manner. The 14-lead, DIL-packaged trimming network uses IC



technology to replace one trimming pot and five fixed resistors. The TRN (trimmer/resistive network) Series 3765 resistive elements are prepared from a cermet paste that has a nominal 50-ppm  $\tau_c$  over the average ( $-40$  through  $+85^\circ\text{C}$ ) temp. range. Screened together, all resistors are of the same paste, resulting in very close  $\tau_c$  matching. Since each resistor in the net is connected to its own set of terminals, you can interconnect terminals in any manner desired. They can be used with the trimmer or with any other component in the circuit.

As the dimensional configuration is

identical to typical DIL ICs, the nets can be automatically inserted, saving board space. The package pins can be wave soldered, solderless wrapped or inserted in receptacles. As the cost of preparing and inserting separate parts can run as high as \$0.10 each and the TRNs replace six components, they afford a \$0.50/TRN saving. They also cut procurement/inspection/stocking costs.

TRNs available cover a range of  $10\ \Omega$  to  $1\ \text{M}\ \Omega$ , with  $\pm 10\%$ , std. and a  $\pm 1\%$  special tolerance. Power rating is 0.75 W at  $40^\circ\text{C}$ , derated to zero at  $125^\circ\text{C}$ . Operating temp. range is  $-25$  to  $+85^\circ\text{C}$  std.;  $-55$  to  $+125^\circ\text{C}$  special. Their  $\tau_c$  is  $\pm 100$  ppm/ $^\circ\text{C}$  max., std. and  $\pm 50$  ppm/ $^\circ\text{C}$ , special. About \$3.00 ea. in production quantities.

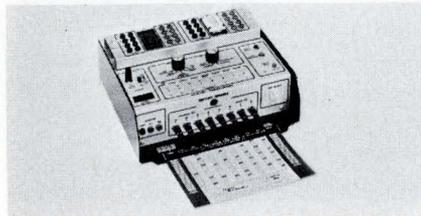
Amphenol Controls Div., The Bunker-Ramo Corp., 120 S. Main St., Janesville, Wisc. 53545.

Circle 283 on Inquiry Card

## Programmer patterns new ROMs

Several manufacturers have either already introduced or will soon announce programmable ROMs. (See "A new memory: the PROM," *The Electronic Engineer*, Aug. 1970, p. 75). And, hot on their heels comes the introduction of a memory programmer designed specifically to pattern these new integrated circuit ROM's. It lets you take an off-the-shelf blank and safely and accurately establish the logic pattern.

With the Model 402 you can manually or automatically program and verify without having to use auxiliary equipment. The ROM chip is addressed with binary coded data, its outputs set for



the desired logic, and the required signals are applied to accomplish the programming.

A typical  $64 \times 8$  ROM can be manually programmed in minutes with a specially designed program data card. The master pattern may then be used to automatically program duplicate ROMs.

The new programmer has an address section with a 512-word capability. It includes an up/down counter, a 3-digit word number readout, and a word capacity selector. Program switches let you select up to eight logical 1's for each word.

Optional features let you program from external sources such as card or tape readers.

The 402 can accommodate many package types such as 16- and 24-pin DILs and 24-pin flat packs. Measuring  $12 \times 10 \times 5$  in., the programmer costs \$945.00. Spectrum Dynamics, Inc., Box 236699, Ft. Lauderdale, Fla. 33307.

Circle 284 on Inquiry Card

## PLATED WIRE MEMORIES

The NM-1000 series is a medium capacity, high-speed, random-access, read/write memory family. Speeds are read access 200 ns, read time 300 ns, and write time 500 ns. Maximum capacity is 163,840 bits. From 0.037 to 0.11/bit. Nemonic Data Systems, Inc., 1301 West Third Ave., Denver, Colo. 80223. (303) 892-7012.

Circle 285 on Inquiry Card

## METAL FILM RESISTORS

Three sizes of these thick film resistors cover a range of  $100\ \text{k}\Omega$  thru  $50\ \text{M}\Omega$ . It has  $\tau_c$ s of  $\pm 150$  ppm and tol. as close as 1% as std. Wattage ratings are  $\frac{1}{4}$ ,  $\frac{1}{8}$  and  $\frac{1}{10}$  W. Mil equivalents RN50, RN55 and RN60. They meet or exceed environmental requirements of Mil-T-10509. Mepco, Inc., Morristown, N.J. 07960. (201) 539-2000.

Circle 286 on Inquiry Card

## CERAMIC PACKAGES

New family of all-alumina-ceramic circuit packages is primarily for MOS MSI/LSI applications; The family includes a 42-lead multipurpose flatpack, a 40-lead edge-plug-in package, a 40-lead wide-base DIP, and a narrow-base DIP with either 24, 28, or 40 leads. Coors Porcelain Co., 600 Ninth St., Golden, Colo. 80401. (303) 279-6565.

Circle 287 on Inquiry Card

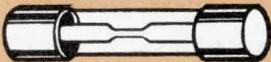
# BUSS QUALITY

## SMALL DIMENSION FUSES AND FUSEHOLDERS

For The Protection of All Types of Electronic and Electrical Circuits and Devices . . .



includes dual-element "slow-blowing", single-element "quick-acting" and signal or visual indicating types . . . in sizes from 1/500 amp. up.



HKA lamp-indicating, signal activating holder.



HMR RF shielded holder for 1/4 x 1 1/4 in. fuses.



HKP panel mounted holder for 1/4 x 1 1/4 in. fuses.

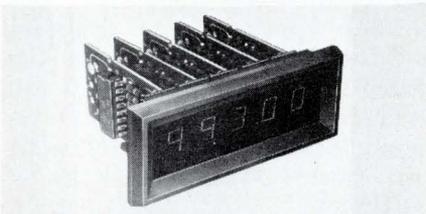


TRON Rectifier Fuses For the Safe Protection of Solid State Devices.

Provide extremely fast opening on overload and fault currents, with a high degree of restriction of let-thru current. Many types and sizes available. Ampere ratings from 1/2 to 1000 in voltage ratings up to 1500.



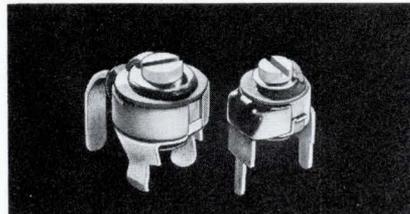
### LED READOUT PACKAGE



TEC-Lite SSR-70 solid state digital readout package combines an infinite life 7-bar segmented LED display, decoder/driver, current limiting resistors and mounting provisions within an assembly which is about 1.9 x 0.4 x 1 in. The bezel assembly accommodates from 1 to 10 of them. TEC, 6700 S. Washington Ave., Eden Prairie, Minn. 55343. (612) 941-1100.

Circle 223 on Inquiry Card

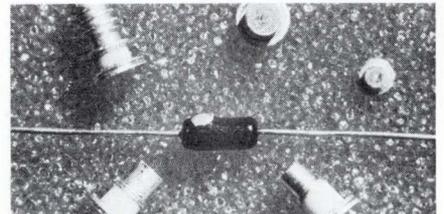
### TRIMMER CAPACITORS



These PC mounted 9300 series miniature and microminiature trimmers have a rotor assembly of specially formulated ceramic materials to provide longer life and complete environmental stability. They feature very even linear tuning. Series includes a range of 1.7 pF to 50.0 pF. \$1.90 to 0.18 ea. Johanson Mfg. Corp., 400 Rockway Valley Rd., Boonton, N.J. 07005. (201) 334-2676.

Circle 225 on Inquiry Card

### PIN DIODE LINE



New line of PIN microwave switching diodes, consists of 12 basic types available in 6 different styles. The GC-4000 series features fast transition speed with voltage breakdown as high as 750 V. Also offers low combination of resistance and capacitance and complete passivation. GHZ Devices, Inc., Kennedy Dr., North Chelmsford, Mass. 01863. (617) 251-4981.

Circle 227 on Inquiry Card

### DIL CARD

These new cards fit std. rack configurations. They have a 55 socket pattern and 14 and 16 DIL socket mixture. The board is double sided with ground and power planes soldered to solderless-wrap post. Data Numerics, 141A Central Ave., Farmingdale, N.Y. 11735.

Circle 224 on Inquiry Card

### RESISTOR NETS

These thick film resistor networks are available to 1% tol., TC matched to 10 ppm. Change in resistance over 1000 hr. life at 85°C is < 1%. They come in DIL, conformal coating or epoxy molded packages. Cal-R, Inc., 1601 Olympic Blvd., Santa Monica, Calif. 90404.

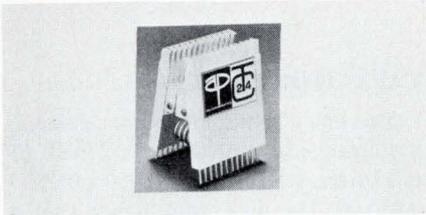
Circle 226 on Inquiry Card

### TELETYPE TERMINAL

New model 37 teletype terminal has all the flexibility and sophistication of the current model 37, but has a wider platen to accommodate std. 15-in. sprocket-fed computer print-out paper. Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60076.

Circle 228 on Inquiry Card

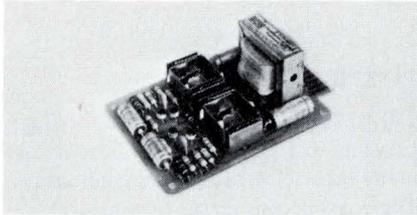
## IC TEST CLIPS



Four new test clips accommodate 24 through 40-pin DIP packages. Model A P 923724 straddles 24-pin DIPs and is available off-the-shelf while 28-, 36-, and 40-pin clips are available on special order. From \$21.00 (1-9). A P Incorporated, 72 Corwin Dr., Painesville, Ohio 44077. (216) 357-5597.

Circle 229 on Inquiry Card

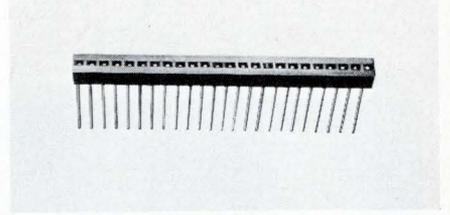
## PLUG-IN POWER SUPPLIES



These low-cost regulated supplies (Card/Pac series) are offered with both single and dual dc outputs on a single PC board. Regulation is 0.01% for line variations and 0.05% load reg. from no load to full load. Power/Mate Corp., 514 S. River St., Hackensack, N.J. 07601, (201) 343-6294.

Circle 231 on Inquiry Card

## DIP STRIP



New contact strips are for mounting odd-size DIP packages, or any device with leads in-line on 0.1 in. spacing and up to 0.025 in. dia. Longer lead length of 0.715 in. lets you stack three wire wraps. Robinson-Nugent, Inc., 800 E. 8th, New Albany, Ind. 47150. (812) 945-0211.

Circle 233 on Inquiry Card

## TRIMMER POTS

New 2300 Series  $\frac{3}{8}$  in. sq. wire-wound multiturn pots meet Mil-R-27208, RT24. They come in PC card mounting, side adjust, or top adjust configurations. Resistance range is 10 $\Omega$  to 20 k $\Omega$ , and power rating is 0.75 W at 85°C. Amphenol Controls Div., 120 S. Main St., Janesville, Wis. 53545. (608) 754-2211.

Circle 230 on Inquiry Card

## $\frac{1}{2}$ % PANEL METERS

High accuracy of these meters is achieved in two ways: by individually drawing dial divisions to suit each meter movement and by matching the meter movement to a pre-printed scale. The first assures tracking at room temp. within  $\pm \frac{1}{2}$ % for a single temp. Beede Electrical Instruments Co., Penacook, N.H. 03301. (603) 753-6362.

Circle 232 on Inquiry Card

## DUAL POWER SUPPLY

Model 50 has 1 A output on each side. There are three models with separately adj. voltage. Outputs of  $\pm 10.0$  to 13.5 V,  $\pm 13.5$  to 16.5 V, and  $\pm 16.5$  to 20.0 V. Maximum ripple is 500  $\mu$ V rms. Line reg. is 0.01% and load reg. 0.10%. Electrostatics, Inc., 7718 Clairemont Mesa Blvd., San Diego, Calif. 92111. (714) 279-1414.

Circle 234 on Inquiry Card



**FNA FUSETRON**  
Fuse 13/32 x 1 1/2 in. slow-blowing, Visual-Indicating, Alarm-Activating. (Also useful for protection of small motors, solenoids, transformers in machine tool industry.)



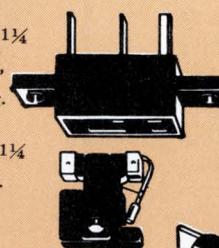
**BUSS MIC-13/32 x 1 1/2 in.** Visual-Indicating, Alarm-Activating.

**BUSS MIN-13/32 x 1 1/2 in.** Visual-Indicating.

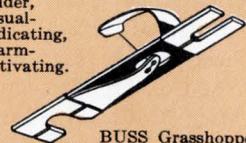


**BUSS GLD-1/4 x 1 1/4 in.** Visual-Indicating, Alarm-Activating.

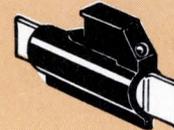
**BUSS GBA-1/4 x 1 1/4 in.** Visual-Indicating.



**BUSS GMT and HLT holder.** Visual-Indicating, Alarm-Activating.



**BUSS Grasshopper Fuse.** Visual-Indicating, Alarm-Activating.



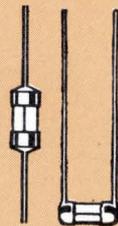
**BUSS ACH Aircraft Limiter.** Visual-Indicating.

### The Complete Line of Signal-Indicating Alarm-Activating Fuses

For use on computers, microwave units, communication equipment, all electronic circuitry.

## SUB-MINIATURE FUSES

Ideal for space tight applications, light weight, vibration and shock resistant. For use as part of miniaturized integrated circuit, large multi-circuit electronic systems, computers, printed circuit boards, all electronic circuitry.



## TRON Sub-Miniature Pigtail

Fuses—Body size only .145 x .300 inch. Glass tube construction permits visual inspection of element. Hermetically sealed. Twenty-three ampere sizes from 1/100 thru 15.



## BUSS Sub-Miniature GMW

Fuse and HWA Fuseholder  
Fuse size only .270 x .250 inch. Fuse has window for visual inspection of element. Fuse may be used with or without holder. 1/200 to 5 amp. Fuses and holders meet Military Specifications.

**BUSSMANN MFG. DIVISION,**  
McGraw-Edison Co., St. Louis, Mo. 63107

For fuses and fuseholders of unquestioned high quality for every protection need . . .

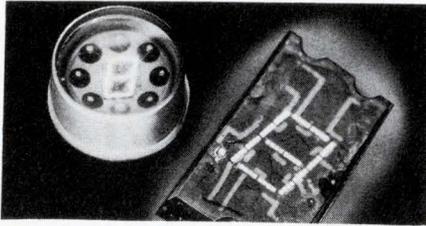
SUPPLIED THE ECONOMICAL WAY  
THRU DISTRIBUTORS

# BUSS QUALITY

FUSES

# NEW PRODUCTS

## SOLID-STATE DISPLAYS



These two numeric displays are seven-segment, diffused planar GaAsP types that emit visible red light. Both are partially alphabetical since they produce the letters A, C, E, F, H, J, L, P, and U, as well as digits from 0 to 9. TIXL302, is a direct replacement for a similar unit currently available. TIXL301, comes in an hermetic TO-5 metal can with window. Texas Instruments Incorporated, Box 5012, Dallas, Tex. 75222.

Circle 235 on Inquiry Card

## ELECTRICAL TAPE

New Scotch brand electrical tape No. X-1244 accepts permanent printing by normal methods, yet printing does not come off even in direct contact with cleaning solvents, jet fuels or hydraulic fluids. A 1-mil polyester film tape, it has a thermosetting pressure sensitive adhesive protected with a liner. For most applications, no thermosetting is required. 3M Co., 3M Ctr., Box 3050, St. Paul, Minn. 55101. (612) 733-9654.

Circle 236 on Inquiry Card

## ANALOG MULTIPLIER

Model 422 analog multiplier provides 5 MHz small signal BW, 1.6 MHz full power response, 100 V/ $\mu$ s slew rate, and only 1° phase shift at 2 MHz. Untrimmed, the gain accuracy is 1%; this accuracy is sustained for freq. to 300 kHz. \$109 (1-9). Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. 02142. (617) 492-6000.

Circle 237 on Inquiry Card

## REED SWITCH

This switch lets you control 480 VA in an ac version (DRAC-5) and 85 W in a dc version (DRDC-6). Overall switch length is 3.465 in. nom. Major dia. of the glass envelope is 0.212 in. max. and envelope length is 1.640 in. max. Use of solid tungsten button contacts and a special reed configuration provides optimum magnetic coupling. Hamlin, Inc., Lake Mills, Wisc. 53551.

Circle 238 on Inquiry Card

## PC SPRAY

Cramolin® solderable spray coating prevents corrosion on PC boards and many other electrical wired connections. The coating also serves as a neutral soldering agent (flux). Drying time is < 10 min. at 23°C (73.4°F). Caig Laboratories, Inc., 455A Union Ave., Westbury, N.Y. 11590. (516) 334-1940.

Circle 239 on Inquiry Card

## CAPACITOR ELEMENTS

This line of NPO monolithic elements has a range of 1 pF through 27,000 pF in 17 sizes, starting from 0.050 x 0.050 x 0.050 in. The max. capacitance change is  $\pm 0.3\%$  over the range of -55° to +125°C. Republic Electronics Corp., Dept. K, 176 E. 7th St., Paterson, N.J. 07524. (201) 279-0300.

Circle 240 on Inquiry Card

MODEL	10000	MODEL	11000	12000	13000	14000	15000	16000	17000	18000
HEIGHT	3.19	HEIGHT	3.19	3.19	4.94	4.94	4.94	4.94	3.50	5.25
WIDTH	3.75	WIDTH	4.94	4.94	4.94	7.50	7.50	7.50	19.00	19.00
DEPTH	6.50	DEPTH	6.50	9.41	9.41	9.41	11.75	16.50	16.50	16.50
VDC	AMPERES	VDC	AMPERES							
0-7.5	2.10	3.7	4.0	5.6	12.0	14.0	21.0	33.2	50.0	87.0
0-16	1.25	5.0	3.9	5.3	11.3	13.0	20.0	32.5	49.0	82.0
0-25	0.85	6.0	3.5	5.0	10.5	12.8	19.0	31.0	47.0	82.0
0-33	0.68	12.0	2.8	4.2	8.0	10.5	15.0	23.0	36.0	58.0
		15.0	2.4	3.7	7.5	9.5	14.0	20.5	27.0	47.0
		24.0	1.5	2.8	4.2	7.0	11.0	15.0	21.0	33.0
		28.0	1.4	2.4	4.0	6.3	9.0	14.0	20.0	29.0

Note: Specifications subject to change without notice.

## HEAT BARRIER

Cool-Heat insulating cream provides a heat shield when applied to a range of electronic assembly and repair operations. With it, silver soldering and brazing can be done adjacent to critical surfaces without scorching or damage. L.G.H. Products Corp., 1860 Broadway New York, N.Y. 10023.

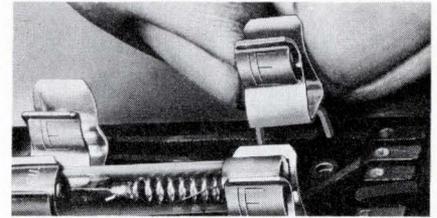
Circle 241 on Inquiry Card

## MINIATURE COAXIAL

New coax cable, insulated with an expanded PTFE fluorocarbon resin, is now available in 95, 75, and 50  $\Omega$  versions. It offers volume reductions as much as 62% and weight reduction as much as 70% over std. Mil-C-17 constructions. W. L. Gore & Assoc., Inc., 555 Paper Mill Rd., Newark, Del. 19711.

Circle 242 on Inquiry Card

## PC BOARD FUSE CLIPS



New easily inserted, high grade spring bronze fuse clip, rated to 15 A is for PCB installation. Twin metal tab mounting prevents rotation or misalignment during assembly. The clip (No. 102068) can be hand or machine inserted. Earless clips without fuse stops (No. 102069) are also available. They are good for use as heat sinks for semiconductors. Littelfuse, Inc., 800 E. Northwest Hwy, Des Plaines, Ill. 60016. (312) 824-1188.

Circle 243 on Inquiry Card

## PLANAR TRIODE

New conduction cooled planar triode of metal-ceramic design with a metal-capillary cathode is for oscillators, modulators, power mixers, and amplifiers up to 3 GHz. The YD 1380/81 tube has a max. plate diss. of 250 W and will provide 100 cw power output with 1300 V plate in Class B grounded grid operation. Siemens Corp., Components Div., 186 Wood Ave. So., Iselin, N.J. 08830. (201) 494-1000.

Circle 244 on Inquiry Card

## CONNECTOR SAVER

Reusable "Sav-Con" connectors absorb engaging and disengaging wear and tear during equipment test and check out phases. Inserted between test cable and unit connector, they require no wiring, and introduce min. resistance, in series with circuits under test. Glenair Inc., 1211 Air Way, Glendale, Calif., 91201.

Circle 245 on Inquiry Card

## PHOTOTRANSISTOR

This light activated phototransistor is capable of 50 mW dissipation. The miniature STPT60 has a fast time switching characteristic (1.5  $\mu$ s typ. rise time, 5  $\mu$ s fall time) to allow a more rapid reading than mechanical contacts. It has a narrow field of view, minimizing cross-talk. Sensor Technology, Inc., 7118 Gerald Ave., Van Nuys, Calif. 91406. (213) 781-2154.

Circle 246 on Inquiry Card

# The new standard in standardized power modules.

For 37 years North Electric has been meeting the exceptional requirements of the custom power equipment market. Now, out of this experience and the engineering skills developed by North, comes a great new line of standardized power modules . . . All designed to give you more versatility and a new high in power reliability! Send for North's new Standardized Power Catalog and start buying your custom power and standard power from one great source . . . NORTH. Call 419/468-8244 (or TWX 419/468-4860) for immediate service. Attention Product Manager, Standard Power Equipment.

*North Electric Company  
Electronics Division / Galion, Ohio  
A Subsidiary of  
United Utilities, Incorporated*



## **NORTH ELECTRIC**

# NEW Mini-Module Regulated dc POWER SUPPLIES



Now you can save space and improve reliability by mounting an Acopian mini-module power supply directly into a printed circuit board. Sizes start at 2.32" x 1.82" x 1". Both single and dual outputs are available. And the duals can be used to power up amps or for unbalanced loads. Other features include:

- Choice of 58 different single output modules ranging from 1 to 28 volts, 40 ma to 500 ma
- 406 combinations of dual output modules with electrically independent, like or different outputs in each section
- 0.02 to 0.1% load and line regulation, depending on model
- 0.5 mv RMS ripple
- Prices as low as \$39 for singles, \$58 for duals

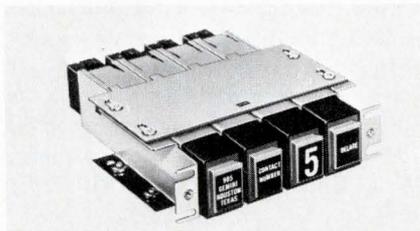
Do you have the latest Acopian catalog? It lists over 82,000 AC to DC power modules for industrial or MIL-spec applications. For your copy, write Acopian Corp., Easton, Pa. 18042, or call (215) 258-5441. And remember, every Acopian power module is shipped with this tag...



Circle 28 on Inquiry Card

## NEW PRODUCTS

### MINIATURE READOUT



Series 0405 readout has the Cue-Switch® feature—an illuminated push-button switch with built-in projection system that provides for multiple message display. Unit displays a 0.50 in. character or message easily read 10 ft away. \$56.00 ea. (1-49). Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, Calif. 91405. (213) 787-0311.

Circle 247 on Inquiry Card

### VOLTAGE DIVIDERS

These voltage divider and other matched resistor assemblies (to  $\pm 0.005\%$  ratio tol. match, and  $\frac{1}{2}$  ppm/ $^{\circ}\text{C}$  TC tracking) are up to 8 times smaller than equivalent networks. Units are available with up to 4 discrete resistors and res. values up to 75 k $\Omega$  ea. Vishay Intertechnology, Inc., 63 Lincoln Hwy, Malvern, Pa.

Circle 248 on Inquiry Card

### INJECTION MOLDER

Polycraft 22 is a manually operated horizontal or vertical injection molding machine with a  $1\frac{1}{2}$  oz. shot capacity. It provides over six tons of clamp, 15,000 psi injection pressure, automatic parts ejection and a 300° to 700°F accurately controlled temp. range. Polycraft Co., Box 28, E. Prospect, Pa. 17317. (717) 252-3293.

Circle 249 on Inquiry Card

### INDUSTRIAL IR EMITTERS

Two new GaAs infrared emitters are 30 to 50% less expensive than comparable units already on the market. TIXL26 is for close range work. It has a 1.0 mW typ. power output when forward biased at 35 mA. The TIXL27, light source has a min. radiant power output of 15 mW when forward current is 300 mA. TIXL26 is \$2.18 ea. (100-999); the TIXL27 is \$16.50 ea. (100-999) Texas Instruments Incorporated, 13500 N. Central Expressway, Dallas, Tex. 75222. (214) 238-3741.

Circle 250 on Inquiry Card

### BEAM EMITTERS

Series CM-20 emitters project narrow cones of IR and luminous energies over distances of 7 to 20 in. Minimum ft. candle of measurement across the target is 20 fc for the CM20-8-01 at 7 in., and 15 fc for the CM20-9-01 at 14 in. They consume only 850 mW of power. Chicago Miniature Lamp Works, 4433 N. Ravenswood Ave., Chicago, Ill. 60640.

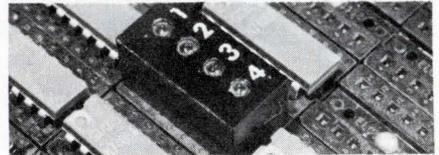
Circle 251 on Inquiry Card

### HIGH-DENSITY CONNECTOR

These all-plastic, 51-contact rectangular connectors do not use metal to retain the contacts. Instead, a ring of plastic, molded within the insulator holds the contact firmly in place. Overall size is only 0.050 x 0.59 x 1.69 in. Viking Industries, Inc., 21001 Nordhoff St., Chatsworth, Calif. 91311.

Circle 252 on Inquiry Card

### PLUG-IN READOUT



The LL-4 logic lite provides four bits of logic status in a DIL package. Inputs are TTL/DTL compatible and represent only one unit load. The unit requires 5 Vdc power. Various markings are available. \$9.00 ea. in unit quan. Unique Devices Co., Box 786, Reseda, Calif. 91335. (213) 881-6634.

Circle 253 on Inquiry Card

### COAX CONNECTORS

Ridgelok series positive locking, all crimp 50 $\Omega$  connectors have only three pieces. Ridgelok can be used in the same area needed for two 50 $\Omega$  BNCs. The connectors have an avg. res. of 4 m $\Omega$  and max. contact res. of 8.3 m $\Omega$  at 3A. Microdot Inc., Connector Div., 220 Pasadena Ave., So. Pasadena, Calif. 91030. (213) 682-3351.

Circle 254 on Inquiry Card

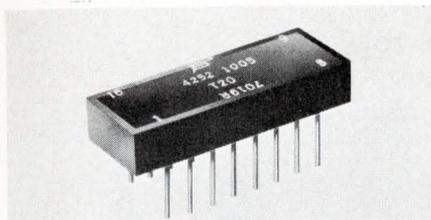
### SENSITIVE RELAY

New polarized dc relay is for commercial uses. The std. Type PYZA is a precision sensing device with sensitivities as low as 70  $\mu\text{W}$ . Contacts are Form K, SPDT, null-seeking and rated at 1 A with a 110 V, 60 Hz ac resistive load. Electro-Mechanical Products Div., Barber-Colman Co., Rockford, Ill. 61101.

Circle 255 on Inquiry Card

The Electronic Engineer • Nov. 1970

### DIL TRANSFORMER



New 16-pin Model 4252-1005 miniature pulse transformer meets Mil-T-21038 grade 7 requirements, and features high insulation resistance, fast rise and fall times, good pulse integrity, and low coupling capacitance. Bourns Pacific Magnetics Corp., 28151 Highway 74, Romoland, Calif. 92380. (714) 657-5195.

Circle 256 on Inquiry Card

### REMOTE CONTROL SYSTEM

New LA7922/7923 system remotely controls communications equipment such as receivers, transceivers, transmitters, and power amps. It operates over a single pair line by dc for short distances and by FSK tone keying for long distances. Racal Communications, Inc., 8440 Second Ave., Silver Spring, Md. 20910. (301) 587-8515.

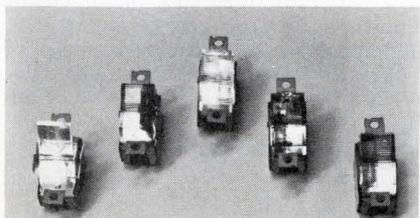
Circle 257 on Inquiry Card

### SIZE 8 DC MOTOR

Model 08-dc motor offers a high torque to inertia ratio of 62,500 rad/s/s, a low ripple torque and low magnetic detent characteristics. It uses a 12-bar armature to minimize cogging and arcing. Clifton Div., Litton Precision Products, Inc., Marple at Broadway, Clifton Heights, Pa. 19018. (215) 622-1000.

Circle 258 on Inquiry Card

### LIGHTED SWITCHES



This line of Rockette switches has completely illuminated rockers (rather than merely lighted windows) to quickly provide function indication, they are rated to 20 A, 125 Vac. From \$2.94 to \$7.45. Specialty Products Div., Cutler-Hammer, Inc., 4201 N. 27th St., Milwaukee, Wis. 53216.

Circle 259 on Inquiry Card

# how to get a \$400 frequency counter for \$199<sup>95</sup>\*



## ...build the new Heathkit® IB-101

- Accurate counting, 1 Hz to over 15 MHz
- Automatic trigger level for wide range input without adjustment
- Five digit readout with Hz/kHz ranges & overrange indicators give eight digit capability
- High Z input
- Computer-type integrated circuitry eliminates divider chain adjustment

The latest Heath breakthrough in low cost, high quality instrumentation. New IB-101 counts from 1 Hz to over 15 MHz; advanced integrated circuitry eliminates blinking readout & divider chain adjustment.

Overrange indicator & Hz/kHz switch give the IB-101 8-digit capability. Set the range switch to kHz & the display reads out to the nearest kHz . . . push the range switch to Hz and read down to the last Hz. Overrange & Hz/kHz indicators light up to give error-free measurement & correct range at all times. Automatic decimal locator eliminates interpolation & figuring.

Exclusive Heath-designed input circuit uses a dual-gate, diode-protected MOSFET . . . provides proper triggering without adjustment from less than 100 mV to over 200 V. Input Z is 1 megohm shunted by less than 20 pF to minimize circuit loading & error. Other features include sockets for all 26 IC's & 5 display tubes . . . 120/240 V AC operation & convenient handle/tilt stand.

Compare the new Heathkit IB-101 . . . then order yours. **Kit IB-101, 7 lbs. . . \$199.95\***

**IB-101 SPECIFICATIONS:** Frequency Range: 1 Hz to greater than 15 MHz. Accuracy:  $\pm 1$  count  $\pm$  time base stability. Gate Times: 1 millisecond or 1 second with automatic reset. **INPUT CHARACTERISTICS** — Sensitivity: 1 Hz to 1 MHz, less than 100 mV rms. 1 MHz to 15 MHz, less than 250 mV rms, after 30 minutes warmup. Trigger Level: Automatic. Impedance: 1 Megohm shunted by less than 20 pF. Maximum Input: 200 V rms, DC — 1 kHz. Derate at 48 V per frequency decade. **TIME BASE:** Frequency: 1 MHz, crystal controlled. Aging Rate: Less than 1 PPM/month after 30 days. Temperature: Less than  $\pm 2$  parts in  $10^7$ /degree C. 20 to 35 degrees C after 30 minutes warmup.  $\pm .002\%$  from 0 to 50 degrees C. **GENERAL:** Readout: 5 digits plus overrange. Temperature Range: Storage; —55 to 80 degrees C. Operating; 0 to 50 degrees C. Power Requirements: 105-125 or 210-250 V AC, 50/60 Hz, 8 watts. Cabinet Dimensions: 8 1/4" W x 3 1/2" H x 9" D not including handle. Net Weight: 4 1/2 lbs.

HEATH COMPANY, Dept. 520-25  
Benton Harbor, Michigan 49022



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Enclosed is \$ \_\_\_\_\_, plus shipping.

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 Please send FREE Heathkit Catalog.  Please send Credit Application.

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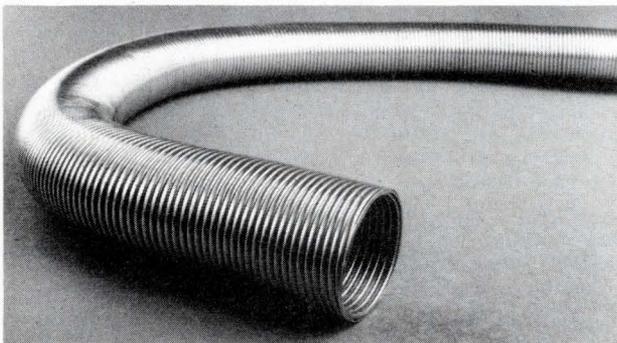
\*Mail order prices; F.O.B. factory. Prices & specifications subject to change without notice. TE-232

# New generation of magnetic shielding.

The name of the shielding material is Westinghouse Hipernom® alloy, and the idea is: less does more. Shielding effectiveness is greater, especially at high frequencies, than the older shielding alloys. You can use Hipernom in thinner sections and save weight. Or use it as straight replacement and get more effective shielding.

Among the people who need Hipernom . . .

- Astronauts carrying rock cores back from the moon in Hipernom cans to preserve lunar magnetic characteristics.
- Circuit designers who, having mastered the art of shielding in milliamp circuits, are starting to move to the microamp range.
- Tape-head designers.
- Image or display tube and oscilloscope manufacturers.
- Computer designers; especially for miniaturized computer components.
- Anyone developing electronic medical equipment.
- Anyone concerned with meeting electromagnetic pulse requirements.
- Anyone at *all* using the same magnetic shielding material he was using five years ago.



Hipernom as formed by one of its many users into flexible tube. Very time-saving, often very cost-saving. Hipernom is available from Westinghouse in strip, sheet, plates and bar. Total metals capability to serve the electronics and aerospace industries. 1-6-70

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Box 45, Blairsville, Pa. 15717  
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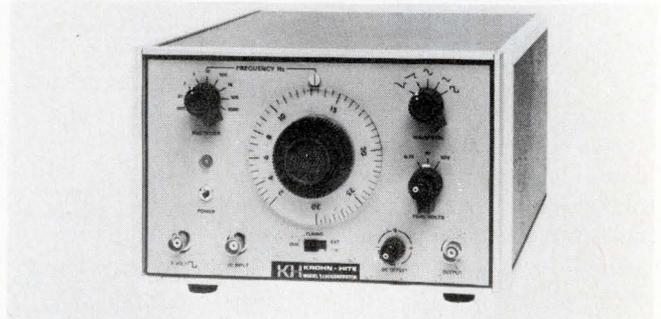
**You can be sure... if it's Westinghouse**



## LAB INSTRUMENTS

### FUNCTION GENERATORS

Marked by their versatility.

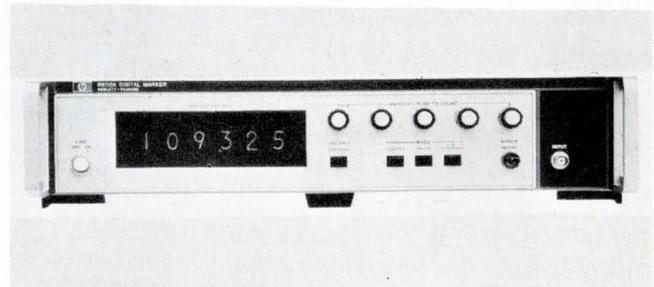


First in this new line of instruments is the Model 5100. This unit has a dynamic frequency range of 0.002 Hz to 3 MHz and gives you a full range of function including sine, square, triangle and positive and negative ramp. Main output is 20 V pk-pk open circuit. A 5 V pk-pk square wave output with < 15 ns risetime can be used for synchronization, gating, and blanking, while you use the main output for other functions. Among the suggested applications are amplifier response measurements, recorder linearity checks and response and linearity tests of servo-systems. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass. 02139.

Circle 277 on Inquiry Card

### DIGITAL MARKER

Has five variable, crystal-accurate markers.



The Model 8600A operates with the manufacturer's Model 8601A sweep generator and any swept display to produce five frequency markers. You can set each of the markers to any frequency in the sweeper's range. The unit employs no tuned circuits to generate sweep markers. Instead it halts the sweep at each marker setting for a period long enough to brighten the scope trace at that position, then re-starts the sweep at the predetermined rate, stopping again at each preset marker. It costs \$1100 with a 45 day delivery. Inquiries Manager, Hewlett-Packard Co., 1601 California Ave., Palo Alto, Calif. 94304. (415) 326-7000.

Circle 278 on Inquiry Card

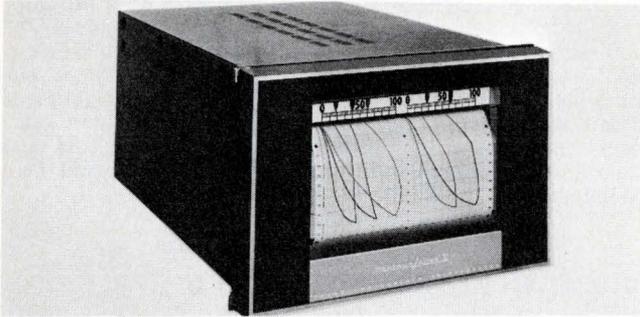
### FREQUENCY SYNTHESIZER

The WJ-1154 covers L-, S-, C- and X-bands in a single instrument. You can use this microwave synthesizer as the local oscillator in microwave receivers or as the swept signal source in automatic test equipment. The unit has both local and remote digital programming (BCD), frequency steps of 1 MHz (with smaller steps available), and a power output of 1 mW (0 dB) leveled to  $\pm 2$  dB across the band. Watkins-Johnson Co., 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. 94304.

Circle 279 on Inquiry Card

## X-Y RECORDER

Has six-signal capability.

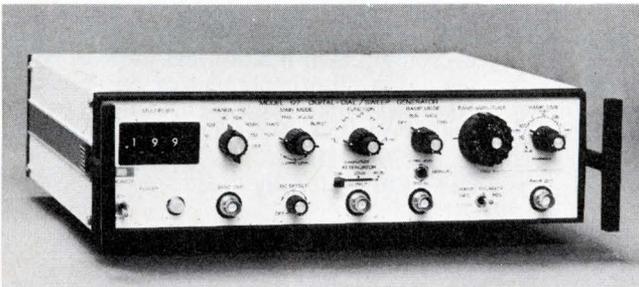


The Contour/riter™ II will record as many as six different signals (five X, plus one Y) at the same time. The recorder comes with one, two, three or four overlapping pens, or, with dual charts, up to five pens. The manufacturer describes it as a "profiling" recorder, suited to unattended recording of many types of process runs, experimental or production testing, and analog tracing of computer results. Automatic re-framing and two-color inking systems are available. The single-pen model is priced at \$2240.00; delivery in 45 days. Digital Systems Div., Texas Instruments Incorporated, Box 66027, Houston, Tex. 77006. (713) 526-1411.

Circle 280 on Inquiry Card

## WAVEFORM GENERATOR

Has digital frequency dial, VCF, and sweep source.



The standard Model 127 has a frequency bandwidth of 0.1 Hz to 3 MHz, or you can get it with a range of 0.01 Hz to 5 MHz. It produces sine, square, triangle, ramp, pulse and sync waveform. You can operate the generator in any one of six modes: run, gate, triggered, burst, pulse and sweep. In the pulse mode, pulse duration as well as repetition rate are variable. Sine distortion is 0.25% over the audio range. Output voltage is 10 V pk-pk into 50Ω, (20 V pk-pk, open circuit) with 60 dB of attenuation. It carries a price tag of \$645 with delivery in 3 weeks or less. Exact Electronics, Inc., Box 160, Hillsboro, Ore. 97123. (503) 648-6661.

Circle 281 on Inquiry Card

## IMPEDANCE COMPARATOR

The Model 1521 impedance comparison bridge lets you make rapid production and receiving inspection of R, L and C components. The unit has adjustable limit switches for automated sorting of components into tolerance bands, test rates of up to 10 kHz and a sensitivity of ±0.3% full scale. The instrument features built-in reference voltages for each range and you can also use it for measuring phase angle differences. \$975. B & K Instruments, Inc., 5111 W. 164 St., Cleveland, Ohio 44142. (216) 267-4800.

Circle 282 on Inquiry Card

## CASE HISTORY NO. 3

# COOL-aids

ONE OF A SERIES OF ASTRODYNE  
COOPERATIVELY ENGINEERED SOLUTIONS  
TO INTERESTING COOLING PROBLEMS.

## Problem

Sixteen (16) TO-3's each dissipating 70 watts and 28 resistors each dissipating 8 watts with limited space for forced air cooling. Maximum ambient air 45°C.

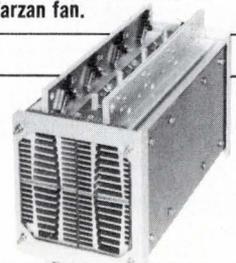
**OBJECTIVE:** To maintain temperature at case at about 106°C.

## Approach

1. Thermal Resistance calculated at .67°C/watt for each device nearest the fan using Astrodyne 2404 assembly  
 $T_c = 106^\circ\text{C}$   
 Interface  $\Delta t = 14^\circ\text{C}$   $T_A = 45^\circ\text{C}$   
 $T_{HS} = 92^\circ\text{C}$   $\Delta t = 47^\circ\text{C}$
2. Assuming 15 CFM per quadrant and taking worst-case condition:  
 (last station)  $\Delta t = 3.16 \times \frac{70}{15} = 14^\circ\text{F} \approx 8^\circ\text{C} \therefore 47^\circ\text{C}$   
 is reduced by 8°C.  
 Therefore:  $\theta_{HS}$  (worst case) =  $\frac{39^\circ}{70} = .56^\circ\text{C/watt}$
3. Length of station/module required at each of the 4 locations for the 70 watt devices (assuming 20 CFM air flow):  
 Length of station =  $\text{std length} \left( \frac{\theta_{Std}}{\theta_{Reg}} \right)$   
 $= 1\frac{1}{4} \left( \frac{0.9}{0.56} \right) = 2.02''$  for worst case  
 Thus, over-all length required is about 8" producing head loss of about .25" H<sub>2</sub>O with air flow reduced to about 14 CFM per quadrant (using PAMOTOR fan).
4. With reduced air-flow, longer stations are required to achieve required thermal resistance:  
 They were calculated to be:  
 L (1st unit) = 2.08" L (3rd unit) = 2.32" total 9.28"  
 L (2nd unit) = 2.20" L (4th unit) = 2.68" total 9.28"  
 This length results in head loss of .28" H<sub>2</sub>O and requires use of another fan. Customer has room for Tarzan fans which can supply necessary air-flow.  
 Including 28 resistors at 8 watts each requires increasing over-all length to 10" to provide both mounting space and thermal capacity.
5. Removing every other fin in central section of each module provided significant increase in air-flow, reducing head loss with Rotron-Tarzan fan.

## Solution

**2404-24SP ASSEMBLY**  
**Thermal Resistance:**  
 .56°C/watt (worst case)  
 .67°C/watt (best case)  
**Air Flow: 16 CFM/quadrant**  
**Maximum Case Temp: 99°C**  
**Watts Dissipated 1344**



WE WILL BE HAPPY TO PROVIDE,  
WITHOUT OBLIGATION, THE MOST EFFICIENT SOLUTION  
FOR YOUR COOLING PROBLEM.



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 PERFORMANCE ▶ LOW NOISE LEVEL ▶ AVAILABLE FROM STOCK

## Rotron's new BISCUIT® BLOWER is not revolutionary



It's unique!

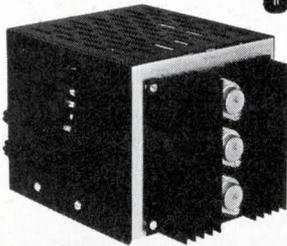
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 write Rotron Incorporated,  
 Woodstock, New York 12498



Circle 32 on Inquiry Card

# ELEXON

\* ONLY \$90.00



5 VOLTS  
 15 AMP  
 POWER  
 SUPPLIES

### SPECIFICATIONS

INPUT: 120 or 240 VAC ±10% 47-63 Hz  
 OUTPUT: MODEL

ELV-75-5 ..... 5 Vdc at 15 amps  
 ELV-75-12 ..... 12 Vdc at 6 amps  
 ELV-75-18 ..... 18 Vdc at 4 amps  
 ELV-75-24 ..... 24 Vdc at 3 amps

LINE REG: .1%, LOAD REG: .1%, RIPPLE & NOISE: .1%  
 • SHORT CIRCUIT PROTECTION • OPERATES 0°C-55°C  
 • OFF THE SHELF DELIVERY!

* PRICES	1-9	10-24	25-49	50-99
ELV-75-5	\$90.00	\$85.00	\$80.00	\$75.00
ELV-75-12	90.00	85.00	80.00	75.00
ELV-75-18	90.00	85.00	80.00	75.00
ELV-75-24	90.00	85.00	80.00	75.00

\*ELV-75 Crowbar Optional — \$10.00

## ELEXON INC.

1422 E. St. Gertrude • Santa Ana, California 92705  
 • (714) 540-9510

Circle 33 on Inquiry Card

# MICROWORLD

## ECL SERIES

This series, the ECL 9500, initially includes the 9502 dual 4-input OR/NOR gate, the 9503 triple 2-input OR/NOR gate, the 9504 quad 2-input NOR gate, the 9528 dual data flip-flop, and the 9581 8-input multiplexer. The series is made up of non-saturating gate elements with typical propagation delays of 2 ns. Temperature compensating networks balance out variations in base emitter voltage and cause certain significant parameters, such as noise margins and speeds, to remain relatively constant over the range of 0 to 75°C. Prices (1-24 pcs) start at \$2.95. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040. (415) 962-3563.

Circle 209 on Inquiry Card

## DUAL TTL ONE-SHOT

In both ceramic and plastic DIPs



The SN54/74123 is a dual-retriggerable and resettable one-shot TTL multivibrator designed to control output pulse width either by lengthening (retriggering) or by shortening (resetting or clearing). The circuit features dc triggering from high-level and low-level active inputs, and also provides an overriding direct clear input. You get both positive and negative going output pulses with fanout to 10 normalized Series 54/74 loads. Prices, in 100-999 pc quantities, start at \$4.72 for the 74123N. Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, M/S 308, Dallas, Tex. 75222.

Circle 210 on Inquiry Card

## MONOLITHIC OP AMPS

Models AD502J and AD502K have superior input offset current and input bias current specifications when compared with the pin-equivalent 741. The max. offset current at 25°C is 12 nA for the AD502J and 4 nA for the AD502K. Max. bias current at 25°C is 25 nA and 7 nA respectively. The improvement in input specs comes from a combination of Darlington input circuitry, and stringent processing technology. Both amplifiers feature full short-circuit protection, internal compensation and a high common mode voltage range. Prices (1-24 pcs) are AD502J, \$6.80 and AD502KH, \$11.80. Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. 02142.

Circle 211 on Inquiry Card

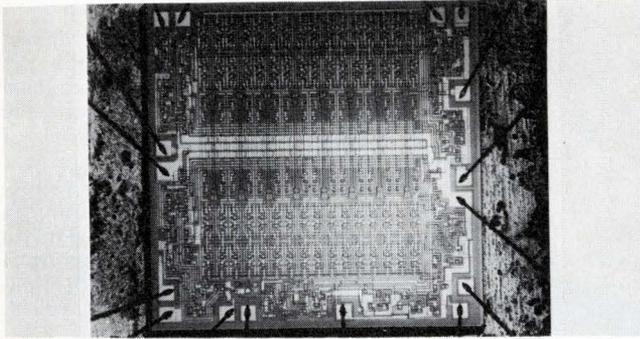
## C-MOS IN PLASTIC PACKAGES

The manufacturer has announced the availability of the cos/mos line of digital integrated circuits in plastic packages. The new CD4000E series contains 19 circuits including basic building blocks and MSI functions. Electrically, the plastic packaged COS/MOS circuits will have all the characteristic operating features of the CD4000 and CD4000D ceramic-packaged series except that the operating temperature range is -40 to 85°C and the quiescent power dissipation limits are slightly higher. RCA Commercial Engineering, Harrison, N.J. 07029. (201) 485-3900.

Circle 212 on Inquiry Card

## RANDOM ACCESS MEMORY

With 35 ns access.



The Model RAM-0064 uses Schottky clamped transistors to achieve high switching speeds. It is suitable for scratch pad memory applications and is organized as a 16-word by 4-bit array with full decoding. Power dissipation is 6 mW/bit. Other features include a single 5 V power supply, input and output voltages of 7 V, 16-pin dual in-line packaging, high-speed write operation with write pulse width of 25 ns, input currents of -1.6 mA and output current of 16 mA. Prices, in quan. of 100 to 999 are: \$25.60 for the 0 to 75°C unit and \$32.00 for the -55 to 125°C unit. Harris Semiconductor, Melbourne, Fla. 32901. (305) 727-5412.

Circle 220 on Inquiry Card

## LOW NOISE PREAMPLIFIER

The PA329 is designed for amplifying low level signals in a low noise application. It consists of two identically matched 86 dB gain amplifiers and features matched open loop voltage gain, low audio noise, and short circuit protected outputs. Applications include stereo tape players/recorders, dictating equipment, movie projectors, video preamplification, driver-post-amp for lossy networks and super gain cascaded amplifiers. Suggested price, \$3.42 ea. (100-999). General Electric Co., Northern Concourse Office Bldg., North Syracuse, N.Y. 13212. (315) 456-2396.

Circle 221 on Inquiry Card

## CUSTOM LSI CAPABILITY

The manufacturer says that the MOS Polycell LSI System can cut non-recurring costs in the design and production of custom MOS LSI arrays by 50% or more. The system provides custom design including logic verification, test sequence generation, chip layout, and artwork preparation. It uses a group of logic cells that are basic logic building blocks. Each cell represents the specific arrangement of diffusion and interconnections to perform a particular logic function. Technical Information Ctr., Motorola Semiconductor Products Inc., Box 20912, Phoenix, Ariz. 85036. (602) 273-6900.

Circle 222 on Inquiry Card

## MORE NEW MICROWORLD PRODUCTS

**TTL circuits.** Sprague adds a 4-bit register (US7494A) and a 4- to 10-line decoder (US7442A). Circle 213

**TTL buffers.** The SN54/7437 and 38, announced by Texas Instruments, are positive NAND buffers. Circle 214

**ROM.** The 8224 is a 256-bit read-only memory for alphabet code conversion. From Signetics. Circle 215

**TTL gates.** Fairchild has added two quad gate circuits (the 9014 and 9015) to its 9000 series. Circle 216

**Low-power MSI.** Advanced Micro Devices adds the 9200 series to its product line. Circle 217

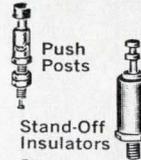
**More 741's.** Two more manufacturers have announced a line of 741-type op amps. Sprague, Circle 218

Analog Devices, Circle 219

# FOR EXCELLENCE IN TERMINATION HARDWARE SPECIFY GRAYHILL



Test Clips



Push Posts

Stand-Off Insulators



Binding Posts



Sockets



Plastic Molded Parts



### Test Clips

Adjustable tension, threaded studs or plug in bases, various sizes.

### Push Posts

Plunger action lets you connect and disconnect quickly and easily, assures positive contact.

### Binding Posts

Screw type or spring loaded, banana plug or stud mounting, single or multiple units, with various colors for circuit identification.

### Stand-Off Insulators

High dielectric strength, low loss insulation, low moisture absorption, various mounting styles.

### Sockets

Lamp or transistor, various colors, various mountings including printed circuit.

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Tight tolerances provide you with "assembly ready" units. Thermosetting plastics to meet most specifications.

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... the Difference Between Excellent and Adequate

Circle 34 on Inquiry Card



# New insulated leg

An exclusive design improvement for insulated feed-thru terminal blocks. Available in a variety of terminal pin and hardware configurations.

This is one of the many new products Kulka has for engineers who innovate. Kulka keeps up to date with new terminal block concepts, new designs, and new materials to meet every requirement. Send for the latest Kulka catalog. Kulka Electric Corp., 520 So. Fulton Ave., Mount Vernon, N.Y. 10551 or call (914) 664-4024.

A North American  
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# Kulka

Circle 35 on Inquiry Card



# ANNOUNCING TELEDYNE SEMICONDUCTOR'S DUAL MONOLITHIC N-CHANNEL FET

Teledyne's new monolithic FET with interlaced construction features matched parameter current performance for low noise, low leakage FET input op amps.

- High Common Mode Rejection Ratio-100 db
- Linear Temperature Track Trimming less than 3  $\mu$ A delta  $I_b$
- High Transconductance 1500  $\mu$ mhos at  $I_b = 200 \mu$ A
- Low Offset Voltage less than 5 mV
- Outstanding Temperature Tracking less than 10  $\mu$ V per  $^{\circ}$ C
- Standard 6 lead TO-18 Package
- High Device to Device Breakdown Voltage-75V.

In addition to these superior features, we offer you immediate delivery.

	Vgs 1-2 mV max	$\Delta$ Vgs 1-2 $\mu$ V/ $^{\circ}$ C max	$I_G$ pA max	CMRR* db
SU 2365A	5	10	20	100
SU 2366A	10	10	20	100
SU 2367A	10	25	20	100
SU 2368A	15	25	20	100
SU 2369A	20	40	20	100

\*Typical

**TELEDYNE FIELD SALES OFFICES:** Palo Alto, California (415) 321-4681 • Hawthorne, California (213) 772-4551 • Anaheim, California (714) 635-3171 • Dallas, Texas (214) 357-0259 • Des Plaines, Illinois (312) 299-6196 • Westwood, Massachusetts (617) 326-6600 • Lutherville, Maryland (301) 825-1920 • Little Falls, New Jersey (201) 256-8557 • Wappingers Falls, New York (914) 297-4316 • Winter Park, Florida (305) 647-7813 • Dayton, Ohio (513) 298-7207 • Liverpool, New York (315) 622-2021 • Wiesbaden, Germany 370243 • Hong Kong K 207764.

**TELEDYNE SEMICONDUCTOR** 1300 Terra Bella Ave., Mountain View, Calif. 94040 Phone (415) 968-9241 TWX: (910) 379-6494

## DRIVER AND FET SWITCHES

The D125BK is a 6-channel driver; the G115BK is a 6-channel MOS FET switch, and the G123BK is a 4-channel commutator. The driver performs the amplification and dc level shifting required between low-level logic and MOS FET switches. All of the multiple switches have integrated FET current-limiter elements to supply collector current to the drivers so no external components are required. Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 94054. (408) 246-8000.

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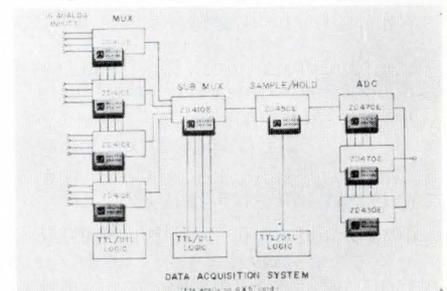
## TTL IC GATES

The SN54/7423 and SN54/7425 are dual 4-input positive NOR gates with separate strobe inputs. You can expand these gates by paralleling the expander inputs and outputs, or by using a SN54/7460 expander gate. In lots of 100-999, prices start at \$1.58 ea. Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741.

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## CONVERSION PRODUCTS

Complete except for power supply.



This line of hybrid conversion products consists of A/D and D/A converters, analog multiplexers, and sample-hold modules. Because of their compatible design, you can use them separately or combine them. All modules come in a 14-lead DIP with full TTL compatibility. Zeltex Inc., 1000 Chalmar Rd., Concord, Calif. 94520. (415) 686-6660.

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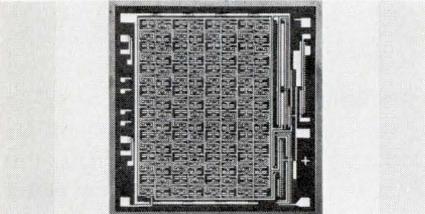
## ASSOCIATIVE MEMORY

The  $\mu$ L4102 signals a match whenever data at its inputs correspond to data already stored. The memory features a 35 ns access time and is organized into four 4-bit words, each with its own address line. Price is \$50 ea. in quan. of 100 to 999. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040. (415) 962-3563.

Circle 204 on Inquiry Card

### SHIFT REGISTER ARRAY

C/MOS device has 64 bits.



Model MS612 has serial input and serial output, and can operate from dc to 25 MHz. In the static mode, the array has less than  $1 \mu\text{A}$  current drain from 5 to 16 V. Other features include single clock input (input clock capacitance is 5 pF) and single power supply operation. Ragen Semiconductor, 53 S. Jefferson St., Whippany, N.J. 07981.

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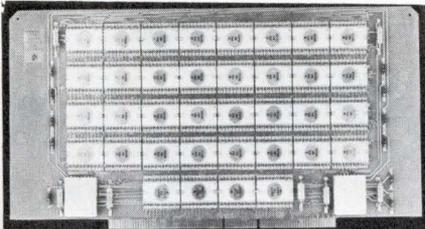
### EIGHT-BIT D/A CONVERTER

The MN302 comes complete with op amp output, switching network and precision resistors. The converter has an operating range of 0 to 70°C; slew rate of  $0.5 \text{ V}/\mu\text{s}$  max. and a temperature coefficient of  $\pm 10 \text{ ppm}/^\circ\text{C}$ . \$79.00 ea. (1-24 pcs). Micro Networks Corp., 5 Barbara Lane, Worcester, Mass. 01604. (617) 756-4635.

Circle 206 on Inquiry Card

### MEMORY SYSTEMS

With MOS/LSI components.



These units are available as read/write, read-only, or RAM/ROM combinations. The systems include clock drivers, decoders, and interface circuitry. Typical specs are 750 ns cycle time, 500 ns access time and 0.25 mW/bit power consumption. North American Rockwell Microelectronics Co., 3430 Miraloma Ave., Anaheim, Calif. 92803. (213) 647-5958.

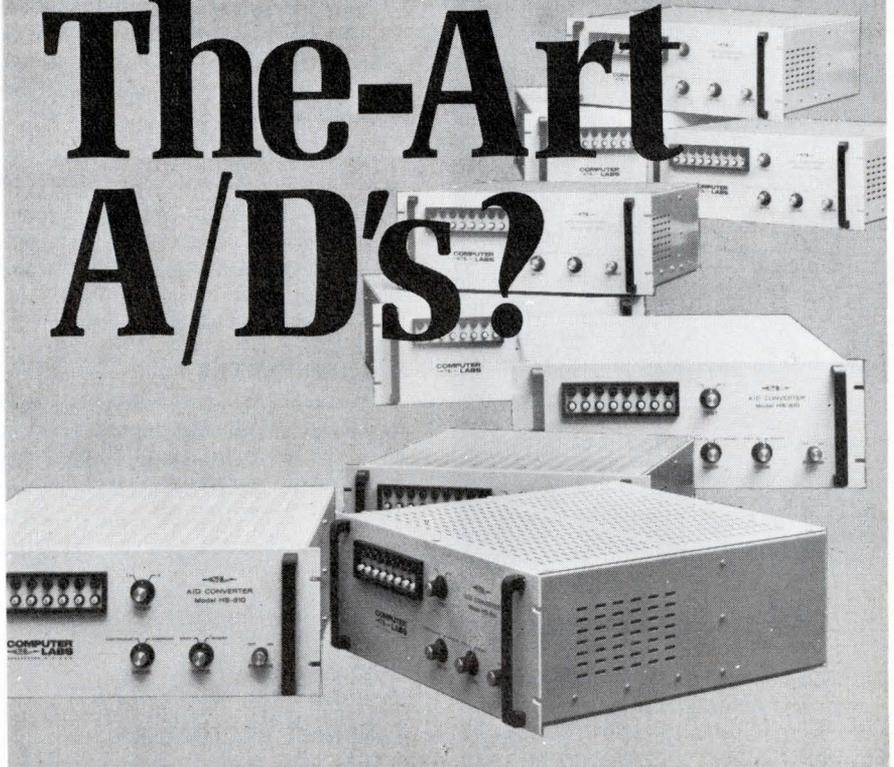
Circle 207 on Inquiry Card

### ANALOG MULTIPLIER

These multipliers are scaled for compatibility with commonly available op amps. Two versions are available, one with a 2% total accuracy and the other with 1%. Both come in epoxy (Model 4090) or a hermetic flat-pack (Model 4091). Prices start at \$45. Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706. (602) 294-1431.

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# Need State-Of- The-Art A/D's?



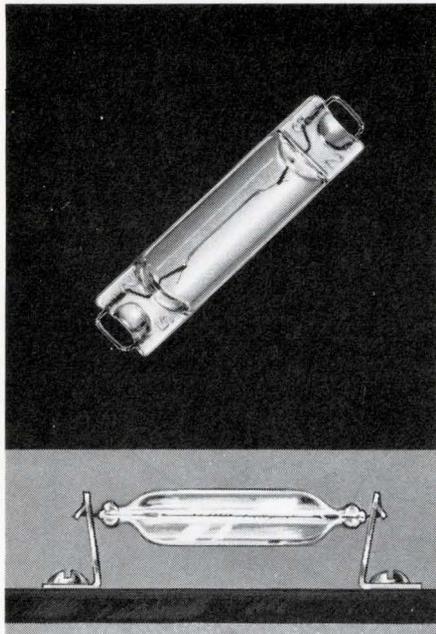
Computer Labs has delivered hundreds of analog-to-digital converters with 7-bit and 8-bit words at 10 MHz rates; or 4 bits at 25 MHz; or 9 bits at 5 MHz (and aperture time of 0.2 ns)! You can get yours with a matching D/A in 3-5 weeks.

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# Pulling down the cost of lighting up an instrument



For a high-reliability light source, the Tung-Sol baseless cartridge lamp is about as simple as you can get. Elimination of cemented-on bases removes two potential failure sources while lowering cost. There are no anchors to generate noise and no soldered connections. Design permits use of an inexpensive clip-type mounting bracket which achieves low silhouette. Can be supplied in 6 v. and 12 v. types. Complete information and application assistance available. Write for catalog A-21. Tung-Sol Division, Wagner Electric Corporation, 630 W. Mt. Pleasant Avenue, Livingston, N.J. 07039; TWX: 710-994-4865, Phone: (201) 992-1100; (212) 732-5426.

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# SYSTEMS

## OPERATIONS MONITOR



The AM-10 remote operations monitor is a low-speed digital data link for industrial telemetry uses. All logic and modems needed to transmit up to 100 channels of data are included. It also can be used as a 100-channel controller, or as a combination supervisory control/monitor system. \$860.00 terminal. Metric Systems Corp., 736 North Beal St., Fort Walton Beach, Fla. 32548. (904) 242-2111.

Circle 260 on Inquiry Card

## D/A CONVERTER

Dacpac™ MP1808 converter comes in all std. unipolar or bipolar 8 binary bit or 2 BCD digit configurations. Settling time to  $\pm 0.10\%$  F.S. accuracy is 5  $\mu$ s, with a TC of 100 ppm/°C. The DTL/TTL compatible unit has an output slew rate of 10V/ $\mu$ s and a 20 mA current capability. \$59.00 ea. Analogic Corp., Audubon Rd., Wakefield, Mass. 01880. (617) 246-0300.

Circle 261 on Inquiry Card

## CASSETTE RECORDERS

Three new digital cassette recorders provide error-free data registration for heavy bit density applications. Model 400T incremental recorder offers completely automatic interchangeable Baud rates of 110, 150 and 300. Model 205 synchronous recorder can store two million bits of information for <\$1000 unit price. Model 425 incremental block recorder features block recording of 16, 24 or 32 parallel data lines at 120 blocks/s. Mobark Instrument, Inc., 1038 West Evelyn Ave., Sunnyvale, Calif. 94086.

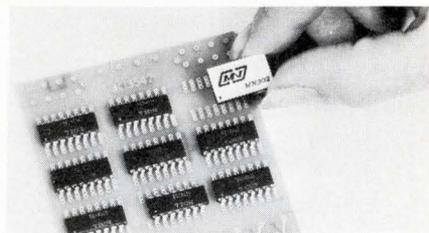
Circle 262 on Inquiry Card

## CORE MEMORY SYSTEMS

New series of 35 memory systems offer storage capabilities from 4 k x 20 to 8 k x 10 bits and feature a 1  $\mu$ s full cycle time. Access time is 390 ns. The FI-4 systems use TTL circuits and Si semiconductors. Construction is 3D, 3 wire organization using 18 mil low TC cores. \$2000. Ferroxcube Corp., Saugerties, N.Y. (914) 246-2811.

Circle 263 on Inquiry Card

## DIL-COMPATIBLE CONVERTER



Packaged for use with std. 30 mil DIL sockets and common PCB layouts, this 8-bit D/A converter features low power consumption and TTL compatibility. The MN302 comes complete with op amp output, switching network and precision resistors. \$79 (1-24)—\$53 (100 quan.). Micro Networks Corp., 5 Barbara La., Worcester, Mass. 01604. (617) 756-4635.

Circle 264 on Inquiry Card

## STORAGE TUBE

Images can be held for more than a week with the beam turned off in this 1.5 in. dia. tube. The SP5105 uses a monolithic-silicon-array target which provides resolution better than 1,000 lines, and retention times of over 12 min. for gray scale and over 1 h. for black and white. Sylvania Electric Products Inc., 730 Third Ave., N.Y. 10017.

Circle 265 on Inquiry Card

## DESK TOP COMPUTER



Printed tape output is a feature of this computer. It has a programming capability of 256 steps, a dynamic range of  $10^{-99}$  to  $10^{99}$ , and it can be programmed for 85% of commonly encountered technical, engineering and scientific computations. Eugene Dietzgen Co., 2425 N. Sheffield Ave., Chicago, Ill. 60614. (312) 549-3300.

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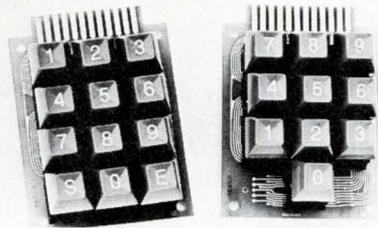
## VOICE RESPONSE UNIT

Model 3100 is a 32 track hard mounted head per track magnetic analog memory. It provides parallel output of 31 pre-recorded spoken words of 500 to 600 ms duration at a 0 dB level. Metrolab, Inc., 10457 Roselle St., San Diego, Calif. 92121. (714) 453-2741.

Circle 267 on Inquiry Card

The Electronic Engineer • Nov. 1970

## KEYBOARD MODULES



Keyswitch modules of the Mercutronic Coding Keyboard are now available mounted on a fiberglass PCB. Operation is the same as earlier models, but the keyswitches are fastened to the PCB with screws, allowing greater flexibility. Generally, a keyboard mounted on a PCB costs 5—10% less (in prod. quan.) than the equivalent keyboard in a metal extrusion. Mechanical Enterprises, Inc., 5249 Duke St., Alexandria, Va. 22304.

Circle 268 on Inquiry Card

## BATCH FABRICATED MEMORY

Designed for main frame memory applications, with cycle times of <100ns for an 8k-bit array, this memory is non-volatile and 100% redundant. Each bit is composed of two "flux rings," which are thick film permalloy elements with flux closure paths in the same plane. Packing density is 32k-bits in a 4 in. square. Cost of undecoded 8k-bit arrays is 0.7-1c/bit. Fully decoded modules of up to 512k-bits will cost 3-4c/bit. Memory can be organized as 2D or 2½D. Signal Galaxies, 6955 Hayvenhurst Ave., Van Nuys, Calif., 91311.

Circle 269 on Inquiry Card

## 9-BIT D/A CONVERTER

New 9-bit D/A converter operates "glitch-free" at speeds up to 1 million conversions/s. Settling time is typ. 500 ns. Full scale output of the Model 6439 is  $\pm 10$  V into a 2 k $\Omega$  load. Parallel TTL outputs are included for special interface requirements. \$350.00. Data Technology Corp., 1050 East Meadow Circle, Palo Alto, Calif. 94303. (415) 321-0551.

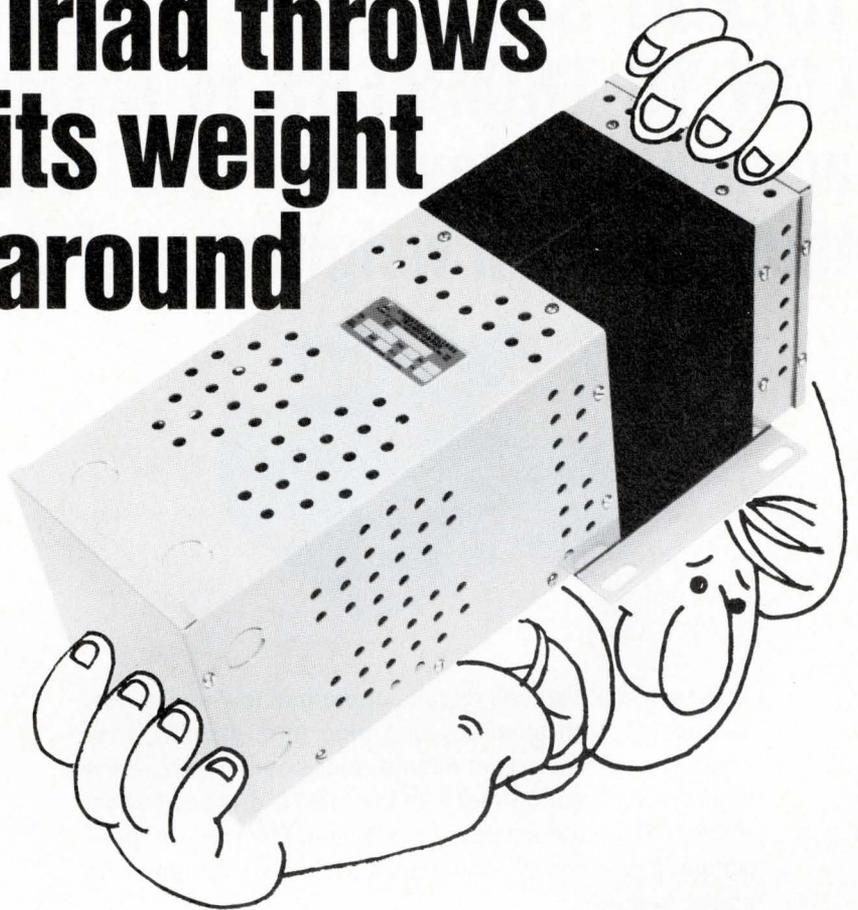
Circle 270 on Inquiry Card

## CORE MEMORY

This 3-wire, 3D system combines performance of 2½D with dependability and cost of a 3D system. The Nano-memory 4850 has a 850 ns full cycle time and 350 ns access time. About \$0.3 to \$0.4/bit in large capacities. Electronic Memories, 12621 Chadron Ave., Hawthorne, Calif. 90250. (213) 772-5201.

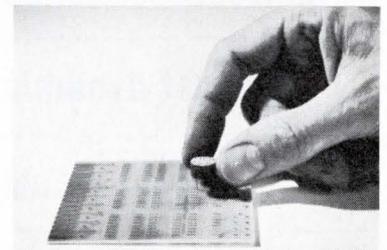
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# Triad throws its weight around



This hunk of transformer is the Triad K-106 voltage stabilizer rated at 1 KVA and weighing 60 lbs. Others in the series are rated from 50 to 750 va. They allow you to hold output voltage constant within 1% of nominal voltage when the input is varied as much as 15% from nominal. Sometimes only a "block-buster" will do the job. Triad has step-down autoformers rated up to 2000 va., universal rectifier powers rated up to 20 amps, and isolation transformers rated up to 1000 va. — all big, rugged and built to last.

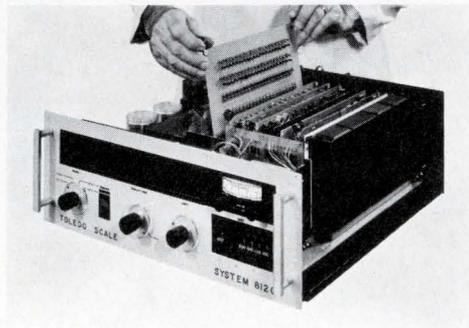
Triad makes the miniature, too. Subminiature toroidal inductors, designed for easy printed circuit board mounting, are stocked in 28 ratings from 50 micro-henries to 400 milli-henries. Triad's Red Spec transistor audio transformers and chokes are in epoxy molded cases with base dimensions of only .310 by .410 inches. Open-type miniatures in a wide range of ratings, mounting types and sizes are in stock.



Call your nearest Triad distributor before you get in a bind on custom-designed components. He has hundreds of items in stock—many in depth for your production requirements. And—we back him up with quick service from our main plant here in Huntington, or from complete warehouse stocks in Venice, California, and Dallas, Texas. Get the Triad catalog today. Triad Distributor Division, 305 North Briant Street, Huntington, Indiana 46750.

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# SOFTWARE

## TIME-SHARING SOFTWARE

New, advanced time sharing operating system is available to users of RCA's medium-scale Spectra 70/46 remote computing systems. An expanded version will be made available to users of the larger Spectra 70/61 systems later this year. TSOS-Version 6 is an efficient operating system for simultaneous local and remote batch, interactive and transaction data processing. RCA News & Information, Cherry Hill, N.J. 08034. (609) 963-8000.

Circle 272 on Inquiry Card

## MINICOMPUTER AID

Quickflow assists in the generation and maintenance of software documentation. Written in ASA FORTRAN for ease of use on a variety of computers, it recognizes special comment cards in the program deck and creates flow charts of the program on the output printer. \$200.00. Compata, Inc., 18345 Ventura Blvd., Tarzana, Calif. 91356. (213) 881-4000.

Circle 273 on Inquiry Card

## CIRCUIT ANALYSIS

Non-linear dc circuit analysis design program (RELCAP) analyzes and evaluates circuit design validity. The time-shared, direct-access program was implemented on the DCS/XDS expanded Sigma 7 system. It can handle up to 70 nodes, 160 branches, and 225 component parts. Davis Computer Systems, Inc. 280 Park Ave., New York, N.Y. 10017. (212) 867-6406.

Circle 274 on Inquiry Card

## OPTIMIZATION PROGRAMS

ALPAC is a completely integrated set of optimization programs which provide for the complete solution of linear or non-linear parameter optimization problems. Eight non-linear parameter optimization algorithms are available. Electronic Associates, Inc., West Long Branch, N.J. 07740. (201) 229-1100.

Circle 275 on Inquiry Card

## CIRCUIT ANALYSIS TOOL

LCAP (Linear Circuit Analysis Program) is a completely user oriented circuit analysis tool, and is able to perform ac and dc analysis of a circuit in the same program from the same file. It accommodates circuits of up to 100 nodes and 400 branches. On-Line Systems, Inc., 60 E. 42nd St., New York, N.Y. 10017. (212) 661-1412.

Circle 276 on Inquiry Card

The Electronic Engineer • Nov. 1970

# ABSTRACTS

**Published information is vital to your job. To save time in finding this information, we have abstracted the important technical features from eight electronic engineering publications. Should any of these articles interest you, contact the magazine. Reprints of articles with an asterisk are available free. Save this section for future reference.**

## Amplifiers

**Precision on amps can be wasted**, Robert Demrow, Analog Devices, Inc., "Electronic Design," Vol. 18, No. 19, Sept. 13, 1970, pp. 94-97. This is the second and final part of a two-part article. Almost all op amp circuits are variations of the basic inverting or noninverting configurations, so it is not difficult to choose the correct one. This article discusses the matching of op amps to the circuit application at hand.

## Circuit Design

**Feedback analysis can be speeded**, Vasil Uzunoglu, Allied Research Associates, Inc., "Electronic Design," Vol. 18, No. 19, Sept. 13, 1970, pp. 84-88. The critical factor in analyzing feedback networks is the driving-point impedance. The use of Blackman's and Bode's formulas are suggested as replacements for classical loop equations. They are easier to use and provide more information. A comparison of classical methods, Blackman's approach, and Bode's approach is given. Networks with multiple feedback paths are included.

**Sequential contacting extends range of variable capacitor**, John Fabricius and John Maher, Sprague Electric Co., "Electronics," Vol. 43, No. 19, Sept. 14, 1970, pp. 108-112. This article describes a new approach to getting a large capacity range into a small variable capacitor. Circuit applications for this new product are discussed and described.

**Laser diodes need high-current drivers**, Raymond Hunt Sr., Monsanto Company, "Electronic Design," Vol. 18, No. 20, Sept. 27, 1970, pp. 50-51. Careful circuit layouts that keep lead lengths short and stray capacitance minimized are needed in designing a high-current pulser. Designs using avalanche transistors and silicon-controlled rectifiers (SCRs) are described. The SCRs are recommended for circuits requiring the highest currents. A circuit with a pulse rate of 50Hz produces 40A pulses of 180ns duration.

## Components

**\*Optoelectronics course, Part 3A**, Jack Hickey, Managing Editor, "The Electronic Engineer," Vol. 29, No. 10, Oct. 1970, pp. 59-63. By providing you with applications for optoelectronic devices, this course goes one step further than most. The applications are kept to simple ideas so that you can gain the concept without getting lost in circuit details. By looking at the various ideas suggested you just might come across an idea you can use.

## Computers and Peripherals

**Positive and negative logic**, Victor Ellins, Sylvania Electronic Systems, "Computer Design," Vol. 9, No. 9, Sept. 1970, pp. 79-84. What is the difference between positive and negative logic? How do I switch from one to the other? What advantage is there to using the guidelines called out in Mil-Std-806? The author answers these pertinent questions, identifying the distinction between positive and negative logic and presenting five theorems which let you manipulate easily between positive and negative logic systems.

**The advanced avionic digital computer system**, Ronald S. Entner, Naval Air Systems Command, "Computer Design," Vol. 9, No. 9, Sept. 1970, pp. 73-76. This fourth-generation computer will combine many of the most advanced hardware and software concepts now under development. The AADC is a modular computer concept designed to meet 1975-1985 Naval airborne data processing requirements. This approach uses old and new technologies to create a cost-effective, integrated system capability based on the concepts of functional and byte-functional modularity.

## Digital Design

**Be logical—consider unfamiliar gating**, Gilbert Starr, QED Systems Inc., "Electronic Design," Vol. 18, No. 19, Sept. 13, 1970, pp. 90-91. AND/OR and OR/AND two-state logic are familiar to most. There are eight canonical, nondegenerate, gate combinations of two-state logic, and the designer who considers all of them may find additional design options and save money. All are interchangeable.

**Universal LSI package for implementing control logic functions**, Oscar Lowenschuss, Raytheon Co., "Computer Design," Vol. 9, No. 9, Sept. 1970, pp. 67-70. You can use a single-package type to implement any possible control logic function. It can be built in LSI logic using today's technology. It's faster and more convenient than control memories and it's easy to use as it reduces interconnection complexity.

**Binary-to-BCD conversion with complex IC functions**, John R. Linford, Motorola Semiconductor Products Inc., "Computer Design," Vol. 9, No. 9, Sept. 1970, pp. 53-61. Four methods of converting from the binary to the BCD code are discussed and compared in this article. All four offer you a tradeoff in speed versus package count. The cost of conversion is reduced by complex function ICs.

## Integrated Circuits

**\*Hybrid resistor trimming: an industry report**, Stephen A. Thompson, Western Editor—Los Angeles, "The Electronic Engineer," Vol. 29, No. 10, Oct. 1970, pp. 48-55. Trimming hybrid resistors is the domain of air abrasive systems right now. But there is a challenge on the horizon in laser trimmers. Steve Thompson looks at both methods in this article and includes comments from typical users throughout the country.

**\*What's your MOS IQ?** Arthur J. Boyle, Technical Editor, "The Electronic Engineer," Vol. 29, No. 11, Nov. 1970. Here's a complete exam on all aspects of MOS technology covered in the previous installments of this very popular course. From design to testing, the reader may test his knowledge and receive a certificate if he passes.

**\*Testing MOS, the how and why**, Ron Danklefs, Redcor Corp., "The Electronic Engineer," Vol. 29, No. 10, Oct. 1970, pp. 41-46. The new generation of complex MOS integrated circuits has brought with it a new generation of testing problems. This article describes what's involved in testing the new MOS circuits.

**Three-state switching brings wired OR to TTL**, John Sheets, National Semiconductor Corp., "Electronics," Vol. 43, No. 19, Sept. 14, 1970, pp. 78-84. A problem with TTL circuits has been their inability to take advantage of a common bus system in computers. Every other major sub-assembly could communicate with all others, but TTL required a modification which affected the system's speed advantage. A new form of TTL permits them to be disconnected electronically from the bus, eliminating short circuit problems that prevailed before.

**Saturating operational amplifiers add up to a simple way to compress ac signals over many decades**, Melvyn G. Morris, National Semiconductor Corp., "Electronics," Vol. 43, No. 19, Sept. 14, 1970, pp. 105-107. Connecting several operational amplifiers in cascade, they saturate one after the other as the amplitude increases. Then, as the outputs are summed, a logarithmic version of the input ac signal is produced. This method offers a simple, inexpensive way to handle a wide range of ac signals and compress several decades.

## Miscellaneous

**Solid-state relays come on strong**, Robert E. Koeper, Managing Editor, "EDN," Vol. 15, No. 15, Aug. 1, 1970, pp. 25-36. Mr. Koeper points out that recent developments in solid-state relays mean that you can no longer think of such relays only in terms of direct replacements for electromechanical types. But even though the solid-state relay has come into its own, the greatest emphasis is still on custom products, with hybrid relays very popular for their lower cost and greater input/output isolation than all-solid-state types. The author briefly discusses the capabilities of various types of solid-state relays, and concludes the article with a tabulation, by maker, of available relays and their specifications.

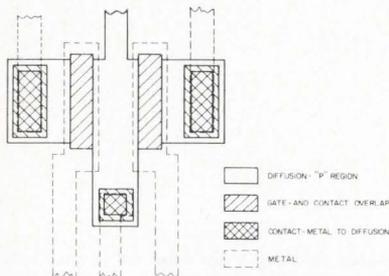
**Shift phase independent of frequency**, Frederick Shirley, Sanders Associates, "Electronic Design," Vol. 18, No. 18, September 1, 1970, pp. 62-66. By placing a zero in the right half of the complex frequency plane for each pole in the left half-plane, a pair of non-minimum-phase networks with the same input can provide a 90-degree phase difference between their outputs. A BASIC program for computing the component values for a four-pole phase shifter is included.

**Generate functions from discrete data**, H. Schmid & D. Busch, General Electric Co., "Electronic Design," Vol. 18, No. 20, Sept. 27, 1970, pp. 42-47. Generating arbitrary functions of one or two variables poses accuracy and complexity problems. The author's method uses a read-only memory to store discrete values of the function, and time-averaging interpolation to construct straightline segments between data points. Memory size determines if one or two variables can be handled. Several timing and block diagrams accompany the article.

# LITERATURE

## MOS/LSI arrays

Computer-aided design of MOS/LSI arrays is the topic of this 12-page brochure. This system transforms the logic design of an equipment into a set of glass master plates, the production tool-



Cell of standard logic circuit

ing for the manufacture of MOS/LSI arrays. The method is carefully explained to you in this booklet and illustrated with logic diagrams, program printouts, and plots. Micro-Design Inc., 1055 First St., Rockville, Md. 20850.

Circle 426 on Inquiry Card

## Ceramic chip capacitors

Monolithic ceramic chip capacitors and discoidal feed-throughs for use in the hybrid, high voltage, and RFI/EMI filter industries are described in a 6-page brochure. A handy reference chart shows actual physical chip sizes as well as dimensions and maximum capacitance values available. A page of graphs of typical characteristic curves illustrates capacitor changes and dissipation factors. Monolithic Dielectrics Inc., Box 647, Burbank, Calif. 91503.

Circle 427 on Inquiry Card

## Optoelectronic devices

Photodiodes, phototransistors, and photovoltaic cells are described in this 8-page brochure. Photos and charts provide dimensions and performance data, while specs are provided individually for each product version in a table of product types. Siemens Corp., 186 Wood Ave. S., Iselin, N.J. 08830.

Circle 428 on Inquiry Card

## Electronic components

Electronic components are offered to you at below manufacturers' prices in this 24-page wholesale components catalog. You'll find bargains on resistors, capacitors, relays, switches, and transformers, to name a few. Parameters are listed in chart form along with the manufacturer and price. Hazelton Scientific Co., Box 163, Hazel Park, Mich. 48030.

Circle 429 on Inquiry Card

## Memory product summary

All standard ferrite cores, commercial and military stacks, and systems produced by this company are described in a short-form catalog. You'll find information on core memory products and systems for electronic data processing, industrial control, and aerospace applications. Electronic Memories, 12621 Chaldron Ave., Hawthorne, Calif.

Circle 430 on Inquiry Card

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**get clickless switching and 1,000,000,000  $\Omega$  isolation.**

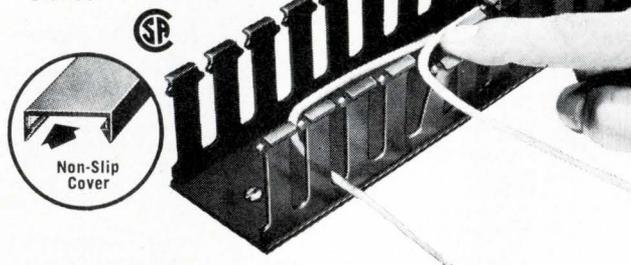
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Circle 42 on Inquiry Card

### Optical electronics

All standard products and their guaranteed specs are listed in this company's 24-page product catalog. Included in the product listings are op amps, current boosters and voltage followers, non-linear function modules, analog memories, analog multipliers, and hybrid analog/digital interface circuits. Optical Electronics Inc., Box 11140, Tucson, Ariz. 85706.

Circle 431 on Inquiry Card

### Magnetic components

Pulse transformers, SCR trigger transformers, delay lines, and inverter transformers are discussed in this 6-page short form catalog. Full specs, termination and schematic drawings, and outline dimensional drawings are included, and a one-page application guide gives you 36 specific applications for these products. Pulse Engineering Inc., Box 12235, San Diego, Calif. 92112.

Circle 432 on Inquiry Card

### Card selection guide

A reference source is available to design engineers and technicians who are seeking information on a line of logic cards and accessories. The 12-page guide lists applications and power requirements for DTL, TTL and analog (A/D, D/A, sample and hold, and multiplier) cards. Complementary hardware and accessories data is also included. Data Technology Corp., 1050 E. Meadow Circle, Palo Alto, Calif. 94303.

Circle 433 on Inquiry Card

### Copper-resin system

"Con-Cu-Bind" is the name of the new conductive copper-resin system, displayed in this technical data sheet. The sheet discusses wet properties, curing, and typical properties of a cured system. Application information is also provided. Conshohocken Chemicals Inc., 8 Rodney Rd., Rosemont, Pa. 19010.

Circle 434 on Inquiry Card

### Philosophy and design of MSI

That's the title of a 12-page paper which discusses standard MSI circuits from the standpoint of philosophy, logic design, semiconductor processing, and packaging constraints. Special attention is given to 30 digital functions, and the commentary concludes with the advantages of MSI building blocks and their use in typical applications. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif.

Circle 435 on Inquiry Card

### Speedy D/A converter

An ultra-fast D/A converter, whose 40-ns settling time to 0.05% accuracy makes it industry's fastest 10-bit D/A modular type, is described in a new application note. Applications for the converter are contained in the data sheet as are salient features, specs, and schematics. Analog Devices Inc., Pastoriza Div., 221 5th St., Cambridge, Mass. 02142.

Circle 436 on Inquiry Card



## Working with low voltages and currents?

# dirty contacts degrade performance

The smallest bit of dirt, the thinnest grease film, can seriously impair the performance of low power circuitry. MS-230 Contact Re-Nu is the ideal cleaner for switches, relays, connectors, indicator light bases and sockets . . . wherever dirt can introduce an unwanted resistance. Try it.

Price: \$2.65/can in cartons of 12 16-oz. cans.

Trial order: 4 cans @ \$3.75/can.

Prices f.o.b. Los Angeles, Chicago or Danbury, Conn.



**miller-stephenson chemical co., inc.**

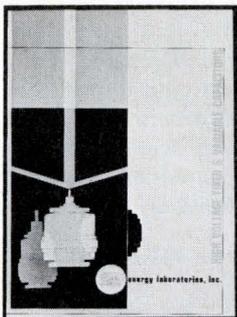
ROUTE 7, DANBURY, CONNECTICUT 06810



# How to put GE SSL's to work.

## High voltage capacitors

A new line of high voltage, fixed, and variable gas dielectric capacitors, with voltage ratings of 20 kV peak and capacitance ranges to 3000 pF are discussed in a comprehensive 48-



page. Included in the listing is a chart which gives type numbers that are interchangeable with vacuum-type capacitors. Special applications are also covered. Energy Labs., Inc., 58-09 32nd Ave., Woodside, N.Y. 11377.

Circle 442 on Inquiry Card

## Clad metal strip

Econ-o-clad, a metallurgical clad metal, offering solutions to design problems which can't be handled with a single metal or alloy, is discussed in a 27-pager. Econ-o-clad is primarily used for those jobs that require low cost and also to obtain properties not obtainable in a single metal. Salient features of the material are discussed as are physical, mechanical and thermal properties. A chart listing properties of commonly used metals and alloys is also provided. D. E. Makepeace, Div. of Engelhard Industries, Pine & Dunham Sts., Attleboro, Mass. 02703.

Circle 443 on Inquiry Card

## Laser calculator

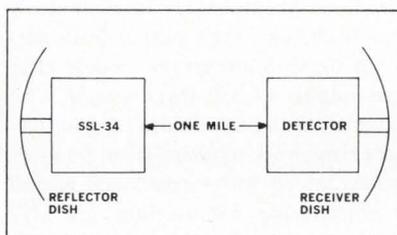
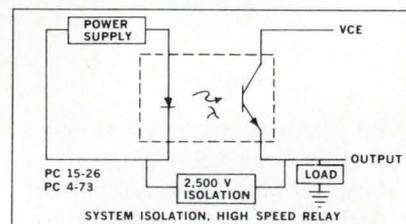
Quick computation of laser parameters is now possible. Sylvania is offering a calculator containing eight slide charts that will aid you in the calculation of average power, energy per pulse, Brewster angle, and diffraction limited resolution angle. Converting wavelengths into wave numbers, frequency, and energy per photon in electron volts and joules is also possible with the calculator. A chart is included too which gives wavelengths emitted by a variety of currently available lasers. Available on company letterhead from: Electro Optics Marketing Dept., Sylvania Electric Systems, Box 188, Mountain View, Calif. 94040.

At General Electric, we make a dozen solid state lamp products (previously called light emitting diodes). All of them tiny. All super-tough. All withstand shock and vibration far better than any incandescent lamp. So they last far longer. And practically eliminate your maintenance problems.

But probably one of the nicest things about them from your point of view is that there are so many ways you can profitably use them.

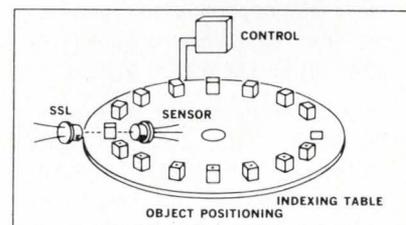
**Indication:** If you want to be *positive* that your system is working, use GE's red SSL-22 indicator light. Now in use as on-off indicators, on maintenance panels and for information displays. Or use GE's green SSL-3 as an indicator, or for film marking.

**Isolation:** For electrical isolation and high-speed switching, we have delivery-ready stocks of two photon couplers. The PC4-73 has the highest transfer ratio (125%) of any coupler on the market. Both PC4-73 and PC15-26 will isolate up to 2,500 volts.



**Communication:** GE's SSL-34 has successfully transmitted (FM modulation, 10.7 MHz subcarrier, 2W transmitter) infrared signals *over a mile* through fog, rain and snow. Several of GE's infrared SSL's, operative in D.C. or pulsed modes, can be used in data transmission, communication links and remote telemetry applications.

**Detection:** Eight different GE SSL lamps are already designed into detection systems, such as level indicators, indexing tables, intrusion alarms, choppers, smoke detectors, size monitors, card and tape readers and for edge tracking.



We'll be happy to send you free technical information on all of our SSL products. Or, for \$2.00, we'll send you the most complete SSL manual available. Covers theory, characteristics and applications, with 108 pages of diagrams and circuits.

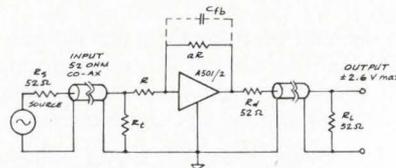
General Electric Company, Miniature Lamp Department, M-EE, Nela Park, Cleveland, Ohio 44112.

GENERAL  ELECTRIC

# LITERATURE

## Op amps for analog circuitry

The practical and theoretical considerations needed to apply wideband op amps to high-speed analog circuitry are outlined in a 12-page brochure. Titled "Design Guide For Wideband Op Amps," the manual discusses basic design theory and key parameters of wideband amps, and includes user information about the company's own models.



Applications in which such amplifiers have been used successfully are described. Intended as a source for engineers involved in the design of high-speed analog circuitry, the literature includes schematics. Intronic, 57 Chapel St., Newton, Mass. 02158.

Circle 444 on Inquiry Card

## Push/pull solenoids

Conical and flat-face solenoids, designed for short, high force strokes and fast response, are discussed in a 26-pager. Ranging in sizes from 3/4 in. diameter x 1/2 in. height to 2 1/4 in. diameter x 1 1/3 in. height, their output force surges up to 85 lbs (custom models offer force outputs of 350 lbs). A section on fundamentals of solenoids, covering engineering and application considerations, along with circuits and graphs for simplifying calculations are also provided. Ledex Div., Ledex Inc., 123 Webster St., Dayton, Ohio 45401.

Circle 445 on Inquiry Card

## Industrial catalog

A new industrial controls catalog explains the 2TI system, a line of relay and solid state components designed to bridge the interface between solid state low level logic and inductive loads on a machine or other systems involving inductive loads. The components can directly replace existing industrial type relays. This system eliminates line transients and arcing caused by contact switching of across the line loads. The result is an increase in life and reliability over equivalent systems. Metals & Controls Inc., Div. of Texas Instruments Inc., 34 Forest St., Attleboro, Mass. 02703.

Circle 446 on Inquiry Card

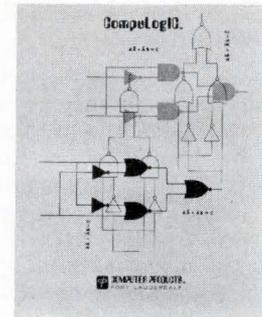
## Digital switch module

Here is a digital switch module conceived primarily as a keyboard switch. Each switch produces a one-shot, millisecond, pulsed output when the switch button is depressed to the trip point. And the switch output is virtually bounce-free. The pulse is always stabilized in less than 100 ns after first contact make resulting in a greater than 10,000 to 1 signal/noise ratio. This 4-page brochure is brought to you by Uni-max Switch Corp., Wallingford, Conn. 06492.

Circle 447 on Inquiry Card

## Circuit modules

New models of plug-in circuit modules, which feature low cost, compact size, high-noise immunity, and low-power requirements, are outlined in a new product folder. Electrical and mechanical specs for the series of modules which



comprise a family of monolithic 930 DTL integrated logic circuits are included in the description. Salient characteristics of the modules include positive logic NAND based circuits which contain two hermetically sealed 14 pin dual in-line elements and a power supply decoupling circuit. Computer Products, 1400 N.W. 70th St., Fort Lauderdale, Fla. 33307.

Circle 448 on Inquiry Card

## Electronic test equipment

Over 5,000 items of electronic test equipment are listed in this 64-page catalog. All equipment is listed under its manufacturer and companies are arranged in alphabetical order. Extra sections are devoted to wave guide and coaxial components, power supplies, and meters. Unless noted, all test equipment is used, reconditioned, and checked in their labs, and 100% guaranteed. Baynton Electronics Corp., 2709 N. Broad St., Philadelphia, Pa. 19132.

Circle 449 on Inquiry Card



## MICRO/PLOTTER

For fully automatic drafting and plotting, the Micro/Plotter is now interfaced with a high-speed, 2-axis control featuring a 300cps optical reader, selectable speeds to 240 ipm, 2-axis digital position display and an 8-channel, variable-block, word-address programming system. Rectilinear and 45° motions are programmed directly. Curved lines and arbitrary slopes are automatically computed and incrementally introduced. The NC-Micro/Plotter control system employs solid state, TTL circuitry. Remote input mode selector permits direct pulse input from data lines, computers or other digital information sources.

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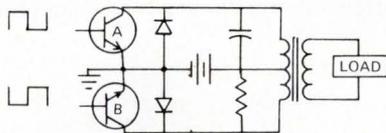
### Thermoplastic resins

A comprehensive 54-page design manual is devoted to Noryl thermoplastic resins. Prepared as an aid to design engineers, the catalog discusses the development of the resin, bridging the price/performance gap between ABS and acetal, nylon and polycarbonate. Charts, tables and diagrams illustrate the resin's properties, load considerations and structural design, design considerations, assembly techniques, and machining techniques. A foldout section at the end of the guide provides an easy reference for formula notations. Plastics Dept., General Electric, Noryl Ave., Selkirk, N.Y. 12158.

Circle 450 on Inquiry Card

### Class S amplifiers

Class S kilowatt amplifiers in which the transistors act as switches at the signal frequency are the subject of a 4-page technical memo. The memo illustrates



typical circuits and discusses the behavior of the amps with reactive loads. Among the topics covered are efficiency, power control, inductive loads, current and voltage spikes, and alternative circuits. Instruments Inc., Box 10764, 3434 Midway Dr., San Diego, Calif. 92110.

Circle 451 on Inquiry Card

### Logicware

Hardware, software, and wiring service for plug-in dual-in-line ICs are the topics of this 32-page catalog. You supply a logic diagram (and it need only be a free-hand sketch) and this company handles all the work from a computer check of the logic diagram to final hardware automatically wire-wrapped. Hardware includes modular frames, drawers, connectors, power supplies, and numerous circuit boards. Software covers computer print-outs of potential problems, IC type lists, pin assignment lists, wire or string lists, and hardware assembly forms. Electronic Engineering Co. of Calif., 1601 E. Chestnut Ave., Santa Ana, Calif. 92701.

Circle 452 on Inquiry Card



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the same day you ask?**

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Custom Electronics' exclusive dedication to the development and production of Reconstituted Mica Capacitors has made it a foremost authority in capacitor design and applicability. On the strength of this specialized experience, Custom can deliver capacitor designs and job quotes within hours of your inquiry. And designs for high reliability in applications above 1KV are continually improving at Custom Electronics, which means you can save time by consulting us from the beginning of your design project.

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Call Custom Electronics, Inc. with your capacitor design problem!



The QC Fanatics

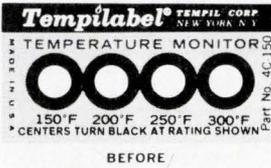
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For descriptive literature and a sample Tempilabel<sup>o</sup> for evaluation . . . (please state temperature range of interest).

Write to: SPECIAL APPLICATIONS DIVISION



Circle 48 on Inquiry Card

# LITERATURE

## Electronic components

A 1970 guidebook of electromechanical components and equipment introduces a transducer selection guide in its pages. The new feature describes popular types, functions, and applications for transducers and has been



added to the guidebook to aid engineers in selecting listed pressure and position transducers, accelerometers and load cells. The 100-pager is sectioned into counters, flow meters, precision pots, servo mechanisms, test equipment, and timers. Available from Electronics Div., American Relays, 39 Lispenard St., New York, N.Y. 10013.

Circle 453 on Inquiry Card

## Data entry keyboards

This group of data sheets explains an electronic data entry keyboard. The first describes the keyboard's best features—a new key with tactile feel, a keyboard that eliminates contact bounce. The next 4-page bulletin gives complete specs—standard keyboard configurations, key and assignment chart, enclosure details, etc. Then a 7-page report gives you preliminary instructions, carefully outlined and illustrated. Cherry Electrical Products Corp., 3600 Sunset Ave., Waukegan, Ill. 60085.

Circle 454 on Inquiry Card

## Circuit component patterns

Reporting on the results of a pre-production test on this company's "circuit zap" boards, this technical bulletin explains the testing of pre-etched, pressure-sensitive, copper circuit component patterns, pads, and conductor paths by an approved Defense Electronics Supply Center Lab. The result—"circuit zaps" are suitable for uses under all conditions requiring compliance with Mil standards. Bishop Graphics Inc., 7300 Radford Ave., North Hollywood, Calif. 91605.

Circle 455 on Inquiry Card

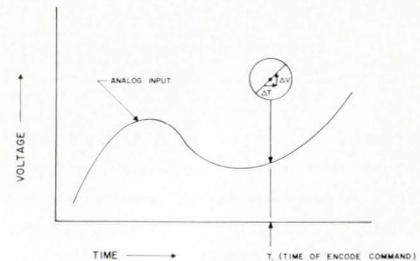
## Digital computer

The "other computer company" is offering a booklet describing their general-purpose digital computer, designated the H316. The 16-bit system is a full-scale digital computer with 72 commands, 1.6- $\mu$ s memory cycle time, and memory size of 4K, expandable to 16K. Applications for the system are covered, as is mode of operation and salient operating characteristics. Instructions for operating the machine are provided, too, as is a list of available software. Available from Honeywell, Computer Controls Div., Old Connecticut Path, Framingham, Mass. 01701.

Circle 456 on Inquiry Card

## Introduction to A/D converters

After reading this 24-page catalog you'll be familiar with the essential details of A/D converters. Four sections cover everything from the basics of A/D converters and codes used by A/D converters to errors in the conversion process



and typical applications. Section three, for instance, carefully explains digital, analog, and aperture error, why these errors exist, and how they are controlled. Applications include color television signals, pulse contour measurements, and time compression and expansion. Computer Labs Inc., 1109 S. Chapman St., Greensboro, N.C. 27403.

Circle 457 on Inquiry Card

## Multilayer ceramic capacitors

This 28-page catalog opens with a full-color diagram of chip construction, followed by descriptions of the various capacitor types available from this company. Then you're given product application notes, and performance data for the materials used in construction. Each capacitor type is then detailed in its own chart, providing specs, ordering information, dimensions, and availability data. Illinois Tool Works Inc., 11620 Sorrento Valley Rd., San Diego, Calif. 92121.

Circle 458 on Inquiry Card

The Electronic Engineer • Nov. 1970



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The tape recorder is operating in a dry bath of Fluorinert® Brand Electronic Liquids. Just as your electronic and microelectronic units will.

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do not react with even the most sensitive of materials. They won't deteriorate with use.

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The coupon will bring you copies of both Mil-Standards and a lot of good solid information about test baths. Send it or call your local 3M man.

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Circle 50 on Inquiry Card

# LITERATURE

## Electronic components compendium

A comprehensive listing (76-pages long) of components for industrial, military and commercial electronic applications, is hot off the press. Designated Catalog C-560, it contains the most current of Sprague's 148 type capacitors, transistors, resistors, filters, and pulse transformers. Condensed technical data, ratings and sizes are included, as is an alphanumeric index which facilitates selection. Sprague Products Co., 233 Marshall St., N. Adams, Mass. 02147.

Circle 459 on Inquiry Card

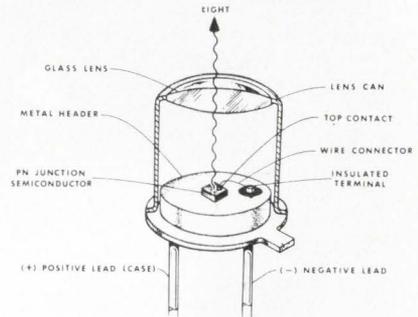
## Selecting a real-time computer

Tips for selecting a real-time computer system for production testing are contained in a handy file-type brochure. The applications-oriented folder emphasizes the solving of production testing problems rather than the benefits of specific computers or software systems. Advantages in using such a system are also discussed. Systems Engineering Labs., 6901 W. Sunrise Blvd, Fort Lauderdale, Fla. 33313.

Circle 460 on Inquiry Card

## Solid state lamps

A theory and characteristics manual, 58 pages, provides you with information and data helpful to the engineering and application of solid state lamps. An introduction discusses the importance of



SSLs to the industry; general applications are given; and following a discussion of theory and characteristics you'll find sections on optoelectronics and photon couplers. An entire section is devoted to such helpful items as a glossary, a table of conversion factors, prefixes, and symbols for semiconductor devices. The entire manual is supplemented with illustrations, graphs, and charts. General Electric Co., Miniature Lamp Dept., #382, Nela Park, Cleveland, Ohio 44112.

Circle 461 on Inquiry Card

## Transistors and diodes

Key parameters and package outline information are given for more than 2,000 semiconductor devices in this 80-page condensed catalog. For your convenience, products are grouped by function type: diodes, small signal transistors, dual transistors, FETs, power transistors, RF/IF amps and oscillators, communication devices, SCRs, and specialty diode products. Fairchild Semiconductor, Box 880A, Mountain View, Calif. 94040.

Circle 462 on Inquiry Card

## Programming devices

Six data acquisition lines, including drum programmers, badge and punched card readers, timers, random access programming circuit selectors, and programming matrix boards, are covered in a 12-page, quick reference catalog. Typical applications for each product are provided, as are salient features, schematics, and theory of operation. The units discussed have been designed for full-time service in commercial applications. Seaelectro Corp., 225 Hoyt St., Mamaroneck, N.Y. 10543.

Circle 463 on Inquiry Card

## A complete line of CUSTOMIZED ROTARY CERAMIC SWITCHES ...

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RSC switches are available in a variety of switching models. RSC high precision, quality built units are designed for applications requiring long life maintenance-free service. Types include shorting and non-shorting, single and multi-deck, up to 18 pole positions. Features include, 10 to 100 amp current carrying capacity, 20° to 90° detents, 2000 to 24000 volts flashover and corrosion-proof construction.

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**RSC**  
 RADIO SWITCH CORPORATION  
 Rt. 79, Marlboro, N. J. 07746

### Transformers, inductors, and toroids

Available in either commercial or Mil construction, a line of toroidal power and DC-DC converter transformers has been tabulated in a selector guide. In addition to electrical ratings, charts, graphs, schematics, and application notes are included in the manual making the literature useful to those involved in specifying magnetic components. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N.Y. 11582.

Circle 464 on Inquiry Card

### Rf coaxial connectors

This 148-page catalog contains a lot of information about rf coaxial connectors. Besides just listing all available products, the catalog serves as a handbook, providing complete mounting installations, general characteristics, cable assembly, physical dimensions, numerical index, and applications data for all commonly used rf connector series. ITT Greomar, 10 Micro Dr., Woburn, Mass. 01801.

Circle 465 on Inquiry Card

### Component selector

Resistors, trimmers, pots, tap switches, transformers, relays, and solid state power controls are described in this 36-page component selector. The convenience of the catalog is that it indicates the availability of these and other products based on nationally exhibited usage patterns. You'll find photos of each product listed, along with dimensional diagrams and essential specs. Ohmite Mfg. Co., 3601 Howard St., Skokie, Ill. 60076.

Circle 466 on Inquiry Card

### Updated 54/74

Off-the-shelf products, 63 in all, are described in this 52-page updated version of the company's 54/74 TTL IC brochure. Electrical and switching characteristics, logic diagrams, and pin configurations are parts of the descriptions. And 20 pages of diagrams and schematics illustrate test circuits and voltage waveforms. Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. 94040.

Circle 467 on Inquiry Card

### ESD timing circuits

Circuit and performance data on uses of a high capacitance ESD are included in an application note which is one of a series. The ESD is combined in the timing circuit with components available from multiple sources. Many variations of the circuits can be designed to provide unique time delays, pulse generation, and the basis for a whole range of time-delay relays and electronic timers. Gould Ionics Inc., Box 1377, Canoga Park, Calif. 91304.

Circle 468 on Inquiry Card

### Capacitors/resistors

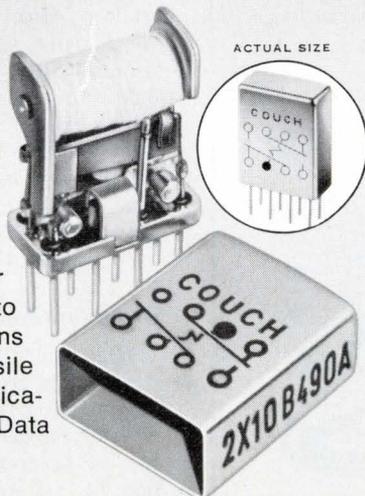
Precision thick-film and precision wirewound resistor networks, cermet chip resistors, thermistors, resistors, and ceramic capacitors are the subjects of a 12-page short-form catalog. Specs are given for each product as well as photos and/or diagrams. Data is provided according to series for easy access to the specific information you need. Cal-R Inc., 1601 Olympic Blvd., Santa Monica, Calif. 90404.

Circle 469 on Inquiry Card

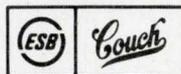
# rotary relays

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Simple and reliable in operation . . . made with premium materials and over-size contacts . . . true 1/7th size crystal can relays . . . pull-in sensitivity of 100 milliwatts or less . . . fully tested to military specifications . . . ideal for missile and aerospace applications. Write for new Data Sheet 2X.



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36 River Street, Boston, Mass. 02126.

Circle 52 on Inquiry Card

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Model	Vdc	AMPS	Regulation		Ripple	Price
			Line	Load		
SINGLE OUTPUT	0.6V	15A	±0.1%	±0.1%	.5 MVRMS	\$185.00
	0.18V	6A	±0.1%	±0.1%	.5 MVRMS	185.00
	0.36V	3A	±0.1%	±0.1%	.5 MVRMS	185.00
THREE OUTPUT	0.5V	5A	±0.05%	±0.05%	1 MVRMS	\$335.00
	0.36V	1A	±0.05%	±0.05%	1 MVRMS	
	0.36V	1A	±0.05%	±0.05%	1 MVRMS	
SIX OUTPUT	0.6V	5A	±0.05%	±0.05%	1 MVRMS	\$495.00
	0.18V	2A	±0.05%	±0.05%	2 MVRMS	
	0.18V	2A	±0.05%	±0.05%	2 MVRMS	
	0.36V	1A	±0.05%	±0.05%	3 MVRMS	
	0.36A	1A	±0.05%	±0.05%	3 MVRMS	
	0.200V	.040A	±0.05%	±0.05%	30 MVRMS	

INPUT: 115 Vac ± 10% 57 to 440 Hz 1 φ

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Circle 53 on Inquiry Card

# DATA TRANSMISSION PROBLEMS?

## Let the Sierra 1914B help you solve them.

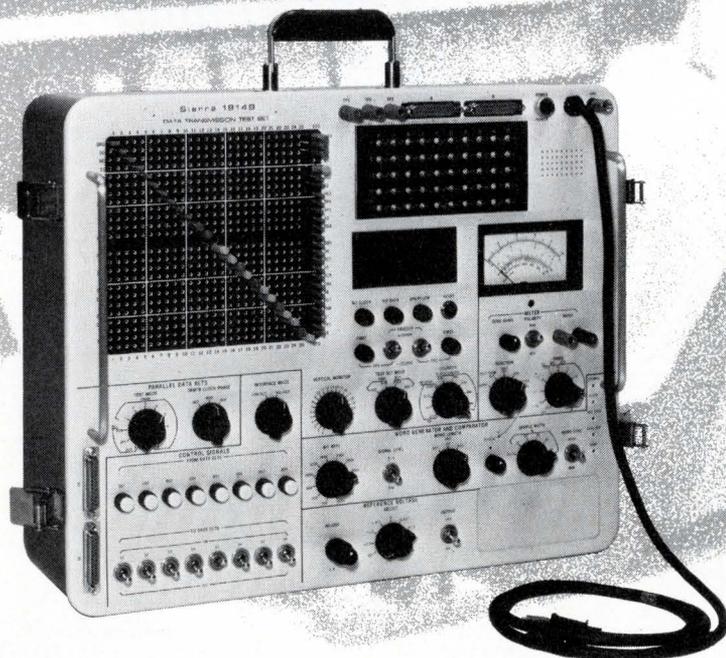
The Sierra 1914B Data Transmission Test Set localizes and identifies the problem. It checks all the supervisory control functions of a modem and the bit- and block-error rate of the entire data transmission system. The 1914B is a field instrument with laboratory features and can test both synchronous and asynchronous voiceband data systems.

It is designed for installation, maintenance, and troubleshooting tests by telephone company personnel, modem users and manufacturers, time-sharing computer companies, and many others.

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# LITERATURE

## Temperature millivolt table

Designed as an aid to users of temperature instrumentation and thermocouples is a handy-dandy thermocouple temperature/millivolt table. The unique feature of this table is that whether thermocouple temperatures are measured in degrees Fahrenheit or Celsius, the reader can use the table to determine the generated millivolt equivalents. Temperature ranges from  $-300$  to  $+3270^{\circ}\text{F}$  and  $-200$  to  $+1800^{\circ}\text{C}$  are detailed in separate charts on the table. Included too are conversion factors for  $32^{\circ}\text{F}$  and  $0^{\circ}\text{C}$  reference functions, and generic names and polarities for each thermocouple conductor. Thermo Electric, Saddle Brook, N.J. 07762.

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## Silicones

A variety of silicone products for improving the performance, reliability, safety, and service life of all types of electronic products are featured in this 20-page bulletin. The information includes the principal features of each product family, specific properties, suggested applications, and packaging information. Among the products listed you'll find silicone resins, encapsulants, protective coatings, adhesive/sealants, and dielectric and heat sink compounds. Dow Corning Corp., Midland, Mich. 48640.

Circle 471 on Inquiry Card

## Thumbwheel switches

Twelve new codes added to this series of industrial grade thumbwheel switches are described in this 8-page catalog. Also, you'll find information on double width models, wave-soldered interconnection pc boards, and snap-on modules for mounting diodes and resistors. Truth tables, specs, and dimensions are provided. Electronic Engineering Co. of California, 1601 E. Chestnut Ave., Santa Ana, Calif. 92701.

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## Organometallics

High-purity organometallics for electronics are reviewed in this 32-page catalog. It describes 15 materials which have been prepared and purified for use as dopants, or in the preparation of 3-5 and 2-6 epitaxial layers, or in the growth of a single crystal. Vapor pressure and analytical data are included. Alfa Inorganics Inc., Congress St., Beverly, Mass. 01915.

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The Electronic Engineer • Nov. 1970

# What's your MOS IQ?

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1. The MOS transistor is an almost ideal switch because (a) no current flows through the gate oxide. (b) when the gate is at the same voltage as the source, no current flows between source and drain. (c) when the gate is open, no current flows between the source and drain. (d) the silicon substrate is "n-type," whereas the drain and source are positive. a.  b.  c.  d.
2. In a p-MOS transistor, the threshold voltage must be (a) positive because the MOS is "p-type." (b) negative for a positive supply. (c) negative for a negative supply, positive for a positive supply. (d) negative because it must invert the n-type silicon under the gate to a p-channel between source and drain. (e) positive because it must invert the n-type silicon under the gate to a p-channel between source and drain. a.  b.  c.  d.  e.
3. The packing density for transistors in p-MOS is higher than in bipolar ICs because (a) since all junctions are reverse biased during normal operation, there is no need for an isolation diffusion. (b) the oxide between gate and silicon substrate is insulating. (c) the edges of both drain and source became automatically aligned with the gate. (d) there are no mobile contaminants that can collect at the oxide silicon interface under the gate, keeping the transistors on. a.  b.  c.  d.  e.
4. P-channel MOS transistors are used almost exclusively for MOS ICs, instead of n-channel MOS transistors because (a) p-MOS transistors are faster than n-MOS. (b) the threshold voltage is higher for p-MOS than for n-MOS. (c) p-MOS tend to be normally on, while n-MOS tend to be normally off. (d) p-MOS tend to be normally off, whereas n-MOS tend to be normally on. a.  b.  c.  d.
5. Which of the following MOS structures combines both low threshold voltage, and self-alignment of gate with source and drain? (a) p-channel MOS on <111> silicon. (b) p-channel MOS on <100> silicon. (c) silicon gate with oxide insulation, and diffused drain and source. (d) aluminum gate with oxide insulation, ion-implanted drain and source. (e) p-channel with oxide-nitride insulation. a.  b.  c.  d.  e.
6. The difference between ac (or dynamic) logic and dc (or static) with MOS ICs is that (a) dc logic uses two supplies, whereas ac logic requires only one. (b) dynamic logic has a much higher frequency response than dc logic. (c) dynamic logic does not require a pull-up resistor, whereas static logic does. (d) in static logic, the data bit is stored in the gate capacitance. (e) in dynamic logic, the load (or pull-up) device is clocked to reduce the quiescent power dissipation. a.  b.  c.  d.  e.

7. The most important advantage of ratioless dynamic shift registers over static shift registers is (a) the ratio between load and pull-down resistance can be higher. (b) the value of their gate capacitances becomes less critical. (c) they don't have to be clocked. (d) they require less chip area, since their power dissipation is lower. (e) they always present a dc path to ground, regardless of state. a.  b.  c.  d.  e.
8. In ratio logic, if we decrease the resistance of the load device (to speed up the risetime), we must also (a) increase the size of the pull-down device. (b) decrease the size of the pull-down device. (c) increase the clock frequency. (d) decrease the clock frequency. a.  b.  c.  d.
9. If two of the four clocks of a four-phase system are generated internally (on the chip) then (a) the clock lines must be heavy enough to charge all gate capacitances. (b) the design becomes more economical for large systems than for small ones. (c) the clocks cannot overlap. (d) we must add a gate supply  $V_g$  to charge the gate capacitances. a.  b.  c.  d.
10. You can usually simplify the problem of driving the input to a MOS gate from a bipolar output by (a) making  $V_{DD}$  positive with respect to  $V_{SS}$ . (b) making  $V_{CC}$  of the bipolar circuit positive with respect to  $V_{SS}$ . (c) making  $V_{SS}$  negative with respect to the gate input. (d) making  $V_{SS}$  positive with respect to bipolar ground. a.  b.  c.  d.
11. One method of driving TTL circuits from a MOS output is to connect both  $V_{SS}$  of the MOS circuit and  $V_{CC}$  of the bipolar circuit to +5 V. This scheme has the advantage of (a) higher speed at the cost of increased power dissipation. (b) lower power dissipation at the cost of level changers at the other MOS inputs. (c) lower power dissipation at the cost of increased parts at the MOS output. (d) input and output compatibility with all other MOS circuits. a.  b.  c.  d.
12. When comparing MOS circuits for use in desk calculators with those used in computers, generally (a) the adder in a calculator must be faster than in a computer. (b) the adder in a calculator operates on fewer bits than in a computer. (c) both calculators use random access memories but the calculator's is much smaller. (d) both the adder and memory in a calculator are about the same size as in a computer but are much slower. a.  b.  c.  d.
13. When using MOS shift registers in a desk calculator, (a) a digit-serial, bit-parallel organization is the most efficient in terms of hardware necessary. (b) a bit-serial, digit-serial organization usually provides the fastest operation. (c) the digit-serial, bit-parallel organization, while faster, makes data correction harder than the digit- and bit-serial organization. (d) the digit- and bit-serial organization is the most efficient in terms of hardware but makes data correction more difficult. a.  b.  c.  d.
14. Which of the following is not a feature of complementary MOS? (a) higher packing density than p-MOS? (b) operation from a single power supply. (c) high noise immunity. (d) good temperature stability. a.  b.  c.  d.
15. The quiescent power dissipation of a complementary MOS inverter (a) is higher than p-MOS because it uses more transistors. (b) is lower than single polarity MOS because one transistor is always off. (c) is higher than p-MOS but lower than n-MOS. (d) depends on whether the output is high or low. a.  b.  c.  d.
16. In complementary MOS logic circuits you get the positive NAND function by connecting (a) all n-channel transistors in series and all p-channel transistors in parallel. (b) all p-channel transistors in series and all n-channel transistors in parallel. (c) both n- and p-channel transistors in series. (d) both n- and p-channel transistors in parallel. a.  b.  c.  d.
17. The complementary MOS transmission gate offers advantages over a single polarity MOS switch (a) because the n- and p-channel transistors in series give a higher off resistance. (b) particularly in small signal applications. (c) because it can switch a wider range of input voltages. (d) because it requires only a single polarity input signal input. a.  b.  c.  d.
18. When writing data into a MOS RAM cell, (a) the voltages on the sense-digit lines determine whether a 1 or a 0 is written. (b) both of the storage transistors are turned off for a 0 and on for a 1. (c) both of the storage transistors are turned off for a 1 and on for a 0. (d) the word select line determines if a 1 or a 0 is written. a.  b.  c.  d.

19. When you want to read a bit from a MOS RAM cell, (assuming p-channel transistors), (a) both sense-digit lines are connected to  $V_{ss}$ . (b) the word select line is brought high to sense the state of the cell. (c) the state of the cell is reversed when reading so the data must be written back. (d) the choice of whether to use single- or double-rail sensing is usually determined by system organization. (e) the sense-digit lines are usually connected to MOS resistors. a.  b.  c.  d.  e.
20. Which of the following statements is NOT true? (a) dynamic memory cells are smaller than static cells because they contain fewer transistors. (b) both static and dynamic memories store data in flip-flops, but the dynamic cell is smaller. (c) dynamic memories must be refreshed while static memories do not. (d) the peripheral circuitry for a dynamic memory is more complex than for a static memory. a.  b.  c.  d.
21. When considering the various types of MOS random access memories, (a) adding decoding circuitry to the chip increases the number of pins required on the package (b) the big advantage of a dynamic memory over a static memory is that the dynamic unit has a much shorter access time (c) you can increase the speed of the MOS memory by using bipolar circuits to do the decoding external to the chip. This however results in increased cost per bit for the MOS chip. (d) a 1 bit/word organization is usually the most useful but also requires the largest number of pins on the package. (e) providing on-chip decoding usually simplifies the interface with the MOS RAM. a.  b.  c.  d.  e.
22. Given two IC read-only memories, one bipolar and the other MOS, which both store the same number of bits, then (a) the bipolar chip would be smaller because it uses only one transistor per bit. (b) both would be the same size but the MOS chip would be easier to program. (c) the MOS chip would be smaller but the bipolar chip would be faster. (d) the MOS chip would be smaller but would consume more power. a.  b.  c.  d.
23. Which of the following provides the greatest improvement in the access time of a MOS ROM? (a) current sensing the memory matrix (b) off-chip decoding. (c) providing high-level inputs instead of TTL levels. (d) providing complementary inputs. (e) using a single-ended output. a.  b.  c.  d.  e.
24. Whether a particular location in a MOS ROM contains a 1 or a 0 is determined by (a) the initial layout of the sites in the memory matrix. (b) the metallization mask. (c) the p-diffusion mask. (d) the gate-oxide mask. (e) all of these. a.  b.  c.  d.  e.
25. An associative memory (AM) differs from a random access memory (RAM) in that (a) the RAM stores data in a random manner while the AM must store it in some orderly fashion. (b) you must know the entire bit pattern of a word in order to retrieve that word from an AM. (c) storage and retrieval of information in the AM is independent of storage location. (d) the RAM has write capabilities while the AM does not. (e) the AM is a sequential device. You get one word out for each access cycle. a.  b.  c.  d.  e.
26. Associative memories are most useful in applications where (a) a number of lists or tables are involved. (b) the data can conveniently be organized by some parameter of interest. (c) you want to perform different processing on each word in the memory. (d) the data is always retrieved as a function of the same parameter. a.  b.  c.  d.
27. Which of the following statements is NOT true? (a) it took integrated circuits to make the associative memory practical. (b) the associative memory cell is more complex than a RAM cell. (c) the associative memory looks at every word during each interrogate cycle. (d) the field of the data word that is used as the search criteria must be defined during the layout of the chip. a.  b.  c.  d.
28. When buying a memory system, you have two alternatives: buy a standard, off-the-shelf system, or specify your own system and have the vendor build it. In evaluating the costs of each, remember that (a) standard systems have cost advantages in the testing, tooling and packaging areas. (b) the custom system is easier to interface with. (c) for small quantities, standard systems tend to be more expensive. (d) if field repair and maintenance are your chief concern, the custom system probably offers the advantage. a.  b.  c.  d.
29. You must include the cost of peripheral electronics (clocking, drive and sense circuits) in the total cost of a semiconductor memory. These are (a) higher for bipolar circuits. (b) higher for MOS static circuits. (c) higher for MOS dynamic circuits. (d) about equal for all three approaches. a.  b.  c.  d.

30. If the cost of the package is low in comparison with the cost of a semiconductor memory chip, then the minimum cost system will use (a) more chips with fewer bits/chip. (b) fewer chips with more bits/chip. (c) large dynamic MOS chips. (d) bipolar chips with on-chip decoding.
31. The single most important reason that MOS testing is more difficult than bipolar testing is that (a) all MOS devices need multiphase clocks. (b) the clock lines of MOS devices have larger voltage swings than those of bipolar devices. (c) MOS devices are extremely sensitive to supply voltage variations. (d) MOS devices require higher clock speeds than bipolar devices. (e) MOS devices are more complex than bipolar devices.

32. When comparing testing requirements for MOS memories and MOS random logic arrays, (a) memories are easier to test because they are slower. (b) memories are easier to test because they require simpler test patterns. (c) memories are harder to test because you must also address the device. (d) random logic arrays are easier to test because they have fewer inputs and outputs.
33. Random bit patterns (those that contain all possible combinations of 1's and 0's) are used as input test patterns (a) only to test devices which require high confidence testing. (b) in most cases, because they fully exercise the device. (c) rarely because they are too difficult to generate. (d) represent a low confidence type of test.

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# CALENDAR

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22	23	24	25	26	27	28
29	30					

**Nov. 17-19: Fall Joint Computer Conf.,** Astro Hall, Houston, Texas. Addtl. Info.—L. E. Axson, IBM Scientific Ctr., 6900 Fannin, Houston, Texas 77025.

**Nov. 17-20: Magnetism & Magnetic Materials Conference,** Plaza Hotel, Miami Beach, Florida. Addtl. Info.—F. B. Hagedorn, Bell Telephone Labs, Murray Hill, N.J. 07971.

## DECEMBER

	1	2	3	4	5
6	7	8	9	10	11

**Dec. 1-3: Nineteenth International Wire and Cable Symposium,** Shelburne Hotel, Atlantic City, N.J. Addtl. Info.—Commanding General, U.S. Army Electronics Command, ATTN: AMSEL-KL-EE (Mr. J. Spergel), Ft. Monmouth, N.J. 07703.

**Dec. 2-3: Conference on Display Devices,** United Engrg. Ctr., New York, N.Y. Addtl. Info.—Sam Stone, Gen'l Tel. & Elec., 208-20 Willets Pt. Blvd., Bayside, N.Y. 11360.

**Dec. 7-9: National Electronics Conference,** Conrad Hilton Hotel, Chicago, Ill. Addtl. Info.—Nat'l Electronics Conf., Oakbrook Exec. Plaza #2, 1121 W. 22nd St., Oak Brook, Ill. 60521.

### '70 & '71 Conference Highlights

**NEC—National Electronics Conference,** Dec. 7-9; Chicago, Illinois.

**IEEE—International Convention & Exhibition,** March 22-25; New York, N. Y.

**WESCON—Western Electronic Show & Convention,** Aug. 24-27; San Francisco, Calif.

### Call for Papers

**Apr. 12-15: National Telemetry Conf. & Exposition,** Washington, D.C. Submit three copies of a completed manuscript (not necessarily in final form) and a 300-word abstract not later than December 14 to: Henry B. Riblet, NTC '71 Technical Program Chairman, The Johns Hopkins University, Applied Physics Laboratory, 8621 Georgia Ave., Silver Spring, Md., 20910.

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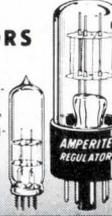
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## Update on a national problem

In a Western Column (June, *The Electronic Engineer*, p. 27) Steve Thompson described one of the few positive measures following in the wake of the aerospace and defense-related engineers' layoffs—the AIAA workshop. As Thompson explained, these workshops, sponsored by the American Institute of Aeronautics and Astronautics, teach effective job hunting. In a series of three meetings, the workshops, patterned after the non-profit group, Thursday 13, run the whole gamut from planning the job search through the follow up.

The AIAA workshops have moved across the country, concentrating in some of the areas of most need. Listed below are the areas with appropriate phone numbers to make reservations. Attendance, which is free, is on a first-to-call, first-served basis. As Geoffrey Potter, Director AIAA Member Services, says, "These workshops will continue as long as there is a need."

- Los Angeles—(213) 322-5746
- San Gabriel—(213) 331-6347
- Orange County—(714) 543-1160
- Long Island—(212) 581-4300
- Vandenberg AFB—(805) 866-8021, ext. 202

A new wrinkle has been the funding (\$22,890) by the Department of Labor for another series of workshops in Philadelphia, Boston, Huntsville, Dallas-Ft. Worth, and Seattle. Conducted by the AIAA, with the assistance of State Employment Service agencies, the same successful format will be used.

The Philadelphia chapter of the AIAA ((215) 839-0191) has organized the first of the Department of Labor-supported workshops. One of the interesting outgrowths of this effort has been the assistance of various groups, such as the Society of American Value Engineers, the IEEE, General Electric Co., and *The Electronic Engineer*. (The Chilton Co., publisher of *The Electronic Engineer*, has donated office space to the Greater Philadelphia section of the AIAA to handle reservations and administrative duties.) The Philadelphia chapter seems to be a live wire group; they are presenting the first Aerospace Applications Award for "demonstrated accomplishments in applying aerospace techniques to improve the quality of life in the Delaware Valley" in what may be the beginning of a nationwide trend.

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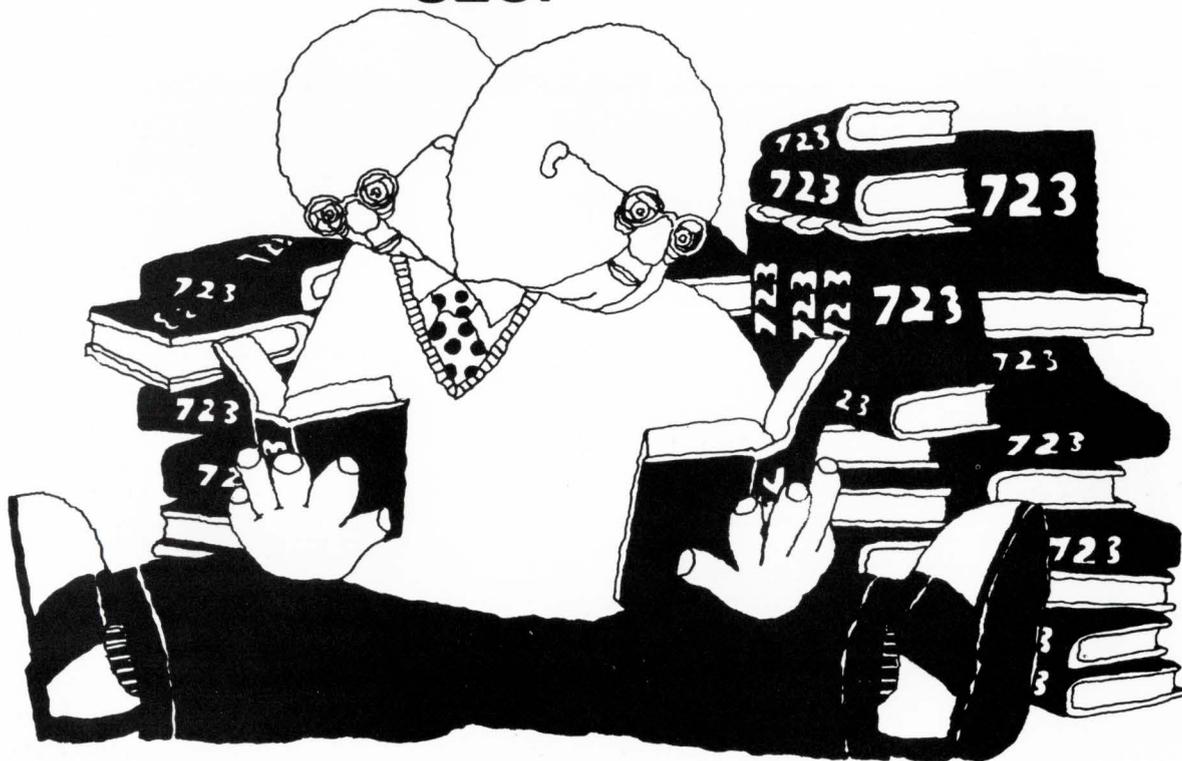
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