

# Electronic Design 17

VOL. 18 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

AUG. 16, 1970







## **ASTRO/348** CONNECTORS FROM CINCH-NULINE internationally accepted – Tri-Services approved!

Cinch-Nuline can meet your needs for these high density, subminiature devices.

The MIL-C-81511 Astro/348 represent the highest state-of-the-art in round connectors. They have .085" contact centers with dielectric separation of .021" (equal to other connectors with .130" centers). The dielectric has a one-piece retention system that eliminates metal construction. Other important features include scoop-proof mating, grounding prior to electrical contact, removable crimp contacts and extreme environmental stability.

The complete line includes shell sizes for contact configurations of 4, 12, 37, 55, and 85 contacts, five receptacle styles and standardized accessories.

For delivery information contact any Cinch Sales Office or write to Cinch-Nuline, a division of TRW Inc., 1015 S. Sixth Street, Minneapolis, Minnesota, 55415.

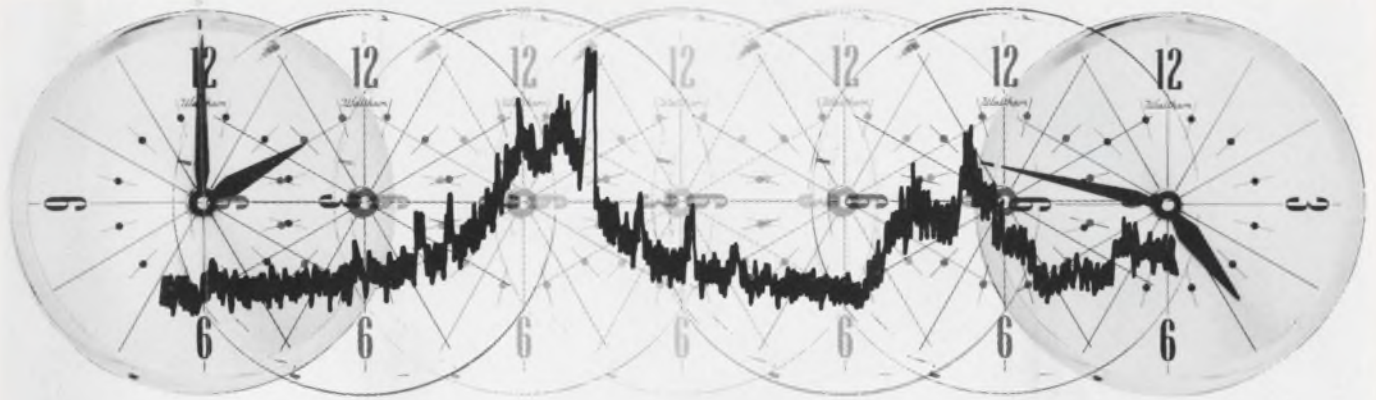
**MIL-C-26500 Omega Connectors** are also available from Cinch-Nuline on short delivery cycles (generally 6-8 weeks) for any shell style, contact size and insert configuration.

CN-7074



**CINCH-NULINE**





# A wave analyzer with a 10,000-second sweep time? Why?

090/6

...because, in low-frequency spectrum analysis work, you need to use a narrow-bandwidth window. The narrower the window you use, the slower you must sweep it across the frequency range to be analyzed. And the slower you sweep, the smaller a frequency range you can cover in any given time. Thus, until now, your choice has been either accuracy or range but not both.

The new HP 3590A/3595A system solves that dilemma. The HP 3595A plug-in is a sweeping local oscillator

with 10,000 seconds of sweep time available. By using it with the HP 3590A Wave Analyzer mainframe, you can scan the entire three-decade audio frequency range at 2 Hz per second, in one sweep. And, by adding an HP X-Y recorder, you can see the results on a single 11 x 17-inch graph.

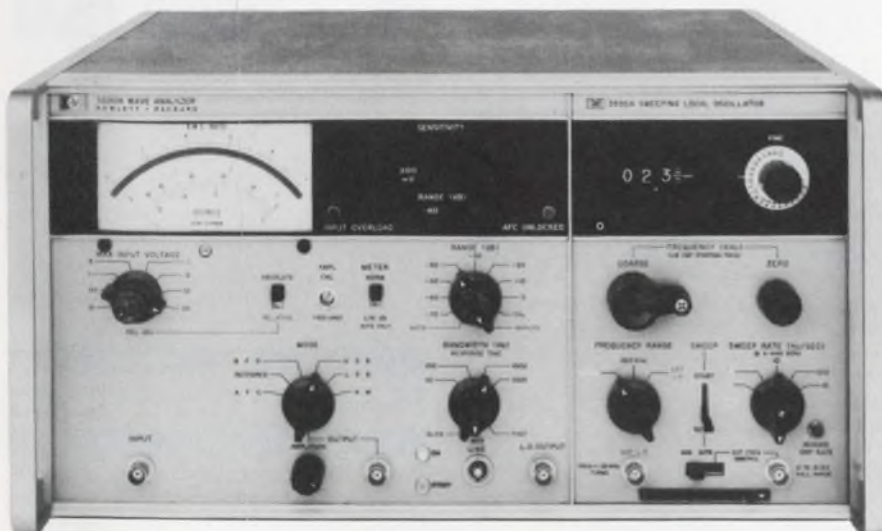
In addition to extended sweep time, the 3590A/3595A combination also gives you a choice of five sweep rates (from 1 Hz to 1,000 Hz per second) and four filter bandwidths (from 10 Hz to 3,100 Hz), an 85 dB dynamic range

over either of two frequency ranges (20 Hz to 62 kHz and 200 Hz to 620 kHz), 3  $\mu$ V to 30 V sensitivity, and built-in autoranging for ease of operation.

The result is a systems-analysis tool ideally suited for work in the lower frequency ranges, with the capability to work in higher frequency ranges as well!

The 3590A Wave Analyzer mainframe is \$3200; the new 3595A plug-in with the 10,000-second sweep time is \$1250. Other plug-ins available for the 3590A are: the 3592A slave and program unit, for use with a second mainframe, \$80; the 3593A with 3-digit mechanical display and 620-second maximum sweep time, \$1100; and the 3594A with 5-digit electronic counter frequency display and 620-second maximum sweep time, \$1600.

To get complete information on the HP 3590A and the various plug-ins, contact your local HP field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.



**HEWLETT  PACKARD**  
SIGNAL ANALYZERS



# visible light

## ...from the MOD line

If you need a visual indication of what is happening in your system, equipment or instrument you should be using the FLV100 or FLV101 light emitting diode. Either one will provide you with a bright red status indicator. These products feature ■ Low cost (99c in 10,000 quantities) ■ High brightness (typically 1500 foot lamberts for the FLV100) ■ Mechanical rigidity (impervious to mechanical shock and vibration) ■ Solid state reliability ■ Moisture resistance (65°C and 95% relative humidity) ■ Low power consumption (within drive capability of standard digital IC's) ■ Wide viewing angle (160 degrees for FLV101) ■ Plug in package for easy mounting  
You can have either a large area, wide viewing angle indicator (the FLV101) or

a highly intense point light source (the FLV100) for the same low price. Whether you need one lamp for an ON/OFF switch or thousands for a complex panel display you should contact Fairchild MOD.

Fairchild Microwave and Optoelectronics Division (MOD), in addition to these devices, makes a complete line of optoelectronic products.

Your local Fairchild MOD distributor, listed to the right, has sensors and emitters in stock. You can order the devices you need from him or if you need detailed information he will be glad to send you data sheets.

The FLV100 and FLV101 are the latest optoelectronics devices from Number 1. Keep watching Number 1 because more new products are on the way.

### FAIRCHILD MOD DISTRIBUTORS

#### SCHWEBER ELECTRONICS

(516) 334-7474 (617) 891-8484 (416) 925-2471 (305) 927-0511  
(301) 427-4977 (205) 539-2756 (216) 336-7020

#### HAMILTON/AVNET SALES

(213) 870-7171 (415) 961-7000 (713) 526-4661 (602) 272-2601  
(714) 279-2421 (206) 624-5930 (303) 433-8551 (503) 255-8550

#### COMPUTER COMPONENTS CORP

(214) 239-0271

#### SEMICONDUCTOR SPECIALISTS, INC

(312) 279-1000 (313) 255-0300 (513) 278-9455 (412) 351-3611  
(317) 243-8271 (612) 861-3400 (314) 423-6500

# FAIRCHILD

MICROWAVE AND OPTOELECTRONICS

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2513 Charleston Rd., Mt. View, Ca. 94040

INFORMATION RETRIEVAL NUMBER 1



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## NEWS

- 21 **News Scope**
- 24 **Do R&D cuts peril U. S. lead in electronics?**  
Some engineering educators say they do, others aren't worried, but all agree research is essential
- 28 **Improved electronics at weapons range puts Navy on target**  
Hydrophone sensors around target rocks will provide accurate bombing scores, displays are more flexible, and new targets are planned
- 34 **Industry 'discovers' standard MOS/LSI chips**
- 38 **Redesign that military product for civilian use!**  
More and more electronics companies are turning defense-contract skills into consumer-market profits
- 45 **Washington Report**
- 48 **Technology Abroad**

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WESCON '70—A special section Pages W1 to W62

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## TECHNOLOGY

- 70 **Simplify random-access memory selection** by following these guidelines, and learn some of the basic aspects of the evaluation process.
- 78 **Use squaring to multiply.** Triangular waves can add up to the square-law function if they are harmonically related and have controlled slopes.
- 82 **Linearize your CRT displays.** Least-square analysis and error-correcting networks permit accurate multi-function registration.
- 86 **Appraise job applicants with confidence** when your employer asks you to interview them. Use this guide to evaluate technical personnel.
- 92 **Semiannual Index of Articles:** January through June, 1970
- 176 **Ideas for Design**
- 185 **Product Source Directory:** Word Generators

---

## PRODUCTS

- 191 **Data Processing:** \$1200 tape-loop memory system stores 72k characters.
- 198 **ICs & Semiconductors:** Read-only 4096-bit memory can be wire-OR'd.
- 202 **Components:** Ceramic i-f filter for FM costs just \$1.20 in quantity.
- |                             |                              |
|-----------------------------|------------------------------|
| 208 Modules & Subassemblies | 218 Microwaves & Lasers      |
| 214 Instrumentation         | 219 Tools & Engineering Aids |
| 216 Packaging & Materials   | 238 Product Index            |

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## Departments

- |   |                        |
|---|------------------------|
| 69 <b>Editorial:</b> U. S. scientific leadership threatened by R&D cuts |                        |
| 13 Designer's Calendar  | 222 Annual Reports     |
| 42 Letters  | 224 Application Notes  |
| 57 Sidelights   | 226 New Literature     |
| 220 Evaluation Samples  | 232 Bulletin Board     |
| 221 Design Aids   | 236 Advertisers' Index |

Information Retrieval Service Card inside back cover

**Cover:** photo, courtesy of General Instrument Corp., Hicksville, N. Y.; color illustration by Art Sudduth.

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# We know our optical mark readers can save you money.

## Just one is saving us \$32,000 a year.

We did it by cutting out the keypunch bottleneck at our Palo Alto plant.

Instead of slow, costly keypunching, we now use one of our optical mark readers. And we're already saving more than \$32,000 a year on payroll processing alone.

The reader handles 125,000 job cards turned in by 3000 employees each month. Everyone writes his own work record on a simple tabulating card, using an ordinary pencil. The process is so easy and efficient, payroll accounting is ready three days earlier than before.

And we don't build our optical mark readers just to handle payrolls in plush offices. They're rugged enough to work in machine shops, warehouses, even on construction sites. In fact, you can put them just about anywhere you need important information fast. Information on material movement, order entry, quality assurance, inventory control.

New design techniques are the key to our readers' reliability. For example, we've developed a special feed system that virtually eliminates card jamming and mutilation. And a unique mark detection feature assures accurate reading of even poorly marked cards.

All our optical mark readers cost less than \$3000. That's another reason they make it so easy for you to save. Your local HP computer specialist can show you just *how* easy. Call him. Or write to Hewlett-Packard, Palo Alto, Calif. 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

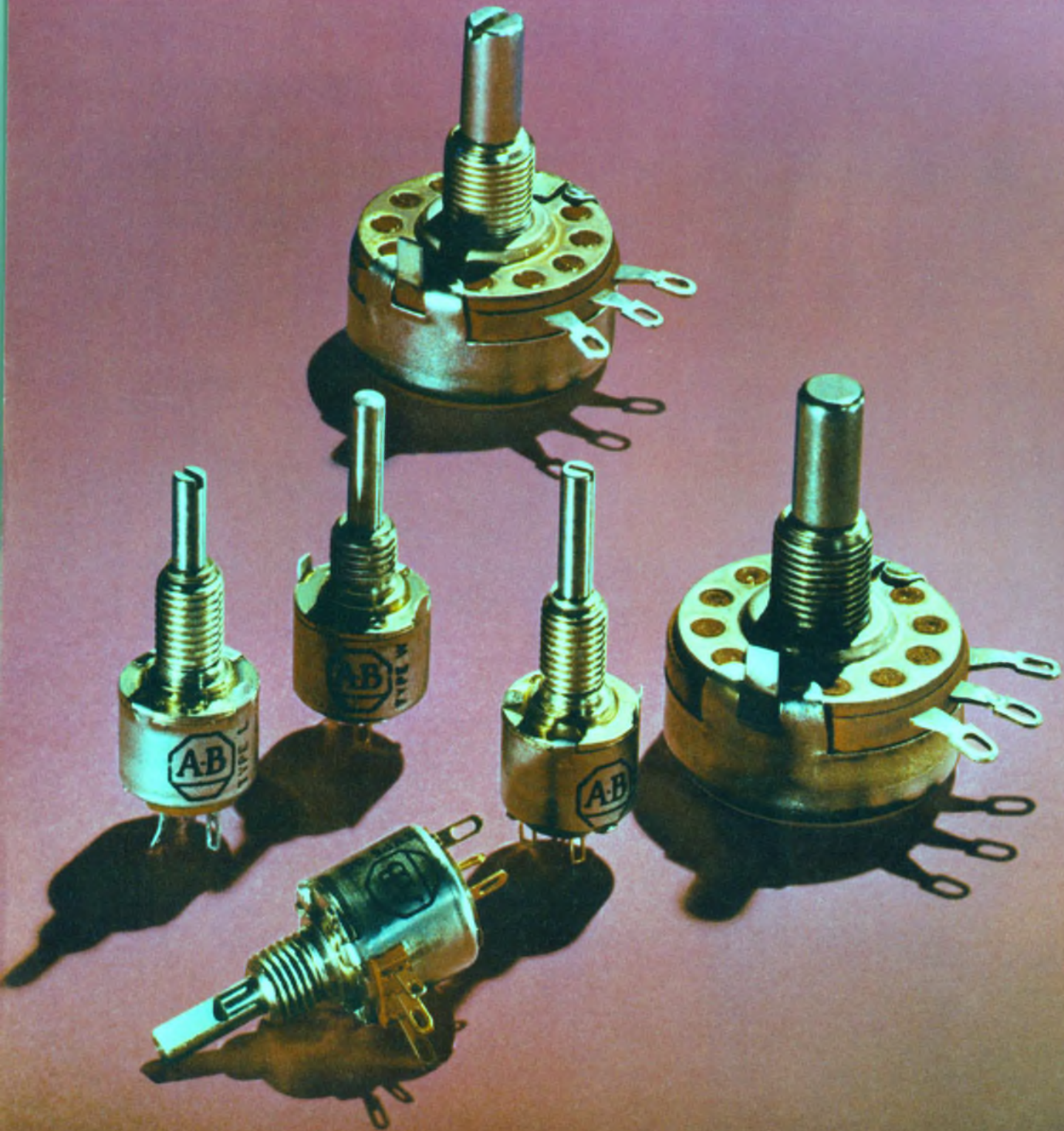
HEWLETT  PACKARD

DIGITAL COMPUTERS

INFORMATION RETRIEVAL NUMBER 3



# Fight noise pollution





# with this quiet family.

Hot Molding with Allen-Bradley's exclusive technique, gives these composition variable resistors an unusually low noise level. And importantly, this low noise level actually decreases in use. Under tremendous heat and pressure the resistance track is molded into place. A solid element with a large cross-section is produced.

This important Allen-Bradley difference means better short-time overload capacity and a long operating life. Control is smooth, resolution almost infinite. These variable resistors are ideal for high frequency circuits. Why should you trust the performance of

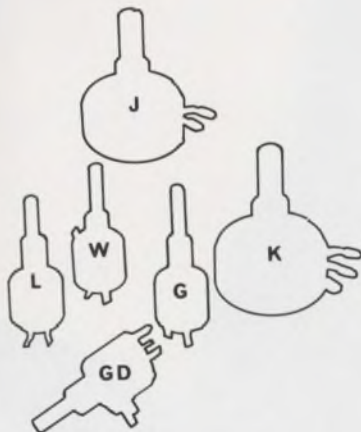
your designs or your reputation to anything less than Allen-Bradley quality? Use the most thoroughly "field tested" (over 20 years) variable resistors available today. Quantity stocks of popular types J, G, W and GD available for immediate delivery from your appointed A-B industrial electronics distributor.

For information write: Marketing Department, Electronics Division, Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wisconsin 53204. Export office: 1293 Broad Street, Bloomfield, N. J. 07003, U.S.A. In Canada: Allen-Bradley, Canada Ltd., 135 Dundas Street, Galt, Ontario.

## SPECIFICATIONS

	TYPE J— STYLE RV4	TYPE K	TYPE G— STYLE RV6	TYPE L	TYPE W	TYPE GD
CASE DIMENSIONS	5/8" deep x 1-5/32" dia (single section)	5/8" deep x 1-5/32" dia. (single section)	15/32" deep x 1/2" dia.	15/32" deep x 1/2" dia.	15/32" deep x 1/2" dia.	35/64" deep x 1/2" dia.
POWER at + 70°C	2.25 W	3 W	0.5 W	0.8 W	0.5 W	0.5 W
TEMPERATURE RANGE	-55°C to +120°C	-55°C to +150°C	-55°C to +120°C	-55°C to +150°C	-55°C to +120°C	-55°C to +120°C
RESISTANCE RANGE (Tolerances: ±10 and 20%)	50 ohms to 5.0 megs	50 ohms to 5.0 megs	100 ohms to 5.0 megs	100 ohms to 5.0 megs	100 ohms to 5.0 megs	100 ohms to 5.0 megs
TAPERS	Linear (U), Modified Linear (S), Clockwise Modified Log (A), Counter-Clockwise Modified Log (B), Clockwise Exact Log (DB). (Special tapers available from factory)					
FEATURES (Many electrical and mechanical options available from factory)	Single, dual, and triple versions available. Long rotational life. Ideal for attenuator applications. Snap switches can be attached to single and dual.	Single, dual, and triple versions available. Long rotational life.	Miniature size. Immersion-proof. SPST switch can be attached.	Miniature size. Immersion-proof.	Commercial version of type G. Immersion-proof.	DUAL section version of type G. Ideal for attenuator applications. Immersion-proof.

## ALLEN-BRADLEY

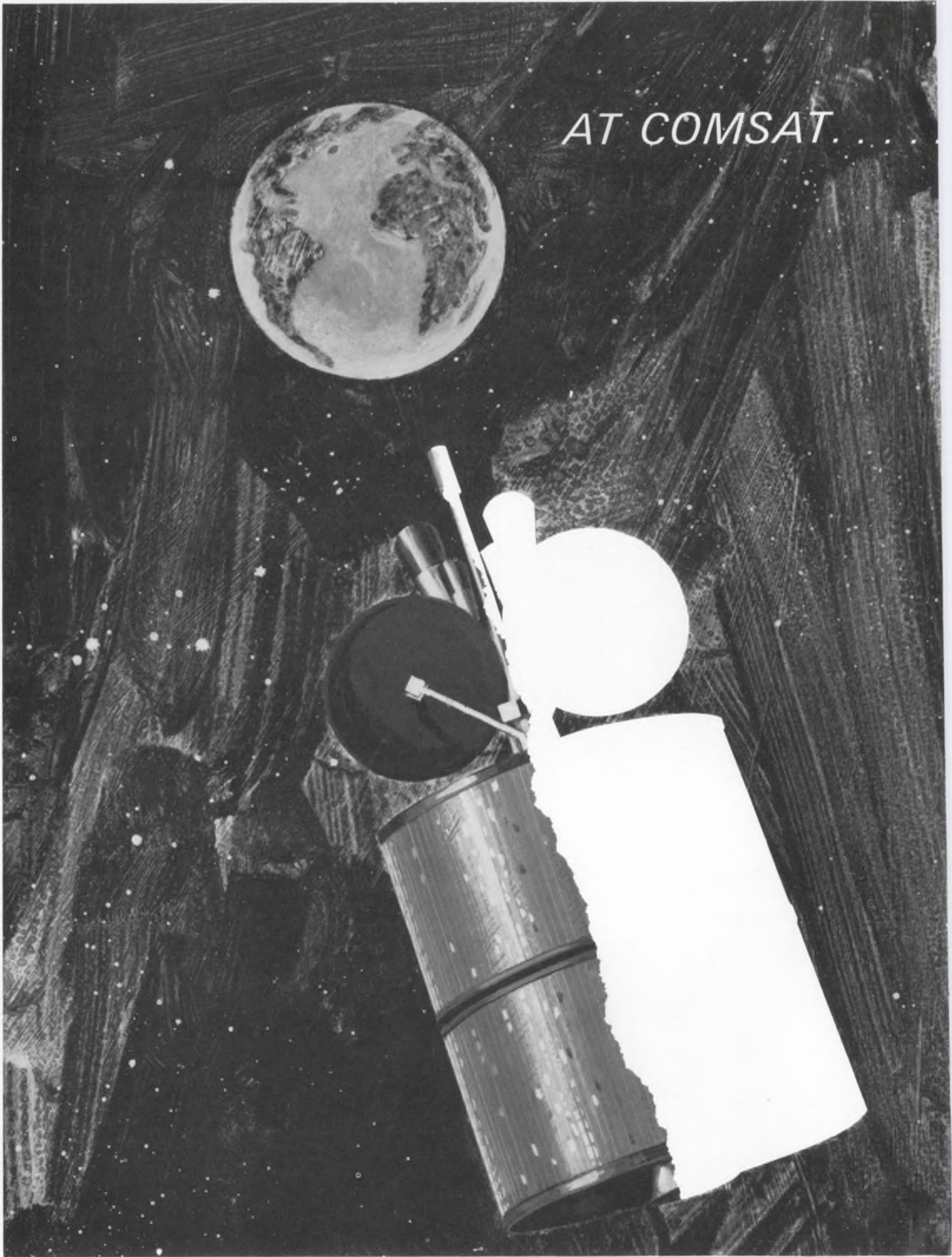


INFORMATION RETRIEVAL NUMBER 4





*AT COMSAT...*





# ..... SLOW CIRCUITS WOULD HAVE BEEN LIKE HAVING HALF-A-SATELLITE!

When COMSAT elected to develop its Time-Division Communications System using digital techniques, it was immediately obvious that system capacity would be limited by circuit speed. That's why they chose Motorola MECL integrated circuits for the job.

COMSAT Laboratories, with the support of INTELSAT, developed an advanced, 700-channel, Time Division Multiple Access system capable of processing and transmitting information to the satellite at a 50 megabit rate. Motorola's Applications Engineering department helped with engineering assistance and the kind of technical information that could be provided only by the people who pioneered high-speed, emitter-coupled logic.

Using high-speed gates, flip-flops and complex functions from Motorola's MECL II line, COMSAT was able to develop general purpose digital logic cards that are actually capable of handling rates of 70 megabits.

More importantly, COMSAT found that these same techniques can be used for 150 megabit units — and there is consideration for logic in the 200 to 500 megabit range.

New, Motorola MECL III circuits can easily handle speeds up to the 300 megabit level, using gates with 1.0 nS propagation delay and flip-flops with toggle/shift frequencies on the order of 350 MHz.

MECL IV circuits, now in development, will yield 500 MHz flip-flops and 900 picosecond gates — thus providing for even higher-capacity communication systems. Other systems such as radar signal processing, audio and video bandwidth compression, digital adaptive reception and digital filtering will also benefit from this advanced line of high-speed integrated circuits.

And, the speed and versatility of high-speed MECL is not limited to digital communication uses. Coming soon are fourth generation computers, ultra-high-speed instrumentation, and a variety of advanced avionics gear — all designed around Motorola MECL circuits.

For complete information about how MECL can put speed in your system, write on your company letterhead to Box 20912, Phoenix, Arizona 85036. Ask for the "MECL High-Speed Systems Design Library."

System Speed, Family Compatibility with MECL				
FAMILY	PROP. DELAY (TYP)	TOGGLE/SHIFT FREQUENCY (TYP)	FUNCTIONS AVAILABLE	GATE POWER DISSIPATION (TYP)
MECL II	4.0 nS	180 MHz	41	25 mW
MECL III	1.0 nS	350 MHz	16	55 mW
MECL IV	0.9 nS	500 MHz	—	20 mW

MECL — Trademark of Motorola Inc.

**MOTOROLA MECL**  
*the only way to go... FASTER*



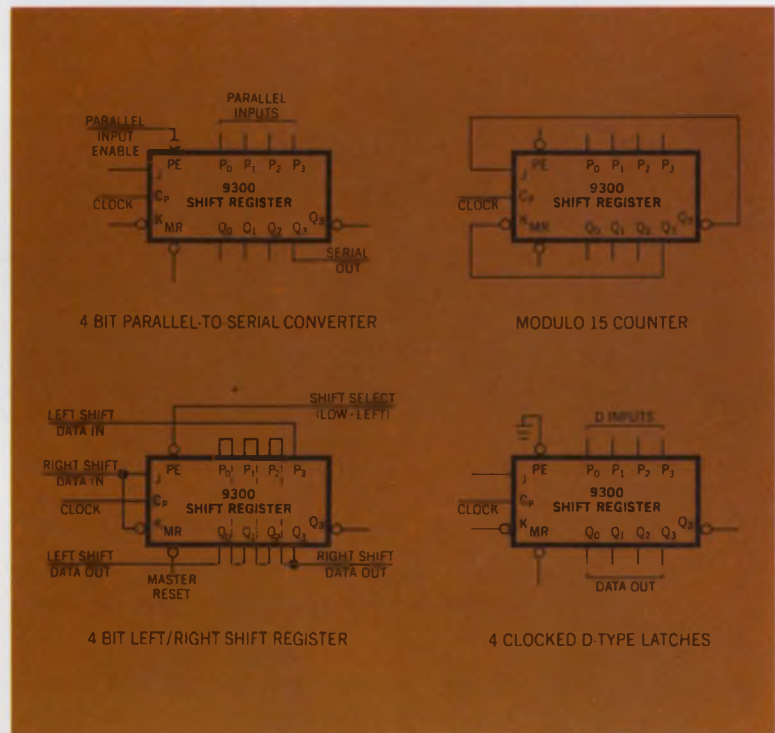
# To make a Register that does a lot more than shift,



Fairchild's 9300 is the world's most versatile shift register. And we can prove it. The 9300 Four-bit Universal Register can perform as a high-speed shift register, modulo N counter, up/down counter, storage element, four clocked D-type latches, a programmable divider, a binary to BCD shift converter, serial to parallel converter (and vice versa), and a dozen other functions. It's a prime example of the kind of versatility inherent in Fairchild's entire MSI family.

Other features which help make the 9300 the fastest-selling register on the market include a 20MHz shift frequency, J and  $\bar{K}$  inputs (which, tied together, provide D-type input), gated synchronous parallel inputs, Q and  $\bar{Q}$  outputs.

The 9300 is completely compatible with all Fairchild MSI elements. It comes in a 16-lead hermetic DIP and Flatpak in both military and industrial temperature ranges.



To order the 9300, call your Fairchild Distributor and ask for:

PART NUMBER	PACKAGE	TEMPERATURE RANGE	(1-24)	PRICE (25-99)	(100-999)
U4L930051X	Flatpak	-55°C to +125°C	\$21.45	\$17.15	\$14.30
U4L930059X	Flatpak	0°C to + 75°C	10.70	8.60	7.15
U6B930051X	DIP	-55°C to +125°C	19.50	15.60	13.00
U6B930059X	DIP	0°C to + 75°C	9.75	7.80	6.50



# you have to get serious about MSI family planning.

We put together a family plan by taking systems apart. All kinds of digital systems. Thousands of them.

First we looked for functional categories. We found them. Time after time, in a clear and recurrent pattern, seven basic categories popped up: Registers. Decoders and demultiplexers. Counters. Multiplexers. Encoders. Operators. Latches.

Inside each of the seven categories, we sifted by application. We wanted to design the minimum number of devices that could do the maximum number of things. That's why, for example, Fairchild MSI registers can be used in storage, in shifting, in counting and in conversion applications. And you'll find this sort of versatility throughout our entire MSI line.

Finally, we studied ancillary logic requirements and packed, wherever possible, our MSI devices with input and output decoding, buffering and complementing functions. That's why Fairchild MSI reduces—in many cases eliminates—the need for additional logic packages.

The Fairchild MSI family plan. A new approach to MSI that's as old as the industrial revolution.

It started with functional simplicity, extended through multi-use component parts, and concluded with a sharp reduction in add-ons.

Simplicity. Versatility. Compatibility.

Available now. In military or industrial temperature ranges. In hermetic DIPs and Flatpaks. From any Fairchild Distributor.



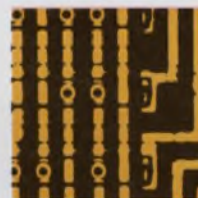
**OPERATORS**  
9304 – Dual Full Adder/Parity Generator



**LATCHES**  
9308 – Dual 4-Bit Latch  
9314 – Quad Latch



**REGISTERS**  
9300 – 4-Bit Shift Register  
9328 – Dual 8-Bit Shift Register



**MULTIPLEXERS**  
9309 – Dual 4-Input Digital Multiplexer  
9312 – 8-Input Digital Multiplexer



**DECODERS AND DEMULTIPLEXERS**  
9301 – One-Of-Ten Decoder  
9315 – One-Of-Ten Decoder/Driver  
9307 – Seven-Segment Decoder  
9311 – One-Of-16 Decoder  
9317 – Seven-Segment Decoder/Driver  
9327 – Seven-Segment Decoder/Driver



**COUNTERS**  
9306 – Decade Up/Down Counter  
9310 – Decade Counter  
9316 – Hexadecimal Counter



**ENCODERS**  
9318 – Priority 8-Input Encoder

**FAIRCHILD**  
SEMICONDUCTOR



# Where's the trend to denser p.c. packing going?

**Here's one answer.**

**Actual size.**

Use Elco Series 6309 card-edge connectors and you can condense the connectors for ten pc boards into 17.1 square inches. Without paying a premium for the privilege.

That's one thousand contacts. On .100" centers. Ready for wrapping. Easy.

But that's only one answer. We have eighteen others. With contact spacings of .100", .125", .150", or .200", accommodating from 14 to 100 contacts in eight different basic configurations.

And that's not counting our Mojo™ (.150") modular connectors, which obligingly, inexpensively, change their size to suit the job at hand.

Ready to accept your boards. Ready to be mounted on metal plates, frames, and boards and with their tails wrapped for whatever little thing you're making. (We can even do that job for you.)

You'll find all our little helpers in the Elco Card-Edge Connector Guide. Call, write, wire or TWX us for a copy. Elco Corporation, Willow Grove, Pa. 19090.

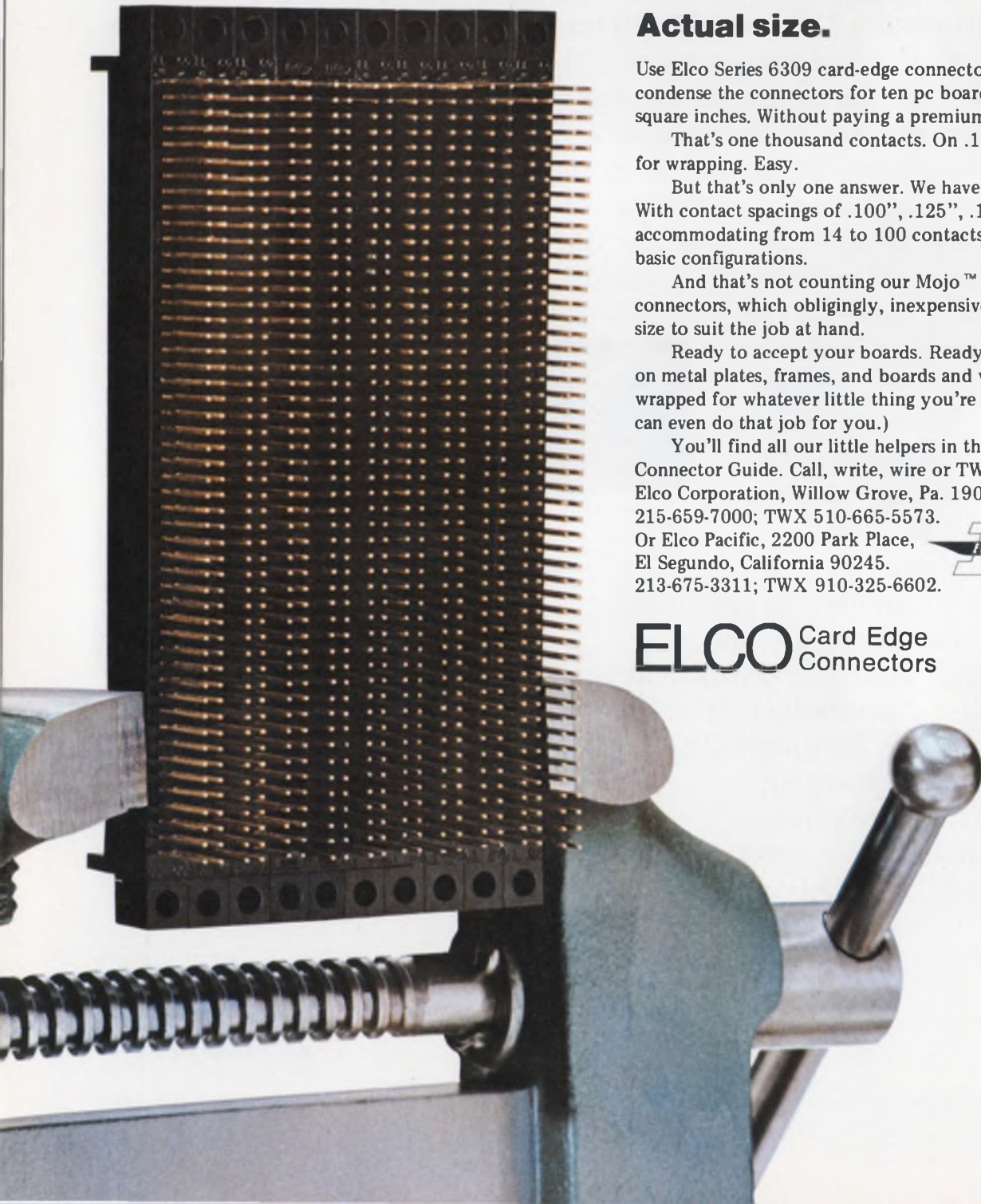
215-659-7000; TWX 510-665-5573.

Or Elco Pacific, 2200 Park Place,  
El Segundo, California 90245.

213-675-3311; TWX 910-325-6602.



**ELCO** Card Edge  
Connectors





# Designer's Calendar

## SEPTEMBER 1970

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

For further information on meetings, use Information Retrieval Card.

### Sept. 21-24

International Conference on Engineering in the Ocean Environment (Panama City, Fla.). Sponsor: IEEE. Lewis Winner, 152 W. 42nd St., New York, N. Y. 10036.

CIRCLE NO. 403

### Sept. 23-24

Electron Device Techniques Conference (New York City). Sponsor: IEEE. Mayden Gallagher, Hughes Res. Labs., 3011 Malibu Canyon Rd., Malibu, Calif. 90265.

CIRCLE NO. 404

## OCTOBER 1970

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

### Oct. 7-9

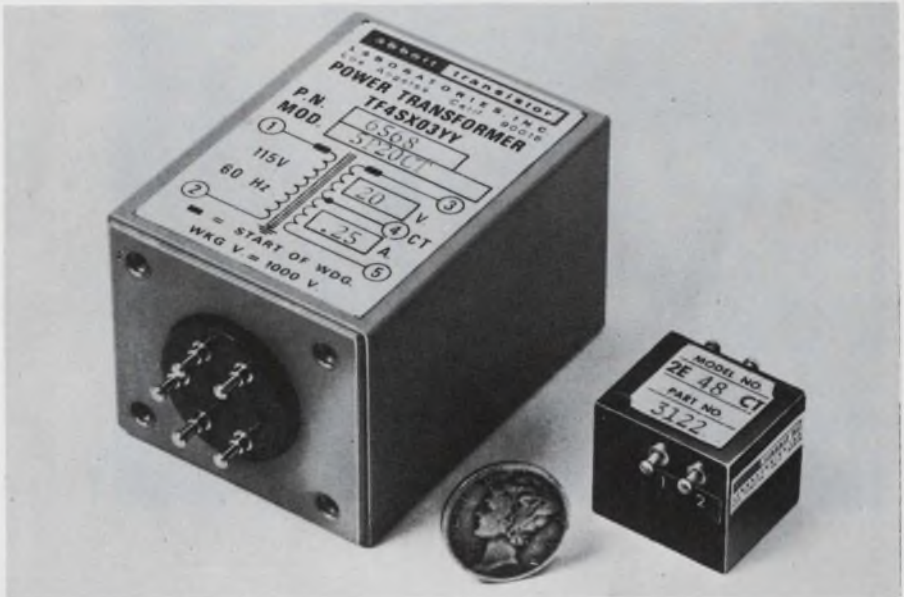
Allerton Conference on Circuit & Systems Theory (Monticello, Ill.) Sponsors: IEEE, Univ. of Illinois. G. Metze, Univ. of Illinois, Urbana, Ill. 61801.

CIRCLE NO. 405

### Oct. 13-15

International Telemetering Conference (Los Angeles). Sponsors: International Foundation for Telemetering, et al. J. Wayne Matthews, c/o Electronic Resources, 4561 Colorado Blvd., Los Angeles, Calif. 90030.

CIRCLE NO. 406



## If You Need A Power Transformer Tomorrow - Call Abbott Today

Now Abbott Stocks 60 Hz and 400 Hz Transformers With Output Voltages from 5 to 5000 Volts

Both the 60 Hz and the 400 Hertz transformers are built to meet the specifications of MIL-T-27B. Long life and reliability are inherent in these hermetically sealed, ruggedly built power transformers. The 60 Hertz line comes in a variety of even power ratings from 5 to 300 watts. The 400 Hz line comes in six power ratings from 2 to 175 watts. Most all of your power transformer needs can be found in this line of Abbott transformers.

	60 Hertz	400 Hertz
<b>Input Primary</b>	115 VAC, 60 Hz $\pm$ 5 Hz, 1 phase	115V, 400 Hz $\pm$ 20 Hz, 1 phase
<b>Insulation</b>	1750 VAC or 150% of secondary voltage (whichever is higher)	2500 VDC or 150% of secondary voltage (whichever is higher)
<b>Construction</b>	To MIL-T-27B, grade: 4, class: "S", life: "X" (10,000 hrs.), case: steel	To MIL-T-27B, grade: 5, class: "S", life: "X" (10,000 hrs.), case: smaller
<b>Environment</b>	To operate in 105° maximum ambient temperature. Encapsulated to meet MIL-E-5272C and MIL-E-5400H for vibration, shock, acceleration, sand, dust, humidity, saltspray, fungus, sunshine, rain, explosion, and altitude (to a vacuum)	Encapsulated to meet MIL-E-5272C, including vibration to Proc. XII, temperature to 105°C, shock, sand, dust, humidity, saltspray, fungus, sunshine, rain, explosion, and altitude (to a vacuum)
<b>Secondary</b>	From 5 volts at 1 ampere to 5000 volts at 32 milliamperes	From 5 volts at 400 milliamperes to 5000 volts at 35 milliamperes

A complete description of all of these power transformers together with their prices is contained in Abbott's 10 page transformer brochure, available FREE on request.

Please write for your FREE copy of Abbott's transformer brochure or see EEM (1969-70 ELECTRONIC ENGINEERS MASTER Directory) Pages 2848 to 2852.

**abbott transistor**  
LABORATORIES INCORPORATED  
5200 W. Jefferson Blvd./ Los Angeles 90016  
(213) Webster 6-8185 Cable ABTLABS

TO: Abbott Transistor Labs., Inc., Dept. 92  
5200 West Jefferson Blvd.  
Los Angeles, California 90016

Sir:  
Please send me your latest 60 Hz and 400 Hz transformer brochures:

NAME \_\_\_\_\_ DEPT. \_\_\_\_\_  
COMPANY \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY & STATE \_\_\_\_\_

INFORMATION RETRIEVAL NUMBER 8





...try a Teletype® 37  
...and look  
into mag tape!

We don't have a crystal ball. And rarely resort to mystic means in recommending what terminal should be used for a particular data communications application.

Some of the things, we at Teletype look at, that make the job a little easier are these:

- |                    |          |
|--------------------|----------|
| Distribution       | Volume   |
| Urgency of message | Language |
| Frequency of use   | Accuracy |

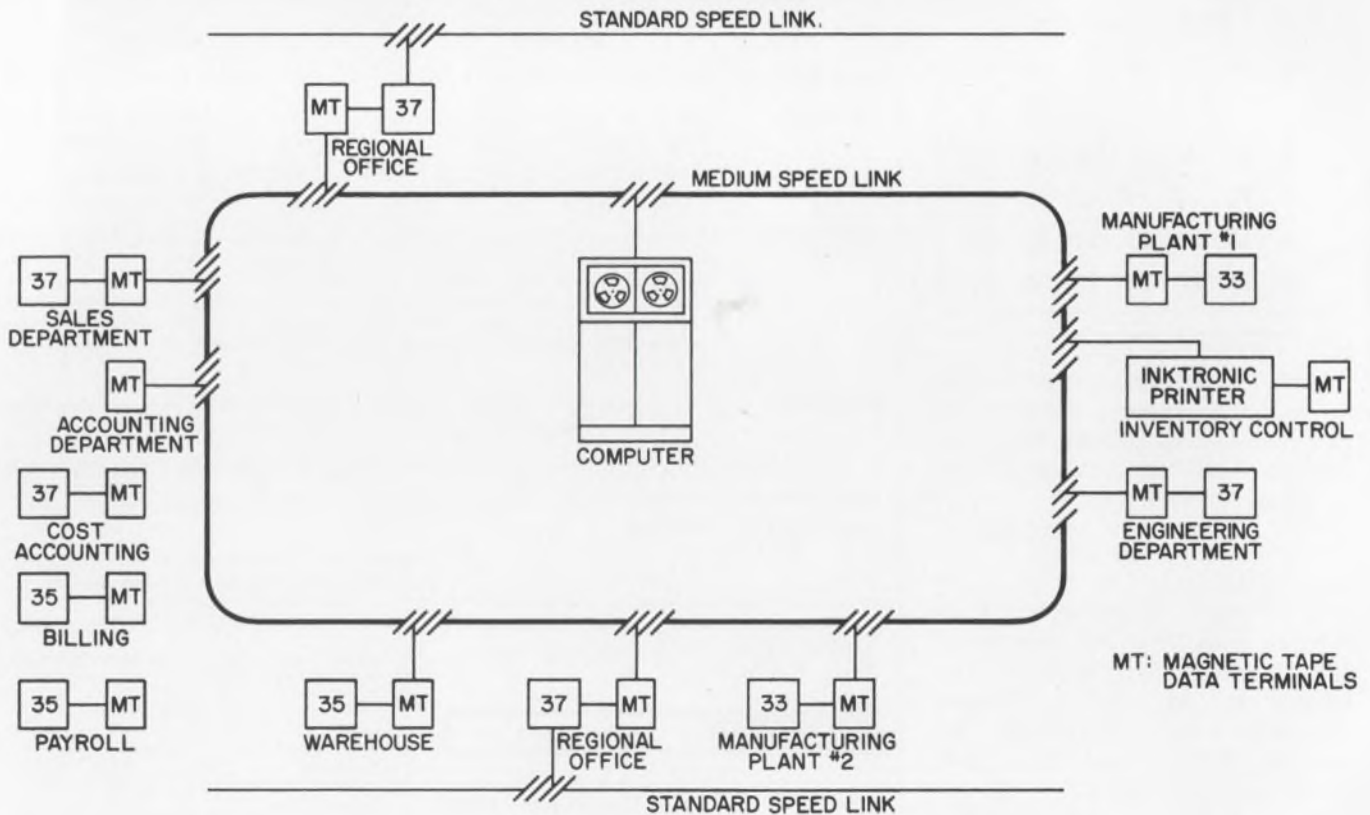
The diagram below demonstrates how you can fit a number of Teletype terminals

into a system based on function and usage requirements. Magnetic tape makes the speed and language of various terminals compatible. In this hypothetical case we use one computer program, one major line control procedure, one computer port, one type of data set per link. And deliver greater data through-put per on-line dollar. Using terminals that offer the best capabilities within each station's communication situation.

Using Teletype magnetic tape data terminals, combined with various Teletype keyboard send-receive sets, you obtain

some unique system flexibility. And the on-line time saving aspects of operation are really dramatic. Magnetic tape data terminals can keep data flowing on-line at up to 2400 wpm.

In the example shown, the manufacturer has linked sales, engineering, accounting and inventory control departments to a central office computer. As well as manufacturing plants, warehouse and regional offices. He's covered all critical data points with a common medium speed link, using a variety of terminals. Magnetic tape data terminals make it possible.



# DATA COMMUNICATIONS

equipment for on-line, real-time processing

Routine aspects of the system are maintained in standard speed links. Branch offices are tied into the regional office terminals on standard speed networks. Regional offices batch routine branch office data on one magnetic tape. Transmit the data to the central office processor at one time. Saving a number of additional computer port requirements.

Since data generated at manufacturing plants is urgently needed, but volume is low, low-cost model 33 terminals are used here. The warehouse data volume is higher, but not complex, so a heavy-duty model 35 is working here.

Volume requirements are heaviest in the accounting department. Cost accounting, payroll, billing and invoice payment functions generate data all day long. Here magnetic tape is prepared off-line at various terminals. And an on-line stand-alone magnetic tape terminal is used to transmit data to and receive data from the central processor.

Sales and engineering departments are equipped with Teletype 37 terminals. But for different reasons.

This terminal offers engineering people some unique format flexibility. Half-line and full-line forward and reverse line feed can be used to communicate complex equations and engineering formulae to the processor. It is possible to add special graphic engineering symbols to the normal compliment of letters, numbers and punctuation marks found in the typebox (up to 32).

The sales department uses the model 37 for order processing. It has on-line vertical and horizontal tab set control, and form feed platen (optional) which makes data transmission and reception on multiple copy business forms easy and economical.

At the inventory control point, this manufacturer has an urgent need to obtain printed page copy of large volumes of inventory items. Magnetic tape is used to feed data to the processor and a Teletype Inktronic® KSR set receives data and prints page copy on-line up to 1200 words per minute.

As you can see, Teletype's modular terminal design allows you to use vari-

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Teletype data communications equipment is available in send-receive capabilities of up to 2400 words per minute. If you would like specific information about any of the equipment described here, write: Teletype Corporation, Dept. 89-16, 5555 Touhy Ave., Skokie, Ill. 60076.



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machines that make data move



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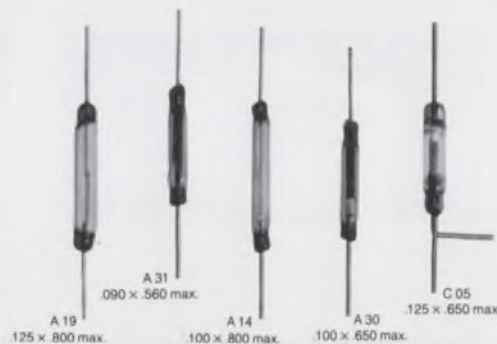


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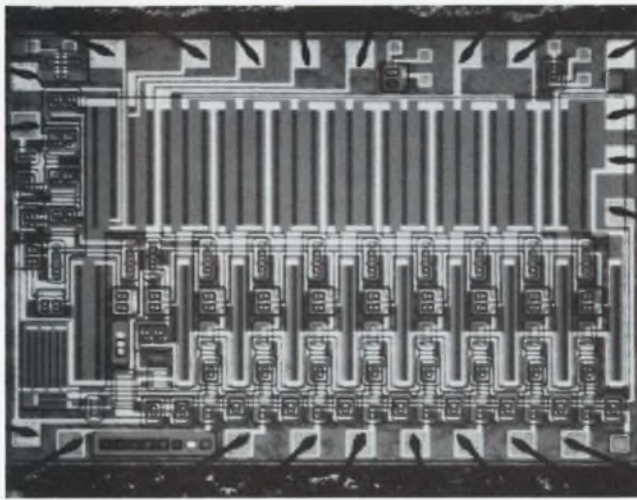
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# Highlighting

THE ISSUE

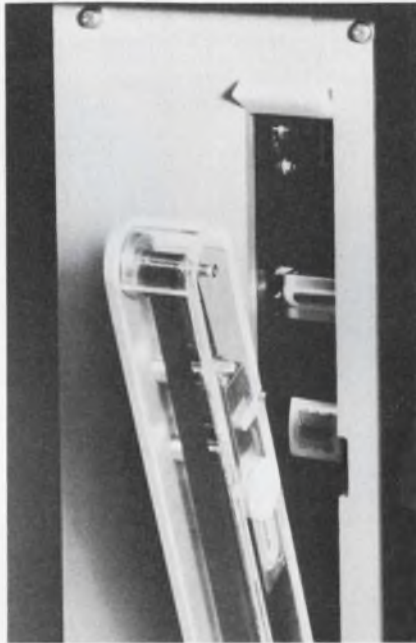


Monolithic random-access memory (RAM) devices offer new approaches for implementing read/write digital memories, but their use is sometimes overlooked because the design engineer lacks a general knowledge of their actual operation.

Basically, the RAM is a group of latches or storage flip-flops that store binary data in a digital system when the system is not using that data. Information can be randomly written into or read out of each flip-flop as required.

Author C. D. Talbert, shown above, an engineer in the Avionics Division of Bendix Corp., at Fort Lauderdale, Fla., tells how RAMs operate and how to select the device best suited to your needs.

**Page 70**



A new data storage system called Comfile provides the data access and organization styles of discs and drums at the low costs associated with magnetic-tape cartridge systems. At the heart of the new system is a 30-inch-long magnetic-tape loop capable of storing up to 72,000 characters of data. This stored data is accessible within an average time of 315 ms.

The magnetic-tape loop is completely enclosed in a magazine that is easily inserted into the drive mechanism. A file-protect mechanism—similar to a write ring in a reel-type drive—guards against inadvertent recording.

**Page 191**



A growing awareness that technology can help solve certain of the nation's most pressing civil problems is reflected at this year's Western Electronic Show and Convention in Los Angeles.

In addition to the regular technical program covering such areas as microelectronics, computers and microwaves, there are papers on ecology and water-pollution instrumentation, medical electronic equipment and earth-resources satellites. Also, Wescon is supplementing its 27-session program with a special two-day symposium on "Applying Technology to Public Problems."

**Page W2**



# Why DEC uses the Teradyne J133 to inspect incoming ICs

Digital Equipment Corporation, as the world's leading maker of small computers, knows the economics of incoming inspection as well as anybody. It knows that even with garden-variety ICs, defectives can easily run to 2 or 3 percent. Assuming 25 to 50 dollars to find and replace a bad IC in a logic module, you don't need a computer to figure out that even *one*-percent defectives can do a job on a balance sheet. So DEC subjects *all* its incoming ICs to



thorough testing. Lots are first sample-tested dynamically. Once a lot passes these tests, DEC puts every IC in that lot through a full battery of functional and dc parametric tests. And it manages these dc and functional tests with an instrument that isn't much bigger than a breadbox and that costs less than a Cadillac. The instrument is a Teradyne J133.

Why did DEC choose the J133 from among the many IC test instruments available?

First, because it is so easy to use and program. Plug-in PC cards do the job, and DEC doesn't have to worry about getting stuck for a program: Teradyne offers cards for over 1000 different ICs.

Second, it is economical. At only about \$5000 apiece, DEC's pair of J133s paid for themselves in a few weeks.

Third, it is handler-compatible. One of DEC's J133s works with a 4800-unit/hour Daymarc handler, taking bowl-fed ICs and putting the bad ones where they belong — in reject bins.



Fourth, it is protected against obsolescence by a strong applications-engineering program at Teradyne and by the continuing development of new program cards to test new devices.

Fifth, it is backed up by a 10-year warranty from a service-conscious manufacturer. If trouble does occur, Teradyne moves fast to keep downtime down.



If you would like to know reasons six, seven, eight, etc., your local Teradyne sales engineer would be delighted to take up the count with you. And if you want a closer, faster, more economical look at your incoming ICs (or transistors or diodes or capacitors or resistors), Teradyne has the answer.

Teradyne, 183 Essex St., Boston, Mass. 02111.

## Teradyne makes sense.

INFORMATION RETRIEVAL NUMBER 14

# News Scope

## DC-10 getting set to fly with 'first' in electronics



*Santa Monica, Calif.*

With advanced guidance for automatic landings in zero-visibility weather, an on-board computer and a color CRT cockpit display among its electronic highlights, the first McDonnell Douglas DC-10 is undergoing taxiing tests prior to making its maiden flight.

If the guidance system is approved by the Federal Aviation Administration, the DC-10 will be the first transport in airline service to fly in Category 3b conditions—zero visibility for landings. The DC-10 is McDonnell Douglas' entry in the jumbo-jet field.

The guidance that allows automatic landings was developed by the Bendix Corp.'s Navigation and Control Div. in Teterboro, N.J.

The computer and the color CRT display—also firsts in airline service—were manufactured by Honeywell's Aerospace Div. in Minneapolis. The cockpit display gives the pilot a symbolic runway with a predicted point at which the plane will touch down. The computer incorporates a digital control system that evaluates sensor data from 13 avionics systems.

To convert pressure inputs to digital frequency-modulated signals, the computer system uses a solid-state pressure transducer with a silicon wafer diaphragm. Two piezo-resistive elements are diffused in the face of the wafer to

control two oscillators. The oscillators generate the signals that are fed to the computer.

Honeywell points out that integrated circuitry is used extensively in the design to increase reliability and reduce complexity.

The computer provides control and instrument output signals by monitoring altitude, airspeed and temperature. And, according to Boris Boskovich, program manager in Honeywell's Aerospace Div., the system will also predict the performance of the automatic landing system as much as 150 seconds ahead of time, based on signals from radios, altimeters and inertial sensors.

Almost 20 feet wide and 182 feet long, the DC-10 accommodates 345 passengers. McDonnell has orders for 237 aircraft. Each plane costs about \$15-million.

### ABM expansion facing showdown next month

The battle in Congress to expand the Safeguard ABM system beyond the four sites already included in a general \$1.3-billion appropriation bill has temporarily receded while forces in the House and Senate regroup.

The House has approved a \$305-million addition for further expansion, but the Senate Armed Serv-

ices Committee has voted to lop that outlay from the bill. The House-approved bill calls for construction of one more site and planning for three others.

The Senate is expected to vote on the general appropriation by mid-September, and then Senate doves hope to bury the entire Safeguard program. Even without the \$305-million addition, there's little confidence the bill will pass easily.

### Who'll be NASA chief? 4 are called possibilities

The resignation of Dr. Thomas O. Paine as head of NASA caught Washington by surprise and has triggered the ever-popular Potomac game of picking a successor before the President does. At least four names are being bandied about.

Names in the running to replace Paine include NASA's deputy administrator, Dr. George M. Low, who was acting director after Dr. James Webb resigned in October, 1968; Air Force Secretary Robert Seamans; Dr. Hilliard Page, president of the General Electric Space Div., and Dr. Wernher Von Braun, now NASA's planning director.

### The computer auction gets its start in U. S.

A Univac 1107, valued at about \$2-million when new, could have been bought for \$50,000, and an IBM 7094 system, with an original price tag of \$2.3-million, had a knockdown price of \$15,000.

But the first public auction of used computers and peripherals proved to be a flop in New York City, in spite of a standing-room-only audience. The problem was that many came to watch, and few were prepared to buy.

Time Brokers, Inc., a computer equipment brokerage house, sponsored the auction in cooperation with Parke-Bernet Galleries, Inc., an auction house usually associated with art offerings. Time Brokers was seeking a new outlet for used computers, and Parke-Bernet was interested in expanding its horizons.

Over ninety lots were offered, including the Univac 1107 and IBM 7094. No bid was entered for



either of these. Two minicomputers were sold, one for \$7,000 and one for \$9,000. The highest price paid for any item was \$52,500 for an IBM 360/20. It was rumored that the buyer was the original seller, who feared that the price was too low.

Despite the setback, it appeared that computer auctions had arrived in the U. S. to stay.

The sale was held July 30, the same day that Standard Prudential Corp., a diversified financial services company, announced that it would open soon in New York City a permanent trade center specializing in the auctioning of computer equipment. The center is to occupy the 10-floor building at 226 West 26th Street, owned by the New York Auction Company, a division of Standard Prudential.

"New York Auction is keeping abreast of the times by changing from auctioneers for fur traders since 1916 to computer auctioneers," said Theodore H. Silbert, chairman of Standard Prudential. "As one industry becomes history, we are pioneering in another."

The disappointing showing at Parke-Bernet was attributed variously to the economic slowdown, smog or the summer doldrums. Both Time Brokers and the art-auction gallery said they hoped to try another sale when the time seemed more propitious.

## New aerospace computer features compatibility

A new military aerospace computer that is software-compatible and input/output-compatible with its commercial prototype has been announced by the Honeywell Aerospace Div., St. Petersburg, Fla.

The military computer, the HDC-601, is totally compatible with the DDP-516, produced by Honeywell's Computer Control Div., Framingham, Mass. Clinton M. Crabtree, director of computer products at the Aerospace Div., says:

"With this new concept, the cus-

tommer does not have to wait for delivery to begin programming. He can do his software work on an existing DDP-516 and be ready to operate when the HD-601 arrives."

Although the two machines are compatible, they are not at all alike. The aerospace machine weighs 30 pounds and occupies 0.7 cubic foot, compared with 250 pounds and 30 cubic feet. The memory of the HDC-601 may be either ferrite core or plated wire. All current production, however, calls for plated wire, which is favored because of its inherent non-destructive read-out characteristic.

## Aerospace concerns hail fly-before-buy proposal

Changes in Defense Dept. procurement recommended by a Presidential commission—from "total package" procurement to "fly before you buy"—have stirred the hopes of the aerospace giants.

"Anything is better than total package procurement" is the general attitude of most.

According to a spokesman for Lockheed, the industry has not yet had a chance to review the entire report of the commission, but the proposed policy "has to be an improvement over total package procurement—that kind of award was catastrophic for the industry."

North American Rockwell's president, Robert Ander, sums up the case against total package procurement this way: "As an automotive man [Chrysler], I was amazed by my first encounter with the total-package procurement concept . . . [It] not only delayed the procurement of many needed systems and equipment, but it also fostered an utterly unrealistic budgeting process. Can you imagine an automobile manufacturer contracting at a fixed price to deliver a model 1977 automobile six years from now."

## Lasers help identify air-pollution gases

Lack of a simple, fast way to measure smog particle sizes and motions precisely, and to determine the types and magnitudes of the pollutants, has hindered the battle to clean up the air over big cities.

But two new pulsed-laser instruments—one developed at the Polytechnic Institute of Brooklyn, the other at the General Electric Space Technology Div., Valley Forge, Pa.—may provide solutions.

A pulsed laser to identify and measure concentrations of pollutant gases has been announced by the Brooklyn institute's graduate center in Farmingdale, N. Y.

Conventional methods of running an analysis to find out what gases are in a mixture can take hours.

"With the pulsed laser," says Dr. Samuel Lederman of the Brooklyn institute, "instantaneous measurements can be made using Raman scattering."

General Electric's laser measures the concentration and motion of air-pollution particles, according to Dr. Fritz Mezger, manager of advanced studies in the company's Space Sciences Laboratory. A laser and a receiving telescope are aligned on the same optical axis. Light reflected by smog is collected by the telescope and focused on a photomultiplier tube. The photomultiplier output gives backscattered light as a function of laser range.

## Custom LSI at low cost promised by Motorola

Motorola's Semiconductor Products Div. has opened a new center in Mesa, Ariz., for the design and manufacture of custom large-scale integrated circuits.

At the dedication ceremonies, Stephen L. Levy, vice president and general manager of the division, promised that the new center "will permit custom circuit design at a rate of a new design a day by 1971."

With the help of computer-aided design—in which a small, inexpensive computer will be used for test generation and layout programs—Levy promises "the lowest fixed design costs in the industry."

He said the center would provide customers with prototype delivery of LSI parts in 10 to 14 weeks. And he described "an expandable system that is capable of delivering MOS/LSI designs now, and will be expanded to provide similar capabilities for bipolar logic designs in the near future."





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# Do R&D cuts peril U.S. lead in electronics?

Some engineering educators say they do, others aren't worried, but all agree research is essential

John N. Kessler  
News Editor

Cutbacks in federal support of research and development may cost the U. S. its future leadership in advanced electronics, says Dr. Harvey Brooks, Dean of Engineering and Applied Physics at Harvard University.

Brooks, who expressed concern for the general climate of technological innovation, told *ELECTRONIC DESIGN*: "At a time when the United States shows signs of losing its technical leadership, particularly its advantage in foreign trade, it doesn't seem to be a very wise thing for the Government to be cutting back on its research program, particularly in engineering and more applied areas."

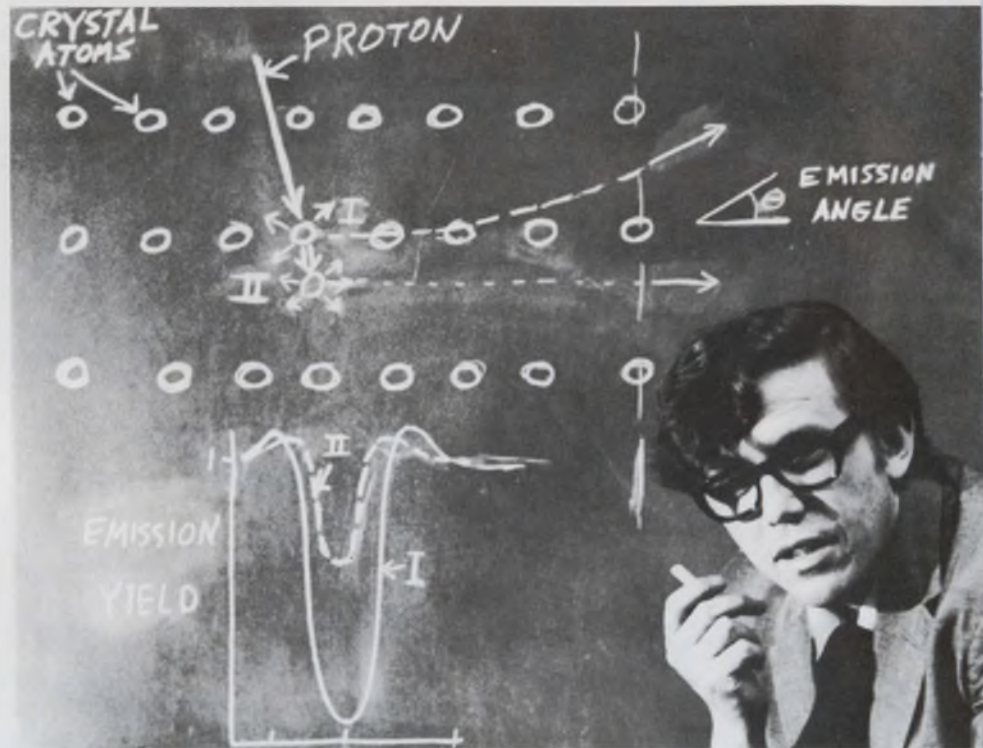
But Dr. Eric Walker, president of Pennsylvania State University and former president of the National Academy of Engineering, isn't alarmed. He told this magazine: "It's high time we've had a shake-out to make sure that what we're doing really is relevant."

## \$53-million slash due

The two opinions represent the opposing poles in a sampling of reaction to Government cuts in R&D funds for colleges and universities. The Bureau of the Budget reports that such spending totaled \$1,471,000,000 in 1969. For 1970, the estimated figure is \$1,418,000,000, down \$53-million. For 1971, the amount planned is \$1,532,000,000, but the increase will go to solve social problems rather than to further basic engineering and scientific research.

At Harvard, federal research funds were cut about 10% in 1968-1969 and, according to Dean Brooks, they will be down 10 to 15% more this year. "This," he says, "represents an even larger cut in effective work, because of the increasing cost of research."

At the other extreme, Penn



Reductions in federal support of research and development at colleges and universities will curtail the supply of PhDs in science and engineering. Scientists like W. M. Gibson (above) of Bell Telephone Laboratories, Murray Hill, N. J., create theories vital for electronics technology.

State's president reports that its budget has suffered little from federal cuts of approximately \$2-million in a research program that totals \$40-million this year. The state of Pennsylvania has made up the difference, Walker explains.

In between, the reactions are somewhat more moderate, but they tend toward pessimism. Dr. Francis H. Clauser, chairman of the Div. of Engineering and Applied Science at California Institute of Technology, says that "ceilings have been placed on funds, and you can't look forward to a climate of growth." Like Brooks, he voices concern for the work of young engineers who do not yet have an established reputation.

In commenting about technologi-

cal innovation at Cal Tech, Clauser says: "Certainly we don't have the atmosphere we had here 10 or 20 years ago, in which there was enough growth so that all segments of the scientific and engineering community were able to find support for good work. Now the funds are limited."

At the Polytechnic Institute of Brooklyn, the cut in federal support of graduate research fellowships is causing concern. "This is serious," says the Dean of Research, Frederick R. Eirich, "because it reduces the trained manpower four, five, six years from now."

According to Eirich, the United States has been leading the world in electronmicroscopy, computers,



supersonic flight and radio astronomy. But, he says, Japan, Germany, the Soviet Union, Britain and France recognize the importance of research in these fields and have become serious contenders to American leadership.

"The best electron microscope," says Eirich, "is not being built here, but in France. And the best computer facilities in a few years will probably be in England."

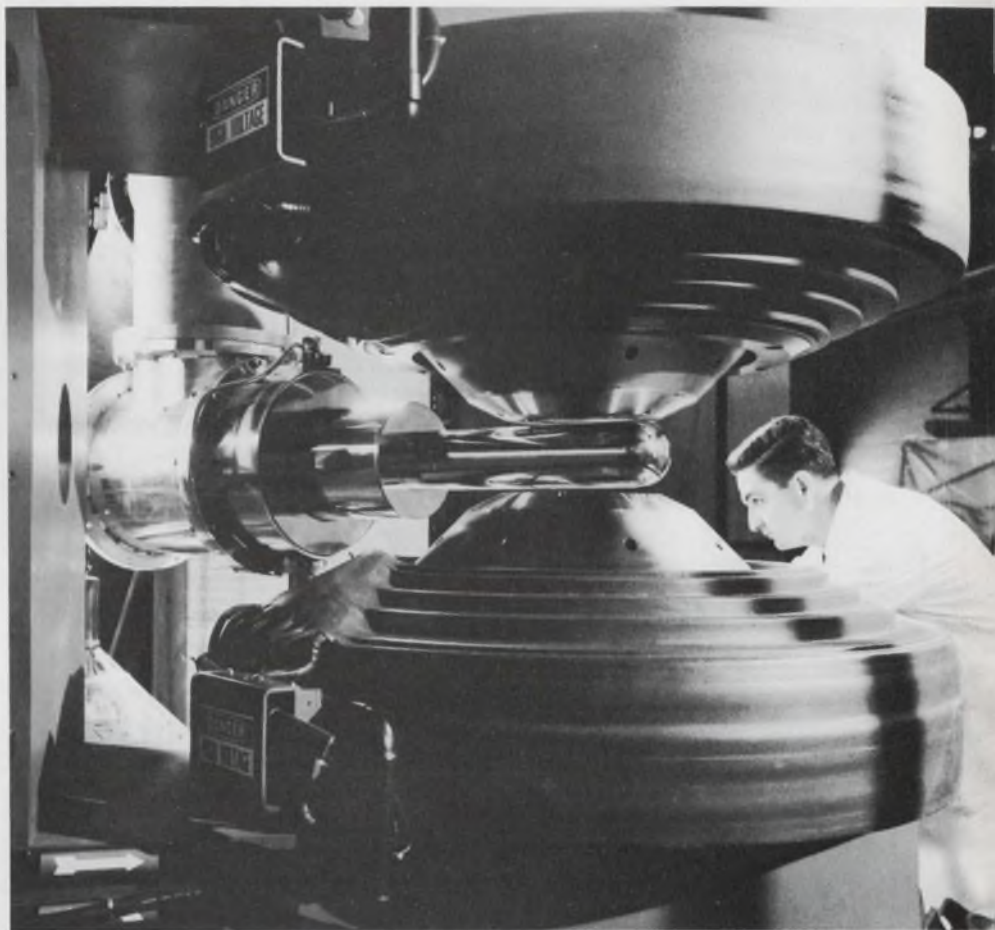
Government agencies, such as the Dept. of Defense, the Atomic Energy Commission and the National Aeronautics and Space Administration, have been forced to cut their academic support as budgetary economy measures. As a result, Eirich says, "we are going to lose [over an 18-month period] almost 30% of our graduate fellowships." And since this is happening at engineering colleges throughout the country, Eirich sees serious consequences for the United States.

"We have lost already—in three or four important fields—the technological leadership of the world, and in 10 years we will have lost more," he says.

### Effect on world trade cited

This is also the view of Dr. Chauncey Starr, Dean of the School of Engineering and Applied Science at the University of California at Los Angeles and vice president of the National Academy of Engineering. "The very serious depletion in our technological resources, as represented by the highly educated scientific and engineering manpower, shows up in our inability to complete internationally in new technologies," he says.

Starr mentions Japanese TV and miniature calculators as being not only as good as American products but, in many instances, better. "Japanese optical goods," he says, "from the point of view of price



Here at Argonne National Laboratory in Illinois, the AEC cuts will total about \$300,000. But the AEC's total high-energy physics budget is down from \$120-million to \$119-million. With the costs of research going up, the net effect is much more than the \$1 million cut would indicate.

### U.S. R&D spending, at a glance

*Federal support of R&D in colleges and universities, as reported by the United States Government:*

	1969 (actual)	1970 (estimated)	1971 (estimated)
HEW	663 (millions)	617 (millions)	678 (millions)
NSF	210	225	270
Defense	247	223	220
AEC	101	100	97
NASA	128	110	88
Agriculture	62	70	81
All others	60	73	98
Totals	1471	1418	1532



**(R & D cuts, continued)**

and quality, are the best of anything we have."

Shipbuilding, he notes, is another example of Japanese ingenuity. "It's not just the cost of labor; it's the fact that they are using more advanced technology in their manufacturing," says Starr.

As an example of the relationship between advanced engineering and international trade, Starr gives this illustration: "The biggest production problem with integrated circuits is their rejection rate. If we had the best advanced engineering and scientific skills brought to bear on that problem, we could come up with an improved production technique." This, he says, would lower total cost and make U.S. electronic products more competitive in world markets.

**A shift to social concerns**

Starr is not overly impressed by the rise in federal spending planned in 1971. According to a spokes-

man for the Bureau of Budget, that \$114-million increase will be used to "assist those who wish to undertake research within or across disciplines related to a better understanding of the problems faced by contemporary society."

"Practically every graduate engineering school in the country has almost 80% of its support coming from the Dept. of Defense," Starr says. And this support, he points out, will drop a little over 10% in three years, while the cost of supporting the same work goes up roughly 15 to 20%.

The Atomic Energy Commission, another big supporter of university engineering research, will drop its support by 5%, but with inflation, the net effect will be about 20%, Starr says.

"The NASA cut," he continues, "will represent close to a 50% real cut."

What about increased amounts planned through the Dept. of Health, Education and Welfare? Starr contends that UCLA doesn't get much support from that department, and never has.

Cuts in the Atomic Energy Com-

mission's high-energy physics budget have resulted in depleted operating funds for some of the nation's giant particle accelerators. The total high-energy physics budget is down from \$120-million to \$119-million for fiscal 1971.

By terminating operation of the 3-billion-electron-volt Princeton-Pennsylvania Accelerator at Princeton, N. J., in June, 1971, the AEC will trim off \$2 million; funding for the 6-Bev Cambridge Accelerator in Massachusetts will be cut from \$3.5-million to \$2.4-million; and budgets have been trimmed at Argonne National Laboratories, near Chicago, and at Lawrence Radiation Laboratory in Berkeley, Calif.

The National Science Foundation (NSF) in its 1970 Report on the Physical Sciences discusses the connection between esoteric concepts and practical applications. It notes, for example, the effect of solid-state physics on the development of the computer.

A spokesman for the foundation puts it this way: "Basic research is the mother of applied research and development." ■■

## Industry links R&D to creative engineering

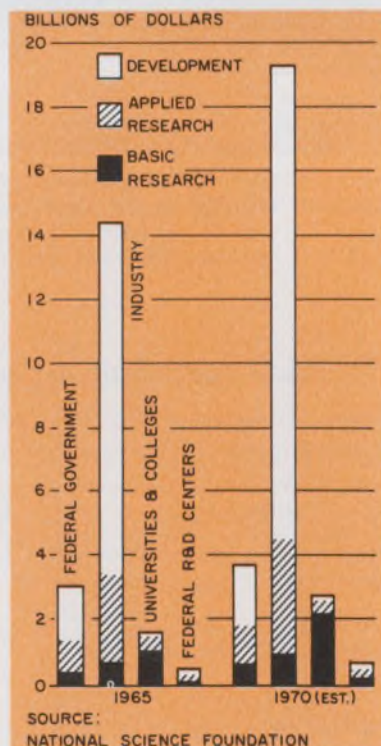
How is industry reacting to federal cuts in R&D spending?

If industry is going to be inventive, if it is going to create cheaper ways of doing things, it must have bright young PhDs in science and engineering, says Dr. Albert M. Clogston, director of physical research at Bell Telephone Laboratories, Murray Hill, N. J.

Clogston is concerned that federal cuts in R&D at universities will limit the number of fellowships and traineeships and indirectly reduce manpower for industrial laboratories.

But focusing on R&D cuts and the current economic downturn in the U. S., Lee Davenport, president of General Telephone & Electronics Laboratories in Bayside, N. Y., doesn't see any long-range damage to electronics growth.

He does admit that the pace of R&D is slowing, and he says:



R&D spending for 1965 and 1970.

"There is an increased emphasis on projects that will place a product in the market promptly."

"Employment is down," according to Davenport, "but not appreciably." And GT&E Labs is looking to hire younger people who can generate and accept new ideas in the research and development area.

Also he notes a shift "toward more systems-oriented people having broad skills in electronic systems, as applied to telephony, communications and the like."

Industry plays a crucial role in the R&D pattern, because it conducts about 70% of all research and development in the nation, according to the National Science Foundation. While the figure for Government R&D has remained essentially the same, or has increased slightly, in the last five years, it has not kept pace with the rising cost of research, according to a spokesman.

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# Improved electronics at weapons range puts Navy on target

Story and photographs  
by John F. Mason  
Military-Aerospace Editor

A target drone streaks through the blue Caribbean skies a few miles northwest of Puerto Rico, passing low over an aircraft carrier. A Terrier missile lunges from the carrier and misses by feet. The orange pilotless aircraft, flying at nearly the speed of sound, makes a sharp right turn and comes back for another pass. This time the missile almost intercepts. The misses are measured for distance by a doppler sensor in the drone and the information is telemetered back to the Navy's Atlantic Fleet Weapons Range headquarters at Roosevelt Roads on Puerto Rico's western tip.

The drone operator, sitting in a small control room in the headquarters building, guides the drone by uhf radio toward a destroyer a few miles away to test the missile skills on the ship.

Next door to the drone room, in the large Range Operations Center, the whole sea range exercise is carried live—or only microseconds old—on one of the most sophisticated large-screen displays the military owns. The sea range, which lies both to the north of Roosevelt Roads in the Atlantic and to the south in the Caribbean, covers a total area of 195,000 square miles

Besides the open sea range, where airborne drones provide target practice to ships and fighter planes and radio-guided boats serve as targets for surface-to-surface



weapons, Roosevelt Roads manages two other ranges. A few miles to the west an inner range, consisting of 60 miles of islands, cays and rocks, provides targets for bombing, strafing and amphibious attacks. And a 16-square-mile underwater range at St. Croix is available for submarines and surface ships to test torpedoes, Asroc rocket-torpedoes, sonar and other equipment.

All three ranges offer realistic training to 46,500 Navy men who go there every year to sharpen their weapons delivery skills. The ranges are equipped with electronic sensors to some extent and are automated in varying degrees. The manual portions are constantly being updated and facilities for new services are being planned.

An elaborate underwater tactical range, for example, is going to be built so the Atlantic Fleet can carry out thorough, well-monitored

antisubmarine warfare exercises just west of Roosevelt Roads.

New floating hydrophone target arrays are to be built in the open sea so that more strafing and bombing practice can be carried out when all the target rocks are in use or being repaired.

A phased-array radar is also being requested that will double the reach of the present surveillance radar and more than double its capabilities.

Besides the drone control room at Roosevelt Roads, the pilotless planes can be controlled from sites on St. Thomas and St. Croix in the Virgin Islands. All three drone stations have acquisition and tracking radar, as well as microwave radio links with each other and to a computer in headquarters for the large-screen display.

"What we need now—or by the January, 1973, deadline the Navy has given us—is a system that will send six drones over the horizon from different directions to surprise an unsuspecting ship," says Don Duckworth, range development engineer. "At present we can control only four, and those must be within line-of-sight."

Over-the-horizon control appears to be the answer, Duckworth says, probably using an airborne data link aircraft.

"We could control a drone by hf," Duckworth says, "but you need to see it to know where you want to



## Culebra is vital to Navy weapons range

The Atlantic Fleet Weapons Range, despite its vast size, is an intricately designed complex. The sea and land areas used as targets and for observation posts, command and control stations, and communications links, have been carefully selected.

Choosing, or in some cases designing, electronic sensors for the complex, tying them together with telemetry and communications, and then providing a data-processing system with displays, has been a major engineering effort. The result is valued at \$250 million and \$300 million.

Duplicating the system now would cost far more, even if there were another complex of uninhabited small islands and rocks with a suitable configuration—and belonging to the United States—to which we could go.

To close down one of our key areas in the range—the island of Culebra, inhabited by approximately 726 people—and its surrounding uninhabited rocks



Protesting the Navy in San Juan

and cays would cripple the range where some 46,500 Navy men train each year. To move part of these facilities to a new island over the horizon, as was first suggested by some of the Culebrans and now by other groups in Puerto Rico, would be an enormously difficult and expensive engineering feat. I believe an electronics design engineer can readily see this.

New microwave communications links could, of course, be built. New radars could be installed, but the cost, engineering complexities and degraded

accuracies of monitoring aerial practice bombing, strafing, and gunfire from surface ships from a site many miles away on the other side of a hill, would be staggering.

The only change the Navy is proposing to the Culebrans, who have shared the uninhabited part of their island with the Navy for 68 years, is to lease 2,200 acres of additional land on the island where only five houses now stand. The land would serve as a safety zone against remote miscalculation in practice bomb runs that are made on the uninhabited, five-year-old bombing target of Ladrón Cay, 3/4 mile off Culebra's northeast coast. This land would continue to be available for farming and cattle raising.

Capt. R. L. Johns, U.S. Navy Commander Atlantic Fleet Weapons Range/Fleet Air Caribbean

go. The aircraft could relay radar position data but only from one drone at a time. We must have multiple control."

Several methods are being studied. One calls for the drone to be equipped with a navigation system, such as loran, and to telemeter its position to the control room. "This would be very expensive," he says, "and is going the wrong way. We want cheaper

drones, not more expensive ones."

Another approach is for the drone to send continuous telemetry data that tells its speed, heading, turns, and other maneuvers, while a computer in headquarters calculates its position. This amounts roughly to having the data-processing portion of an inertial guidance system on the ground.

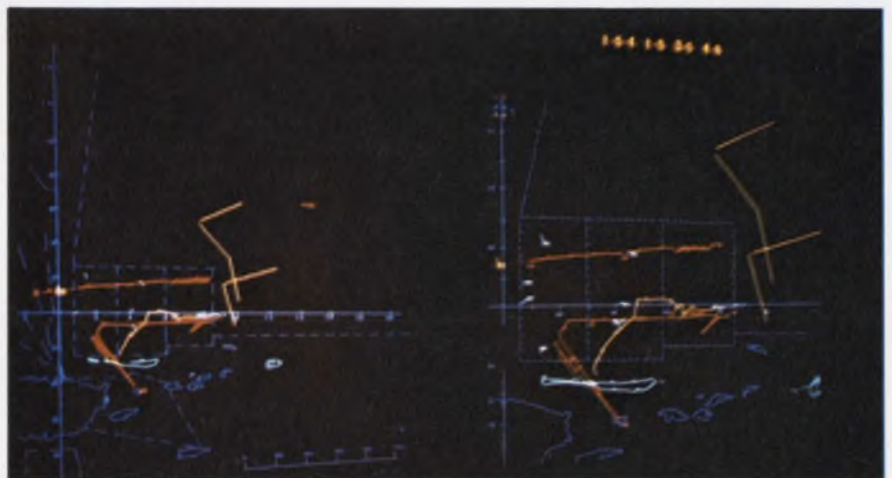
A third approach calls for a beacon in the drone that responds

to two surface-based, pulsed and timed transmitters. The return signals would provide two ranges from known sites, thus revealing the drone's position.

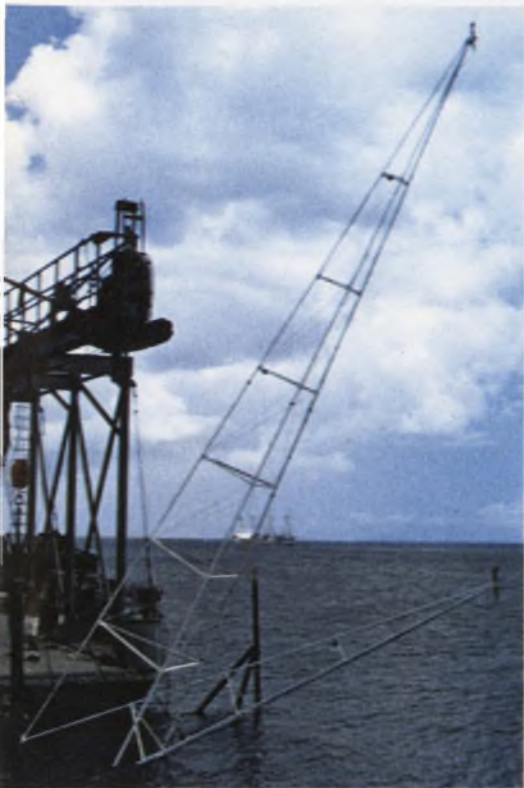
The Navy's need for more multiple-target training by 1973 and more antisubmarine warfare exercises may bring in a phased-array radar to help out the conventional surveillance radar and the height finder that now sit on Pico del Este



Three 7-by-7-foot translucent screens present in six colors the positions and tracks of ships, aircraft and drones on the sea ranges to the north and south of Puerto Rico. The information is fed both through a computer and manually by operators at consoles. Projection is from the rear of the screen.







At the underwater tracking range off St. Croix, 11 hydrophone arrays (similar to the one at left) are anchored at the bottom of the sea, where they track with great precision any moving object that is equipped with a time-synchronized pinger. Ships evaluate their new torpedoes, Asroc rocket-torpedoes, their sonar and other gear. Much of the show is run from a console (below).



is going to be improved. At present, words go from the Univac 1230 computer to an interface buffer. The buffer takes the word, processes it and sends it to a digital-to-analog converter. From there it goes to a symbol generator, which is a photoelectric device. The output from this device is amplified and fed to the synchronizers in the projectors, which plot the data.

"The only part of the system that gives us any trouble," says Chief Warrant Officer William Tarvin, "is the photoelectric device we use as a symbol generator. If anything breaks down, it's this device. It's a mechanical monster."

"Right now, we've got an analog system from the interface buffer to the projectors," Tarvin says. "We are going to get rid of the symbol generator we have now and replace it with a small general-purpose computer. This will give us a digital system from the big Univac computer right up to a digital-to-analog converter at the projector. The computer will contain the instructions to generate the symbology that we want. This will give us only one analog step—from the converter to the projector."

#### Air-to-ground and ship-to-shore

On a complex of islands, cays and rocks, some 20 miles west of Roosevelt Roads, Navy aircraft deliver their rockets and bombs, and ships bombard the shore with shells and torpedoes.

The rock called Fungy Bowl, 700 by 300 feet, rising to a height of 180 feet, makes an excellent high and low level radar target. It is also illuminated at night.

Culebrita Island, which has a 300-foot hill, a lighthouse and a sheer cliff, provides a number of functions. It has six banners mounted on poles that are used for strafing, and it is equipped with acoustic devices that report the success or failure of the strike by wire to the lighthouse observation post up the hill.

The most sophisticated setup, and the one that points to the future, is the way the observation post on Luis Peña Cay works with the nearby target of Agua Cay. Luis Peña is equipped with a modified Nike Ajax radar that monitors the over-the-shoulder, or loft bombing,

mountain, east of Roosevelt Roads.

Used by both the Navy and the Federal Aviation Administration, the radars have a range of 150 miles for air targets and 50 miles for those on the surface. A phased array would double this range and could track at least eight surface targets and seven airborne targets at a time.

#### News from the range

The big push in the range telemetry facility at the moment is to convert from vhf to uhf by October. Two of the new 16-foot tracking antennas are installed and a third is on the way. The 6-foot antenna and receiving system is also in place. Because the radio horizon for the antenna for surface-to-air missile operations is only about 27 miles, airborne data-link aircraft are used to relay information.

"Moving to uhf frequencies, which are 10 times higher than the present vhf frequencies, changes operating procedures considerably," says the facility's senior analyst, D. C. Gibson.

The receiving antenna must be physically larger to intercept approximately 100 times more radio energy than that needed at vhf.

"This, of course, results in great-

ly reduced antenna beam width," Gibson explains. The uhf antennas will have a 2-degree beam width compared to the present 35-degrees width.

"At a range of 50 miles, the present vhf antennas provide coverage over a 62,000-yard-wide cone. The uhf antennas will cover a 3400-yard cone."

On a typical day, the sea range might be the scene of an antisubmarine warfare exercise involving a submarine, surface vessels and aircraft. There will be surface-to-air missile shoots, dog fights with air-to-air missiles, and bombing runs on surface drones.

All this is carried live, or only microseconds old, on three large screens in the Range Operations Center. Ship commanders and other VIPs watch on translucent, 7 by 7-foot screens, in a vivid six-color presentation, the positions and tracks of ships, aircraft and drones.

Data is fed to the three rear-screen projectors by near-realtime digital computers (Univac 1230) and manually by radar operators seated at consoles in front of the screens. Called Vigicon Display, the system was built by the Nortronics Div. of Northrop Corp., Hawthorne, Calif.

As effective as the display is, it



and dive bombing on the 150-yard-wide rock, some 800 yards away.

"Here's the way, we work it," explains Tarvin. "A plane comes toward Agua Cay at about a 2000-foot altitude. The radar at Louis Peña locks on. From the radar, we get the plane's range and bearing, its altitude, speed and dive angle.

"When the pilot releases the bomb, he automatically triggers a tone to us by uhf radio. We then calculate where the bomb would hit. This data is then sent by microwave back to Roosevelt Roads to the drone control room. It's displayed on the same 36-inch by 36-inch displays that show the drones over the sea range."

This much automation is good, Tarvin explains, but more is needed. "Instead of having to calculate where the bomb dropped, we would like hydrophones around Agua Cay with cables to Louis Peña. This would give automatic, precise scoring information. For targets farther from the observation post, microwave links could be used instead of cables."

A hydrophone target in open water has advantages over hydrophones around a rock, says Duckworth. "Dive bombing beats the rock up pretty badly, and we have to put a bulldozer on it to smooth it out. Then we have to repaint new targets. A hydrophone array, on buoys, would solve this problem.

"Floating targets should be in shallow water to permit repair by scuba divers," Duckworth says. "And no more than seven miles from shore. Beyond this calls for elaborate and expensive amplifiers which require maintenance."

Work on the hydrophone array for Agua Cay is already under way. Upgrading a second target may begin soon.

Construction of a large 3000-yard, open-sea target equipped with hydrophones is also planned. It will have changeable targets and will be used for antisubmarine warfare exercises.

### Evaluating the underwater gear

Off St. Croix a three-dimensional—air, surface and underwater—tracking range is available. With the aid of 11 underwater arrays, each equipped with four hydrophones, 20 underwater targets can



Culebra's uninhabited peninsula makes an ideal target for ship-to-shore bombardment. Men at the observation post (foreground) score the gunner's skill by watching with binoculars and calling in results by uhf radio. Scoring on most of the target rocks and islands is not as automated as the Navy would like. Observers (left) talk with other posts via uhf, to civilian aircraft by vhf and to ships by hf.

be tracked simultaneously. Radar and theodolites track objects on the surface and in the air.

Torpedoes can be tracked from water entry to the end of the run. Sonar detection can be evaluated using torpedoes, submarines and surface ships as targets.

Objects to be tracked underwater must be instrumented with a pinger, consisting of a precision electronic countdown circuit, amplifier and acoustic transducer.

Pingers of all tracked objects are synchronized to a central-range timing system by a radio link, receiver and synchronizer. Approximately every 1 1/3 seconds, each object puts a 1.5-ms pulse into the water at 75 kHz. The acoustic energy travels through the water to the array of hydrophones from which the signals are hardwired ashore. They are amplified and the travel times fed into the facility's SDS 910 computer. Travel times are known because a synchronous timing system is used. The position is then displayed on a 30-inch by 30-inch Milgo plotting board. The delay is only about 2 1/2 seconds.

At the moment, two of the hydrophone arrays are being pulled up and new ones put down. The old ones were damaged by lightning during an electrical storm.

"We have such a good ground

system," explains Fred R. Berloga, manager of the underwater range, "and the rest of the island such a poor one, that when the high voltage surge occurred it drained right through us, down to our arrays and burned two out."

The new arrays are different from the old ones. While both consist of four hydrophones 30 feet from each other, the old ones floated above the bottom, their tilt in the current being measured by a pendulum potentiometer. Unfortunately, the potentiometers degraded in time and the readings became less accurate.

The new arrays are fixed on the bottom, even though the bottom is not level. The reason this freedom is possible is that computer software has improved so that, when the tilt of a fixed array is determined, it is simply programmed into the computer and the solution comes out correctly. Not only can the computer handle this problem, but the 30-foot base line between hydrophones doesn't have to be so precise. Instead of 1/8th inch maximum error in the old arrays it can now be off as much as an inch.

Two improvements the underwater range needs are a link to the big Univac computer at Roosevelt Roads by microwave and a more powerful radar. ■■



# Scanning for disease—a new diagnostic tool

## Computer processor and CRT display, used with radioactive technique, pinpoints damaged tissue

John N. Kessler  
News Editor

Computer processing and display technology is being used in conjunction with radioactive substances to pinpoint diseased areas of the body with greater accuracy than ever before, a University of Pennsylvania doctor reports.

The physician, Dr. David H. Kuhl, associate professor of radiology at the university, says the technique is especially useful in brain diagnoses. In carrying out experimental studies, Dr. Kuhl has been using a new brain-scan instrument that he and Roy Q. Edwards, chief engineer at the University of Pennsylvania Medical School, designed.

The instrument, combining a computer and a cathode-ray display, operates in real time and permits a doctor to obtain a three-dimensional fix for a damaged or diseased area. Also, by reprocessing the image data, quantitative information—the degree of damage or disease—can be obtained.

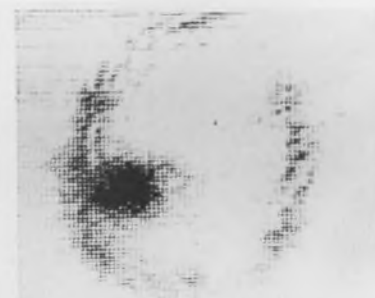
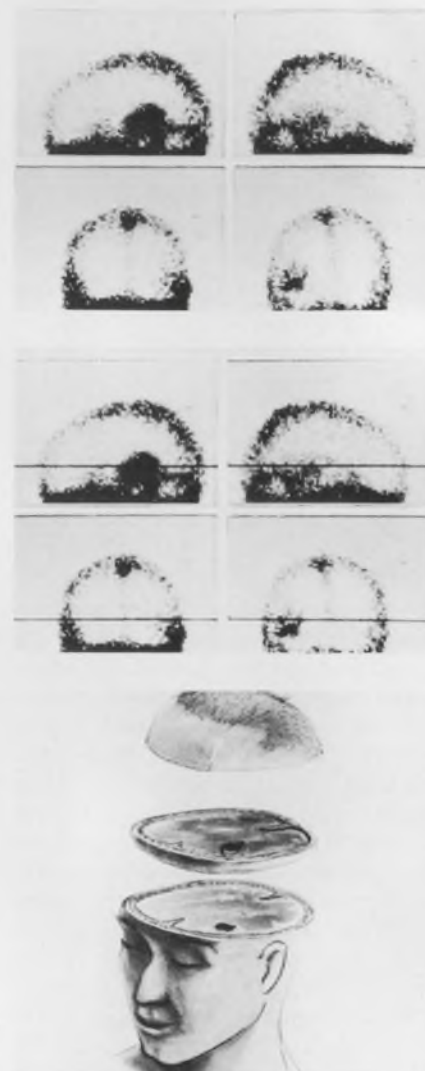
This work is being supported by a grant from the Atomic Energy Commission and the U. S. Public Health Service.

Basically the brain-scan instrument consists of scintillation counters that detect the presence of radioactive substances, which have been administered orally or intravenously to a patient. The radioactivity tends to accumulate around diseased areas of the body. By scanning at a specific rate, the doctor determines the intensity of radiation for a specific body area.

In early work by Dr. Kuhl and Edwards, this information was recorded on paper tape. The new instrument records image data directly on a magnetic drum; it is then run through a small computer processor for smoothing and boundary definition—techniques similar to those used by NASA in increasing the resolution of photographs of the moon and Mars. The processed information is then displayed on a cathode-ray tube.

Computer processing permits, for the first time, the viewing of cross-sections of the body, thereby enabling the physician to narrow the diagnostic possibilities and to focus his treatment directly on affected areas.

Another important advantage of the computer method is that ex-



To view a transverse section of the brain (at top), a doctor turns a knob to adjust a cursor (black line) through the area of interest. The four radiation detectors then scan at lines tangent to the side of the head. This determines the radioactivity in a thin cross-section of the brain. The scan at the bottom was produced in 170 seconds.

**Brain-scanning system** developed at the University of Pennsylvania is being used in experimental studies. Data is stored in a digital memory beneath the bed, and the pictures are viewed as they build up on the display screen.



# SCRs



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TIC44	600	30	200	2N3007	.350	100	200
TIC45	600	60	200	2N3008	.350	200	200
TIC46	600	100	200	2N3555	1.6	30	20
TIC47	600	200	200	2N3556	1.6	60	20
2N3001	350	30	20	2N3557	1.6	100	20
2N3002	350	60	20	2N3558	1.6	200	20
2N3003	350	100	20	2N3559	1.6	30	200
2N3004	350	200	20	2N3560	1.6	60	200
2N3005	350	30	200	2N3561	1.6	100	200
2N3006	350	60	200	2N3562	1.6	200	200

ing, squib firing, fuzing and read-out-tube driving functions.

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\*1969 Worldwide figure from D.A.T.A., Inc., publishers of *Electronic Data*.

**TEXAS INSTRUMENTS**  
INCORPORATED



**(Brain Scan, continued)**

tremely small amounts of radioactive material can be recognized when their gamma rays penetrate tissue.

The picture, produced by a raster scan, is made up of radiation counts recorded in 6-bit binary code. This is recorded on a magnetic storage drum. In this way, as an area of the body is being scanned, the previously recorded information is recirculated. The drum speed is 30 revolutions per second. Thus a picture similar to that on slow-scan TV is seen.

The brightness of a CRT spot is

proportional to the voltage applied to the operational amplifier that controls the intensity of electrons hitting the screen. A range of 64 shades of gray is available, according to Dr. Kuhl.

**Significant advantages cited**

The radiologist says that the average general-purpose digital computer has a number of disadvantages when used to process image data. The hybrid system of digital processor and analog CRT that he is using, he reports, provides the following advantages:

- Flexibility—the system permits radio-nuclide scanning of the

brain and the rest of the body.

- Simplicity — the instrument does not require the use of complex programs.

- Immediacy—pictures can be processed so rapidly that the physician can remain with the patient and redirect the scan to focus on affected areas.

To view a transverse section of the body, the operator turns a knob that controls a line cursor. The cursor passes through the suspected region and the radiation counters are automatically positioned. The operator presses a button to begin the scan. Three to five minutes is usually sufficient for a good picture, says Dr. Kuhl. ■■

## Industry 'discovers' standard MOS/LSI chips

For the first time, standard MOS/LSI—previously confined to computer memory—is being used in an industrial product. Larse Corp., Palo Alto, Calif., is manufacturing chips that form the heart of sending/receiving remote monitoring and control units.

Each unit is contained in a box about as big as a pack of king-sized cigarettes but a little longer—1 by 3.2 by 7.5 inches. In addition to the single MOS/LSI chip, each box contains a few support elements. All the user has to do is connect it into his system and supply electrical power. The units can be used in almost any remote monitoring and control system, such as traffic control, monitoring of water supply and distribution facilities

and weather-data collection.

The nearest competing equipment for either the sending or the receiving unit would occupy half a rack, cost about 50% more (\$1500 or more compared to \$600 to \$650 for an MOS sending unit) and consume almost 70 times as much power—typically 20 W compared to 300 mW, according to George Larse, company president.

**A natural for industry**

The low cost, low power dissipation, and high noise immunity of standard MOS/LSI make it a natural for industrial environments. Larse foresees that it will revolutionize electronics for industrial and consumer applications. Why hasn't it been used in these areas before?

"Because," says Larse, "people assumed that the amount of circuitry that goes on one chip would have to be unique to a single system and therefore couldn't be standardized." But with LSI, he says, it is possible to put many different options on one standard chip so that it can fill the needs of many users.

For example, the Larse telemetry units can work with almost any kind of communication link (telephone line, dc wire, microwave link, radio link, etc.) and can trans-

mit or receive in eight different modes, including single-word, continuous, tone interrogation and coded interrogation. Every receiving unit has two types of output: a control that provides an output flashing signal for human interface and a data-ready indicator signal for computer interface. All these options are provided in every unit, but the user must choose a different unit for different communication modes (frequency shift keying, AM tone, line switch, etc.).

**Pneumatic equipment is out**

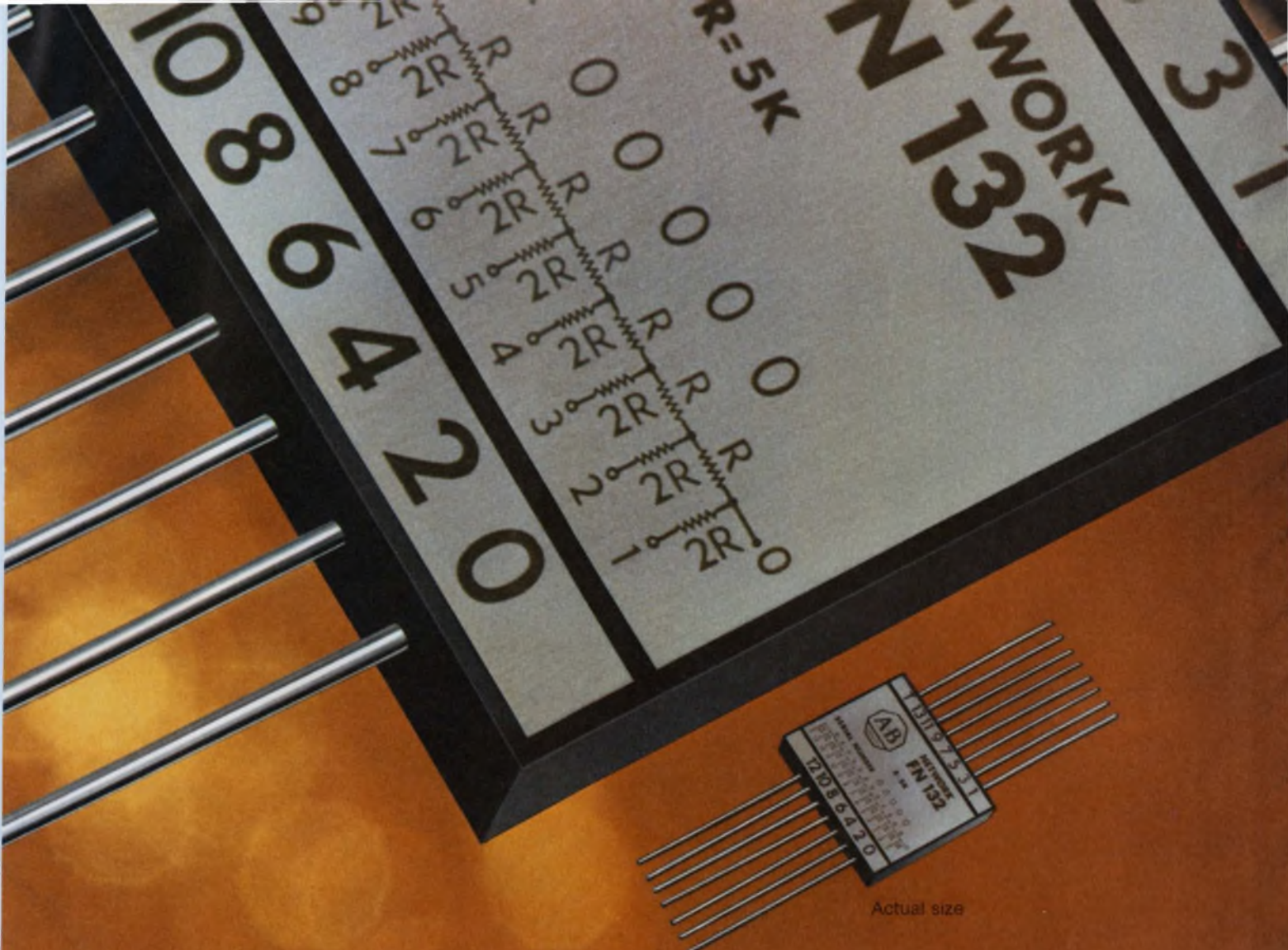
Larse believes that standard MOS will eventually replace pneumatic equipment now used for control functions in factories. "One of the problems with electronic equipment in a factory," he says, "has been that it inadvertently gets triggered by electrical noise and transients. But MOS has inherently high noise immunity, and now we're getting the cost down to the point where it will be competitive with pneumatic devices."

Larse Corp. designs its own MOS/LSI chips, sends them out for mask and wafer making, then tests, scribes, dices and packages the chips inhouse. Wafer yields have been running around 30%, Larse says—which is considered phenomenally high for LSI. ■■



Standard MOS/LSI devices, such as this data communicator developed by Larse Corp., may eventually replace pneumatic equipment now used for control functions in factories.





Actual size

# Now true precision in Allen-Bradley thin film networks.

Resistance networks for A/D and D/A conversion, digital volt meters and numerical control systems demand extreme precision. Allen-Bradley can deliver. Precision that starts with a patented chromium-cobalt resistive material vacuum deposited on a substrate made to Allen-Bradley specifications. Precision based on exclusive computer drawn grids. Precision backed by extensive design and testing facilities. Precision on a continuing basis assured by Allen-Bradley's 14 solid years of experience.

Add the reliability of a single substrate, uniform temperature characteristics, much lower attachment costs and you see why Allen-

Bradley thin film networks are the logical replacement for discrete precision resistors.

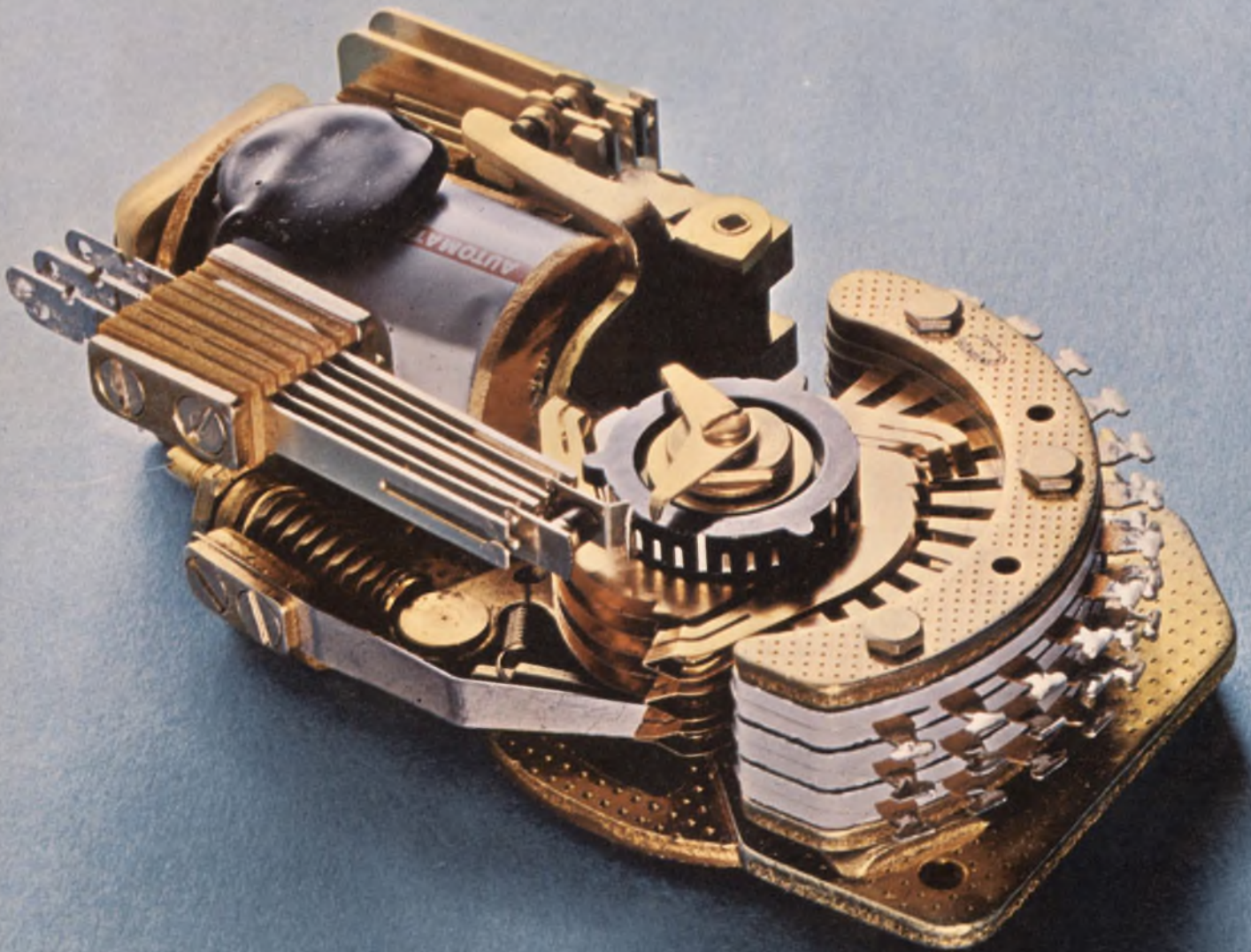
SELECTED SPECIFICATIONS	
RESISTANCE RANGE	1K ohms to 2 megs, standard 25 ohms to 50 megs, special (Single substrate range - 10,000 to 1)
TCR LEVELS -55°C to +125°C	± 25 ppm/°C ± 10 ppm/°C ± 5 ppm/°C
TCR TRACKING	± 5 ppm/°C standard to ± 1 ppm/°C special
TOLERANCES	Absolute to ± 01% @ +25°C Matching to ± 005% @ +25°C
RESOLUTION	Line width and spacing to 0001 inch
ENDURANCE	Exceeds MIL-R-10509F Characteristic E Procedure: MIL-STD-202D

Investigate the superiority of Allen-Bradley thin film networks. Write: Marketing Department, Electronics Division, Allen-Bradley Co., 1201 South Second Street, Milwaukee, Wisconsin 53204. Export office: 1293 Broad St., Bloomfield, N. J. 07003, U.S.A. In Canada: Allen-Bradley Canada Ltd., 135 Dundas Street, Galt, Ontario. Several standard networks are available through your appointed A-B industrial electronic distributors.





**Reliability is a spring, a wheel  
and two thingamajigs.**







Every AE Type 44 stepping switch comes with them.

**One-spring power.**

The drive spring is a coil. What it does is store up power. When it comes time to switch, the spring lets loose and moves the wiper assembly forward. Each time using precisely the same pressure.

Notice our spring is tapered at one end. It's designed to perfectly match the power input. That's why you always get the best possible transfer of energy.

At one end of the drive spring is an adjusting screw. We turn it a little this way or a little that way and the tension is always perfect.

Try that with a flat spring.

**We re-invented the wheel.**

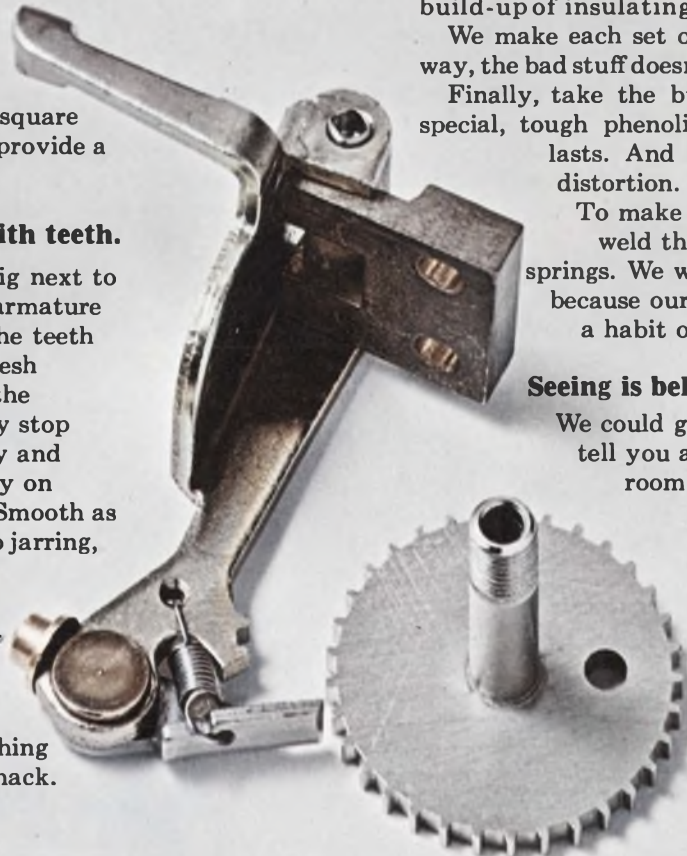
The ratchet wheel is a little different. The way it's made, for one thing. First, we blank it. Next, shave it. And finally, case-harden it. Then it's super strong.

Notice the big, square teeth that always provide a sure bite.

**A thingamajig with teeth.**

That thingamajig next to the wheel is the armature assembly. When the teeth on the end of it mesh with the teeth on the ratchet wheel, they stop the wiper assembly and position it precisely on the contact bank. Smooth as silk, every time. No jarring, no jamming, no banging.

No adjustments, either. As the teeth wear, they just drop further into the wheel. So nothing ever gets out of whack.



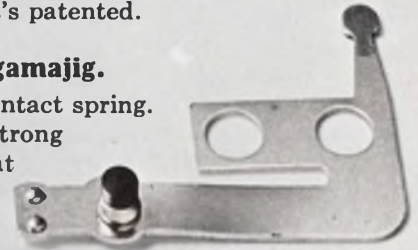
**A pawl that floats.**

On the end of the armature is the pawl. We made it "free floating" to eliminate the jamming and binding that go with the old style pawl stop block. And while we were at it, we stopped pawl breakage and put an end to double-stepping or overthrow.

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We could go on talking reliability and tell you about our testing and run-in room. There's a lot more to tell.

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SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS  
INFORMATION RETRIEVAL NUMBER 19



# Redesign that military product for civilians

## More and more electronics companies are turning defense-contract skills into consumer-market profits

**Jim McDermott**  
East Coast Editor

A Plainview, N.Y., company that built a \$200 airborne power supply for a military IFF transponder has redesigned it into a minicomputer supply selling at \$100.

A company in Bohemia, N.Y., has redesigned a \$200 military aircraft antenna into one for general aviation use—again, at about half the original cost.

A Palo Alto, Calif., concern has reworked its design of a flight director display for the Navy's A-6A attack plane and come up with a simplified version for civilian aircraft. The military version sold for \$40,000; the price of the civilian unit is \$9700.

These successes typify what some electronics companies are doing these days to counter the temporary downturn in the nation's economy.

With many firms hit hard by sharp decreases in military spending, an obvious reaction is to attempt to use the background in military technology to produce in-

dustrial or consumer items—preferably by redesigning a product that the company has already developed for the military.

But the ground rules for designing civilian products differ from those for turning out military equipment—in some cases they are even more demanding—and it is easy to squander money in new developmental costs. What are the guidelines to profitable redesign?

Interviews by ELECTRONIC DESIGN with a number of manufacturers who have successfully converted a military product into a salable commercial item indicate that these are the common denominators of redesign:

- Costs must be markedly reduced.
- Repackaging is necessary.
- Maintenance must be simplified.
- The product must be reworked for a more esthetic appearance.

The overriding problem in redesigning from a military to civilian version is reducing the product cost. Although many techniques

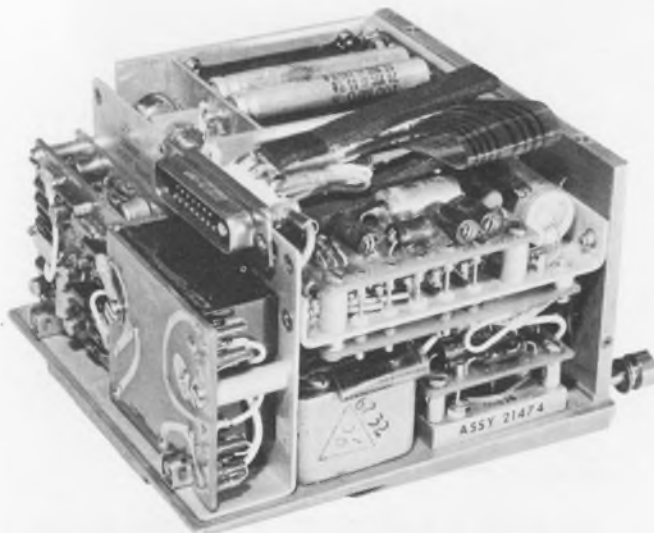
are uniquely related to a particular military design, there are cost-shaving design principles that can be universally applied.

For example, Clifford Crawbuck, chief engineer at Trio Labs in Plainview, N.Y., who is responsible for the redesign of an airborne power supply for an IFF (identification, friend or foe) transponder into a minicomputer supply selling at half the cost, makes these points (Figs. 1 and 2):

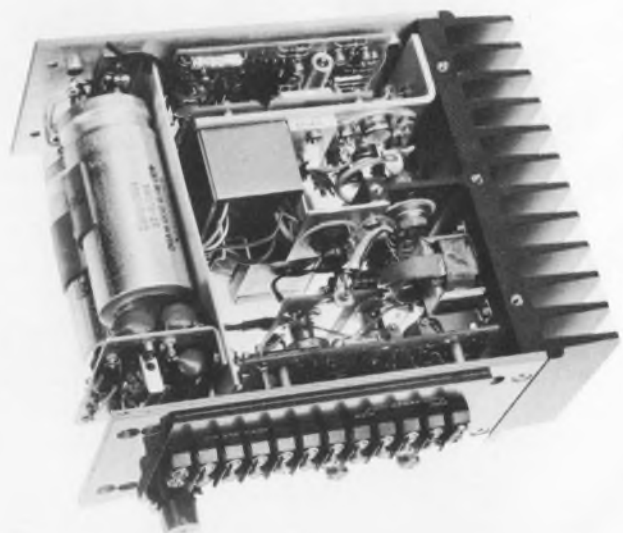
"The compact military designs are expensive to fabricate, and because of limited heat dissipation, they require costly, high-temperature components. So the first step in lowering the price is to repack the equipment—providing more room between the individual components.

"This makes it easier to build and also helps get rid of the heat. With the equipment running cooler, lower-cost, derated components can be used. For example, where the military supply uses 125°C capacitors, we use 85°C units in the computer version.

"Along another line, when repackaging, eliminate costly castings and substitute sheet metal frames and chassis.

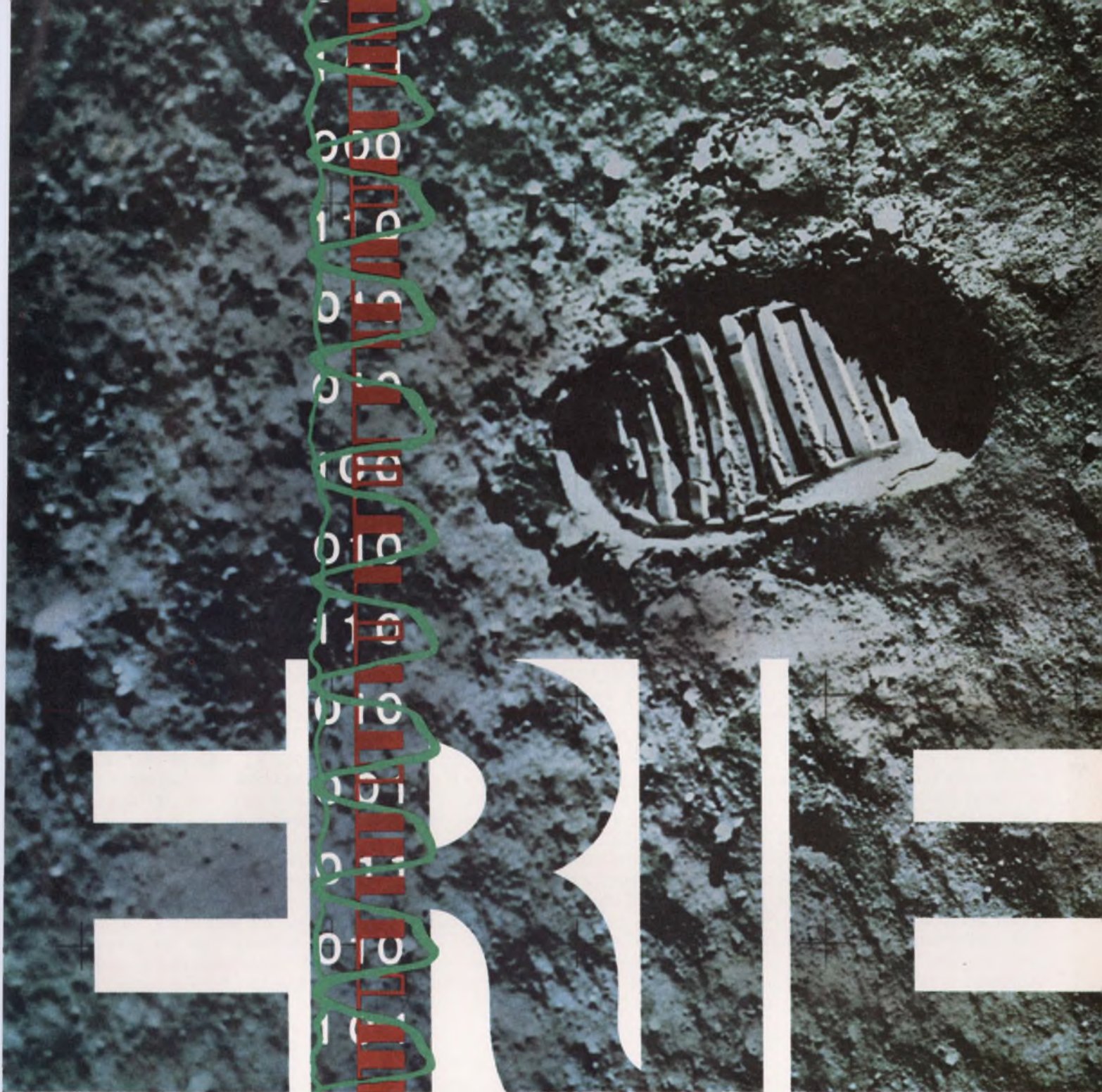


1. Military version of airborne power supply by Trio Labs, has costly, high-packaging density. It has eight different output voltages.



2. Commercial version of the military unit was redesigned into this 5-V, 20-A minicomputer supply. Note the better heat dissipation in this version.





When you can't afford a "wrong number"...

Symbolic representation of the TV, voice, ranging data and biomedical telemetry signals from the moon. Photograph courtesy of NASA.

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Where are they? How are they? What do they see... and say? NASA and the world want to know. And, the only way to find out is over the special Motorola S-band equipment on both the Command and Lunar Modules. Once the Apollo Astronauts are over 30,000 miles out, it's their *only* communications link with Earth. It simply can't fail. That's why Motorola called on ERIE TECHNOLOGICAL to develop the EMI filters and Monobloc capacitors that would help this equipment perform flawlessly on every Apollo mission since Motorola has been involved. Proof, once again, that it pays to bring ERIE in early.

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**(Redesign, continued)**

"Use standard components, readily available from more than one supplier. This includes many MIL-standard components, which it frequently pays to use, instead of a special low-cost component from a single supplier."

Does it pay to save simply by substituting low-cost equivalents for such standard components as resistors and capacitors?

"Not necessarily," Crawbuck says. "In the computer and industrial applications for which our power supplies are used, we want reliability and equipment life that is better than that of the military equivalent. We achieve this by using a total of 80% of high-reliability components."

**Simplification of design helps**

The less-stringent requirements of nonmilitary application can be another source of cost reduction, according to Joseph Margolin, vice president of Granger Associates, Bohemia, N.Y. For proof, he points to his redesign of a military aircraft navigation antenna to one with equally good performance for general aviation and at about half the cost (Figs. 3 and 4).

He took advantage of the fact that while the military version was designed to withstand supersonic speeds and high vibration, the general aviation unit would be flown at only 200 or 300 miles an hour.

"The less rigorous environment allowed us to use smaller and light-

er mechanical elements," Margolin notes. "Also, whereas the original antenna operated from 108 to 122 MHz, the civilian version was reduced to 108 to 118 MHz. Although the bandwidth reduction seems small, it permitted simpler matching elements and fewer detailed parts in the antenna assembly."

**Paring of equipment advised**

To reduce the cost of large military equipment or subsystems, an evaluation of each functional assembly is required, according to John Sabel of Kaiser Aerospace & Electronics Corp., Palo Alto, Calif., designer of both military and civilian versions of an aircraft flight director display.

The military display, called the AN/AVA-1, was designed for the A-6A Intruder attack plane. Called a contact analog display, it gives the pilot the impression he's looking ahead out the window, when actually he's not. It has ground and sky references, and upon these, various attack symbols are superimposed.

While the military version sold for \$40,000, Sabel was given the task of designing a simplified version—the FP-50—that currently is selling for \$9700.

There are two basic elements in the FP-50: a cathode-ray tube display and a computer that generates the ground, sky and other elements. These are tied in with the plane's navigational instruments, so that as the craft moves, the scene moves with it.

"With the military system,"

Sabel says, "the mission is takeoff, navigation, attack and landing. But for general aviation we used only the navigation and landing circuitry, our first cost trade-off."

"Another area where we made considerable savings was in the display itself. The original requirements were for high-brightness display, because it was under a bubble canopy, which is subject to high ambient light. This required an expensive, high-brightness tube, plus a costly 15-kV power supply.

"But the FP-50 uses a Sony five-inch TV tube and deflection circuits and substantially lower voltage. To overcome ambient light, we recessed the face of the tube and added an optical, high-contrast filter. This, plus the fact that the ambient light is much lower in general aviation planes, gave us a workable, low-cost solution."

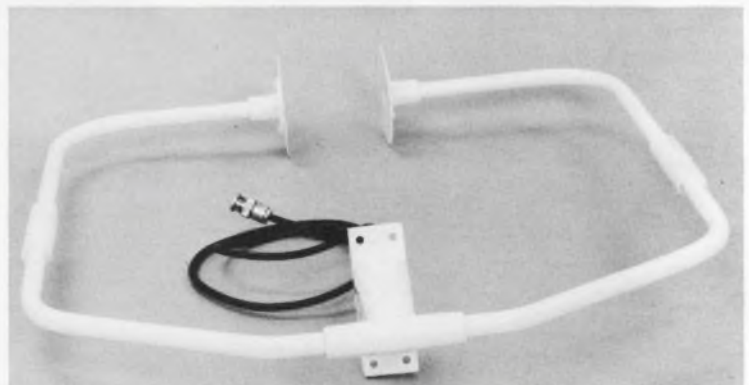
As far as packaging is concerned, Sabel and Crawbuck of Trio Labs are in agreement.

"The military always wants equipment in minimum size, weight and power," Sabel points out. "And dense packaging runs the cost up rapidly. For the general aviation model, we reduced packaging density and cost by separating the system into two units: the display and computer/symbol generator."

As for the esthetic appearance of equipment, the military isn't overly concerned about it but the civilian buyer is. Granger Associates points out that in its redesign of the military aircraft antenna much effort was expended in molding the housings for eye-appeal. ■■



3. Military version of aircraft navigation antenna by Granger Associates withstands supersonic speeds. It is installed during plane construction.



4. The general aviation version has the same performance electrically, but is lighter. It is designed for lower speeds and to be mounted as a retrofit item.





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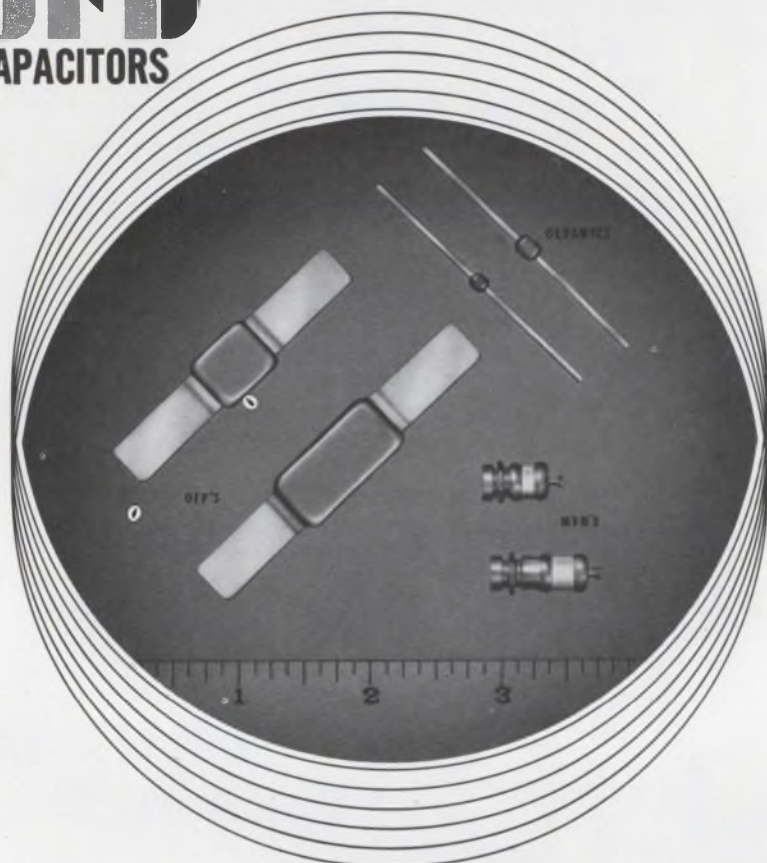
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The Uniceram series of microminiature ceramic fixed capacitors, glass encapsulated, has a Q measured at 1 MHz and 25°C (values 1,000pf and smaller) of 5,000 min. and features a constant ceramic dielectric that is fused into a solid monolithic structure. This construction insures complete protection from moisture and environmental stresses. JFD ceramic capacitors are available in leaded and unleaded configurations and are ideal for high speed switching and for capacitance at VHF and higher frequencies when low inductance is essential. Capacitance range 0.5 to 3,000 pf.

Also available under the Uniceram brand is a series of Hi Q capacitors with Hi RF power capabilities. Q measured at 1 MHz and +25°C (for values of 1,000 pf and smaller) is 5,000 min. Entitled UFP's, these fixed ceramic units are the smallest high RF power capacitors available and represent the state of the art in manufacturing techniques. Capacitance range 10 pf to 3,000 pf.

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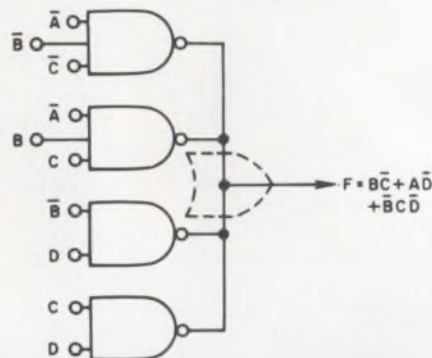
See JFD Electronics Corp. at the Wescon Show — Riker Maxson Components Group Booths 1324 and 1325.

# Letters

## Some second thoughts on DTL efficiency

Sir:

The article "Boost Your DTL Efficiency With Wired-OR" (ED 8, April 12, 1970, pp. 89-91) omits one important consideration: serviceability. Consider the following circuit using 930 Series DTL:



(Incidentally, this circuit is the correct wired-OR implementation for F, as shown on p. 90 of the article.)

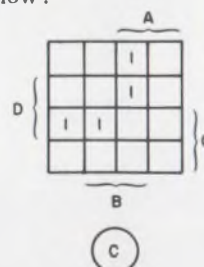
Now suppose that due to some failure—incorrect wiring, etc.—F remains at logical 0. The DTL gate outputs must be removed from the wired-OR one at a time until the one causing the problem is found. If the wired-OR happens to be on a PC board or wire-wrapped panel, this can be a tedious task.

*Rudolph Pappa*

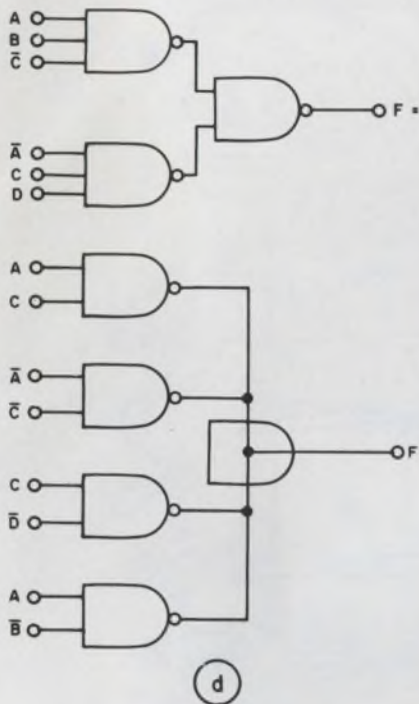
Link Division  
Singer-General Precision, Inc.  
Sunnyvale, Calif.

## Author's reply:

The wired-OR implementation indicated by Mr. Pappa is indeed the correct one and corresponds to the circuit in my notes. The logic network on page 90 contains a misprint. Note also that Figures 6c and 6d were omitted; they are shown below:







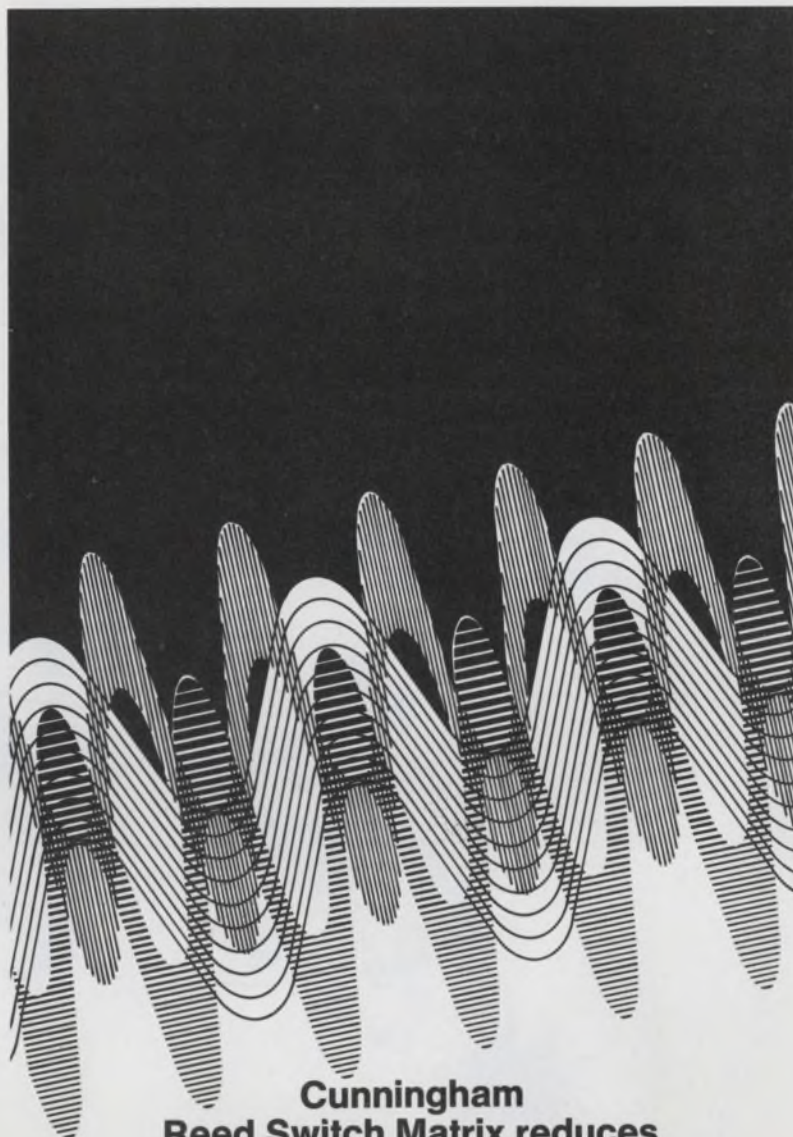
Mr. Pappa's point on serviceability is well taken. The wired-OR does present a problem when the output, F, is at a permanent ground. Granted that all DTL outputs must be removed to find the defective gate, we really are only interested in determining which IC package is bad.

Thus in Fig. 6d, all four 2-input gates are in one package, and so a failure in the wired-OR circuit need not be narrowed down to the gate level. Rather the IC package is replaced to cure the problem. The wired-OR circuit of Fig. 6b uses circuitry from two ICs, and so repair of this circuit at most requires the replacement of the two packages.

As a general rule, then, it becomes rather obvious that all circuits connected to the wired-OR point should be contained in the same IC package, and if this is not possible, then the number of packages used should be minimized.

I must wholeheartedly agree with Mr. Pappa that troubleshooting a bad IC when, say, six different ICs provide the wired-OR functions can indeed be more tedious than saving one or two gates is worth.

*Gilbert I. Starr*



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INFORMATION RETRIEVAL NUMBER 23



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Long, long ago, in the early awakenings amongst the Isles, a happy accident happened.

A grape, then a series of grapes were squashed in such a peculiar way that, fermentation being what it is, someone sensed

putting the results in a container would prove of high interest. Thus does history begin.

Bacchus, who established the first really popular excursion trips with his Dionysian Tours to Egypt, India, etc., forthwith then set another record as the world's original wine bottler.

His own person found this endlessly pleasurable and grew to accommodate more of the same. In fact, the Bacchus chassis soon became unstable, unable, even fixed. Or, if you like, utterly stoned, thus making necessary an evolutionary step in package movement so admirably exemplified today by products made for modern markets by the well known firm of Jonathan.

One of the results of Jonathan's great humanitarian interests is movement by the

Jonathan Type 110 Ultra Thin Steel Series Precision Full Ball-bearing Slide. In fact, they decided that the bulky balking that was Bacchus' bag is still a problem for electronic chassis slides. Modern packaging concepts demand high capacity, compact design and ruggedness. And solutions for quick disconnect and tilt problems still must be solved. The people at Jonathan have the perfect solution—the Type 110.



The Type 110 is a full ball-bearing steel slide with a heavy duty pivoting mechanism that will easily handle any rated load requirement. It is readily available and inexpensive.

Jonathan's Type 110 is so improved that its smooth action would make the Saturnalia Santa smile with delight.

Others, too, such as Raytheon, who utilize this versatile slide in its 706 Computer, (see photo) an expandable, low-cost processor with large computer capability and compatibility. This newest addition to the Raytheon computer family uses a packaging concept designed for reliability and maintenance ease. Sm-o-o-o-th Jonathan Slides help make it possible. What's your requirement? Detail us your needs, today!



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INFORMATION RETRIEVAL NUMBER 24

ELECTRONIC DESIGN 17, August 16, 1970



# Washington Report

DON BYRNE, WASHINGTON BUREAU

## Defense Dept. reorganization heads for struggle

The proposed reorganization of the Defense Dept. may face a hard battle in Congress when the DOD agency seeks legislation to enact some of the proposals. As outlined by Defense Secretary Melvin R. Laird, the new plan would take the Joint Chiefs of Staff out of the chain of command and replace them with a single senior military officer. This idea is particularly repugnant to Congress, which, as one member puts it, has "always feared the man on horseback."

The reorganization report, prepared by a Presidential Commission headed by Gilbert M. Fitzhugh, board chairman of The Metropolitan Life Co., also recommends splitting the functions of the Pentagon into three major groups; management of resources, evaluation, and operations, each headed by a deputy secretary of defense. The position of director of defense research and engineering, the top science job in the Pentagon, would be abolished; and the director would be replaced by three assistant secretaries.

The report also recommends the establishment of a defense test agency under a civilian director, operating independently of the armed services. The services would no longer test their own weapons or equipment. Big development programs would be broken down into smaller sections to give more contractors a chance to bid and to broaden the industrial base.

And, finally, the report recommends abolishing of the total package concept of procurement. It would be replaced by the prototype-development policy, which was used by the military prior to the ballistic missile programs and McNamara's era in the Pentagon. Secretary Laird has already put this concept into action, and from now on, all major systems will be developed in a series of steps, with prototype hardware constructed and tested at each step. The development would be stopped at any stage at which the hardware did not perform as promised.

Congressional and military leaders agree that about 90 per cent of the proposals could be put into effect by Secretary Laird by executive fiat. The other 10 per cent, they also agree, will make for some "interesting" debate on Capitol Hill.

## Western Union seeks domestic satellite

Western Union is asking the Federal Communications Commission to approve its application for a \$95-million, three-satellite domestic communication system. Western Union said the system would include 10 TV channels, indicating that it would seek business from the three TV networks in addition to its own communications.

Comsat, AT&T and TelePromTer Corp. are expected to file similar petitions.

## Senate bars Defense loan guarantees over \$20-million

The Senate has approved an amendment to the Defense Production Act which would, in effect, stop the Government from underwriting a \$100-million loan that Lockheed was reported to be negotiating with some 24 banks. The amendment makes it illegal for the Government to guarantee



any more than \$20-million and adds that the money may not be used to avoid bankruptcy. The measure now goes to the House. Meanwhile the debate over the \$200-million "contingency fund" already approved by the House for Lockheed continues in the Senate.

Lockheed has more than \$600-million in claims and litigation pending against the Government, and says it needs the \$200-million to continue operation this year. The contingency fund is contained in the over-all authorization for the C-5A program, part of a \$19.2-billion defense spending package.

## **FAA sees 300% rise in R&D costs to meet traffic demands**

The Federal Aviation Administration has revised its thinking on research and development needs for the next decade: it sees a jump of almost 300% in expenditures to meet the demands of the air traffic system of the 1980s.

The FAA now estimates that it will need between \$150-million and \$160-million a year in R&D funds if it is to meet its goals. Previously the agency had been projecting \$60-million a year over the next decade. This was knocked down to \$47.5-million by the Department of Transportation, and then to \$45-million by the House. The money bill is now before the Senate.

## **Capital Capsules:**

The National Transportation Safety Board has told the Federal Aviation Administration that it believes **passive radar reflectors could and should be made part of light aircraft equipment.** The board made the recommendation because "small aircraft are difficult and sometimes impossible to detect with present-day radar." . . . Dr. John S. Foster Jr., Director of Defense Research and Engineering, has told the House Appropriations Committee that **Communist China has embarked on a major space program, aimed primarily at surveillance rather than placing weapons in orbit.** Foster says the Chinese are moving slowly on ICBM and intermediate range missile development . . . **General Electric will build the \$50-million Earth Resources Technology Satellite** that is expected to be ready for launching early in 1972. The satellite will record crop growth, water distribution, pollution and soil makeup. GE will develop two spacecraft, the equipment needed for a ground data system, and six ground platforms for remote site data collection . . . The high cost of living on the moon is also up. **NASA has just awarded \$14.1-million more to United Aircraft for work on an improved portable life-support system for astronauts.** The contract now totals \$74-million . . . Manufacturers of general-aviation planes are feeling the effects of the material economic decline. **Piper Aircraft has shut down operations for four to eight weeks,** blaming the closedown on a high inventory caused by the economic slump. **Aero Commander meanwhile is laying off some 100 production workers and engineers,** also due to slow sales; earlier it had laid off 700 production workers but had rehired half of them . . . **One of the larger aerospace corporations** recently unsuccessful in several large bids, is **eyeing its leasing and data transmission field.** The Defense Dept. would be a prime practically idle computers with the idea of moving into the computer target for sales.



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**Faster measurements.** Auto Scale-Factor Readout is exclusive to Tektronix! It labels the CRT with time or frequency/div; volts, ohms, C (temperature), or amps/div; invert and uncal symbols; and automatically corrects for 10X probes and magnifiers. Readout is required when using the NEW 7D13 Digital Multimeter and the NEW 7D14 Digital Counter plug-ins. It can be ordered initially or as a conversion kit, which is easily installed. Either case, the cost is only an additional \$400.

### THE 7000-SERIES

An Integrated Test System! With the introduction of the 7D13 and 7D14 digital plug-ins, the 7000-Series becomes an Integrated Test System. **ITS** much more than an ordinary oscilloscope. SEVENTEEN plug-ins covering a wide performance spectrum are available to solve virtually all of your measurement problems. Some of the features offered are: dual-trace, differential comparator, 10- $\mu$ V differential, sampling, current amplifier, digital multimeter and digital counter. For instance! Plug-ins can be chosen to give the 7503 delaying sweep and 90-MHz bandwidth.



# TEKTRONIX®

committed to progress  
in waveform measurement

**Greater versatility.** The following 7000-Series mainframes offer unique four-plug-in versatility. The 7704 (150 MHz), R7704 (150-MHz rackmount), 7504 (90 MHz), and 7514 Storage (90 MHz). The 7000-Series does not require a full complement of plug-ins, you can start with only one horizontal and one vertical plug-in and add more as your measurement requirements change.

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7503 Oscilloscope without readout, Option 1 .....	\$1375
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ANNOUNCING:

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Price: \$145.00



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These new power modules from ERA provide *cool performance, total protection* for specialized use in IC, computer, telemetry, strain gauge and transistor applications.

The Transpac CP series is equipped with unique heat sinking for cool (71°C, free air) operation at high currents, protects itself and your equipment through built-in short circuit protection with instant recovery, adjustable current limiting and overvoltage protection.

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5	3.2	2.8	2.5	CP-5-2P5	\$125.00
3.6	6.5	5.7	5.0	CP-3P6-5	\$145.00
5	6.5	5.7	5.0	CP-5-5	\$145.00
3.6	13.0	11.4	10.0	CP-3P6-10	\$185.00
5	13.0	11.4	10.0	CP-5-10	\$185.00
3.6	22.0	19.5	17.0	CP-3P6-17	\$230.00
5	22.0	19.5	17.0	CP-5-17	\$230.00
3.6	32.0	28.5	25.0	CP-3P6-25	\$310.00
5	32.0	28.5	25.0	CP-5-25	\$310.00



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INFORMATION RETRIEVAL NUMBER 26

# Technology Abroad

## British gird for big semi memory battle

Firms in the United Kingdom are hoping to break the U. S. hold on semiconductor memory markets in that area with a series of new products this year. Coming up: a 64-bit MOS random-access memory with 200-ns access time from Mullard; a word-oriented 16-word, eight-bit read/write memory capable of dc-to-4-MHz operation from Marconi-Elliott Microelectronics Ltd.; and 256-bit low-threshold MOS RAMs with 0.5-to-1.0- $\mu$ s access time from both Marconi-Elliott and Plessey.

## 18-mile waveguide to be communications link

An experimental communications link, consisting of a 50-mm-diameter circular waveguide nearly 18 miles long, will be installed by the British Post Office between Martlesham Heath and Mendlesham in Suffolk. When completed, the two-inch "pipe" will be capable of transmitting up to 300,000 simultaneous two-way telephone conversations or 200 color-TV channels.

The frequency range in the waveguide link will be divided into two main bands: 32 to 50 GHz and 50 to 90 GHz. In the lower band, the system will provide 16 high-speed digital broadband channels, each capable of supporting a data rate of 500 megabits per second.

## West Germany develops multilingual TV 'dubber'

West Germany is working on a system that will permit simultaneous broadcast of audio signals in as many as 12 different languages to "dub" a single video picture.

Each language is assigned one

of the 12 vacant horizontal scan lines that exist in the brief no-transmission period between transmission of each of the frames that make up the moving TV image. Audio and visual signals thus are transmitted sequentially, with synchronization provided by use of a clock-pulse-controlled memory.

Because of the relative brevity of the no-transmission period, audio signals are first compressed by a 1:385 rate, then expanded as the memory reads out from the appropriate channel.

Standard Elektrik Lorenz AG says the only big remaining problem is getting authorities to agree on standards for multisound transmission.

## Israeli minicomputer invades U. S. market

An Israeli minicomputer, the Elbit-100, is being marketed in the U. S. Manufactured by Elbit Computers Ltd. of Haifa and sold in this country by Electronic Products International Corp., Wheeling, Ill., the machine is a 2-microsecond, 12-bit model available in 1024 to 12,288-word configurations. It's priced at \$4650.

Air traffic control data recorders are usually custom-made and fairly expensive. This situation may change if EMI Electronics of England has its way. The company says it is developing a \$20,000 radar display video tape recorder based on commercially available Sony TV recorders.

Siemens AG of Germany has announced it will soon begin manufacturing transistors in Singapore. The company expects its staff there to grow from 150 to 1000 in three years.



# LINEAR

## We deliver the goods

For the last six months, in this column, we've been running on about what we're going to do for you: We'll give you LIC this. LIC that. LIC to make the mind boggle.

Promises, promises?

Nay. Realities, realities!

Specifically, we've made three basic commitments in LIC:



### 1. Technological leadership.

We took the crown in 1965 when we introduced the  $\mu$ A709 Op Amp, which essentially "opened" the LIC market. We intend to keep that LIC crown. By giving you more of the same.



**2. Second sourcing.** A stable high-volume second source for those linears we didn't invent but which have found a place in the market. That's us. We'll duplicate them. Sure. But more than that, where we can, we'll improve their performance without raising the price.



**3. Price leadership.** We'll give you LIC devices at prices so low you'll be able to use them in new applications, where it would have been prohibitive before. Pragmatic pricing, as it were.

Not blue sky. Terra firma.

We deliver on our promises. To see how, read on.



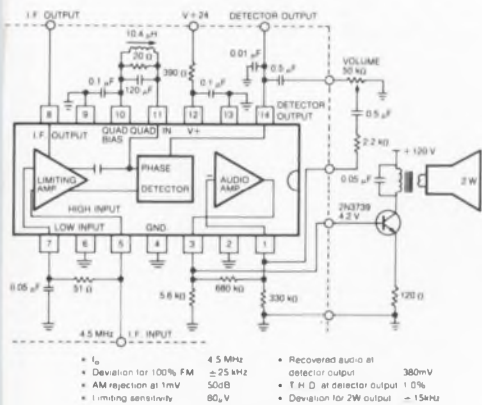


## logical crown invention devices

### We make promises into realities like the $\mu$ A754C TV/FM Sound System

It's just beautiful! What we did was put a four-stage differential limiting amplifier, a double-balanced quadrature demodulator, an audio driver stage, and a regulated power supply all on one chip. Wow!

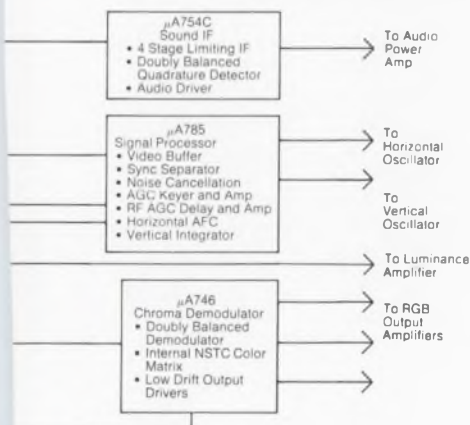
That's the smashing new  $\mu$ A754C: 80  $\mu$ V sensitivity. 50dB AM rejection. 3V RMS output. All at low harmonic distortion plus a low impedance IF output compatible with ceramic filters.



Use 'em in TV, mobile receivers, line-operated and automobile FM and as synchronous AM detectors.

Available now in dual-in-line  
\$1.40 at 1 K pieces and  
TO-100 \$1.50 at 1 K pieces

Reader Service Number 218



## Fairchild becomes 1st rate 2nd source for linear IT (invented there) devices

As No. 1 in 2nd sources, we give you not only pin-for-pin duplicates, but even better performers, if we can find a way of making 'em better without adding to the cost.

Now here's one of our *MH* (Made Here) but *IT* (Invented There) *IID* (Highly Distinguished) *LIC* devices: The -are you ready for this? -

### MHITHDLIC $\mu$ A761 Two Channel Core Memory Sense Amplifier!

We promised to build the industry standard core memory sense amplifier, SN7524/25. So we did. Then, because we are who we are, we improved it by some tighter threshold matching for greater signal-to-noise performance and less pattern sensitivity. Our  $\mu$ A761 can be used by commercial and military computer manufacturers in small and large memories. It has greater speed for faster system cycle times. AC characteristics for simulated core input signals are guaranteed. Each channel has independent T<sup>2</sup>L compatible outputs and inputs, but they share common threshold and power supplies.

The  $\mu$ A761 is an exact pin-for-pin replacement for the SN7524/25, but if you need the same specifications as the SN7524/25, specify the  $\mu$ A7524

and  $\mu$ A7525 Two Channel Core Memory Sense Amplifier.

Electrical Performance	
• Threshold uncertainty	$\pm 2mV$
• Differential input bias current	30 $\mu$ A
• Input to output delay	20nS
• Propagation delay	15nS
• Recovery	20nS

Guaranteed AC min ONE and max ZERO tests

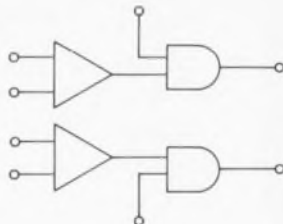
The  $\mu$ A761 is available: In fully hermetic ceramic DIP. Now. Off the shelf from your friendly Fairchild distributor. At prices that are the lowest in the industry!

Reader Service Number 219

### And two more MHITHDLIC products from Fairchild $\mu$ A729/ $\mu$ A732 Stereo Multiplex Decoders

The industry's standard FM Stereo Multiplex Decoders, now available for immediate delivery from Fairchild. And made even more Highly Distinguished by Fairchild by improved sensitivity, higher channel separation, and lamp drive capability increased to 100mA. The  $\mu$ A732 is a pin-for-pin replacement for the MC1304 and the  $\mu$ A729 is a pin-for-pin replacement for the MC1305. Both are available now. Off the shelf.

Reader Service Number 220







## Fairchild price leadership means big big big savings for you!

Prices shown are for industrial/commercial products. Similar savings apply to military grade products (see your local distributor).

### Save 31% on $\mu$ A723

Precision Voltage Regulator consists of temperature-compensated reference amplifier, error amplifier, power pass transistor, current limiting circuitry.

TO-5 or DIP 0 to +70°C. Now \$2.25/100 pc. You save \$1.00.

Reader Service Number 211

### Save 50% on $\mu$ A725

Instrumentation Op Amp for precise low-level signal processing where low-noise, low-drift, accurate closed-loop gain is required.

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### Save 31% on $\mu$ A741

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### Save 62% on $\mu$ A748

High Performance Op Amp designed for applications requiring individual tailoring of open loop frequency responses. Ideal for feedback applications where flexibility is required.

Unity gain frequency compensation achieved by single 30 pF capacitor. Slewing rates of 6V/ $\mu$ S achieved by feed forward compensation.

Same pin configuration as  $\mu$ A741.

Easy to use. Increases system performance. Lowers component count.

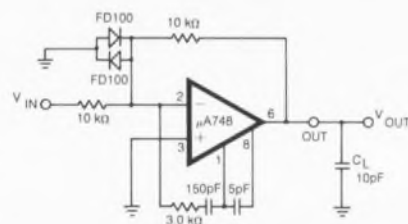
- High voltage gain: 200,000 V/V
- Short circuit protected
- Large common mode and differential voltage ranges
- No latch-up

TO-5, DIP or Mini DIP. 0 to +70°C. Now \$1.25/100 pc.

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Off the Fairchild distributor shelf.

Reader Service Number 216



### Save 59% on $\mu$ A749

General purpose dual monolithic op amp. Each amplifier useful at frequencies up to 20 MHz.

Output stage uses external load resistor, which makes circuit ideal for matching special output loads, allows tailoring of open loop gain.

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- 140dB channel separation at 10KHz

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• 2V/ $\mu$ S slew rate at unity gain  
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Reader Service Number 217



## Fairchild retains technology with integrated entertainment

(at a practical price, too!)

Perhaps there are others who might have the talent to partition a complete system into functional blocks. Perhaps. But who else could have done it and kept the cost practical?

Aha, no one!

Another proof of leadership, right?

The result of *this* coup is a TV in which all the signal processing is performed with 4 to 7 LIC devices.

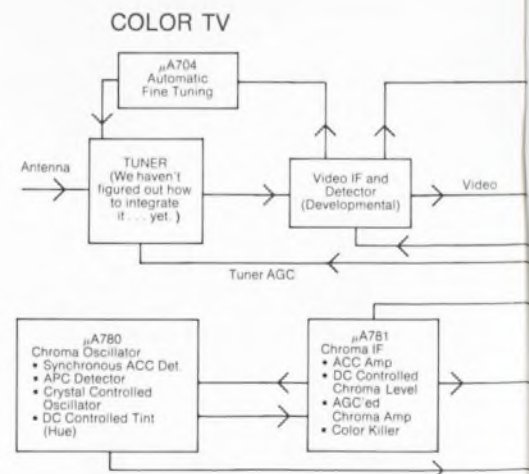
Beats the stuffing out of vacuum tubes in cost and performance.

Even includes such consumer convenience functions as automatic interstation muting and automatic color control.

Our new manufacturing facility is designed to produce torrents of these low-cost devices for consumer industries. As well as low-cost linears for the military and industrial equipment manufacturers. Our commitment: to be all things linear, to all people.

Incidentally, if you're interested in playing with the  $\mu$ A780 Chroma Oscillator and the  $\mu$ A781 Chroma IF, let us know, on your company letterhead, here at the factory.

We'll get you samples, data sheets, application information.



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G. W. A. DUMMER, Formerly Superintendent Applied Physics  
Royal Radar Establishment, British Ministry of Technology

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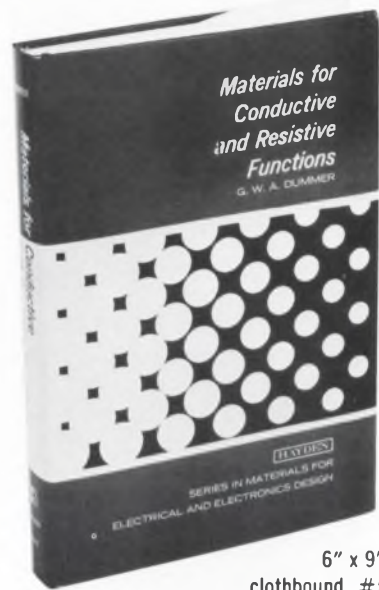
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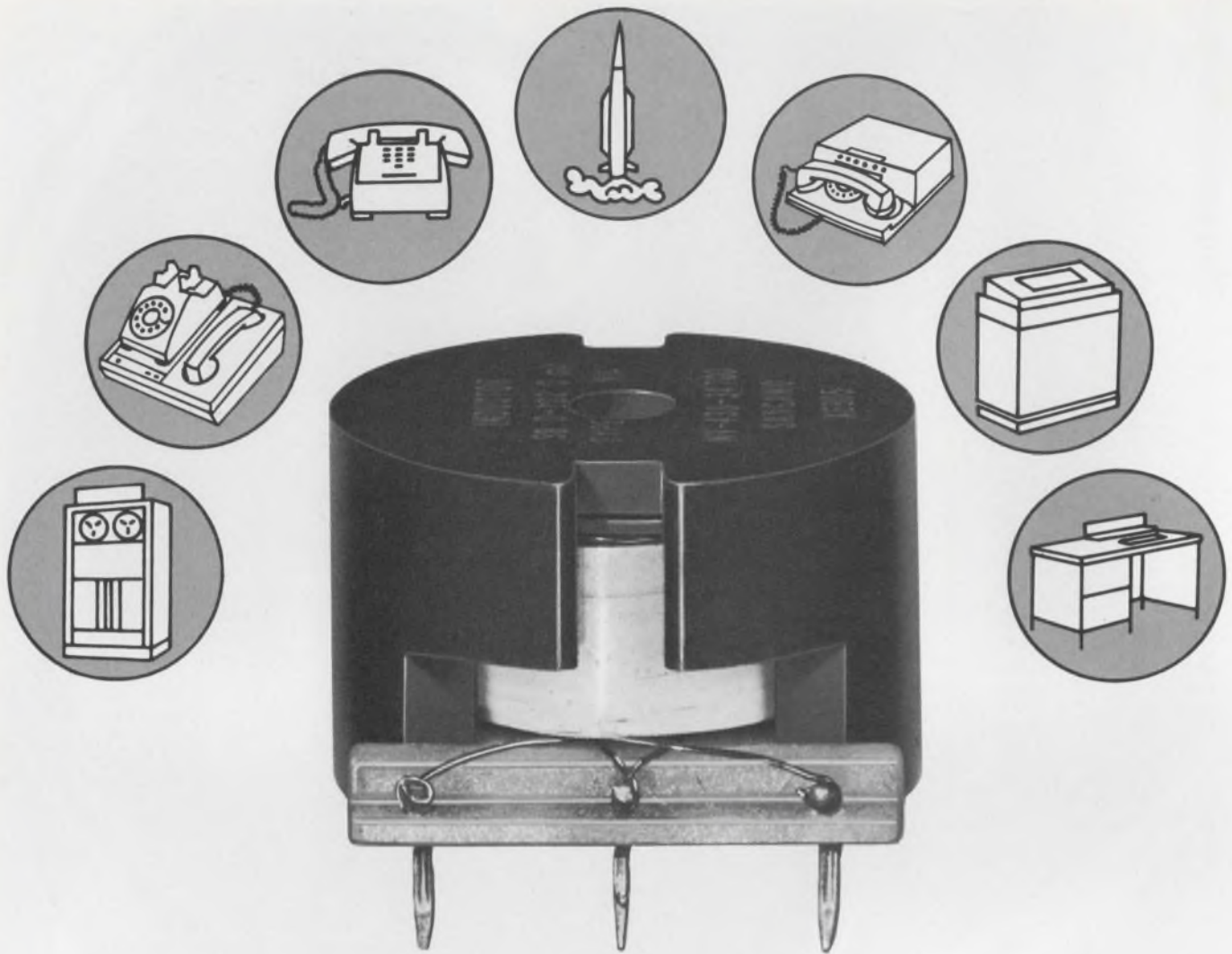
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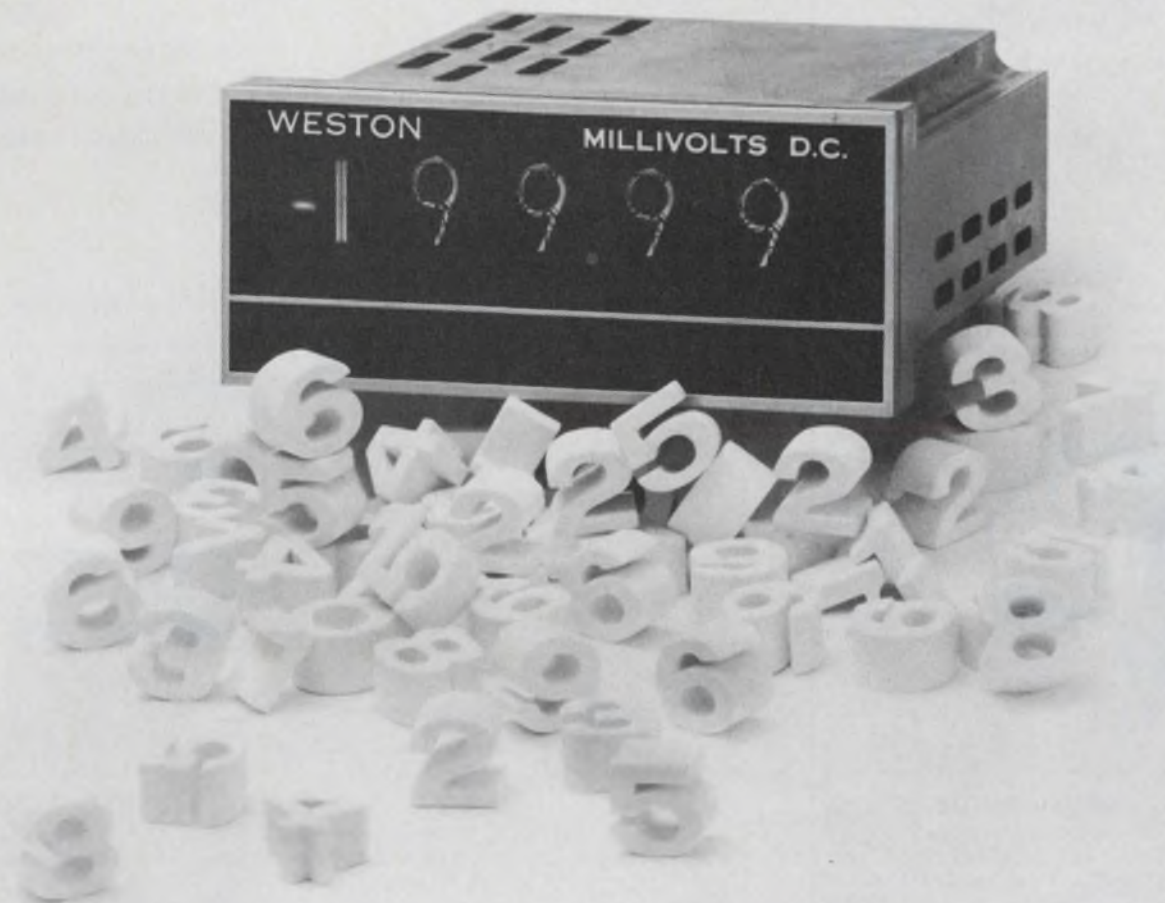
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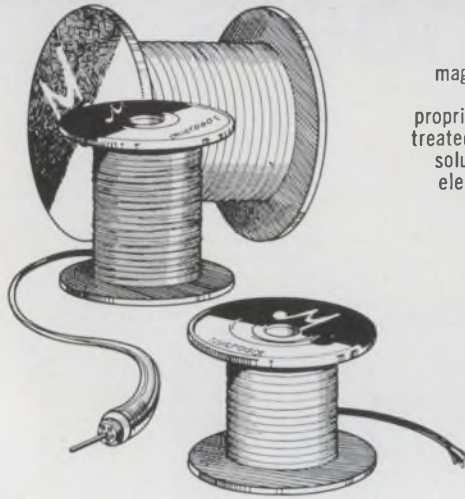
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\*Du Pont Trademark

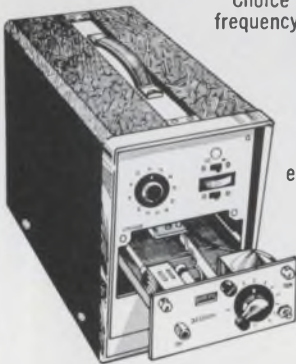
We present, for your pleasure and profit, a sampling of the superb in electronics and aerospace products. Engineered by divisions and companies of Microdot Inc. Designed to solve specific problems. For lack of space, your particular problem may not be discussed here. Don't fret. Call us. For some very, very interesting solutions.

## Watts the difference?

Microdot's Model 445 oscillator, of course. A 50-watt plug-in performer from our Instrument Division. With VHF-UHF power.

Choice of heads for 6 frequency ranges. From 2-2500 MHz.

Has positive no-load protection. Must equipment for everything from power meter calibration to antenna pattern measurements.



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Especially "Micromate." The only metal shell microminiature connector that mates with all existing plastic types. Perfect for external use — and when frequent disconnect and remating is needed. No retrofitting required, either.

In standard pin sizes (9, 15, 21, 25, 31, 37, 51).

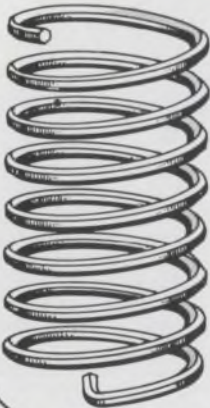


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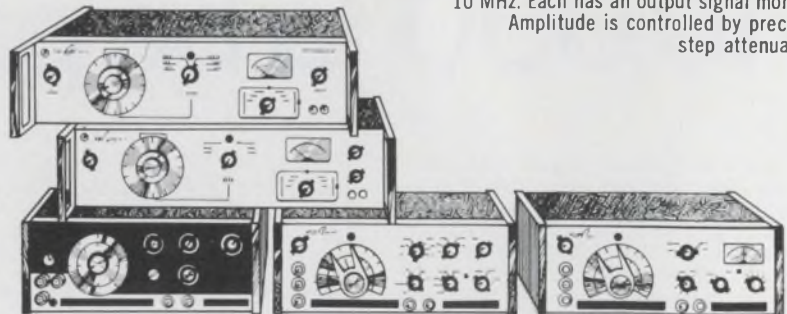
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Perma-Thread from our Kaynar Manufacturing Division. Available in Std. 208 Free-running and Pitch-Lok 209 Locking series. Inserts increase assembly reliability, eliminate thread failures, stay securely in place. They're the lightest, smallest inserts on the market. Interchangeable with all other coiled inserts.



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Microdot's Instrument Division is offering a new line of general test oscillators and waveform generators. Five in each series. Waveforms cover frequency spectrum of .005 Hz to 3 MHz. Output signals: sine, square, triangle, ramp and sync pulse. Oscillator frequencies range from 10 Hz to 10 MHz. Each has an output signal monitor. Amplitude is controlled by precision step attenuation.



**MICRODOT INC.**

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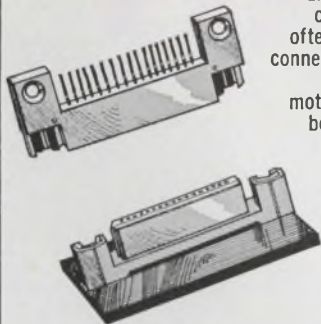


# etc.

## First things first.

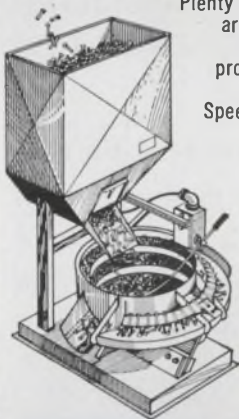
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## SIDELIGHTS

# Assignment to the Caribbean

When our Military-Aerospace editor, John F. Mason, went to Puerto Rico to see how the Navy has successfully converted 195,000 square miles of open sea and 60 square miles of islands and rocks to automated weapons ranges, he wasn't prepared for the peripherals:

■ He hadn't counted on having to enter San Juan Naval Station through the back gate to avoid the demonstrators out front shouting: "Yankee go home!" and "Get out of Culebra!" Culebra is the small island that's more or less the center of the complex of rocks and cays the Navy uses for strafing and for bombing practice. Once inside, Mason bravely stood behind the perimeter fence to view the protestors, and was surprised to note how much some of the blond girls looked like the ones he had seen demonstrating outside the Pentagon.

■ He couldn't see the admiral because he was closeted all morning with a team of television reporters and cameramen from New York, asking about the Navy's plans to quit or stay on Culebra.

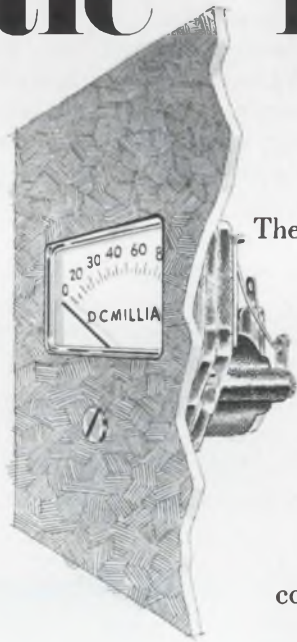
■ And later, in the observation post on Culebra itself, he had a hard time photographing the operators and equipment without tripping over TV camera cables and reporters from New York.

Apart from these minor distractions, Mason brought back a good technical picture of a sophisticated electronic complex that cost \$250-million and continues to grow. For his report, see page 28.



Atlantic Fleet Weapons Range deputy commander, Capt. E. C. McGowan, flew Military-Aerospace Editor John F. Mason, center, over most of the range's targets and to St. Croix to visit the underwater range for submarines and sonar.

# JEWELL'S SPACE-SAVING little meters



The Jewell Series 80T panel meters combine maximum readability with minimum panel space. That big plastic barrel has been eliminated making the Series 80T a little meter on both sides of the panel.

Don't let the size fool you! You'll see the large easy to read scale on an uncluttered dial. Behind the dial, Jewell's efficient taut-band mechanism is completely frictionless and self-shielded. Since Series 80 meters cost no more than conventional meters you don't have to pay a lot to get a little.

*actual size*



Want more facts about the "Space saving little meters"? Write for our new catalog . . . or get in touch with your nearest Jewell representative, distributor, or modification center.

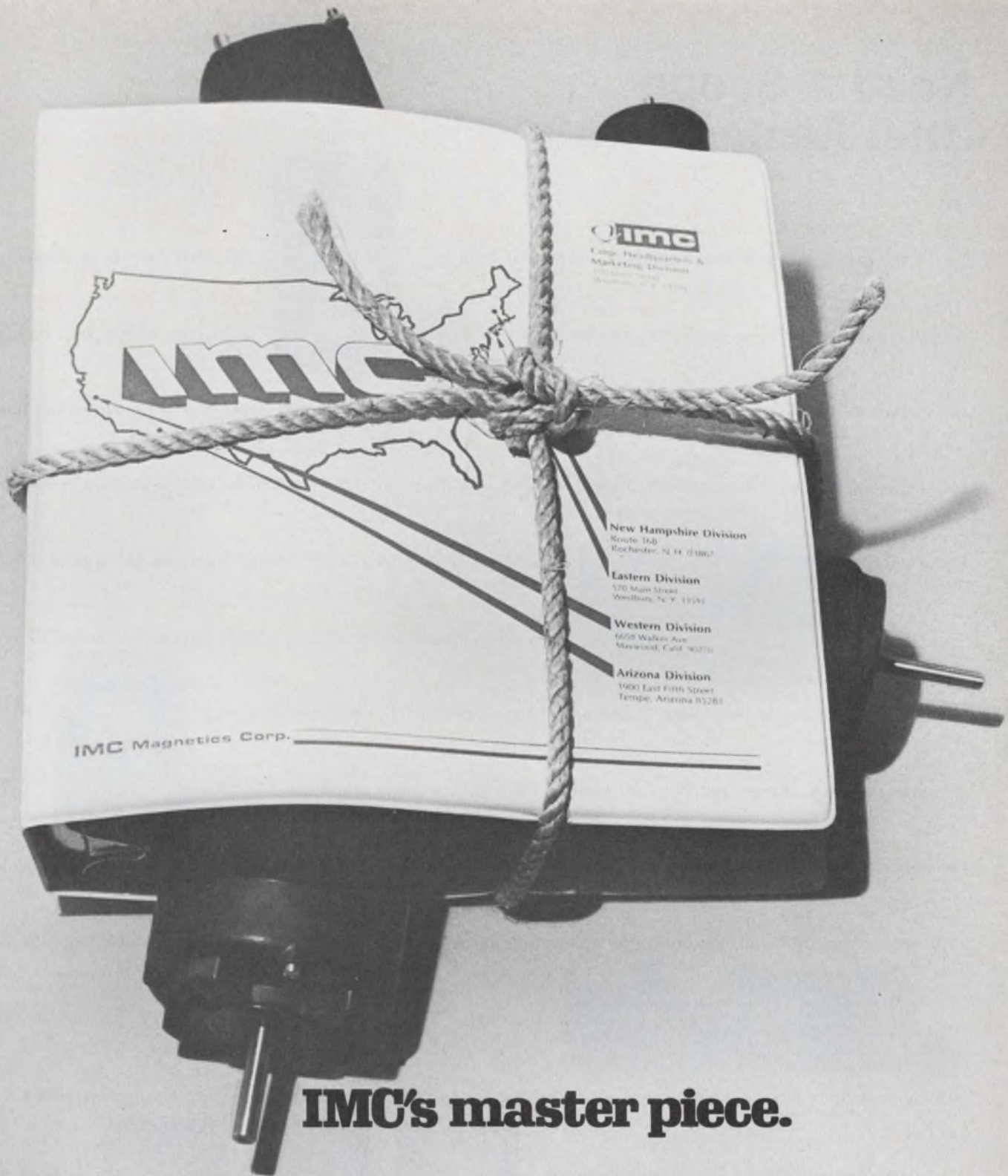
## Jewell

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INFORMATION RETRIEVAL NUMBER 32 ►





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
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# Need A Scope That Remembers?

If you make real-time measurements in the 50 MHz to something for you to remember: Only Hewlett-Packard offers



100 MHz frequency range, here's a storage scope with bandwidth

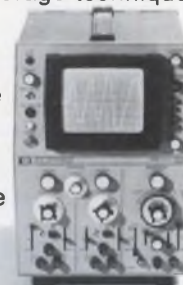
capabilities in these frequencies. In addition to this exclusive capability, Hewlett-Packard offers a scope that remembers sampling displays and spectrum analysis displays.  If you want low-frequency, high-sensitivity in a low-cost

scope that you can



remembers, HP has it, too.  In all the HP scopes, at the twist of a knob, vary persistence—an HP exclusive. HP's storage technique allows you

to store gray shades for complete Z-axis information—another HP exclusive. HP storage industry-standard, aluminized, P-31 phosphor; so you get the same brightness, the same



CRT's use burn-

resistance, the same writing speed, the same operating life you get with a conventional CRT—another HP exclusive.

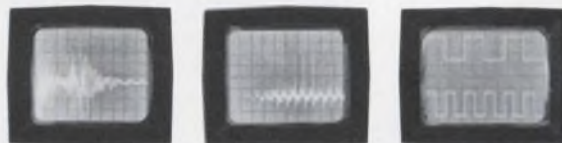
And, HP storage CRT's are the only ones with an internal graticule to eliminate parallax.  With an HP storage scope,



you really get three scopes in one. Use it to store, or to vary

display time, or as a conventional scope. Choose a 180 or 140 series storage oscilloscope with plug-ins which match

your high frequency needs. Choose the low-cost



1200 series for

your low-frequency measurements.  For application information on HP scopes that remember, contact your

local HP field engineer.

080/5

Or, write to Hewlett-Packard, Palo Alto, California 94304.  
Europe: 1217 Meyrin-Geneva, Switzerland.  
Prices: HP 141 Mainframe, \$1395 or \$1500;  
HP 181A Mainframe, \$1850; HP 1200 Series, \$1550 or \$1900.

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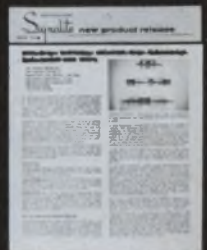
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## with the New Uni-Imp "ZERO" Reaction Time Voltage Surge Protector

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Now it is possible to protect sensitive components, even semi-conductor equipment, against voltage transients without concern for the rate of voltage rise. The "zero" reaction time of Signalite's new Uni-Imp is only one of the many unique features. Others include: bipolar, making them immune to di/dt restrictions; infinite high leakage resistance . . . plus more are described in a new data sheet.



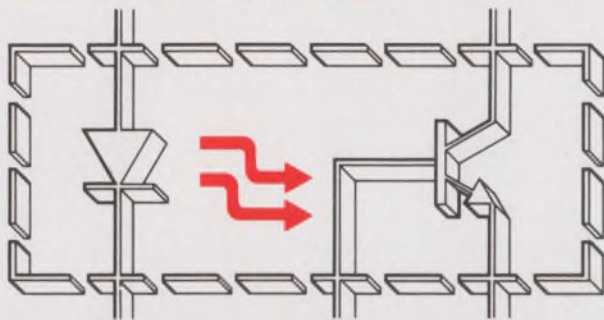
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Consider the GaAsLITE opto isolator.



Couple a GaAsLITE to a silicon detector, and you get almost perfect isolation between input and output; 100,000,000,000 ohms. Our opto isolators listed here do just that, and more. They give high performance at great speeds for very low cost. Scan the details. Each is packaged for mass production handling, and each is priced to suit quantity applications.



**MCT 2:**

**a GaAsLITE/phototransistor opto isolator compatible with semiconductors in digital or linear circuits.**

High current transfer ratio (35%) and isolation characteristics make the MCT 2 an ideal isolation transformer, pulse transformer, or relay. It can transmit a complex signal between subsystems without noise feedback.

The MCT 2 is a planar GaAs diode optically coupled to an NPN silicon planar phototransistor. It delivers hundred-billion-ohm isolation resistance and voltage isolation in excess of 1500 V, with coupling capacitance of 1.3 pF. New ISO-DIP six-lead plastic dual-in-line package makes it easy to work with and gives maximum economy.

**Characteristics:**

- Max. emitter forward voltage 1.5 V @  $I_F = 100$  mA
- Detector  $H_{FE}$  typ. 150 @  $V_{ce} = 5$  V,  $I_c = 100$   $\mu$ A
- Bandwidth 300 kHz @  $I_c = 2$  mA
- Price: 1,000 quantities, \$3.55. (All prices quoted are suggested resale price.)



**MCD 2:**

**if you need a really fast GaAsLITE opto isolator, this is it.**

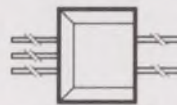
In the MCD series, we've coupled a GaAsLITE to a diffused planar Si PIN photodiode. The new MCD 2 gives you a turn-on time of 5 nanoseconds, yet offers the high voltage (1500 V) and resistance ( $10^{11}$  ohms) isolation you need for amplifiers, isolation transformers, pulse transformers, relays, feedback circuits or logic switches. Its coupling capacitance is very low, too; 1.3 pF. It will perform beautifully in linear or digital circuits. And the ISO-DIP packaging makes pc board stuffing a snap.

**Characteristics:**

- Max.  $V_F$  1.5 @  $I_F = 100$  mA
- Typ. DC transfer ratio 0.2%
- Bandwidth 8.5 MHz
- Price: 1,000 quantities: \$3.95.

# GaAsLITE Update

How Monsanto GaAsLITEs, optically coupled to light detectors, become ideal switches for digital or linear circuits.



**MCS 1:**

**a new opto isolator — GaAsLITE/photo SCR — a SPST relay with no contact bounce, microsecond response and solid state reliability.**

High input-output isolation ( $10^{11}$  ohms with 2500 V breakdown) and 3 pF coupling capacitance make the MCS 1 perfect for high speed switching or relay functions where an IC is looking at AC line voltages or any application that now uses an equivalent SCR. A bi-stable device, with a built-in memory, it can be used as a latching relay in DC circuits and carry 200 V across the anode.

**Characteristics:**

- $V_{AX} \geq 200$  @  $R_{OK} = 27K$
- $V_{AK} = .9$  V (typ.) @  $I_A = 200$  mA
- $I_F = 4$  mA } @  $V_{ce} = 50$  V,  $R_{OK} = 27K$
- $I_H = .1$  mA }
- Price: \$11 ea., 1,000's.

**Coupled pairs are in stock world wide**

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# helps you keep a low profile

It's small. Only  $3\frac{3}{8} \times 2\frac{5}{8} \times 1\frac{1}{8}$  in. Yet it's capable of 80 watts output, 50 watts internal dissipation at 90°C case temperature. Its high open-loop gain and low distortion make it an ideal choice for driving DC torque motors, servo motors, Sonar transducers and other applications where maximum performance and minimum space requirements are essential.

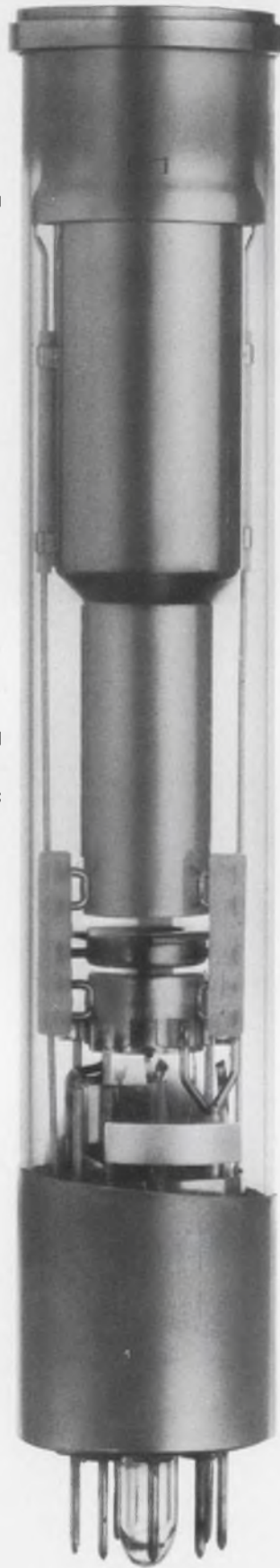
You won't even need a heat sink if you're operating short term high peak periods with moderate average power levels. Give Inland a call for all your amplifier requirements. But think of us first at the early design stages, when we can help you eliminate interface problems because of our systems capabilities through our affiliated divisions.



**Open up  
closed-circuit  
markets...**

**...with this new  
one-inch-diameter  
Plumbicon\***

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What a boost the entire CCTV industry would enjoy if existing cameras could operate well at significantly lower light levels and higher response speeds. That's exactly what this new Philips **Plumbicon** camera tube has to offer. Its one-inch-diameter makes it **retrofitable into existing cameras now using vidicons**. Developed originally to meet the exacting needs of live broadcast television, the **Plumbicon** won the industry's "Emmy" in 1967, as the year's most significant technological advance. Since then it has dominated its field - today it's in 9 out of 10 colour cameras in use throughout the world. When used in CCTV applications - in medicine, industry, education or commerce - this superb tube makes practical many applications hitherto only theoretical. The very high sensitivity, low dark current and fast response mean greatly improved picture quality - even when the subject is poorly illuminated or moving rapidly. All of which means the **Plumbicon** can make existing CCTV equipment work better, can make **CCTV colour** a practical proposition... can open up vast new markets, not only for cameras, but for related equipment as well! Let's help you open up new opportunities!

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Manufactured, distributed and sold  
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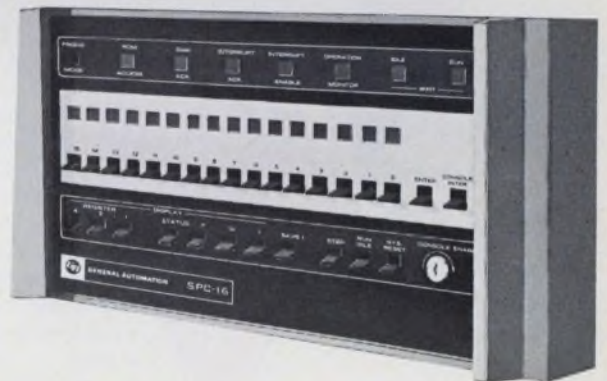
# Rugged Reliability is only one great feature of the new SPC-16 computer for your industrial automation

SPC-16 also performs like two computers in one... hardware features accommodate real-time dedicated control in the foreground, while performing background batch processing.

SPC-16 blends an unmatched combination of fast response time and powerful computing capability with fail safe features and rugged industrial reliability.

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# OUR ANGLE: angle position indicators that do more and cost less

## SHOULDN'T YOU TAKE A NEW READING ON THIS COST-PERFORMANCE ANGLE?

For better ways to measure synchro and resolver data, North Atlantic offers the best of both worlds: budget prices for the popular API-8025; superior performance and increased capability of the new 8525. • Both are interchangeable without any mechanical or wiring modifications.

North Atlantic's solid-state 8525 offers an accuracy of 0.05° (3 minutes). Following a 180° step input, it synchronizes a five-digit NIXIE readout in 1/2 second flat. And it tracks at up to 1000° per second.

Where cost can be traded against performance, the proven electromechanical API-8025 . . . a recognized indus-

MODEL 8525



MODEL 8025

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For complete information on the cost-performance angle, please write or phone now.

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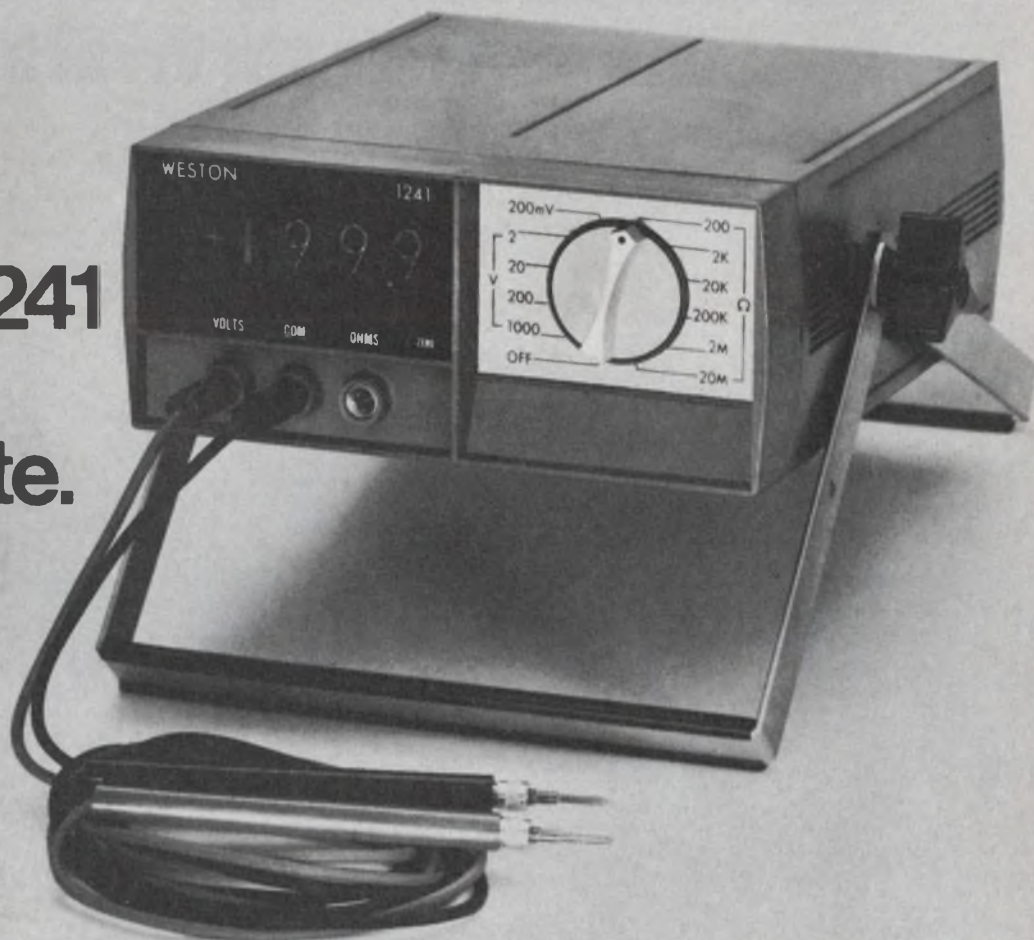
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INFORMATION RETRIEVAL NUMBER 40 ►



# Any DC VOM with 0.1% accuracy should cost more.

**Model 1241**  
**\$289**  
**complete.**



We wanted the price low enough that anyone taking DC voltage or resistance readings wouldn't have to think twice about choosing our new Model 1241. As it turned out, we can give you an even bigger break. Because most of the circuitry, as well as the rugged housing and many convenience features, had been developed previously for the Weston 1240 DMM which we introduced last November.

Here's a proprietary-designed Weston instrument you can pack in your tote case, use on the bench, or mount in a

standard 3½" panel. The only "extra" you may ever need is an optional battery pack for remote field applications. Model 1241 gives you high-impedance measuring capability to 3½ digits on five voltage and six ohm ranges.

In addition to its outstanding accuracy of 0.1% of reading  $\pm 0.05\%$  F.S. on Volts (0.5%  $\pm 1$  digit on Ohms), this advanced meter features complete circuit overload protection. Fuses are replaceable without opening the rugged, glass-filled thermoplastic case. And, of course, there's Weston's patented dual

slope\* integration, automatic decimal positioning, and non-blinking display.

If you want to see how much quality a dollar will buy today, contact your Weston Distributor. He also has in stock our 1240 DMM, with 26 AC-DC ranges plus all the above features. Or write today for complete specifications.

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Even the best engineer can get lost on a hunt for Ferramic® components. That's why we wrote a new guide book.

The book combines two basic aids in one handy volume. In the locator section, you'll find the right component for most circuit design requirements. But when a circuit requirement doesn't fit the usual selection process, you can find additional information in section two. This part of the book is a basic text on ferrite design and technology. And it's all in the familiar terms of electronics, not magnetics.

Our new book can help you solve all but the most unusual ferrite circuit design problems. And when the book can't help, the people who wrote it can.

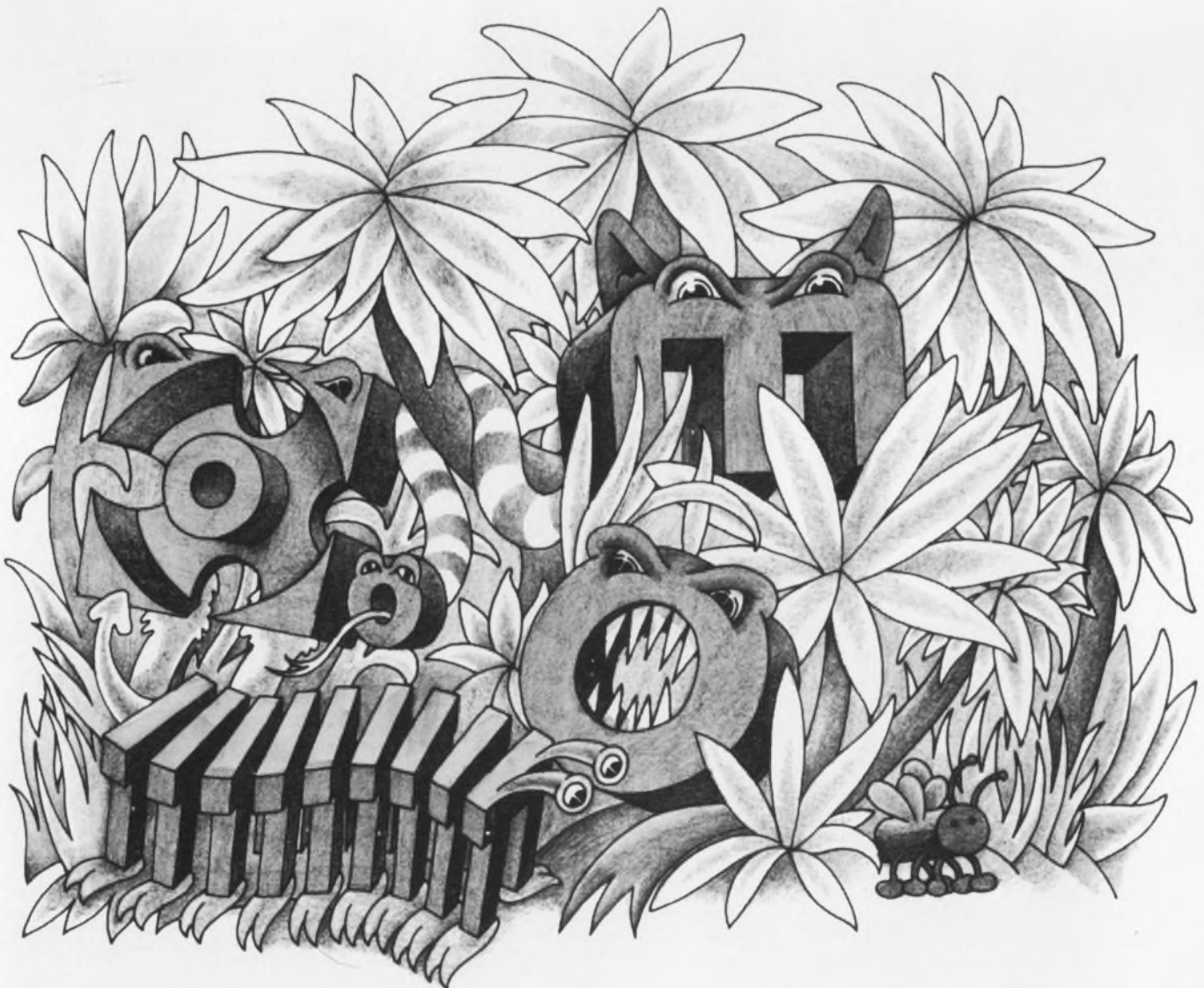
One way or the other, we'll help you survive the ferrite jungle.

For your free personal copy of *Ferramic Components*, write Indiana General, Electronic Products, Keasbey, N.J. 08832.

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## Don't venture into the ferrite jungle without our survival kit.







## For swept RF measurements of both magnitude and phase, try this test lab.

HP's 8407A Network Analyzer makes quick RF measurements, 100 kHz to 110 MHz with ease, accuracy and thoroughness. Inadequacies of alternate techniques have been eliminated and swept measurements over a wide dynamic range are now possible.

We're talking about full characterization — both magnitude and phase — of filters, amplifiers, attenuators, transistors, antennas, and any other RF component, device or network you can name. And you can check them at any stage of design, development or production.

The system consists of:

- 8601A Generator/Sweeper, a precision swept source, 0.1 to 110 MHz, with flat output, highly linear sweep and low residual FM.
- 8407A Network Analyzer mainframe with 8412A Phase-Magnitude Display unit for CRT presentation of test results.
- Accessory coax devices and probes to monitor the unknown's responses to the swept test signal.

For coaxial work: 11652A Reflection-Transmission Kit with all the accessories you'll need: precision power

splitter, high directivity flat coupler, termination and matched cables. Just hook up — make high accuracy swept measurements of complex transmission and reflection coefficients simply and quickly. For circuit work: 11654A Passive Probe Kit with high impedance voltage probes and dividers plus current probes. You can measure circuit and device performance without disturbing their behavior. And using voltage and current probes simultaneously, you can make swept impedance measurements with 10,000:1 dynamic range.

Dynamic measurement range is greater than 100 dB, and you can see 80 dB in one viewing of the 8412's CRT. And you can see phase response at the same time with 360° phase range. The system also provides 0.05 dB magnitude and 0.2° phase resolution.

The 8407A is a narrow-band detector that tracks the sweeping test signal; tracking provides these unique benefits:

1. Wide dynamic range and high sensitivity — make high-gain/high-loss measurements on sensitive networks and devices.
2. Accurate measurements — free from errors encountered in broadband detec-

tion methods resulting from harmonics and other spurious signals.

The 8407A RF mainframe costs \$2950; 8412A Display, \$1575; 11652A Reflection-Transmission kit (for coax), \$325; 11654A Passive Probe kit, \$325; 8601A Generator/Sweeper (general purpose precision swept source, useful for many applications), \$2250.

You can get the full story by phoning your local HP engineer and asking for a demonstration. He'll also be glad to give you Application Note 121-1, a comprehensive description of what this system can do for you; plus Application Note 121-2 which describes how to make wide dynamic range impedance measurements on a swept-frequency basis. Or write to Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

04016R

**HEWLETT  PACKARD**  
NETWORK ANALYZERS

INFORMATION RETRIEVAL NUMBER 121



# Wescon '70

# The theme is solving real-world problems





A growing awareness that technology can help solve certain of the nation's most pressing civil problems is reflected at this year's Western Electronic Show and Convention in Los Angeles.

In addition to the regular technical program covering the significant and practical in areas such as microelectronics, computers and microwaves, there are papers on ecology and water-pollution instrumentation, medical electronic equipment, and earth-resources satellites. Also, Wescon is supplementing its 27-session program with a special two-day symposium on "Applying Technology to Public Problems."

Twenty of the technical sessions are being held in the California Museum of Science and Industry, near the Sports Arena, and the seven sessions of a special computer-oriented program dealing with software and hardware considerations are being offered at Hollywood Park race track.

More than 40,000 engineers are expected to attend the show August 25-28. Nearly 600 U. S. and overseas companies are displaying their products at more than 1000 booths at Hollywood Park and the Sports Arena.

The special symposium—a departure from traditional Wescon programming—is being held August 26 and 27 in the Los Angeles Hilton Hotel. It is made up of four sessions, starting with a keynote meeting and covering the areas

of transportation, communications and the urban society. Among the scheduled speakers are Dr. C. Lester Hogan, president of Fairchild Camera and Instrumentation Corp.; the Hon. James M. Beggs, Under Secretary, U. S. Department of Transportation; Dr. Peter C. Goldmark, director of CBS Laboratories; Dr. John R. Pierce, consultant at Bell Telephone Laboratories; and Dr. Daniel E. Noble, vice chairman of the board of Motorola, Inc.

Dr. John V. Granger, president of the Institute of Electrical and Electronics Engineers, will keynote the show with an address entitled "Electronics: Past Imperfect, Future Conditional"—an analysis of the topsy-like growth of electronics since the late 1940s. He will suggest major changes in the identity of the electronics industry in the years ahead.

Other attractions during the week include: Display of the 26 winning products selected in Wescon's annual Industrial Design Awards program; the annual Distributor-Manufacturer-Representative Conference at the Century Plaza Hotel on August 24; the Eta Kappa Nu awards luncheon honoring the nation's outstanding engineering students; and a Science Film Theater of outstanding technical motion pictures to be screened daily at Hollywood Park.

Take a Wescon tour with us beginning on page W4.

<b>Design trends in major engineering areas as reflected in the technical papers</b> . . . . .	W4
Aerospace . . . . .	W4
Components . . . . .	W5
Computers . . . . .	W6
Environmental . . . . .	W8
Medicine . . . . .	W9
Microelectronics . . . . .	W10
Microwaves . . . . .	W13

<b>Complete guide to technical papers listed by engineering subject</b> . . .	W16
<b>Outstanding new products</b>	
Modules & Subassemblies . . . . .	W26
Instrumentation . . . . .	W32
Components . . . . .	W44
Data Processing . . . . .	W51
Packaging & Materials . . . . .	W54
Tools & Engineering Aids . . . . .	W56
Microwaves & Lasers . . . . .	W60



# Technology expands on all fronts

Papers at Wescon stress the thrust of electronics into new territories. But the emphasis is on the practical

## Aerospace

### New space systems: a design challenge

Space work will continue to challenge the design engineer despite the cutback in NASA spending. A number of conventional programs will be carried through the decade, in addition to several new ones that represent a dramatic step forward in design sophistication.

Besides detailing the "far-out" space station scheduled to go up late in the decade, Wescon's Session 13 will provide comprehensive information on the advanced communications experiments next in NASA's series of applications technology satellites; the earth-resources technology satellite; the synchronous meteorological satellite; and a multifunction satellite for conventional trunk-line communications, TV distribution and small-user service.

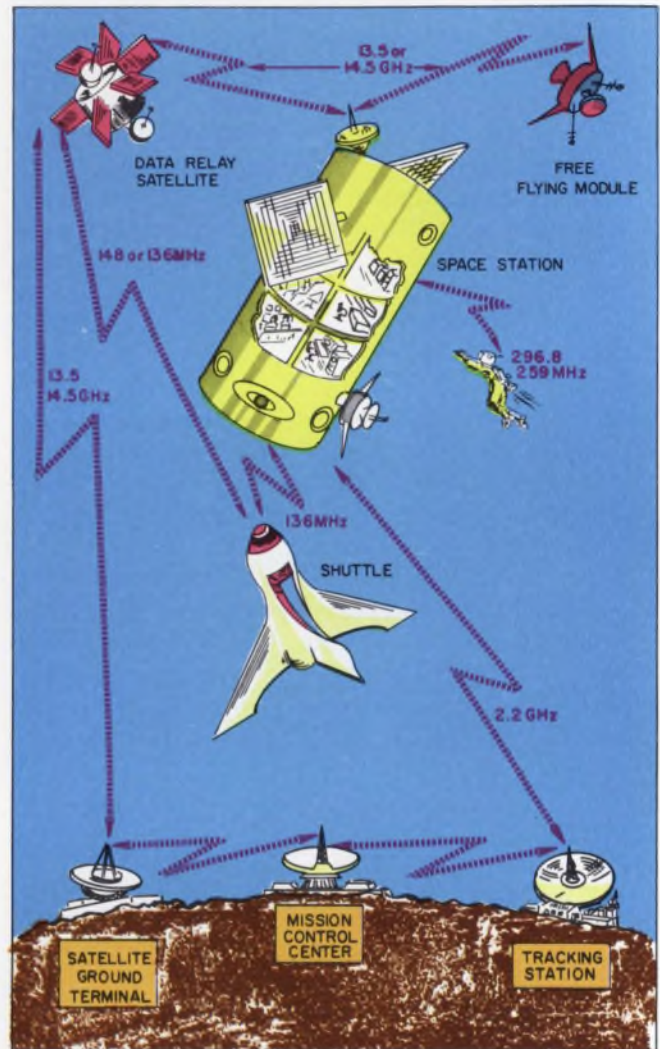
To keep the meeting within the world of reality, session organizer S. H. Durrani, Comsat Labs, Clarksburgh, Md., has included only projects that are already funded.

The first project described is the space station that will go up in the late 1970s and stay up for 10 years, according to a paper by A. Adelman and R. W. Kockenberger, Federal Systems Div., IBM, Huntsville, Ala. The 300-mile-high earth-orbiting structure will initially accommodate crews of 10 to 12 scientists. Gradually, the station will be expanded to a space base that can house contingents of 50.

Free-flying modules—as many as four at a time—will go out on specific missions as far as 200 miles from the station. There will be free-flying scientists outside the structure, and space shuttles ferrying crews and supplies from the earth and back. And there will be the laboratory's ground stations. All of these "terminals" need foolproof communication links.

A detailed look at data collection, processing, and dissemination in the spacecraft and to the ground is presented in the paper.

A data relay satellite will be used to solve the



Twelve-man, earth-orbiting space station will get replacements and supplies via shuttle, communicate by a relay satellite, be equipped with free-flying modules, and permit its scientists to work outside.

line-of-sight problem and to funnel to the ground multiple voice channels, two-way color television and broadband experiment data.

Because the space station will be as self-contained as possible, much of the experimental data is processed on board. What is sent to the ground will be in the form of information rather than raw data. "However, for significant events or experiments, all raw data can be transmitted," the IBM spokesmen say.



On-board transmitters will have 50-W power and will use 15-foot parabolic antennas.

Internal communications in the space station must be built between all on-board systems and experiments. They must provide for collecting, routing and disseminating data between on-board devices, including command, audio, video, digital, rf and tracking.

"The current trend in large astrionics systems," the IBM engineers say, "is toward multiplexing (using a data bus for data acquisition and distribution) to reduce cabling and provide flexibility, decreased weight, increased reliability, ease of maintenance, simplified manufacturing, and improved configuration control."

### NASA builds 30-foot deployable antenna

The advanced communications experiments next in NASA's series of applications technology satellites, ATS-F, are described in a paper by A. H. Sabelhaus of NASA's Goddard Space Flight Center, Greenbelt, Md., and R. P. Pahmeier of General Electric's Space Systems Div., Valley Forge, Pa.

Among the outstanding features of the satellite design are a 30-foot deployable antenna, with highly accurate pointing of 0.1 degree and a slewing capability of 17.5 degrees in 30 minutes.

According to the authors, these are ideal characteristics for the satellite's missions, which are to provide educational TV to villages in India and navigation and air traffic control between a synchronous satellite and two or more commercial aircraft over the North Atlantic. The satellite is also intended to provide two-way tracking and data links between a synchronous satellite and one or more low-altitude satellites.

The next two papers describe the first earth resources technology satellite, which is expected to go up in 1972, and the synchronous meteorological satellite. The earth-resources satellite paper is given by B. T. Bachofer of the General Electric Space Center, Valley Forge. The weather-station paper is by Donald Fordyce of NASA's Goddard Space Center.

Departing from government programs, session chairman Durrani delivers a paper on a multi-functional satellite for the late 1970s. Durrani foresees a greatly expanded demand for conventional trunk-line communications, as well as a number of new services, including TV distribution, domestic communications, aeronautical-maritime service, small-user service, and space-vehicle communications.

Designers in the growing field of automatic test equipment get an unusual opportunity in Session 5 to hear in one setting four military users of such equipment tell what they like and don't like about it.

"We're having a good feed-back right from the user," session organizer Fred Liguori, Emerson Electric Co., St. Louis, Mo., told ELECTRONIC DESIGN. "The four speakers discuss not only design problems but how to manage the systems."

William Morris of Tobyhanna Army Depot, Tobyhanna, Pa., tells his experiences with DI-MATE (depot installed maintenance automatic test equipment) that is used to test Army avionics. "We found that it's better to install a system in its working environment while it's still in its prototype stage instead of waiting until it's fully tested. The real-life problems that crop up can be solved by changing the design. We actually develop the system after it's installed."

H. A. Fraser, Kelly Air Force Base, San Antonio, Tex., gives the Air Force's recommendations for a future GPATS (general-purpose automatic test set) to test avionics in Air Force planes. William E. Grunald, U. S. Army Missile Command, Huntsville, Ala., and A. T. Carver, RCA, Burlington, Mass., pool their observations on the LCSS (land combat support system). And a representative from Newark, Ohio, shares his experiences with the versatile automatic test equipment, VATE, a system used to test inertial guidance in aircraft. ■■

## Components

# Digital techniques require new filters

The engineer is having a rough time selecting the best filter or equalizer for every project he works on.

The increase in data transmission by both radio and telephone—a phenomenon made possible by improved digital techniques—calls for more sensitive filters with narrower bandwidth, reduced passband ripple, and better envelope delay characteristics. Radar and control systems engineers must be on the lookout for greater phase linearity or phase matching between filters.

How can an engineer find the best filter from the growing number available?

Ways to make these decisions is the theme of Wescon's Session 10, entitled "Active and Passive Filters and Equalizers." The four-paper session was organized by Robert A. Johnson, Collins Radio Co., Newport Beach, Calif.

"The choice of a filter is made very difficult by the fact that both price and performance are very similar for a number of filter types," Johnson says in discussing the session. At present, he points out, most voice-channel filters are pas-



sive. These include LC, LC-crystal, crystal, mechanical and monolithic, all with carrier frequencies ranging from 12 kHz to 8 MHz.

"Adding to the difficulty are additional options that can be selected, such as the use of a low-pass filter in the audio stage to improve the noncarrier side selectivity." Another choice, he adds, is this: "If delay equalization is needed, should it be internal to the voice-channel filter or should it be separate at audio frequencies? If separate, a choice must be made between a number of active and passive equalizer types. Some of the active equalizer designs include the use of phase-inverting transistor networks, operational amplifiers, negative impedance inverters or gyrators, each arranged in various configurations.

"Similar decisions," Johnson continues, "must be made by designers of radar systems or various control systems where perhaps phase matching or linear phase, or possibly the time domain response, are more important performance criteria than the amplitude or envelope delay."

### Three approaches to a better equalizer

Charles E. Schmidt, Lenkurt Electronics Co., San Carlos, Calif., in his paper on "Delay Equalizers," examines three approaches to design techniques: equal-ripple, least-squares and maximally flat. "The least-squares design has considerably better performance over most of the passband than the equal ripple," Schmidt says. "But it has slightly poorer performance at the band edge. The maximally flat design," he continues, "is extremely poor at the band edge." Schmidt concludes that "the least-squares approximation is a happy medium between the two."

The least-squares approximation is also used in the design of a multistage adjustable delay equalizer described by Jerry G. Willford and Jay V. Robertson, Collins Radio Co., Newport Beach, Calif. In their paper, "Active Filters and Equalizers Using Operational Amplifiers," the authors describe how the delay adjustment can be made by changing a single resistor and how this adjustment is incorporated in the optimization program. A basic realization procedure using operational amplifier building blocks is also described. The minimum sensitivity, the authors say, is achieved by separating the filter into isolated first and second-order stages which, in addition, simplify the design and alignment procedures. The design procedure is made clear through a six-stage, twin-tee equalizer design example.

In addition to outlining specific design methods the papers include information on performance characteristics as determined by basic parameters such as crystal, inductor or amplifier gain stability. A paper by C. W. Pond, Hughes Air-

craft Co., Newport, Calif., called "Phase Matched Bandpass Crystal Filters," discusses in some detail the degree of phase-match possible for various crystal cuts and filter types. The crystal filter designs include discrete component narrow-band and intermediate bandwidth filters, as well as a few words on monolithic (quartz mechanical) filters. ■■

## Computers

# The spotlight is on minicomputers

Because of the increasing impact of computer applications on engineering, Wescon is featuring this year a special four-day computer-oriented technical program. Minicomputers highlight the sessions, which also cover time sharing, computing systems, computer-aided design, programmable calculators and software.

Some 10,000 minicomputers are sold annually for design into industrial and process controls, automatic test systems, and other specialized systems. The advantages and limitations of these machines and their associated peripheral equipment are presented in the Wescon program, as well as discussions of application problems.

There are currently more than 60 different models of minicomputers on the market. (See "The Minicomputer: machine with an endless future," *ELECTRONIC DESIGN* 9, April 26, 1970, p. C6.) The number of minicomputers applied in industrial and process control applications has increased dramatically in the last two years, according to Ernest T. Roland, executive vice president, Jackson Associates, Columbus, Ohio. His paper in Session C is entitled, "Minicomputers and Peripheral Equipment—a Current Review."

While his paper is essentially concerned with selecting a minicomputer for process controls, Roland's conclusions also can be applied to industrial control.

He says that the first job is to match the requirements of the system. In process control the minicomputer is used in data acquisition; direct digital control; a combination of the two; or as the lowest member of a computer hierarchy.

In these applications the transducers or sensors are the governing interface. Roland develops a method and chart that define the accuracy required for various types of process measurements, in terms of the binary bits needed in the minicomputer. These range from 4 bits for 6% to 16 bits for 0.002%.

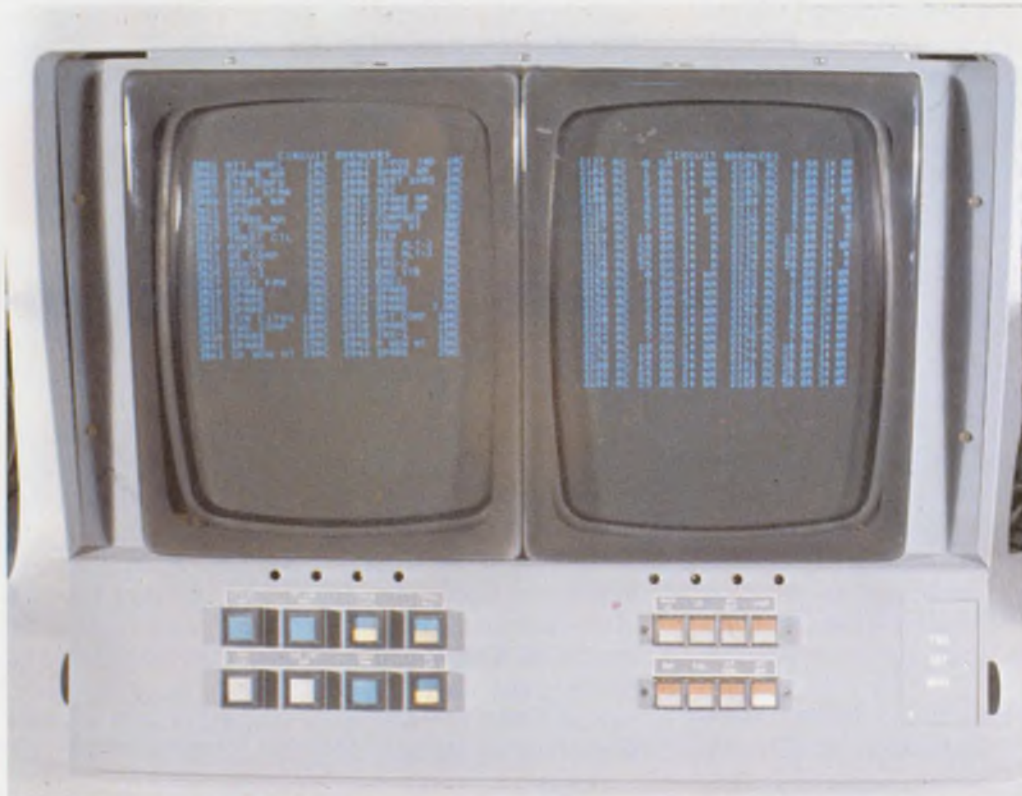
A universal problem, Roland notes, lies in





The shortage of medical personnel is expected to increase the need for labor-saving electronics equipment. This Statham patient monitoring cart contains all the

instrumentation required for cardiac monitoring and resuscitation. It's shown in use at M. D. Anderson Hospital, Houston (Session 12).



**Cathode-ray tube display center** is used in Bendix Corp.'s new Airborne Display and Electric Management System (Paper 17.2).



making direct cost comparisons between different minicomputers, once the general requirements are established. He pinpoints common denominators that provide meaningful comparisons. These include the central processor, the memory, the in-out structure and the software package as well.

### A matter of system design

One of the principal problems in designing minicomputer-controlled systems, says Alvin J. Fanthorp, electrical engineer, P. E. Developments Co., Cincinnati, Ohio, lies in the lack of compatibility between the computer and the sensors or transducers supplying information to the system. In his paper in Session C, entitled "Minicomputer Sensor and Interface Selection," he notes that while computer control-system costs dropped with the introduction of the lower-cost minicomputers, the proportion of money spent on the sensor-computer interface has risen. This is because most of the basic sensors used are hand-me-downs from analog systems that must be adapted to the computer.

As a result, the designer is called upon to compensate for nonlinearities, time delays, or other types of inaccuracies by utilizing the computer's capability to act as a part of the sensor system.

What will probably be the most controversial of the minicomputer sessions will be a paper in Session C by Dr. Sergio Ribeiro, member of the technical staff, National Semiconductor, Santa Clara, Calif. It is called "Talking to the Minicomputer."

"There is a need for more practical and usable minicomputers," he told ELECTRONIC DESIGN. "I feel that, so far, the people who make them have not understood very well the way they are applied. Since they are used in dedicated operations, there should be a more practical interface between operator and minicomputer than teletypewriters and paper tapes."

He pointed to the Wang and Hewlett-Packard 91 programmable calculators.

"The minicomputer systems should be like these calculators," he said. "The input goes through the keyboard. The output goes to a CRT or printer, which is built into the system as inexpensively as possible, and which is not faster than the job requires."

"But the minicomputer manufacturer gives the buyer the building blocks to put together himself—and often the buyer doesn't know how to do this very well. He frequently comes up with something too expensive, too cumbersome, or possibly inadequate."

"And to further aggravate the problem," said Dr. Ribeiro, "minicomputers are very often used for purposes that were never intended, like as-

sembling and compilation.

Time sharing, a prime tool for design and development is undergoing continuous growth in technical and program capability, according to Victor O. Muglia, systems-analysis group leader, Hoffman Electronics Corp., El Monte, Calif. He is the organizer of the Wescon Session E on the "Evaluation of Time-Sharing Services."

"This group of papers," he told ELECTRONIC DESIGN, "will review the common features and the differences in time sharing among a variety of users."

Muglia himself will deliver a paper on "An Overview of the Time-Sharing Industry."

Lessons learned in the use of time sharing for engineering work over the past two years will be discussed in a paper by Arthur H. Wehry, senior design engineer, Tridea Electronics, El Monte, Calif. Some of the potential costly pitfalls for the new time-sharing user will also be presented.

The role of time sharing for the military—for remote-site testing, test-data gathering and test-data reduction as well as other engineering and scientific applications will be described by Jerome L. Zaharais, head, application section, data computation branch, Naval Weapons Center, China Lake, Calif.

The group of programmable calculators now available, including those from Wang Laboratories, Hewlett-Packard, Cintra Scientific, and Olivetti, provide the engineer with a powerful and relatively simple-to-use means of computation. Session D, entitled "Hands-on Programmable Calculators," will present five papers on the application and future of these machines. In addition, the manufacturers will provide a number of calculators at the session so that the participants will have an opportunity to try their hands at the machines. ■■

## Environmental

# New instrumentation gets top priority

New electronic instruments are needed to help solve urgent environmental problems. Two sessions at Wescon are designed to highlight this need and to stimulate the interest of instrument designers in meeting it: Session 6 on "Instrumentation Guidelines for the Study and Control of Ecology and Water Pollution" and Session 20 on "West Coast Environmental Problems." The latter covers in particular land slippage, oil seepage and fire problems, air pollution and airport and freeway noise.

Speakers at the two sessions will describe a



particular environmental problem and the type of instrumentation now being used. They will explain why this instrumentation is not adequate and will outline what is needed to replace it.

"To help predict earthquakes," says Robert D. Nason, research seismologist at the U. S. Environmental Sciences Administration, Earthquake Mechanism Laboratory, San Francisco, "some system for measuring distances 10 miles apart to an accuracy of better than 1/2 inch is vitally needed.

"We need to place such instruments a small distance apart all along a fault line that may extend for hundreds of miles in length," continues Nason who is a speaker at Session 20.

Why would this help to detect earthquakes? Nason explains it this way: A fault line is an area of breakage caused by earthquakes in the past. Once a fault appears, it constitutes a weak area in the earth, and future earthquakes tend to occur there rather than elsewhere. But even when there is no major earthquake, small tremors occur along the fault line, causing slight land deformations at distances up to 10 miles on either side of the fault.

"To predict earthquakes," says Nason, "we need to know whether the deformation that occurs a few days or hours before an earthquake differs from long-term deformation. Does the amount of deformation accelerate just before an earthquake? This would be a way of warning us that an earthquake is coming."

#### What do fish eat?

John S. Pearse, marine biologist at the Kerckhoff Marine Laboratory, Corona Del Mar, Calif., and one of the speakers at Session 6, says marine biologists urgently need new instrumentation that will monitor small changes in microscopic particles suspended in the ocean. Why? Because these particles may constitute food for marine microorganisms that in turn provide food for commercial fish and crustaceans. When man introduces small microscopic particles into the ocean from industrial wastes, for example, it is important to know whether they contain nutrients on which living organisms can feed. If so, they may upset the balance of nature and in time wreak havoc.

For example, he points out, in recent years, the kelp beds along the coast of Southern California have largely disappeared, and with them commercial fish. At the same time, he says, sea urchins, which normally must eat kelp to live, abound. What caused the sea urchins to reproduce so rapidly, and how do they survive now that the kelp is gone? The theory is, says Pearse, that unseasonably high temperatures in the late fifties killed a large part of the kelp. Normally when

this occurs, the sea urchins die off from lack of food. The kelp then reappears, and along with it, tiny microorganisms that feed on the larvae of the sea urchins and in turn are eaten by the commercial fish. Thus the balance of nature is restored.

The larvae that grow into adult sea urchins control the microorganisms by eating the kelp in which they live, and the microorganisms control the sea urchins by killing off their young. Unfortunately, when some of the kelp was killed in the Fifties, this normal balance was never restored. Why? Probably, says Pearse, because waste material from sewage had introduced a new element into the cycle: suspended particles that contained nutrients on which adult sea urchins could live. As a result, the sea urchins overpopulated the area, killing all the kelp and with it the microorganisms that provide food for the commercial fish.

"In barren areas like Palos Verdes," says Pearse, "where there are no kelp beds at all, the sea urchins—both larvae and adults—abound, and there is almost no other kind of marine life."

"To prevent future upsets of this sort," he observed, "we very much need instrumentation that would monitor suspended particles in the ocean, so that we can keep a record of small changes over a period of time."

In the past, he states, samples of the sea water were collected and taken to the lab for chemical analysis. But this is very tedious. "What we really need," he says, "is some kind of instrumentation that we can put into the ocean for continuous monitoring." ■■

## Medicine

# Electronics will cut shortage of doctors

The growing shortage of doctors and nurses is expected to greatly expand the need for labor-saving electronics equipment, according to Dr. Morton D. Schwartz of the University of Southern California's Biomedical Engineering Department and organizer of Session 12. This shortage of medical personnel could total 1/2 million people by 1975, says Dr. Schwartz. As a result, he expects the electronic equipment sold to the medical market to double, from about \$1 billion in 1970 to over \$2 billion by 1976. Speakers at the session will describe state-of-the-art equipment designed to meet special needs and will discuss areas where new or improved equipment is needed.

One promising prospect for alleviating the shortage of doctors and nurses is a computer terminal at the bedside of cardiac patients. Such a system is described in a paper by Dr. Jerome Russell, director of the Computer Science Facility, Department of Cardiology, Cedars-Sinai Medical Center, Los Angeles. He is chief designer of this system, as well as earlier ones. According to Dr. Russell, the system "eavesdrops" on several cardiac monitoring units, each tied to a patient's bed. It measures and records many bodily functions at once and analyzes the data. It can be commanded by a doctor or nurse to perform special measurements or to display recorded information.

"For example," says Dr. Russell, "if you want to correlate an eight-hour plot of the patient's heart rate with his arterial pressure for the same period, you can command the computer to display the information graphically on the screen. Then, if you want a permanent record, another command will cause a Cal Comp plotter in the computer room to make a paper printout."

The terminal consists of a standard TV monitor, a telephone dial and push buttons for entry, and a Data Disc 6500 unit tied to a Xerox Data Systems Sigma 3 computer. The computer is attached to a controller that generates the graphical images and stores them on a magnetic disc in a composite video signal format that can be displayed on the TV screen.

Dr. Russell points out that the system does not automatically sound an alarm when it receives a warning from a sensor connected to the patient's body. "For example," he says, "if there is no electrical signal on the electrodes in the patient's heart, the computer does not automatically sound the No. 1 alarm. Instead, it checks the blood pressure signal, and if this is satisfactory, the message on the screen is simply 'Check ECG on Bed 3.'"

Dr. Russell says he does not believe that a single time-shared system of this type is the best approach to automating a hospital, because of its high initial cost and the overdependence on a central computer, which can break down. "I think a better approach," he states, "is to make a decentralized computer network using a number of small computers dedicated to specific tasks." One such computer might be dedicated to looking for life-threatening conditions, he explains, and another to managing the terminal interactions. A whole network of such small stand-alone machines could communicate with a central file processor.

#### Hospital as a hostile environment

The need for improved equipment to eliminate hazards to patients' safety is stressed in a paper

by Allan F. Pacela, chief research scientist, Beckman Instruments, Inc., Fullerton, Calif. Pacela says, "the hospital is a hostile environment for electronic equipment"—particularly since currents as small as 20  $\mu$ A can be a lethal shock to a catheterized heart patient. Pacela explains that hundreds of millivolts of ground-potential difference may exist between different outlets in the same hospital room. Since the patient's impedance may be as low as 1000 ohms, this amount of voltage could kill him.

According to an estimate by an insurance firm, Pacela says, 1200 accidental electrocutions occur each year in U.S. hospitals—most of them unreported. He discusses instrument design improvements that would prevent such tragedies—for example, grounding of patients, isolation of patient/equipment interface, redundancy and fail/safe design.

Two papers—one by Charles A. Broutman and Malcolm G. Ridgway of TRW Systems, Redondo Beach, and the other by Kenneth L. Dufour of Humetrics Corp., Los Angeles—discuss instrumentation needs for medical screening by paramedical and untrained personnel.

In an interview with *ELECTRONIC DESIGN*, Broutman pointed out that most of the screening systems used today consist of instruments that were designed for diagnostic purposes and must be used by doctors. What is needed, he said, is instrumentation that can be used by technicians, as well as doctors, to perform a kind of "go-no-go" test that can determine quickly whether or not a person has a certain disease. He suggested that the trend will be toward measuring a total body system. For example, he says, "Instead of an instrument that measures blood pressure, you need a system that will measure many different parameters of the cardiovascular system, and preferably one that is connected to a computer so you can correlate the different parameters and get a diagnostic readout."

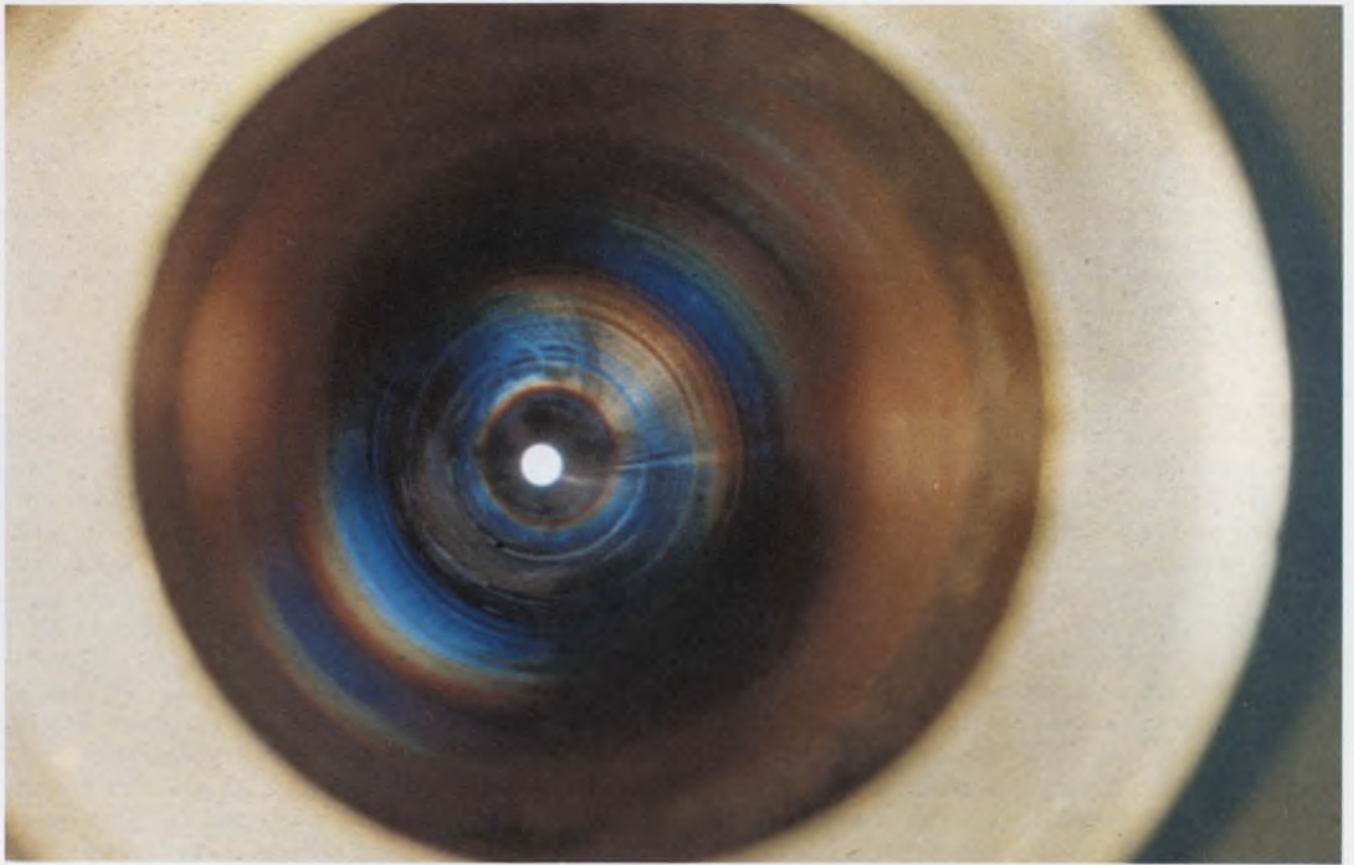
Kenneth Dufour of Humetrics Corp. describes two mass-screening devices that were designed by his company to detect abnormal electrocardiographic changes—one for adults and the other for children. Both devices can be operated by nonmedical personnel. ■■

## Microelectronics

# The accent is on ICs at home and abroad

Wescon sessions on microelectronics cover a wide range of subjects from the burgeoning field of optoelectronic devices to LSI memories to ICs—at home and abroad.





**View down a helical waveguide** symbolizes an experimental millimeter-wave communications system that is now under investigation at Bell Telephone Laboratories,

Holmdel, N.J. Such an operational system would have a capacity of 230,000 two-way telephone channels (Paper 3.2).



**The integrated-circuit overseas** is the subject of Session 8. American exhibitors at the recent Mesucora show in Paris (photo left) were impressed with the rapid growth in the European electronics market.



"Optoelectronics—the combination of optics and electronics in the solution of engineering problems—is a field of promise and excitement," according to L. Merrill Palmer of Centralab Semiconductor Div., Globe-Union Inc., El Monte, Calif. Palmer, who organized Session No. 15 on "Optoelectronic Devices and Applications," says the area has a tremendous growth potential. Its uses include solid-state vidicons, optical isolators and many others.

Some applications are practical only with optoelectronic devices, according to Palmer, and new knowledge is required on the part of the electronic designer. Terms that may be common to a physicist—such as spectral response, color temperature and lumens per square meter—are unfamiliar to the electronic design engineer. Session 15 gives him an excellent opportunity to obtain some practical information.

A paper, "Survey of Photosensitive Materials and Devices," by A. Seck, also of Centralab, provides introductory material on the subject. He discusses the various ways light is changed into electrical energy and also covers operating characteristics, limitations and relative merits of a wide variety of semiconductor photosensitive devices. This paper is extremely helpful in making the proper selection of a photosensitive device to achieve optimum results in most photosensor applications.

In a paper on "Opto-Hybrid Integrated Circuit Photosensitive Devices," Palmer offers solutions to some interface problems.

### **Photon-coupled devices offer advantages**

Two different applications for optoelectronic devices are described by W. M. Otsuka and R. A. Hunt, Sr., Monsanto Electronic Special Products, Cupertino, Calif., in their paper, "Innovations with Light-Emitting Diodes." The first application discussed is the monolithic gallium arsenide alphanumeric display. The second and potentially more exciting application is the optical isolator. Photon-coupled devices can offer the circuit designer many advantages in terms of superior input to output isolation, ultrafast response and transistor and IC compatibility.

Two very different sessions being held at the same time will be vying for attention. Session No. 7 is on "LSI Memories" and Session No. 8 on "The Integrated Circuit Overseas."

The organizer of Session No. 7, Andrew C. Tickle of Zeion Inc., Canoga Park, Calif., observes that, "The high density and relatively simple logical organization of memories make them ideal for the demonstration of new processes, design and manufacturing techniques."

In the first paper of Session 7, "Silicon Gate MOS Technology and Its Memory Application,"

D. Frohman-Bentchkowsky, of Intel Corp., Mountain View, Calif., describes this technology, compares it to some of the other MOS technologies and discusses its impact in terms of yield, performance and over-all costs. A major feature of this technology is the self-aligned gate structure, which leads to low gate and feedback capacitances, resulting in higher speed operation, lower internal-drive requirements and lower input and clock capacitances.

### **All about ion implantation**

Ion implantation, another process possessing the very desirable self-aligning feature, is presented at this session in a paper by Tickle and his associate from Zeion, L. F. Roman. In addition to improving speed and possibly yields, the authors state, ion implantation can produce higher ohmic value resistors to replace inefficient MOS transistor loads. In bipolar circuits, improvements can be achieved, they say, by implanting low-voltage clamping diodes to prevent saturation and adding shallow ohmic contacts.

How do you take advantage of the high density and low power of MOS when you need the speed of bipolar memories? Use a hybrid technique, says J. J. Kubinec of Computer Microtechnology, Inc., Sunnyvale, Calif., in his Session 7 paper, "Performance and Economic Relationships of a Beam Lead Multichip Memory."

The memory "module," built by Computer Microtechnology and discussed by Kubinec, is a 4096-bit random-access memory (RAM) containing both MOS and bipolar IC chips. The RAM consists of 16 MOS memory chips (256 bits per chip), four bipolar one-of-eight decoder chips and two bipolar read-write sense amplifiers. Each chip is fixed as a substrate by ultrasonic bond on aluminum beam leads. The substrate has two layers of aluminum interconnect separated by a glass dielectric. Kubinec compares the cost and reliability considerations involved in using this technique with using individual packages.

### **A look at the European market**

For engineers and managers whose interests extend beyond the limits of design and territorial limits of the United States, ELECTRONIC DESIGN's Managing Editor, Raymond Daniel Speer, has organized Session No. 8. This session, although primarily dealing with ICs, provides a very broad view of the European electronics market in general. Attendees will also obtain a sociological insight to Europe, in addition to a purely technical one.

According to Speer, "Session 8 will put the European market in perspective. The speakers, unquestionably expert in their fields, will de-



scribe and analyze the manufacture and application of ICs in foreign markets, the problems of selling in Europe and the solutions to them, tariffs as barriers to trade, and the role of the American company in the world market." ■■

## Microwaves

# Renewed interest in millimeter waves

A big explosion in the millimeter-wave field has been "just around the corner" for something like ten years now, and microwave engineers have learned to add several grains of salt to reports they read of the "rapidly growing interest" and "potentially huge markets" in this area. Actually, there has been a great deal of interest in millimeter waves, but it has been cyclical rather than sustained.

While recognizing these facts, Robert M. Knox, Chairman of Wescon's Session 3, "Millimeter Systems, Devices and Guides," nevertheless feels that "... spectrum crowding at lower frequencies and the desire for narrower beamwidths and broader information bandwidths have once again caused a revitalization of interest in this (30 to 300-GHz) frequency range. The gradual improvement in availability of active components has also stimulated increased activity in millimeter-systems development."

Knox's statement is supported by the session's leadoff paper, "Millimeter-Wave Systems—An Overview," by Alan J. Simmons of the Microwave Products Div., Control Data Corp., East Boston, Mass. He is concerned mainly with outlining the wide range of applications for millimeter-wave systems. Some of the systems he describes are actually in operation; others are only in the planning stage.

Basically, Simmons breaks the systems into two groups—sensors and communications.

The sensor applications include research-laboratory work on ionized plasmas, passive radiometry and active radar. The laboratory work is not of great commercial importance but it emphasizes an important advantage that millimeter waves have over lower-frequency microwaves: Only millimeter waves are short enough to penetrate dense ionized media and provide transmission data from which such important parameters as electron densities can be calculated. The impetus behind this work is mainly the study of hydrogen fusion for power generation.

Millimeter-wave radiometry—the passive detection of objects by their thermal emission in the millimeter-wave region—is a fairly new field with some exciting implications. Simmons points

out three solid advantages of millimeter waves in radiometric applications:

- High resolution, approaching that of optical photographs.
- Subtle temperature discrimination, made possible by the use of sensitive receivers.
- Better penetration of clouds, fog and even rain than is possible with infrared and optical frequencies.

In the active radar field, millimeter waves are attractive in short-range applications that require high resolution. "Hands-off" landing systems and collision-avoidance radars are examples of radar systems that need millimeter waves.

"The most rapidly expanding area of millimeter-wave applications at present," says Simmons, "is in communications." He cites the ability of millimeter-wave systems to provide huge information bandwidths as the primary reason for this expansion.

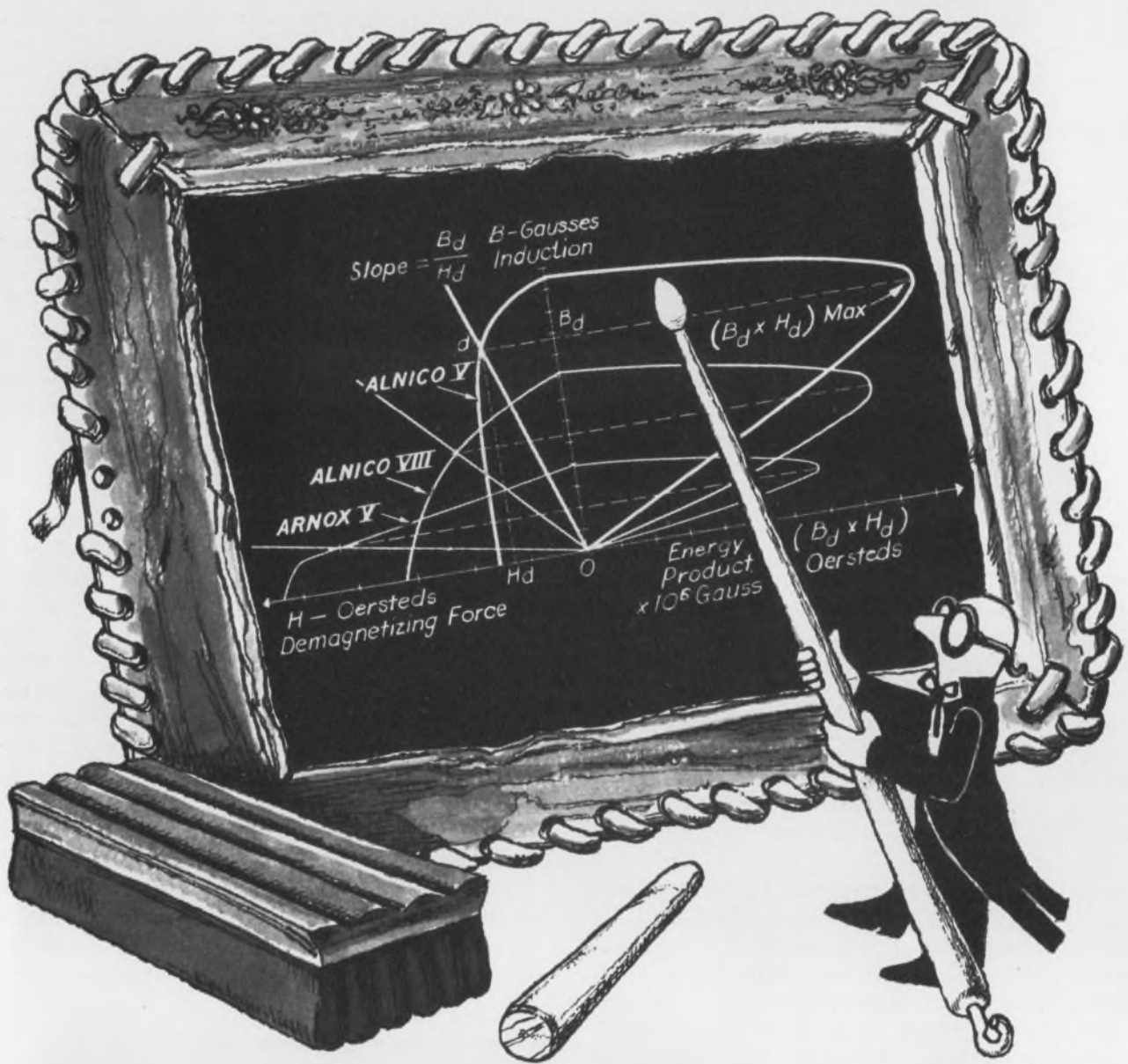
Backing up this viewpoint is the paper, "A Digital Transmission System Using Circular Electric-Mode Waveguide," by E. T. Harkless of Bell Telephone Laboratories, Holmdel, N. J. He gives a fairly detailed description of an experimental millimeter waveguide transmission system with a capacity of 230,000 two-way telephone channels. The system uses two-inch circular waveguide and has an error-rate objective of 1 in  $10^7$  over a 4000-mile path.

The millimeter waveguide system uses a frequency range covering 40 to 110 GHz. This band is divided into 120 channels each of which is 550 MHz wide. Of particular interest, in this paper, is the description of the passive networks used to separate the 550-MHz channels from each other for amplification and regeneration.

## Miniaturizing at millimeter frequencies

The successful introduction of hybrid microwave integrated circuits (MICs) at the lower microwave frequencies has created pressures for similar developments at millimeter-wave frequencies. Unfortunately, ordinary microstrip circuitry cannot be used at millimeter frequencies. To avoid propagation of higher-order modes, the center-line width and dielectric thickness must be made quite small as frequency is increased. This causes excessive losses in the center conductor.

To overcome this problem, an alternative form of waveguide—rectangular image line—can be used. In a paper entitled "Rectangular Dielectric Image Lines for Millimeter Integrated Circuits," Dr. P. P. Toulouios and R. M. Knox of the IIT Research Institute, Chicago, Ill., present an analysis of the rectangular image line, along with dispersion curves for various aspect ratios and dielectric constants. ■■



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# The technical program in review

Here's a timetable showing who's giving papers, what the subjects are, and when and where the sessions are being held



The latest products of many of the 600 companies at Wescon will be displayed at Hollywood Park.

## Communications

Millimeter Wave Systems—An Overview—Alan J. Simmons, Control Data, Boston. (3.1/Tues./a.m./C)

A Digital Transmission System Using Circular Electric Mode Waveguide—J. H. Mullins, Bell Telephone Laboratories, Holmdel, N. J. (3.2/Tues./a.m./C)

Rectangular Dielectric Image Lines for Millimeter Integrated Circuits—P. P. Toullos and R. M. Knox, ITT Research Institute, Chicago. (3.3/Tues./a.m./C)

Millimeter Wave IMPATT Power Sources—N. B. Kramer, Hughes Research Laboratories, Torrance, Calif. (3.4/Tues./a.m./C)

Recent Advances in Low-Noise Transistor Amplifiers—R. I. Dismar, Watkins-Johnson Co., Palo Alto, Calif. (9.1A/Wed./a.m./C)

Some New Developments in Low-Noise Traveling-Wave Tube Amplifiers—J. N. Nelson, Watkins-Johnson Co., Palo Alto, Calif. (9.1B/Wed./a.m./C)

Recent Advances and Performance Characteristics of Mixers and Tunnel Diode Amplifiers and Their Use in Low-Noise Microwave Receivers—William W. Raukko and Edmund Moley, Aertech Industries, Sunnyvale, Calif. (9.2/Wed./a.m./C)

Use of Parametric Up-Converters in Receiving Systems—W. J. Gemulla, Zeta Laboratories, Mountain View, Calif. (9.3/Wed./a.m./C)

Consideration of Components for Use in High Performance Wide Band Receivers—W. Dale Bush, Sylvania Electronic Systems Group, Mountain View, Calif. (9.4/Wed./a.m./C)

New Single Sideband Mechanical Filters—Robert A. Johnson, Collins Radio Co., Newport Beach, Calif. (10.1/Wed./p.m./A)

Phase Matched Bandpass Crystal Filters—C. W. Pond, Hughes Aircraft Co., Newport Beach, Calif. (10.2/Wed./p.m./A)

Active Filters and Equalizers Using Operational Amplifiers—Jerry G. Williford and Jay V. Robertson, Collins Radio Co., Newport Beach, Calif. (10.3/Wed./p.m./A)

Delay Equalizers—Charles E. Schmidt, Lenkurt Electronics Co., San Carlos, Calif. (10.4/Wed./p.m./A)

Space Station Communications—A. Adelman and R. W. Hockenberger, IBM, Huntsville, Ala. (13.1/Thur./a.m./A)

A Multifunctional Satellite for the Late 1970's—S. H. Durrani, COMSAT Laboratories, Clarkburg, Md. (13.4/Thur./a.m./A)

A Low-Level, High-Speed, Solid-State Multiplexer with Programmable-Gain Amplifier—David Hartke, Xerox Data Systems, El Segundo, Calif. (14.1/Thur./a.m./B)

A Versatile Interface Control Station—Nico H. Roos, Control Systems Division, Motorola, Phoenix, Ariz. (14.2/Thur./a.m./B)

A High-Speed High-Resolution Analog-to-Digital Converter Utilizing Parallel/Decision Successive Approximation and Error Correction—Donald Reiss, Electronic Engineering Co. of California, Santa Ana, Calif. (14.3/Thur./a.m./B)

A Versatile Data Distributor Which Provides Both Analog and Digital Outputs—Brett M. Nordgren and John Mickowski, Hewlett-Packard

Co., Berkeley Heights, N. J. (14.4/Thur./a.m./B)

Further Developments in TXE2 (Reed Electronic Programmable Telephone Central Office System)—A. G. Orbell, British Post Office Corp., and G. H. Taylor, Plessey Co. Ltd., Nottingham, England. (19.1/Fri./a.m./A)

Studies for a UK Public Data Communications Network—N. G. Smith, British Post Office Group., G. C. Hartley, Standard Telecommunications Research, and R. F. Purton, Plessey Telecommunications Research., Nottingham, England. (19.2/Fri./a.m./A)

The TXE4 System—J. Tippler, British Post Office Corp., and L. G. S. Clark, Standard Telephone & Cables Ltd., an ITT associate. (19.3/Fri./a.m./A)

A Review of Current UK Developments in Pulse Code Modulation Switching—J. Martin, British Post Office Corp. (19.4/Fri./a.m./A)

CCITT No. 6 Signalling System—The U.K. Field Trial Equipment—B. R. Horsfield, British Post Office Corp., and R. F. B. Speed, GEC-AEI Telecommunications Ltd. (19.5/Fri./a.m./A)

## Computers and Computer-Aided Design

Silicon Gate MOS Technology and its Memory Applications—D. Frohman-Bentchkowsky, Intel Corp., Mountain View, Calif. (7.1/Wed./a.m./A)

Performance and Economic Relationship of a Beam Lead Multichip Memory—J. J. Kubinec, Computer



## Papers by categories:

Communications  
Computers and Computer-Aided Design  
Consumer  
Environment and Pollution  
Industrial Electronics  
Management and Marketing  
Material and Packaging  
Medical Electronics  
Microelectronics  
Military, Space and Avionics  
Microwaves  
Solid-State Devices and Theory

Microtechnology, Inc., Sunnyvale, Calif. (7.2/Wed./a.m./A)

Ion Implantation in LSI Memory Manufacture—L. F. Roman and A. C. Tickle, Zeion, Inc., Canoga Park, Calif. (7.3/Wed./a.m./A)

LSI Memory Design Considerations—W. Mandl, Macrodata Co., Chatsworth, Calif. (7.4/Wed./a.m./A)

Medical Electronics Equipment for Multiphasic Health Testing by Paramedical Personnel—Kenneth L. Dufour, Humetrics Corp., Los Angeles. (12.3/Wed./p.m./C)

The Constant Assistant: A Computer Terminal at the Intensive Care Bedside—Jerome A. G. Russell, Cedars-Sinai Medical Center, Los Angeles. (12.4/Wed./p.m./C)

Mechanical Engineering Aspects of 1024 Bit Multi-Chip Semiconductor Memory—Kurt M. Striny and Irving Weingrod, Bell Telephone Laboratories, Allentown, Pa. (16.1/Thur./p.m./A)

Time-Shared Computer Control of Automated Test Stations—P. A. Hogan and A. E. Nelson, Honeywell Aerospace Div., Minneapolis, Minn. (16.4/Thur./p.m./A)

Basic Software Development Management Concepts—Winston W. Royce, Earth Resources Technology Satellite/Ground Data Handling System, TRW Systems, Redondo Beach, Calif. (A.1/Tues./a.m./D)

Managing Software Development for the Apollo Real-Time Control Center—Lynwood C. Dunseith, NASA Manned Space Craft Center, Houston, Tex. (A.2/Tues./a.m./D)

Managing Software Development for a USAF Command System—Lt. Col. T. J. DeSchon, SAMSO, El Segundo, Calif. (A.3/Tues./a.m./D)

Managing the Development of Commercial Software Systems—William I. Butler, Mellonics Information Center, Litton Industries, Canoga Park, Calif. (A.4/Tues./a.m./D)

Evaluating Software Products for Commercial EDP—Lester G. Miller, Eastman Kodak Co., Rochester, N. Y. (B.1/Tues./p.m./D)

Proprietary Software: Profitability Through Evaluation—Calvin J. Anderson, Mobil Oil Corp., New York, N. Y. (B.2/Tues./p.m./D)

An Approach to Software Selection—John M. Thurlow, ESSO Mathematics & Systems Inc., Florham Park, N. J. (B.3/Tues./p.m./D)

A Supplier Looks at Proprietary Software Evaluation—Fred Braddock, Informatics Inc., Sherman Oaks, Calif. (B.4/Tues./p.m./D)

Minicomputers and Peripheral Equipment—A Current Review—Ernest T. Roland, Jackson Associates, Columbus, Ohio. (C1/Wed./a.m./D)

A Batch Chemical Process Controller—Robert Young, Emery Industries Inc., Cincinnati, Ohio. (C.2/Wed./a.m./D)

Application of Mini-Computer to Gas Plant Control—H. R. Courts, Unitech, Inc., Austin, Texas, and Michael I. Chiseri, Chem Systems Inc., New York, N. Y. (C.3/Wed./a.m./D)

Talking to the Mini-Computer—Sergio Ribeiro, Dicom Industries, Sunnyvale, Calif. (C.4/Wed./a.m./D)

Electronic Calculators: An Enduring Aid for Creative Technical Assignments—Frank Chen, Wang Labs, Tewksbury, Mass. (D.1/Wed./p.m./D)

Delusions of Generality—Tom Osborne, Hewlett-Packard Co., Palo Alto, Calif. (D.2/Wed./p.m./D)

The Programmable Calculator as a Teacher—Ruby Panholzer, Consultant to Cintra/Physics International, Mountain View, Calif. (D.3/Wed./p.m./D)

Micro-Mini-Midi-Maxi: System Parallels for the Desktop Machine—James B. Williams, Olivetti Corp. of America, New York, N. Y. (D.4/Wed./p.m./D)

Evolution and Future of Programmable Calculators—Ken Lake, Stanford Research Institute, Menlo Park, Calif. (D.5/Wed./p.m./D)

A Survey of Interactive Systems—Juris Reinfelds, University of Georgia, Athens, Ga. (E.1/Thur./a.m./D)

The UC On-Line System as a Tool for Solving Engineering Problems—Robert N. Schreiner, TRW, Redondo Beach, Calif., and Burton Fried, UCLA, Los Angeles Calif. (E.2/Thur./a.m./D)

Dedicated Versus General Purpose Kopetz, University of Georgia Computer Center. (E.3/Thur./a.m./D)

Terminals for Interactive Computer Systems—Hermann Bodenseher, University of Georgia Computer Center. (E.4/Thur./a.m./D)

Engineering Evaluation of Timesharing—Art Wehry, Tridea Electronics, El Monte, Calif. (F.1/Thur./p.m./D)

Military Timesharing Evaluation as Performed by a Navy Laboratory—Jerome L. Zaharias, Naval Weapons Center, China Lake, Calif. (F.2/Thur./p.m./D)

Evaluating Timesharing for the Business, Consulting, and Professional Service User—Bernard Spinrav, Development Research Association, Los Angeles, and Bruce Sangster, General Electric, El Monte, Calif., and Mathias J. Quint, Hoffman Electronics Corp., El Monte, Calif. (F.3/Thur./p.m./D)

## Code to abbreviations

a.m.—Morning sessions (10 a.m. to 12:30 p.m.)

p.m.—Afternoon sessions (2 p.m. to 4.30 p.m.)

Sessions 1-20 will be presented at the Museum of Science and Industry. Sessions A-G will be offered at Hollywood Park.

A—Meeting Room I  
B—Meeting Room II  
C—Meeting Room III  
D—Meeting Room IV

Numerals refer to sessions and to papers within a session—for example, 6.1 is paper 1 in session 6.

Aerospace Education, Electronics, and Manufacturing Industries Evaluation of Computer Timesharing Services with an Overview of the Timesharing Industry—Victor O. Muglia, Hoffman Electronics, El Monte, Calif. (F.4/Thur./p.m./D)

Computer-Aided Circuit Design—Nathan Sokol, Design Automation Inc., Lexington, Mass. (G.1/Fri./a.m./D)

Functional Testing—John Fike, Telpar Inc., Dallas, Tex. (G.2/Fri./a.m./D)

Printed Circuit Board Design and Testing—Robert Ruggles and Jack DeNauw, Sanders Associates, Nashua, N. H. (G.3/Fri./a.m./D)

Computer-Aided LSI Design—L. J. Sevin, Mostek Corp., Dallas, Tex. (G.4/Fri./a.m./D)

## Consumer

The New Video IF for Television—Gerald Lunn, Motorola Inc., Mesa, Ariz. (1.1/Tues./a.m./A)

Monolithic and Hybrid ICs in Automotive Electronics—Sumner B. Marshall, Sprague Electric Co., Worcester, Mass. (1.2/Tues./a.m./A)

Consumer Integration—Does It Need Federal Intervention?—Norman Doyle, Fairchild Semiconductor, Mountain View, Calif. (1.3/Tues./a.m./A)

Chrominance Signal Processing with Integrated Circuits—Gary Kelson, Signetics Corp., Sunnyvale, Calif. (1.4/Tues./a.m./A)

## Environment and Pollution

Water Quality Planning—R. C. Timme, Interstate Electronics Corp., OceanicS Div., Anaheim, Calif. (6.1/Tues./p.m./C)

Instrumentation for Marine Ecological Monitoring and Control—Roy D. Gaul, Dillingham Corp., San Diego. (6.2/Tues./p.m./C)

Electronics in a Modern Sewage Treatment Plant Laboratory—Frank F. Wada, Department of Public

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Works, Los Angeles. (6.3/Tues./p.m./C)

The Importance of Estimating Particulate Material Suspended in the Sea—John S. Pearse, University of California, Santa Cruz. (6.4/Tues./p.m./C)

Stream Analyzers—Vital to Understand and Control Our Environment—Thomas J. Kehoe, Beckman Instruments Inc., Fullerton, Calif. (6.5/Tues./p.m./C)

Space Station Communications—A. Adelman and R. W. Hockenberger, IBM, Huntsville, Ala. (13.1/Thur./a.m./A)

Synchronous Meteorological Satellites—Donald Fordyce, NASA, Goddard Space Center, Greenbelt, Md. (13.5/Thur./a.m./A)

Air Pollution—Problems and Programs—Speaker to be announced. (20.1/Fri./a.m./B)

How to Live with Faults and Earthquakes—Robert D. Nason, Environmental Sciences Services Administration, U. S. Dept. of Commerce, San Francisco, Calif. (20.2/Fri./a.m./B)

Oil Field Fire and Blowout Problems—Red Adair, Red Adair Comp. Inc., Houston, Tex. (20.3/Fri./a.m./B)

Airport and Freeway Noise—Karl D. Kryter, Sensory Sciences Research Center, Stanford Research Institute, Menlo Park, Calif. (20.4/Fri./a.m./B)

## Industrial Electronics

The Case for Air-to-Air In-Line Systems—W. D. Holt, Bendix Scientific Instruments, Rochester, N. Y. (4.1/Tues./p.m./A)

High Volume Batch Production—Court Skinner, American Micro Systems, Inc., Santa Clara, Calif. (4.2/Tues./p.m./A)

Comparisons of Batch and Continuous Processing and Equipment in Thin-Film Manufacturing—John Crane and John Duryee, Univac Division, Sperry Rand, St. Paul, Minn. (4.3/Tues./p.m./A)

Impact of Computer Control of Vacuum Deposition Processes—R. M. Centner and R. A. Wilson, Bendix Research Laboratories, Southfield, Mich. (4.4/Tues./p.m./A)

A Versatile Interface Control Station—Nico H. Roos, Control Systems Div., Motorola, Phoenix, Ariz. (14.2/Thur./a.m./B)

A High-Speed High-Resolution Analog-to-Digital Converter Utilizing Parallel/Decision Successive Approximation and Error Correction—Donald Reiss, Electronic Engineering Co. of California, Santa Ana. (14.3/Thur./a.m./B)

A Versatile Data Distributor Which Provides Both Analog and Digital Outputs—Brett M. Nordgren and John Mickowski, Hewlett-Packard Co., Berkeley Heights, N. J. (14.4/Thur./a.m./B)

Mechanical Engineering Aspects of 1024 Bit Multi-Chip Semiconductor Memory—Kurt M. Striny and Irving Weingrod, Bell Telephone Laboratories, Allentown, Pa. (16.1/Thur./p.m./A)

Interconnections Between Chip and Package Medium: Devices and Techniques—L. K. Keys, Magnavox Co., Fort Wayne, Ind. (16.2/Thur./p.m./A)

Thick and Thin Film Circuits Materials—Gerald D. Slawewski, Sylvania Microelectronics, Waltham, Mass. (16.3/Thur./p.m./A)

Time-Shared Computer Control of Automated Test Stations—P. A. Hogan and A. E. Nelson, Honeywell Aerospace Division, Minneapolis, Minn. (16.4/Thur./p.m./A)

Minicomputers and Peripheral Equipment—A Current Review—Ernest T. Roland, Jackson Associates, Columbus, Ohio. (C1/Wed./a.m./D)

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Aerospace, Education, Electronics, and Manufacturing Industries Evaluation of Computer Timesharing Services with an Overview of the Timesharing Industry—Victor O. Muglia, Hoffman Electronics, El Monte, Calif. (F.4/Thur./p.m./D)

## Management and Marketing

Corporate Marketing—James Cunningham, Systron Donner Corp., Concord, Calif. (2.1/Tues./a.m./B)

Systems Sales Representative—D. B. Pivan, Pivan Engineering, Chicago, Ill. (2.2/Tues./a.m./B)

Mini-Computer Terminal Manufacturer—Cloyd Marvin, Four Phase Systems, Cupertino, Calif. (2.3/Tues./a.m./B)

Sales Consultants—Ben Anixter, Anixter, Bosch & Russell, Inc., Palo Alto, Calif. (2.4/Tues./a.m./B)

Sales Representatives—Gaylord Moxon, Moxon Electronics, Los Angeles. (2.5/Tues./a.m./B)

Navy Management Approach to the Introduction of Versatile Avionic Shop Test (VAST) System—Joseph Carsley, Naval Air Systems Command, Washington, D. C. and Ralph Lohman, PRD Electronics Inc., Washington, D. C. (5.3/Tues./p.m./B)

IC Progress in Europe—H. E. J. Finke, Motorola Semiconductor Products, Geneva, Switzerland. (8.1/Wed./a.m./B)

IC Applications in Europe—P. Cooke, CETA Electronics Ltd., London, England. (8.2/Wed./a.m./B)

Marketing ICs Off-Shore: Problems and Solutions—Carlos Auriema, Ad Auriema Inc., New York, N. Y. (8.3/Wed./a.m./B)

The American Manufacturer in the World Market—Fairchild Semicon-



# P&B solid state relay hybrids advance the art of switching

These six new devices expand dramatically your range of switching options. Now, you can conveniently interface semiconductor logic circuits with inductive loads such as motors, solenoids, or relays. Inputs as low as 5 microwatts can be used to switch 7 ampere loads, for example. Many millions of times, too.

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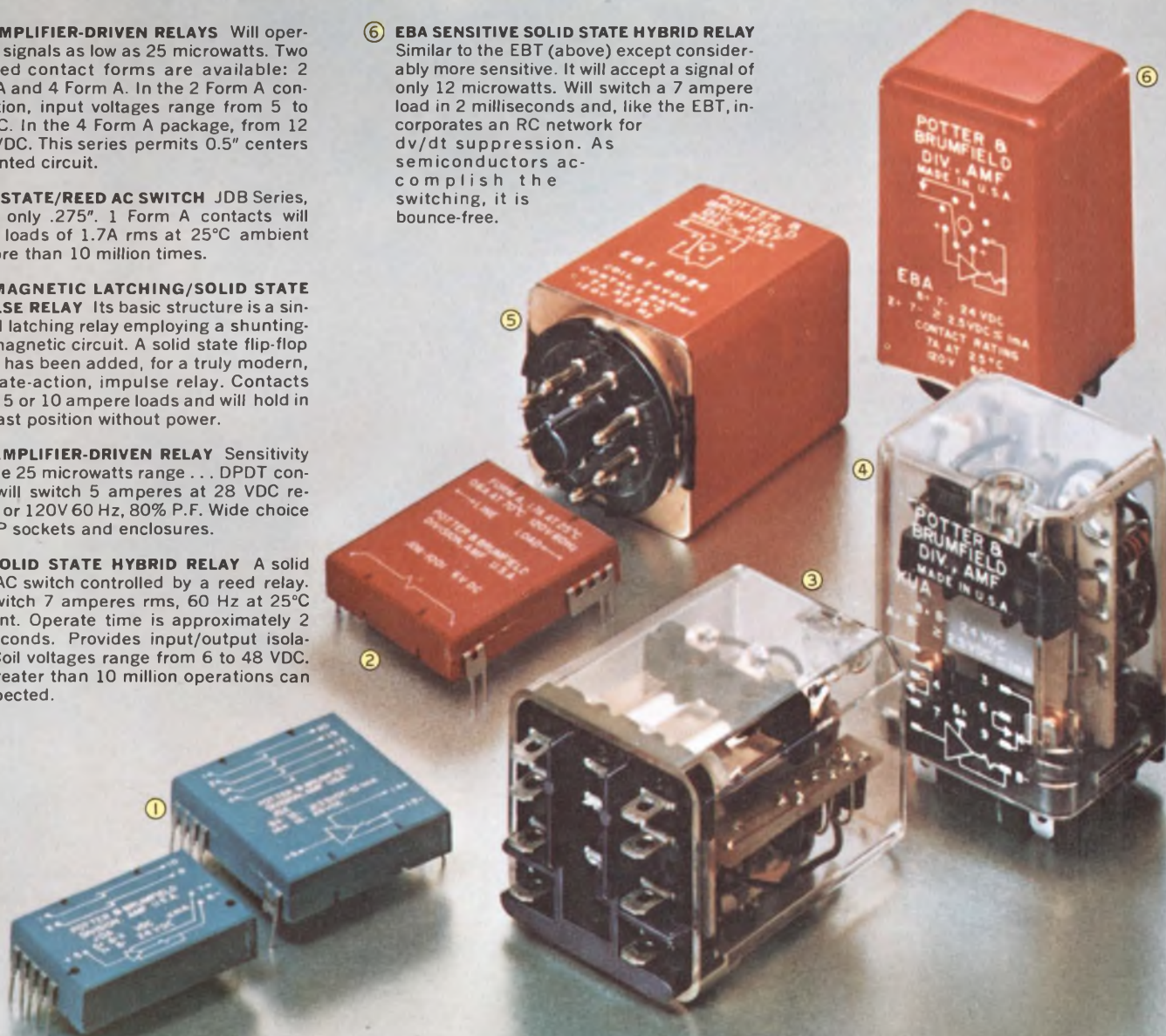
② **SOLID STATE/REED AC SWITCH** JDB Series, height only .275". 1 Form A contacts will switch loads of 1.7A rms at 25°C ambient for more than 10 million times.

③ **KUR MAGNETIC LATCHING/SOLID STATE IMPULSE RELAY** Its basic structure is a single coil latching relay employing a shunting-type magnetic circuit. A solid state flip-flop circuit has been added, for a truly modern, alternate-action, impulse relay. Contacts switch 5 or 10 ampere loads and will hold in their last position without power.

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⑤ **EBT SOLID STATE HYBRID RELAY** A solid state AC switch controlled by a reed relay. Will switch 7 amperes rms, 60 Hz at 25°C ambient. Operate time is approximately 2 milliseconds. Provides input/output isolation. Coil voltages range from 6 to 48 VDC. Life greater than 10 million operations can be expected.

⑥ **EBA SENSITIVE SOLID STATE HYBRID RELAY** Similar to the EBT (above) except considerably more sensitive. It will accept a signal of only 12 microwatts. Will switch a 7 ampere load in 2 milliseconds and, like the EBT, incorporates an RC network for dv/dt suppression. As semiconductors accomplish the switching, it is bounce-free.





ductor, Mountain View, Calif. (8.5/Wed./a.m./B)

Stimulating and Evaluating Ideas for New Products—Lincoln Hays, LTV ElectroSystems Inc., Dallas, Tex. 11.1/Wed./p.m./B)

Scheduling and Controlling Product Development—John J. Kope, Jr., Cimron Div., Lear Siegler Inc., San Diego, Calif. (11.2/Wed./p.m. B)

Engineer's Role in New Product Planning—Harley Halversen, Hewlett-Packard Microwave Div., Palo Alto, Calif. (11.3/Wed./p.m./B)

Technological Forecasting and Product Planning—Glen E. Penisten, Advanced Technology and Strategic Planning Div., Texas Instruments, Dallas Tex. (11.4/Wed./p.m./D)

Overview-Comparison of Management Control Systems—Robert V. Morse, Hollander Associates, Fullerton, Calif. (18.1/Thur./p.m./C)

Applications of Management Control Systems—Robert W. Miller, TRW Systems Group, Redondo Beach, Calif. (18.2/Thur./p.m./C)

Cost/Schedule Control System Criteria (C/SCSC)—Capt. Charles C. Manes, AF Systems Command. (18.3/Thur./p.m./C)

TOPS, A New MCS for Maximizing Profits—G. L. Hollander and E. A. Tilley, Hollander Associates, Fullerton, Calif. (18.4/Thur./p.m./C)

Position Paper: Managing Control Systems: The Problems Outweigh the Benefits—Speaker to be announced. (18.5/Thur./p.m./C)

Basic Software Development Management Concepts—Winston W. Royce, Earth Resources Technology Satellite/Ground Data Handling System, —Lynwood C. Dunseith, NASA Manned Space Craft Center, Houston, Tex. (A.2/Tues./a.m./D)

Managing Software Development for the Apollo Real-Time Control Center—Lynwood C. Dunseith, NASA Manned Space Craft Center, Houston, Tex. (A.2/Tues./a.m./D)

Managing Software Development for a USAF Command System—Lt. Col. T. J. DeSchon, SAMSO, El Segundo, Calif. (A.3/Tues./a.m./D)

Managing the Development of Commercial Software Systems—William I. Butler, Mellonics Information Center, Litton Industries, Canoga Park, Calif. (A.4/Tues./a.m./D)

Evaluating Timesharing for the Business, Consulting, and Professional Service User—Bernard Spinrav, Development Research Association, Los Angeles, and Bruce Sangster, General Electric, El Monte, Calif., and Mathias J. Quint, Hoffman Electronics Corp., El Monte. (F.3/Thur./p.m./D)

## Material and Packaging

Silicon Gate MOS Technology and its Memory Applications—D. Frohman-Bentchkowsky, Intel Corp., Mountain View, Calif. (7.1/Wed./a.m./A)

Performance and Economic Relationship of a Beam Lead Multichip Memory—J. J. Kubinec, Computer Microtechnology Inc., Sunnyvale, Calif. (7.2/Wed./a.m./A)

Ion Implantation in LSI Memory Manufacture—L. F. Roman and A. C. Tickle, Zeion, Inc., Canoga Park, Calif. (7.3/Wed./a.m./C)

Survey of Photosensitive Materials and Devices—Al Seck, Centralab Semiconductor Div., El Monte, Calif. (15.2/Thur./a.m./C)

Interconnections Between Chip and Package Medium: Devices and Techniques—L. K. Keys, Magnavox Co., Fort Wayne, Ind. (16.2/Thur./p.m./A)

Thick and Thin Film Circuits Materials—Gerald D. Slawewski, Sylvania Microelectronics, Waltham, Mass. (16.3/Thur./p.m./A)

## Medical Electronics

How to Design Medical Electronic Equipment for Patient Safety—Allan F. Pacela, Beckman Instruments Inc., Fullerton, Calif. (12.1/Wed./p.m./C)

The Present and Future Role of Instrumentation Systems in Medical Screening—Charles A. Broutman and Malcolm G. Ridgway, TRW Systems, Redondo Beach, Calif. (12.2/Wed./p.m./C)

Medical Electronics Equipment for Multiphasic Health Testing by Paramedical Personnel—Kenneth L. Dufour, Humetrics Corp., Los Angeles. (12.3/Wed./p.m./C)

The Constant Assistant: A Computer Terminal at the Intensive Care Bedside—Jerome A. G. Russel, Cedars-Sinai Medical Center, Los Angeles. (12.4/Wed./p.m./C)

Clinical Laboratory Instrumentation—Rodney E. Willard, Loma Linda University, Loma Linda, Calif. (12.5/Wed./p.m./C)

## Microelectronics

The New Video IF for Television—Gerald Lunn, Motorola Inc., Mesa, Ariz. (1.1/Tues./a.m./A)

Monolithic and Hybrid ICs in Automotive Electronics—Sumner B. Marshall, Sprague Electric Co., Worcester, Mass. (1.2/Tues./a.m./A)

Consumer Integration—Does It Need Federal Intervention?—Norman Doyle, Fairchild Semiconductor, Mountain View, Calif. (1.3/Tues./a.m./A)

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High Volume Batch Production—Court Skinner, American Micro Systems, Inc., Santa Clara, Calif. (4.2/Tues./p.m./A)

Comparisons of Batch and Continuous Processing and Equipment in Thin-Film Manufacturing—John Crane and John Duryee, Univac Div. Sperry Rand, St. Paul, Minn. (4.3/Tues./p.m./A)

Impact of Computer Control of Vacuum Deposition Processes—R. M. Centner and R. A. Wilson, Bendix Research Laboratories, Southfield, Mich. (4.4/Tues.p.m./A)

Silicon Gate MOS Technology and its Memory Applications—D. Frohman-Bentchkowsky, Intel Corp., Mountain View, Calif. (7.1/Wed./a.m./A)

Performance and Economic Relationship of a Beam Lead Multichip Memory—J. J. Kubinec, Computer Microtechnology Inc., Sunnyvale, Calif. (7.2/Wed./a.m./A)

Ion Implantation in LSI Memory Manufacture—L. F. Roman and A. C. Tickle, Zeion, Inc., Canoga Park, Calif. (7.3/Wed./a.m./A)

LSI Memory Design Considerations—W. Mandl, Macrodata Co., Chatsworth, Calif. (7.4/Wed./a.m./A)

IC Progress in Europe—H. E. J. Finke, Motorola Semiconductor Products, Geneva, Switzerland. (8.1/Wed./a.m./B)

IC Applications in Europe—P. Cooke, CETA Electronics Ltd., London, England. (8.2/Wed./a.m./B)

Marketing ICs Off-shore: Problems and Solutions—Carlos Auriema, Ad Auriema Inc., New York, N.Y. (8.3/Wed./a.m./B)

The American Manufacturer in the World Market—Fairchild Semiconductor, Mountain View, Calif. (8.5/Wed./a.m./B)

Survey of Photosensitive Materials and Devices—Al Seck, Centralab Semiconductor Div., El Monte, Calif. (15.2/Thur./a.m./C)

"Opto-Hybrid" Integrated Circuit Photosensitive Devices—L. Merrill Palmer, Centralab, El Monte, Calif. (15.3/Thur./a.m./C)

Self-scanned Photosensor Arrays—R. H. Dyck, Fairchild Semiconductor, Palo Alto, Calif. (15.4/Thur./a.m./C)

Mechanical Engineering Aspects of 1024 Bit Multi-Chip Semiconductor Memory—Kurt M. Striny and Irving Weingrod, Bell Telephone Laboratories, Allentown, Pa. (16.1/Thurs./p.m./A)

Interconnections Between Chip and Package Medium: Devices and Techniques—L. K. Keys, Magnavox Co., Fort Wayne, Ind. (16.2/Thur./p.m./A)

Thick and Thin Film Circuits Materials—Gerald D. Slawewski, Sylvania Microelectronics, Waltham, Mass. (16.3/Thur./p.m./A)

## Microwaves

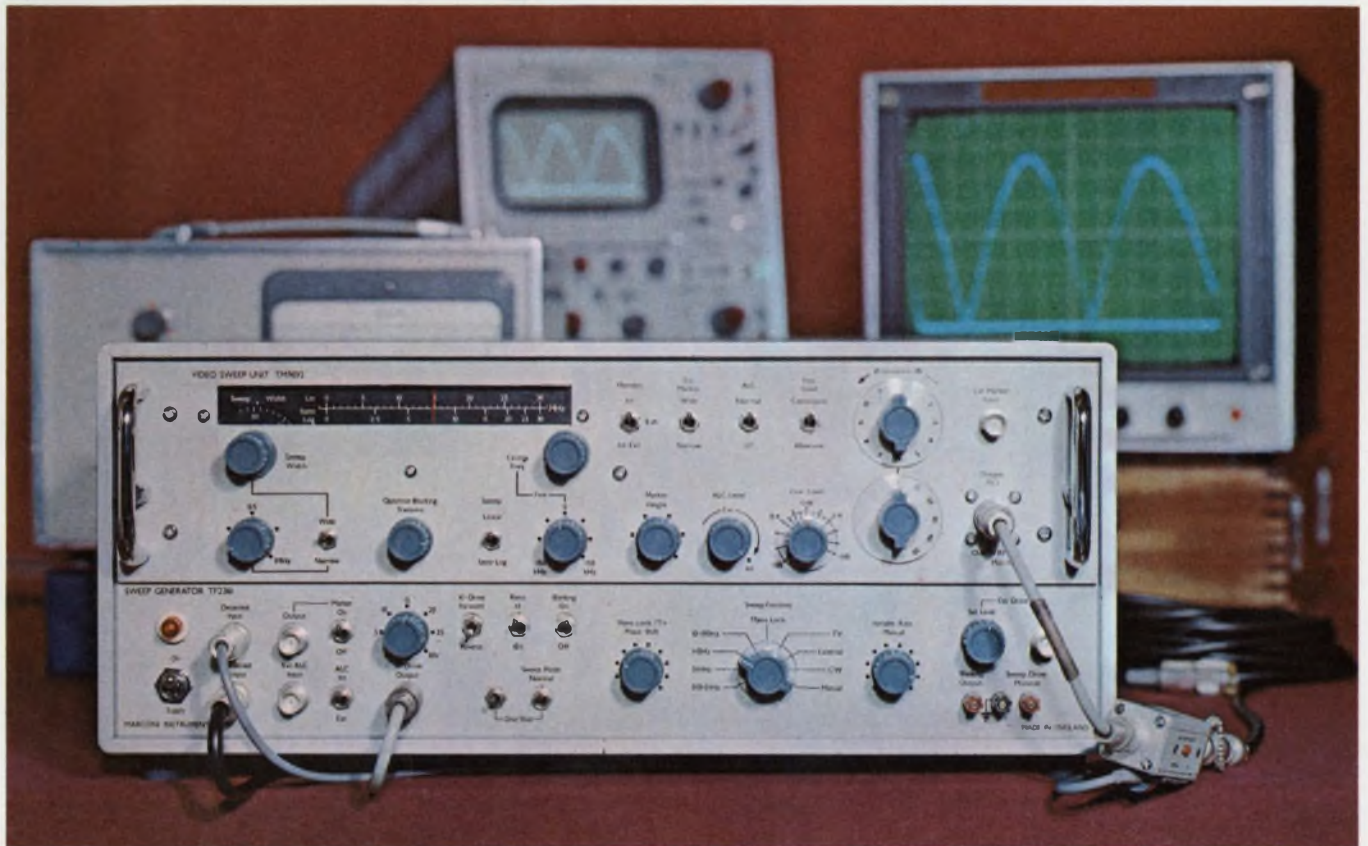
Millimeter Wave Systems—An Overview—Alan J. Simmons, Control Data, Boston. (3.1/Tues./a.m./C)

A Digital Transmission System Using Circular Electric Mode Waveguide—J. H. Mullins, Bell Telephone Laboratories, Holmdel, N. J. (3.2/Tues./a.m./C)

Rectangular Dielectric Image Lines for Millimeter Integrated Circuits—P. P. Toullos and R. M. Knox, IIT Research Institute, Chicago. (3.3/Tues./a.m./C)



# The flattest sweeper news in years!



With a detected system flatness within  $\pm 0.05$  dB over the full video range, and a battery of features to aid precise measurement, the new TF 2361 provides a standard of accuracy not usually associated with general purpose sweep generators.

This powerful new instrument is designed for use with video or v.h.f. sweeper plug-ins to form accurate and comprehensive measurement systems - particularly in the TV field.

A wide range of sweep speeds from 0.01 Hz to 100 Hz make it ideal for use with X-Y plotters, display units or oscilloscopes.

The TF 2361 main unit, which contains common power supplies and circuitry for the plug-ins, features readily removable chassis units for straightforward servicing. Altogether an extremely comprehensive and well specified sweep generator.

**VIDEO 25 kHz to 30 MHz** \* Unique detected system flatness to within  $\pm 0.05$  dB over the full band makes it ideal for wide range, accurate frequency response checks on receivers, amplifiers, filters and attenuators.

\* Unique alternate-sweeps-at-different-levels feature complements the advantages of the flat output in making accurate frequency response checks.

\* Unique TV lock facility locks sweep to a TV sync and blanking waveform to provide a TV video sweep system.

**V.H.F. 1 MHz to 300 MHz** \* Comprehensive internal and external markers can be added to the detected output or can be used separately: positive or negative pulse or birdie markers can be selected.

\* R.F. attenuator may be used separately.

\* Comprehensive range of detectors and probes available.



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ENGLISH ELECTRIC CORPORATION

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INFORMATION RETRIEVAL NUMBER 125





## an unfair comparison...

### The new Cyclohm Fan from Howard vs. "the other fan"

The new Howard tubeaxial fan delivers a larger volume of air over a wider range, runs up to 10 years without service or lubrication, has a rugged cast aluminum frame, yet costs about the same as "the other fan" you're now using. (See why we call the comparison "unfair"?)

In all fairness, we admit the new Howard Cyclohm fan is exactly the same size as "the other fan." They're interchange-

able. But then we come to comparisons like Howard Cyclohm's six-blade impeller (vs. three) which is computer-mated to the famous Howard Unit Bearing Motor with a 5-year warranty based on an engineered lifespan of 10 years (vs. a traditional bearing motor). Then, too, there's 115 CFM air delivery (vs. 100). And cost: The new Howard Cyclohm never costs more than "the other fan" . . . and Howard delivery is overnight!

**Be fair to yourself: Send for all the unfair facts.**



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Millimeter Wave IMPATT Power Sources—N. B. Kramer, Hughes Research Laboratories, Torrance, Calif. (3.4/Tues./a.m./C)

Recent Advances in Low-Noise Transistor Amplifiers—R. I. Disman, Watkins-Johnson Co., Palo Alto, Calif. (9.1A/Wed./a.m./C)

Some New Developments in Low-Noise Traveling-Wave Tube Amplifiers—J. N. Nelson, Watkins-Johnson Co., Palo Alto, Calif. (9.1B/Wed./a.m./C)

Recent Advances and Performance Characteristics of Mixers and Tunnel Diode Amplifiers and Their Use in Low-Noise Microwave Receivers—William W. Raukko and Edmund Moley, Aertech Industries, Sunnyvale, Calif. (9.2/Wed./a.m./C)

Use of Parametric Up-Converters in Receiving Systems—W. J. Gemulla, Zeta Laboratories, Mountain View, Calif. (9.3/Wed./a.m./C)

Consideration of Components for Use in High Performance Wide Band Receivers—W. Dale Bush, Sylvania Electronic Systems Group, Mountain View, Calif. (9.4/Wed./a.m./C)

## Military, Space and Avionics

Depot-Installed Maintenance Automatic Test Equipment (DIMATE) Lessons Learned Through Application—William Morris, Tobyhanna Army Depot, Tobyhanna, Pa. (5.1/Tues./p.m./B)

Observations for Future General Purpose Automatic Test Sets (GPATS)—H. A. Fraser, Kelly AFB, San Antonio, Tex. (5.2/Tues./p.m./B)

Navy Management Approach to the Introduction of Versatile Avionic Shop Test (VAST) System—Joseph Carsley, Naval Air Systems Command, Washington, D. C., and Ralph Lohman, PRD Electronics Inc., Washington, D. C. (5.3/Tues./p.m./B)

Experience, Status and Plans for the Land Combat Support System (LCSS)—William Grunewald, U. S. Army Missile Command, Huntsville, Ala., and O. T. Carver, RCA, Burlington, Mass. (5.4/Tues./p.m./B)

User Experience with Versatile Automatic Test Equipment (VATE)—I. L. McLaughlin, Newark Air Force Station, Newark, Ohio. (5.5/Tues./p.m./B)

Space Station Communications—A. Adelman and R. W. Hockenberger, IBM, Huntsville, Ala. (13.1/Thur./a.m./A)

Advanced Communications Experiments for the ATS-F Satellite—A. H. Sabelhaus, NASA-Goddard, and Robert P. Pahmeier, General Electric, Riverdale, Md. (13.2/Thur./a.m./A)

Earth Resources Technology Satellite System—B. T. Bachofer, General Electric Space Center, Valley Forge, Pa. (13.3/Thur./a.m./A)

A Multifunctional Satellite for the Late 1970's—S. H. Durrani, COMSAT Laboratories, Clarksburg, Md. (13.4/Thur./a.m./A)

Synchronous Meteorological Satellites—Donald Fordyce, NASA Goddard Space Center, Greenbelt, Md. (13.5/Thur./a.m./A)

A Precision Area Navigation System—John F. Gilbert and Allen G. Quynn, Boeing Co., Seattle, Wash. (17.1/Thur./p.m./B)

Airborne Display and Electric Management System—Robert C. Eckenfelder, Bendix Corp., Electric Power Div., Eaton, N.J. (17.2/Thur./p.m./B)

The Next Steps in Air Traffic Control Modernization—Neal Blake, Federal Aviation Administration, Washington, D. C. (17.3/Thur./p.m./B)

Implications of Advanced Avionics on Airline Operations—Kenneth B. Olsen, American Airlines, Tulsa, Okla. (17.4/Thur./p.m./B)

Managing Software Development for the Apollo Real-Time Control Center—Lynwood C. Dunseith, NASA Manned Space Craft Center, Houston, Tex. (A.2/Tues./a.m./D)

Managing Software Development for a USAF Command System—Lt. Col. T. J. DeSchon, SAMSO, El Segundo, Calif. (A.3/Tues./a.m./D)

Military Timesharing Evaluation as Performed by a Navy Laboratory—Jerome L. Zaharias, Naval Weapons Center, China Lake, Calif. (F.2/Thur./p.m./D)

Aerospace, Education, Electronics, and Manufacturing Industries Evaluation of Computer Timesharing Services with an Overview of the Timesharing Industry—Victor O. Muglia, Hoffman Electronics, El Monte, Calif. (F.4/Thur./p.m./D)

## Solid-State Devices and Theory

Millimeter Wave IMPATT Power Source—N. B. Kramer, Hughes Research Laboratories, Torrance, Calif. (3.4/Tues./a.m./C)

Recent Advances in Low-Noise Transistor Amplifiers—R. I. Disman, Watkins-Johnson Co., Palo Alto, Calif. (9.1A/Wed./a.m./C)

Recent Advances and Performance Characteristics of Mixers and Tunnel Diode Amplifiers and Their Use in Low-Noise Microwave Receivers—William W. Raukko and Edmund Moley, Aertech Industries, Sunnyvale, Calif. (9.2/Wed./a.m./C)

Consideration of Components for Use in High Performance Wide Band Receivers—W. Dale Bush, Sylvania Electronic Systems Group, Mountain View, Calif. (9.4/Wed./a.m./C)

A Low-Level, High-Speed, Solid State Multiplexer with Programmable-Gain Amplifier—David Hartke, Xerox Data Systems, El Segundo, Calif. (14.1/Thur./a.m./B)

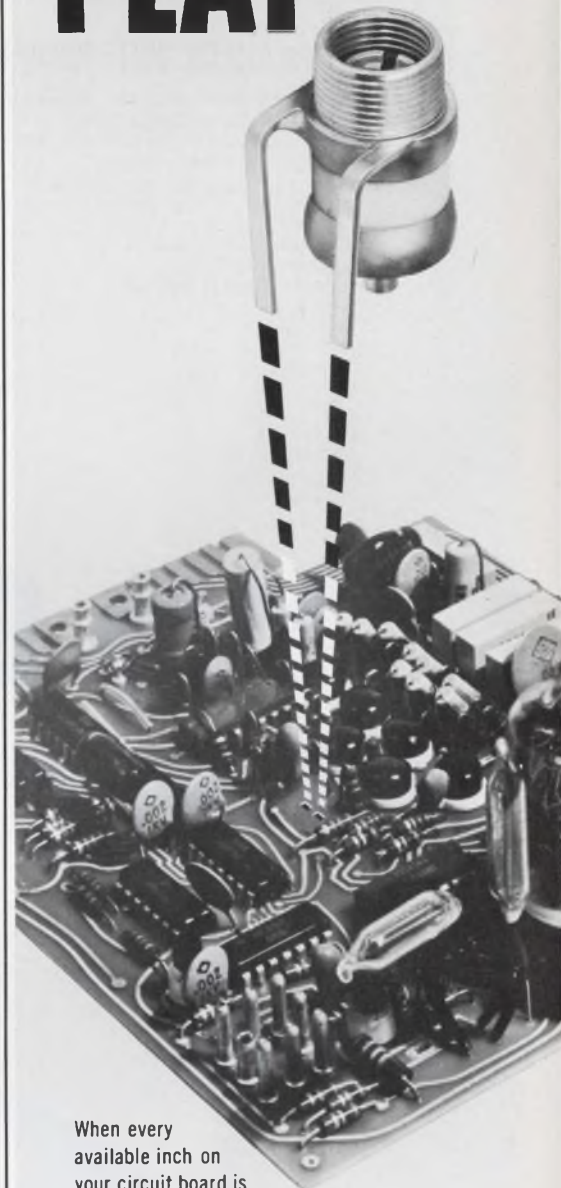
Innovations with Light Emitting Diodes—Bill Otsuka, Monsanto Electronic Special Products, Cupertino, Calif. (15.1/Thur./a.m./C)

Survey of Photosensitive Materials and Devices—Al Seck, Centralab Semiconductor Div., El Monte, Calif. (15.2/Thur./a.m./C)

"Opto-Hybrid" Integrated Circuit Photosensitive Devices—L. Merrill Palmer, Centralab, El Monte, Calif. (15.3/Thur./a.m./C)

Self-scanned Photosensor Arrays—R. H. Dyck, Fairchild Semiconductor, Palo Alto, Calif. (15.4/Thur./a.m./C)

# SQUEEZE PLAY



When every available inch on your circuit board is critical, bulky trimmers just won't do. Johanson's new Vertical Mount series allows you to "squeeze in" the added capacitor punch of an air trimmer, in less than half the space. Four basic models, all with high Q and low temperature coefficients, are available with both single and double leads. Before you get caught in a squeeze, send for full details on Johanson Vertical Mount capacitors.



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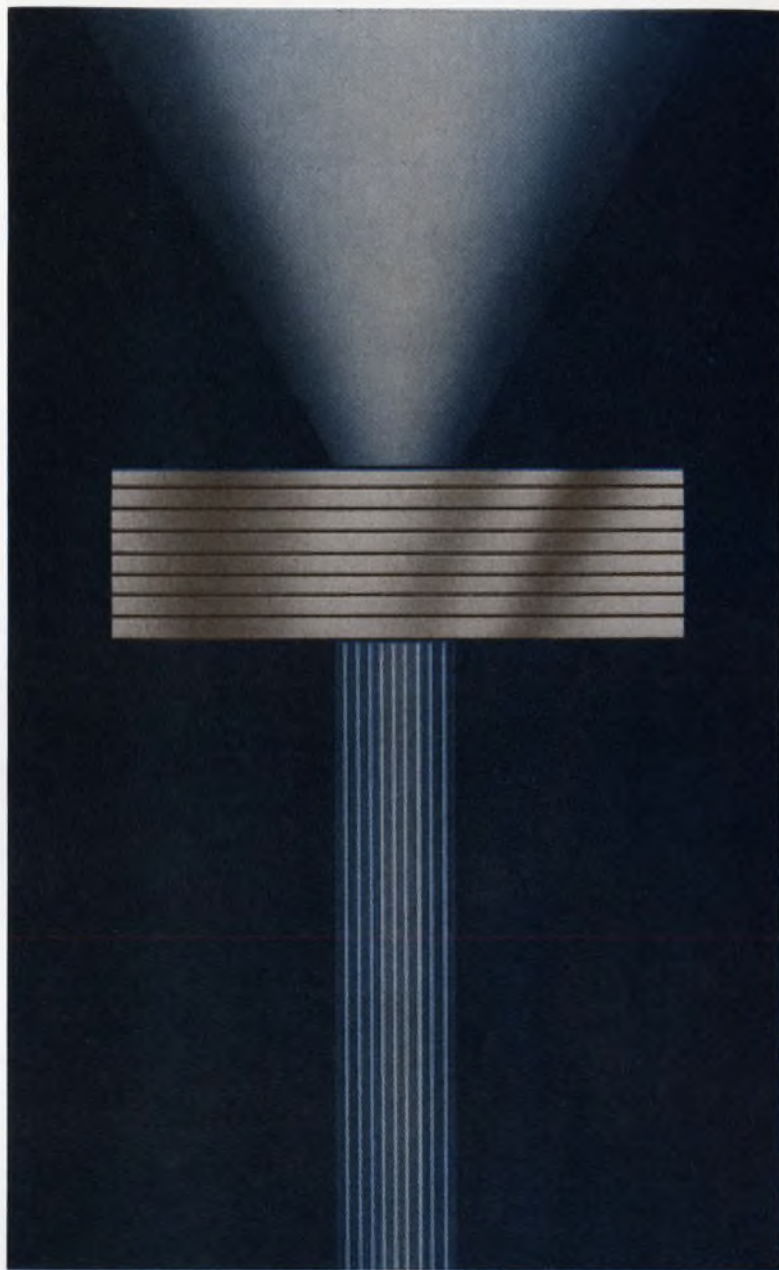
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**Buckbee-Mears  
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produce small  
holes in thick  
metal!**

*Our secret is to  
laminate metal*



Until now, no one has been able to produce holes in thick metal at anything smaller than a one-to-one ratio. We put our world leading technology in photomechanical reproduction to work and came up with a way to laminate sheets of etched metal in perfect register. We can produce sharply cornered holes of any design in metal much thicker than the width of the hole.

The trick was to eliminate the radii in the corners caused by the laminating process. Our scientists succeeded so well that Buckbee-Mears can accurately register 10,000 holes per square inch over an 11" by 11" area. We can even register up to 40,000 holes per square inch if you need it!

Tolerance on registry is  $\pm .0005"$ . Tolerance on hole size

is  $\pm .0002"$ . We are able to laminate up to 1,000 layers of .005" thick material in accurate collimation.

There are countless applications for small holes in thick metals. A few examples might be core nests, fluid amplifiers and collimator screens. Buckbee-Mears can produce masters and the actual laminated metal parts. Either or both.

If you need small holes at better than a one-to-one ratio in any type of metal, any thickness, talk to Buckbee-Mears. We've got a capability to solve your problem.

Solving people's problems is the way we became the world's leader in photomechanical production. Call or write Bill Amundson, our industrial sales manager, and tell him what you need. His number is 612-227-6371.

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INFORMATION RETRIEVAL NUMBER 129



# Wescon '70 products

## \$29 d/a converter and \$89 a/d converter handle eight bits with 0.2% accuracies

*Datel Systems Corp., 943 Turnpike St., Canton, Mass. Phone: (617) 828-1890. P&A: \$29 for the d/a converter, \$89 for the a/d converter; 4 wks.*

Making analog-digital converters more practical to buy than to design in-house, two new plug-in modules set outstanding cost-performance standards in the converter field. One product is an eight-bit digital-to-analog converter that sells for only \$29 in single unit quantities and drops to \$25 for quantities of 100. The second product is an eight-bit analog-to-digital converter costing but \$89 in single-unit quantities.

The new d/a converter, model DAC-29, is completely self-contained and does not require any external components for operation. It includes input buffer logic, electronic switches, a ladder network, a voltage reference source, and an output buffer amplifier.

Two versions of the DAC-29 are

available, offering resolutions of eight binary bits or two-digit BCD bits. Input digital coding is straight binary or two-digit BCD for unipolar outputs and two's complement for bipolar outputs.

The unit features a linearity of  $\pm 0.2\%$  with a voltage resolution of 40 mV, and an output settling time of 20  $\mu$ s to  $\pm 0.2\%$ . Full-scale outputs can be either 0 to 10 V or  $\pm 5$  V at 5 mA.

Overall accuracy is  $\pm 0.2\%$  for full scale with a temperature coefficient of  $\pm 30$  ppm/ $^{\circ}$ C. Long-term stability is better than  $\pm 0.1\%$ .

The new a/d converter, model ADC-89, employs digital integrating circuit techniques and thick-film hybrid circuitry to make its price-performance breakthroughs.

Overall accuracy for the ADC-89 is  $\pm 0.2\%$ , while its temperature coefficient is  $\pm 0.005\%$ / $^{\circ}$ C. The unit offers a long-term stability of better than  $\pm 0.05\%$ .

Full-scale inputs can be unipolar

(0 to 10 V) or bipolar ( $\pm 10$  V) at an input impedance of 50 k $\Omega$ . Output coding can be straight binary for unipolar inputs or two's complement for bipolar inputs.

The unit, which can be operated in an asynchronous mode, has a digitizing speed of 5 kHz (200  $\mu$ s). Input power requirements are  $\pm 15$  V dc at  $\pm 35$  mA and 5 V dc at 300 mA.

Both converters offer an operating temperature range of 0 to 70 $^{\circ}$ C and have DTL/TTL-compatible inputs and outputs. Their plug-in package is suitable for PC-board mounting with dual-in-line pin configurations.

The DAC-29 d/a converter module occupies only 1.6 cubic inches with dimensions of 2 by 2 by 0.4 in. The ADC-89 a/d converter has a volume of 2.4 cubic inches and measures 2 by 3 by 0.4 in. It can be mounted on PC boards with center-to-center spacings of 0.5 in. Booth No. 574 Circle No. 294



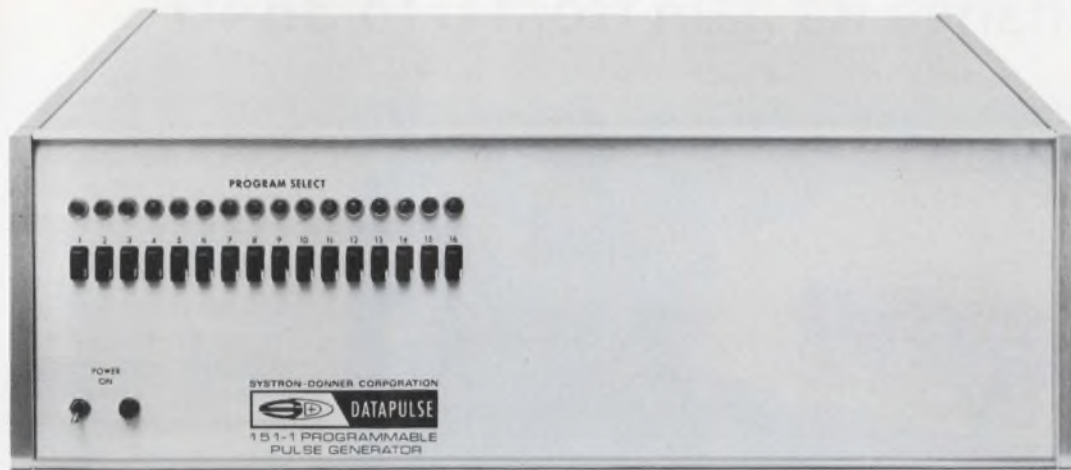
Modular eight-bit digital-to-analog converter gives an overall full-scale accuracy of  $\pm 0.2\%$  for only \$29. Its output settling time is 20  $\mu$ s to  $\pm 0.2\%$ .



Plug-in eight-bit analog-to-digital converter module carries \$89 price tag and yet delivers an overall accuracy of  $\pm 0.2\%$ . The unit is completely self-contained.



# G U A R A N T E E



## If your new Datapulse 150 series pulse generator doesn't pay for itself in 90 days, we'll take it back.

If your pulse generator just sits on your work bench and you reach over now and then to turn a knob or two—the Series 150 is not for you.

But, if you're like everybody else, your pulse generator is part of some test set-up. You perform several different tests and you repeat them several times. **You can't afford anything else.**

### HERE'S WHY!

Rep Rate to 50 MHz—Delay and Duration from 10 nanoseconds to 10 milliseconds—Pulse Amplitude to  $\pm 10$  volts with top and baseline anywhere from + to - 10 volts—Transitions take less than 5 nanoseconds.

**The Model 151** sets all parameters with **one punch** of a button. You pocket all the dollars you used to spend for manual set-up time.

**The Model 152** does the same thing—and transition times are variable out to 10 microseconds.

**The Model 153** sets all parameters from digital input information if you already have a semi-automatic or automatic system.

**The Model 154** adds variable transitions again.

Optional automatic sequencing and/or parallel manual control round out the picture to give you a choice of 16 different units. Let one of them pay for itself in your test set-up. After that, the time saved is pure profit.

Prices start as low as \$1,000.

For more information, address Datapulse Division, Systron-Donner Corporation, 10150 W. Jefferson Blvd., Culver City, California 90230. Phone 213-836-6100 or TWX 910-340-6766.

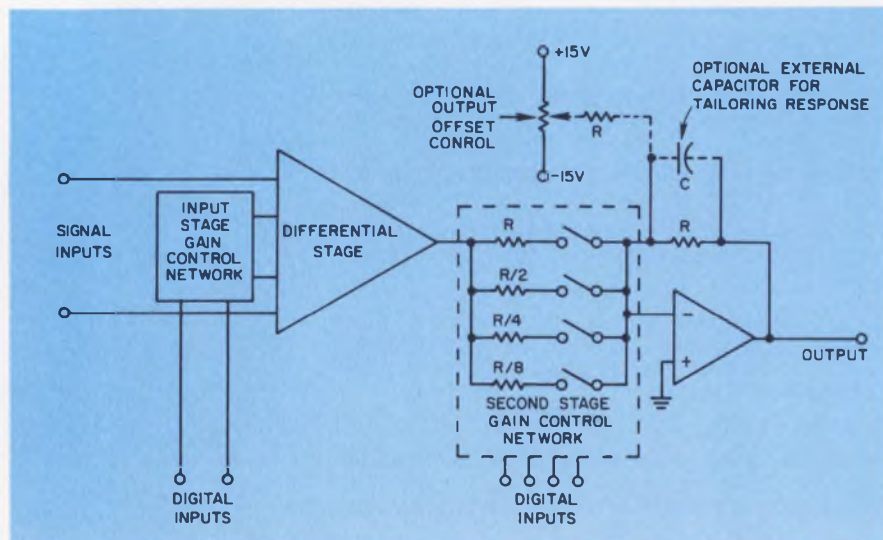
DATAPULSE  
DIVISION

SYSTRON  DONNER

INFORMATION RETRIEVAL NUMBER 130



# Digitally programmable data amplifier can change its gain from 0 to 3840



Modular data amplifier varies its gain from 0 to 3840 in response to digital commands. This programmable device consists of a differential input stage followed by a single-ended stage and two gain switching networks.

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: \$245; stock.

Designed to operate from low-level signals and under computer control, a new programmable-gain data amplifier can vary its gain from 0 to 3840. This modular \$245 PC-board unit, which measures 3 by 2.1 by 0.4 in., is said to offer performance comparable to that of rack-mounted amplifiers selling for \$1200 to \$1500.

Able to interface directly with standard logic levels, like DTL and TTL, the model 3600K amplifier contains all the necessary gain switching networks. Its gain can range from 0 to 16 in steps of 1, from 16 to 256 in steps of 16, and from 256 to 3840 in steps of 256.

The 3600K has a settling time of 500  $\mu$ s to final value,  $\pm 0.01\%$  of full scale. Its gain accuracy and linearity are  $\pm 0.1\%$  and  $0.01\%$ , respectively, and its common-mode rejection exceeds 100 dB. The device also offers a voltage drift of  $\pm 1 \mu$ V/ $^{\circ}$ C and a noise of 2  $\mu$ V rms.

An active guard driver aids in rejecting common-mode noise by driving internal and external shields with common-mode signals. The epoxy-cased amplifier operates from standard  $\pm 15$ -V supplies.

Gain switching, which takes place in two stages, is performed by a combination of MOSFET and bipolar transistor switches. The first stage provides gain multiples of 1, 16, and 256. The second stage uses a four-element binary resistor network to achieve total gain multiples of 0 to 3840 for the overall amplifier.

The unit's gain can be digitally controlled directly from the computer. Decoding from straight binary to the proper gain codes is simple. Alternatively, the amplifier can be made autoranging by the addition of external logic.

Booth No. 1135 Circle No. 267



# A NEW FIELD-OF-ONE IN LIGHTED PUSHBUTTON SWITCHES.

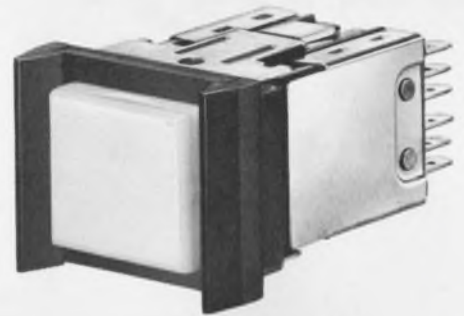
*Switchcraft's "PUSH-LITE" switch offers reliable leafspring switching in a neat little package.*

This whole new field of compact ( $1'' \times 1\frac{1}{6}'' \times 1\frac{3}{4}''$ ) pushbutton switches reduces the size of your control panels, consoles—and cost, too! Our new field-of-one consists of 6 series—including non-illuminated and illuminated single and twin-lamp units in two housing colors (black or grey). Up to 4PDT switching in momentary and push-lock/push-release functions. Ratings range from dry circuit switching, up to 3 amps., A.C., non-inductive load.

A rugged molded housing encloses the highly reliable leafspring switching and protects against dust, dirt and mishandling.

Pick from flange or barrier mounting—individually or in matrix configurations. Series PL "PUSH-LITE" switches mount from front of panel with clamp brackets, simply and quickly. No mounting screws show!

Design with up to two lamps and either full or split display screens—vertically or horizontally. Full display provides up to 3 lines of 6 characters each. Virtually unlimited lighting versatility

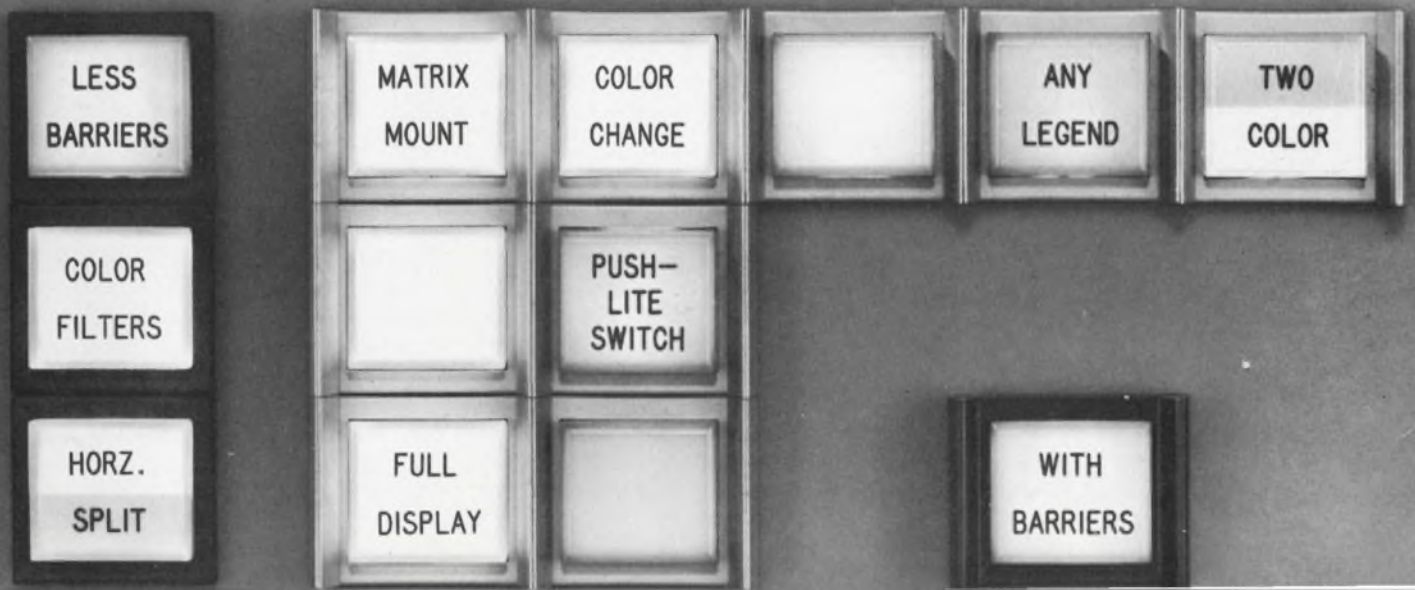


ACTUAL SIZE

provided by 7 different colors of pushbuttons, insert filters and silicone boots.

For additional information, contact a Switchcraft Representative or write for Catalog S-345. SWITCHCRAFT, INC. 5529 N. Elston Avenue Chicago, Illinois 60630

**SWITCHCRAFT**  
INC.



# 60% less cavity!



**This MCM\* now does the same job in less than half the space!** Size and weight reduction is one of many packaged advantages that General Electric MCM's provide for advanced microwave systems. For instance, the new C-2003E Microwave Circuit Module is a master-oscillator and power amplifier — using GE planar ceramic tubes — for IFF or ATC pulsed transponder applications. It's the electronic equal of the larger version we developed to give high RF gain, high power and unmatched stability under the most adverse environments and under severe load mismatch. General Electric combines research with production know-how to provide systems designers with one efficient source for high performance planar tubes and toughly packaged circuits. For more information, circle the appropriate number on the reader's service card, or write MDBS, Tube Department, Owensboro, Kentucky. 272-12



## GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 132

W30

### MODULES & SUBASSEMBLIES

**FET op amp for \$26  
holds bias to 15 pA**



*Zeltec, Inc., 1000 Chalomar Rd., Concord, Calif. Phone: (415) 686-6660. P&A: \$26; stock.*

Packaged in a 1 by 1 by 0.4-in. module, a new \$26 FET-input operational amplifier features a 15-pA maximum input current, a 100,000:1 common-mode rejection and a unity-gain frequency response of 4 MHz. Model ZA802M1 has a maximum input voltage drift of 50  $\mu\text{V}/^\circ\text{C}$  over the range of  $-25$  to  $85^\circ\text{C}$ . Its gold-plated leads meet MIL-G-45204A.

*Booth No. 1225 Circle No. 259*

**FET op amp for \$29  
performs out to 10 MHz**

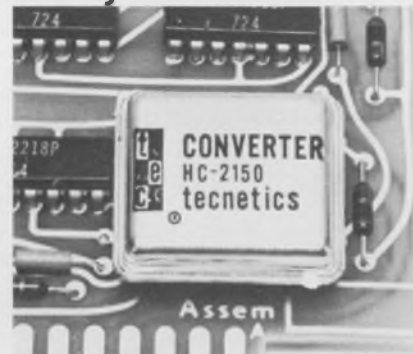


*Monitor Systems, an Aydin Co., 401 Commerce Dr., Fort Washington, Pa. Phone: (215) 646-8100. P&A: \$29; 2 wks.*

Called the Monimodule model A104A, a new general-purpose wideband FET operational amplifier features a frequency response of 10 MHz and a slewing rate of 25  $\text{V}/\mu\text{s}$ . The unit has a settling time of 1  $\mu\text{s}$  to 0.01% and a voltage drift temperature coefficient of 50  $\mu\text{V}/^\circ\text{C}$ . Its input bias current is 20 pA, and open-loop gain is 80 dB.

*Booth No. 138 Circle No. 290*

**Dc-dc 3-W converters  
are hybrid modules**

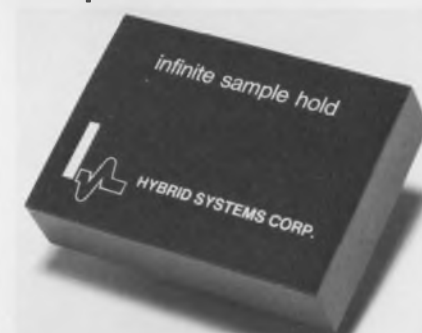


*Tecnetics Inc., Boulder Industrial Park, Boulder, Colo. Phone: (303) 442-3837.*

Series HC 3-W hybrid dc-dc converters give design flexibility to the systems and instrument designer by eliminating the need for highly regulated multiple-output power supplies. These units operate from an input voltage of 20 V dc and are available with single output voltages from 5 to 300 V dc, or with dual outputs of  $\pm 12$ ,  $\pm 15$ ,  $\pm 18$  or  $\pm 25$  V.

*Booth No. 1917 Circle No. 256*

**Dual-function module  
samples or detects**



*Hybrid Sysms Corp., 95 Terrace Hall Ave., Burlington, Mass. Phone: (617) 272-1522. P&A: \$235; stock to 2 wks.*

Without requiring external components, a new module can perform the function of either sample-and-hold or peak detection with no droop or decay, depending on pin interconnections. Model 750 digitally stores the analog signals being processed. The unit has a linearity of 0.05% and can resolve input signals to 15 mV.

*Booth No. 447 Circle No. 297*





# a "NEW" Generation of Multimeters at a "NOW" Price



- AC, DC, volts and current, Ohms
- .1% basic accuracy
- 100  $\mu$ V resolution, AC and DC
- Auto-Polarity on DC ranges
- Automatic zero correction
- Self-contained Battery Pack, Optional

## \$375



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## Five-digit premium-quality multimeter expands capabilities with plug-in cards



Dana Laboratories, Inc., 2401 Campus Dr., Irvine, Calif. Phone: (714) 833-1234. P&A: from \$2995; 2 wks.

Featuring a basic dc voltage accuracy of  $\pm 0.003\%$  of reading  $\pm 0.001\%$  of full scale, the model 5800 five-digit multimeter with overrange capability starts at a basic price of \$2995 and extends its measurement capabilities with plug-in PC card accessories which allow the choice of three different methods of measuring ac voltages.

Ac voltages can be measured using an average-responding converter card (model 01) at an extra cost of \$545. It operates from 10 Hz to 100 kHz ranging in accuracy from  $\pm 0.08\%$  of reading  $\pm 0.02\%$  of full scale to  $\pm 0.8\%$  of reading  $\pm 0.1\%$  of full scale.

A patented computing rms converter card is available (model 02) at an extra cost of \$695. It also operates from 10 Hz to 100 kHz ranging in accuracy from  $\pm 0.06\%$  of reading  $\pm 0.02\%$  of full scale to  $\pm 0.8\%$  of reading  $\pm 0.1\%$  of full scale for undistorted sine waves. It can also make accurate measurements of square, triangular, sawtooth and distorted sine waves.

A true-rms converter card (model 03) costing \$745 will be introduced by the end of 1970. It generates a square law electronically. A piecewise-linear approxi-

mation to a square law is first generated, then a pseudo-random waveform is added to the input signal; both signals are then impressed upon the piecewise-linear square law.

Because of this electronic square law, filtering can be done with active devices instead of depending on the thermal time constant of a thermocouple.

The true-rms converter operates from 10 Hz to 1 MHz ranging in accuracy from  $\pm 0.08\%$  of reading  $\pm 0.02\%$  of full scale to  $\pm 1\%$  of reading  $\pm 0.5\%$  of full scale (at 100 kHz).

Three selectable front-panel filter positions allow full flexibility in the choice of noise rejection vs reading speed. One position places all filters out of the input circuit and allows measurement over the basic frequency range of 10 Hz to 100 kHz. Another position selects a five-pole Bessel filter with 30-dB rejection at 60 Hz to give a frequency response of 50 Hz to 100 kHz. The third position selects a five-pole Bessel filter with 100-dB rejection at 60 Hz, and with a response of 400 Hz to 100 kHz. Settling times to 0.1% of final value for the three filters are 950, 300 and 110 ms, respectively.

The multimeter's input circuit uses a successive-approximation a/d converter, with three digitizing

modes of operation: periodic, auto-track, and hold. The periodic mode is the one generally used in most multimeters. The tracking mode allows 80 readings/s when the input signal is varying. The auto-track mode allows the voltmeter to automatically determine if the input signal has stabilized, before a reading is taken.

The model 5800 measures dc voltages from  $\pm 1.09999$  to  $\pm 1099.99$  V in four ranges at a resolution of  $10 \mu\text{V}$ . Input resistance ranges from 1 to  $10 \text{ M}\Omega$ .

A chopper preamplifier board (model 05) is available to extend dc voltage measurements down to 10 mV full scale at  $0.1\text{-}\mu\text{V}$  resolution, with two additional dc voltage ranges. Its cost is \$250.

Another accessory is a four-wire converter for measuring resistances (model 04) costing \$400. It has a total of nine ranges to measure  $1 \Omega$  to  $100 \text{ M}\Omega$  full scale. Resolution is  $10 \mu\Omega$ . The converter is a floating current source with its own independent precision zero reference. This means that the impedance of the leads for the component under test cannot degrade the accuracy of a measurement. Selectable five-pole filters are also provided for resistance measurements.

A programmer printer output module is another accessory. Two versions are available. One costs \$450 (BCD-output version) and the other costs \$750 (programming/BCD-output version). Each uses light-emitting diodes and photo-transistors for high programming speeds and unlimited life and is TTL IC compatible. Each provides a system-over-ride input, which when grounded, transfers control of the multimeter to a rear input regardless of the position of the front-panel switches.

The model 5800 can also perform ac/ac and dc/dc voltage ratio measurements.

Booth No. 365      Circle No. 286





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Temperature Ratings: -55C to +85/125C

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INFORMATION RETRIEVAL NUMBER 167





# ENCYCLOPEDIA ELECTRONICA

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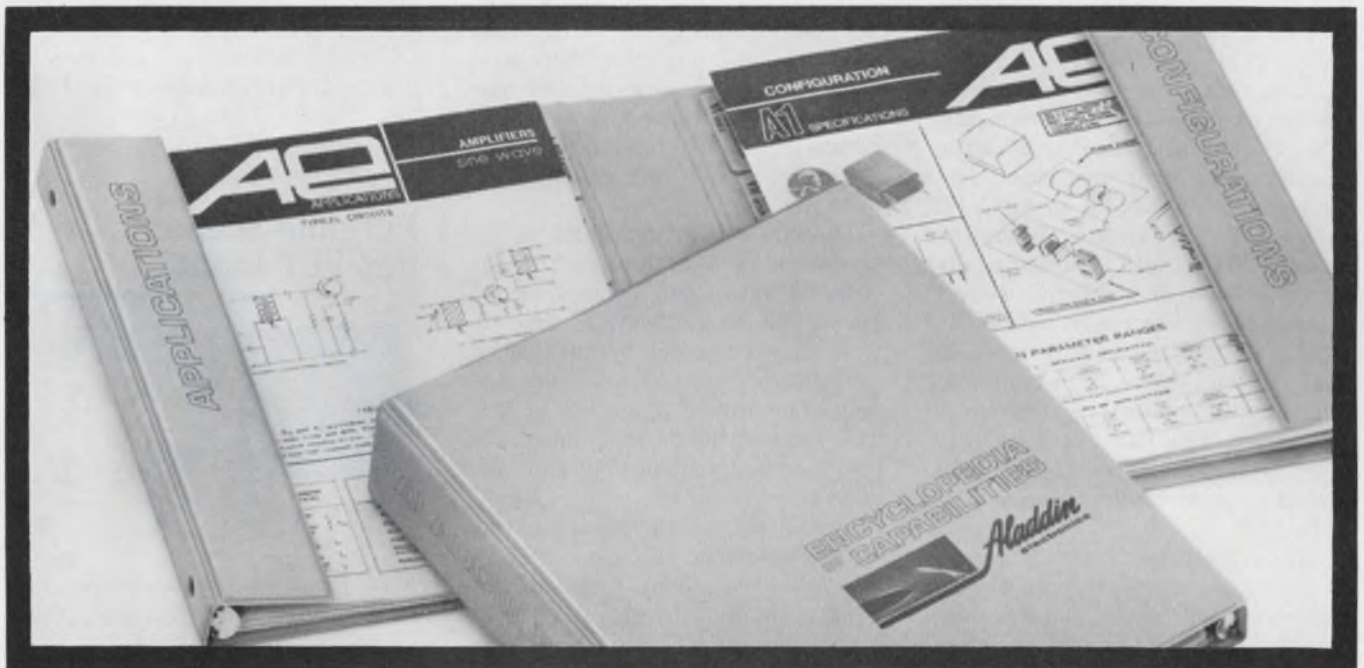
The *Aladdin Encyclopedia of Capabilities* is a genuinely new concept in magnetics component selection. It can reduce hours of tedious computations and reference-checking to minutes, and days (or weeks) of sample delays to virtual assurance of an on-the-button sample on the first try.

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**AE**

INFORMATION RETRIEVAL NUMBER 135



## Autoranging \$950 counter measures 0.1 Hz to 20 MHz



Monsanto Electronic Instruments, 620 Passaic Ave., West Caldwell, N. J. Phone: (201) 228-3800. P&A: \$950; September, 1970.

Occupying only one-third the volume of competitive instruments, a new half-rack reciprocal-taking counter for \$950 measures frequencies from 0.1 Hz to 20 MHz with full five-digit resolution. Model 107A also automatically computes and displays the correct decimal point and range indication.

In addition, the new instrument has a solid-state light-emitting-diode digital readout for enhanced reliability. The half-life reliability of this five-digit display is estimated to be one million hours (100 years).

Other features of the 107A include programmability, a BCD output, a self-test mode, and an oven-stabilized crystal-controlled clock for increased accuracy. This instrument can be used to measure frequency or rotational speeds (rpm).

Besides operating independently for conventional measurement applications, the new counter can be used in combination with other instrumentation in systems applications. It may also be connected to a printer for monitoring and recording purposes.

Gate time selection and range selection are fully automatic, and yet the 107A delivers an accuracy of plus-and-minus the time-base accuracy, plus-and-minus one count, plus-and-minus noise. Temperature stability for the time base is three parts in one million from 0 to 40°C.

Measurement time, which is determined by the duration of the external gate time, varies from 25 ms to 10 s. Computing time to find the reciprocal of the period (frequency) is 600  $\mu$ s, and display time ranges from 0.2 to 2 s. The sample rate is the sum of the measurement, computing and display times.

The instrument's input characteristics include a sensitivity of 100 mV rms and an impedance of 1 M $\Omega$  shunted by 20 pF. Input signal amplitudes can be as large as 35 V peak, ac plus dc.

Besides its five-digit display with automatic decimal-point location, the 107A has an overrange indicator that illuminates when register capacity is exceeded. There is also a manual reset push-button.

The new counter measures 4-1/4 by 7-1/2 by 11 in. Its power consumption is 25 W.

Booth No. 551 Circle No. 298

## Oscilloscope for \$346 performs out to 10 MHz



Kikusui Electronics Corp., Marubeni-Ida (America), Inc., 200 Park Ave., New York, N. Y. Phone: (212) 973-7152. P&A: \$346; stock.

Selling for just \$346, a new five-in. single-trace oscilloscope features a bandwidth of dc to 10 MHz. Model 555G provides a vertical amplifier with a rise time of 35 ns and a sensitivity of 20 mV/cm to 10 V/cm. Its sweep rate can vary from 1  $\mu$ s/cm to 1 s/cm, and its sweep calibration accuracy is  $\pm$ 5%. Input impedance is 1 M $\Omega$  and 38 pF.

Booth No. 430 Circle No. 288

## Portable scope has FET input

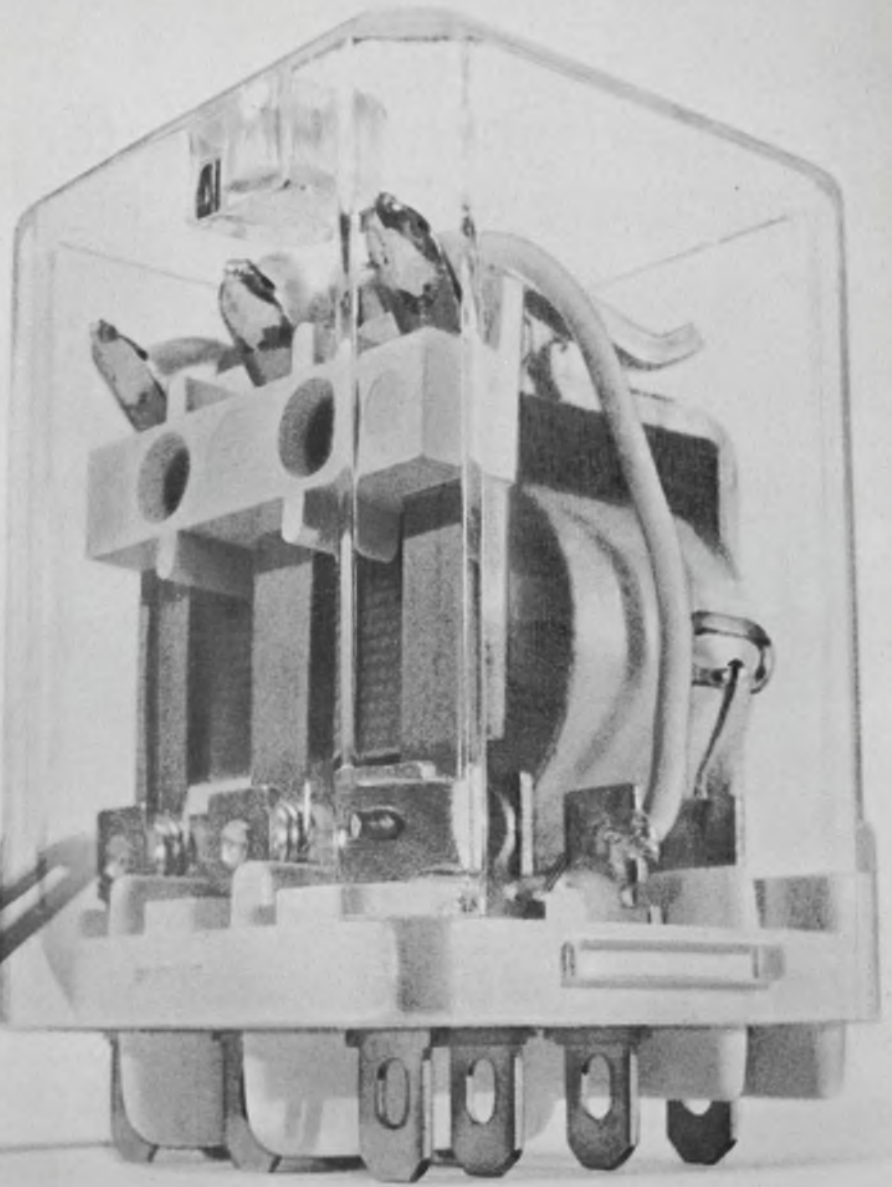
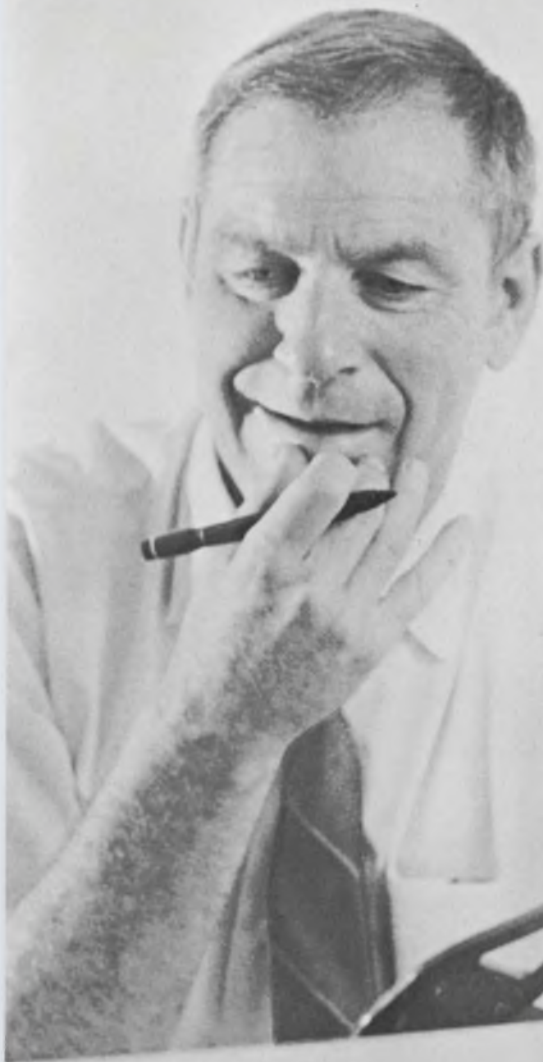


E-H Research Laboratories, Inc., P. O. Box 1289, Oakland, Calif. Phone: (415) 834-3030.

Achieving high sensitivity with junction-type field-effect transistors in its input circuit, the Iwatsu SS-200 Synchronoscope is a compact lightweight portable oscilloscope with simplified operation. The electronically switched dual-trace vertical deflection system features a bandwidth of dc to 200 MHz with a sensitivity of 10 mV/division for both channels.

Booth No. 210 Circle No. 292





## Two new Clare GP Relays: better because we don't skimp.

You get a better 10 amp. General Purpose Relay when you specify the new Clare GP2 or GP3. Because we don't skimp. Not in design, not in materials, not in manufacturing.

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tin-coated blades. A nickel-plated heel-piece and core.

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Don't think these Clare relays cost as much as the ones you're probably now using. They don't. In fact, you'll save quite a bit thanks to our simpler design and manufacturing savvy.

Get the whole story. You'll see that Clare GP Relays are better—because we don't skimp. Circle the Reader Service number now.

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A General Instrument company.

## Resolver/synchro converter is accurate to 0.01 degrees



North Atlantic Industries, Inc., 200 Terminal Dr., Plainview, N. Y. Phone: (516) 681-8600. P&A: \$3500 to \$3800; 5 wks.

Providing orders-of-magnitude improvement in speed and accuracy over its predecessors, the 545/100 high-speed resolver/synchro-to-digital converter features a tracking rate of 20,000 degrees/s at a static accuracy of 0.01 degrees  $\pm 1$  digit.

Other key features include a five-decade readout to give resolution of 0.01 degrees, a range of 000.00 to 359.99 degrees, a maximum update of 100 ms for a worst-case input step of 180 degrees, and a velocity constant of 200,000/s.

Frequency range extends from 50 to 400 Hz. Input impedance is 300,000  $\Omega$  and a digital BCD output is available.

The converter implements the basic servo-mechanism principles for digitizing resolver or synchro angular data that were originally developed for the electromechanical converters. However, instead of using an actual rotating servo system, the model 545/100 simulates the electromechanical closed loop with a solid-state electronic servo.

This technique improves static accuracy, dynamic and tracking

rate, reliability, update response and versatility drastically.

For instance, the new converter exploits its precision dynamic performance by featuring such things as track-and-hold, sample-on-command, and sample-at-fixed-intervals operation modes.

In principle, the conversion process is based on matching the shaft angle of a built-in local resolver or synchro transducer to the shaft of a remote transducer whose angle position is being digitized.

Instead of actual rotation components, the 545/100 performs the analogous function of adjusting the angle of a simulated resolver until this simulated angle matches the actual angle of the remote data source. At angular coincidence, the local electrically generated angle is identical to the remote shaft angle, with the value displayed digitally.

Applications include bench check-out measurement of resolver and synchro angles during the development of systems and subsystems, data acquisition for manual and automatic testing, and on-line control systems operated by a computer.

Booth No. 324 Circle No. 287

## 3-1/2-digit voltmeter costs just \$189.50



Alco Electronic Products, Inc., P.O. Box 1348, Lawrence, Mass. Phone: (617) 686-3887. Price: \$189.50.

Small enough (3 by 5-3/8 in.) to fit in an attache case and weighing but 4-1/2 lb, a new portable 3-1/2-digit voltmeter sells for only \$189.50. Model DVM-110 is capable of measuring dc voltages up to 1000 V in four ranges. It has a large direct-reading neon display with 33% overranging on all scales. The unit employs voltage-to-frequency a/d conversion.

Booth No. 1720 Circle No. 272

## Function generators span 0.5 MHz to 10 MHz



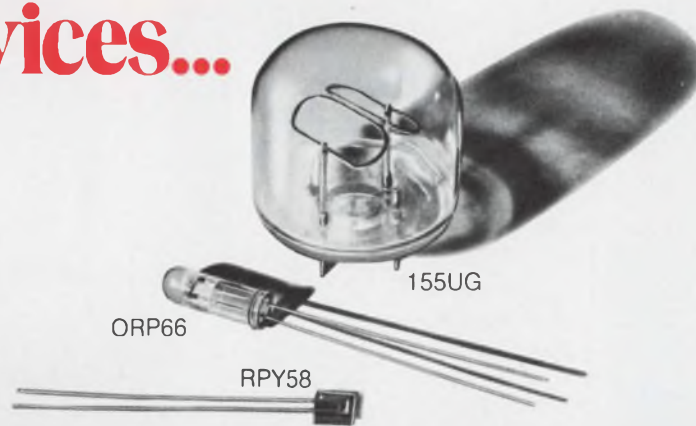
Interstate Electronics Corp., sub. of A-T-O, Inc., P. O. Box 3117, Anaheim, Calif. Phone: (714) 772-2811.

Operating over a ten-decade frequency spectrum of 0.0005 Hz to 10 MHz, five new function generators produce outputs of variable-width-pulse, sine, square, triangle, ramp, and fixed-duty-cycle-pulse waveforms. Voltage offset of the series 50 units is fixed to provide all-positive or all-negative waveforms. A continuously variable offset is also featured.

Booth No. 450 Circle No. 269



# Amperex photosensitive devices...



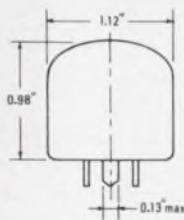
155UG  
ORP66

RPY58

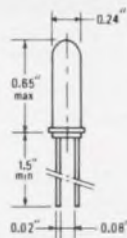
## another facet of our electro-optics capability.

In addition to the well-known lines of Plumbicon\* and vidicon TV camera tubes, X-ray image intensifiers and instrument cathode ray tubes, Amperex' total capability in electro-optics encompasses a broad line of photosensitive devices. Included are high-vacuum and gas-filled photo tubes covering a wide spectral range and a complete line of cadmium sulphide photoconductive cells.

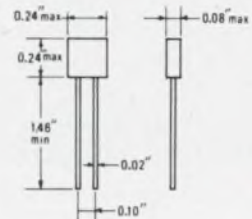
**155UG:** Typical and popular is the 155UG gas filled photo tube, sensitive to ultra-violet radiation. It has a peak spectral response at 220nm and only 10% response at 206nm and 250nm. It is intended for use as an on-off device in flame-failure and flame-detection circuits.



**ORP66:** The ORP66 cadmium sulphide photoconductive cell offers shock and vibration resistance and high sensitivity in a hermetically sealed envelope. It has wide spectral response, peaking at 630nm. It is intended for on-off as well as variable brightness control applications.



**RPY58, RPY71:** Examples of very inexpensive cadmium sulphide photoconductive devices are types RPY58 and RPY71, with peak spectral response at 550nm. Sensitivities are linear; 3 orders of magnitude in the RPY58; 4 orders of magnitude in the RPY71. Both of these devices are ideally suited for electronic control applications in toys, cameras, etc.



For more information on Amperex photosensitive devices, contact:  
Electro-Optical Devices Division, Amperex Electronic Corp., Slatersville, R. I. 02876 Tel.: 401-762-3800



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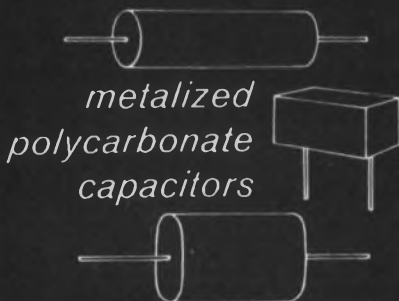
\*Reg. T.M. of N.V. Philips of Holland

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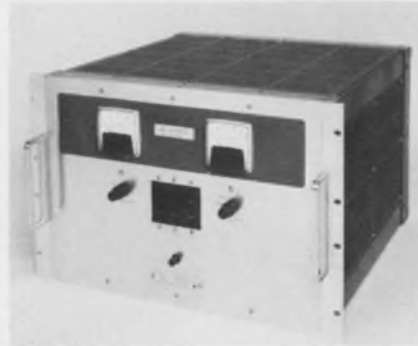
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INFORMATION RETRIEVAL NUMBER 138  
W40

## INSTRUMENTATION

### 80%-efficient supplies go to 300 A at 300 V



Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, N. Y. Phone: (516) 694-4200.

Designed for use in mainframe computers and test equipment, series LB-720 power supplies use SCR circuitry to perform at 80% efficiency at current ratings to 300 A and voltage outputs to 300 V dc. Six different models are available with voltage ranges from 0 to 7.5 V or 0 to 300 V. All models are remotely programmable over the entire range.

Booth No. 1007 Circle No. 271

### Data generator has MOS clock



Signetics Corp., Measurement/Data Div., 341 Moffett Blvd., Mountain View, Calif. Phone: (415) 961-9384. P&A: \$5000; September, 1970.

Combining the functions of an MOS clock with a data generator, a new laboratory test instrument for testing MOS integrated circuits provides timing signals while generating words up to 32 bits in length. The model 501 MOS-clock/data-generator may be used in any application in which 30-V clocks or data outputs are required.

Booth No. 525 Circle No. 274

### Function generator covers over 9 decades



Wavetek, P.O. Box 651, San Diego, Calif. Phone: (714) 279-2200. P&A: \$595; stock.

Besides an output symmetry adjustment, a new waveform generator offers positive and negative pulse outputs as well as sine, square, and triangle waveforms, and a broad 0.0005 Hz to 10-MHz frequency range. The model 142 also features a voltage-controlled-gain input, allowing the output to be frequency modulated, dc programmed, or swept.

Booth No. 359 Circle No. 293

### Waveform generator is programmable



Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif. Phone: (213) 682-3351.

A programmable waveform generator, which supplies a sine, square, triangular, or a sine-squared-pulse output, provides three-digit resolution from 0.01 Hz to 1.1 MHz in eight decade ranges. Model F280A has a maximum voltage output of 11 V pk-pk into a 50- $\Omega$  load in the manual mode, or 16 V pk-pk when programmed. All manual controls are programmable.

Booth No. 630 Circle No. 270



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INFORMATION RETRIEVAL NUMBER 139

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INFORMATION RETRIEVAL NUMBER 140

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DELAY LINE HAVING TIME DELAY TO  
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Over Wide Frequency Range.**

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30	6	250
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50	10	350
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70	14	400
80	16	475
90	18	500
100	20	500

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INFORMATION RETRIEVAL NUMBER 141

**"IT'S GOOD BUSINESS  
TO HIRE THE HANDICAPPED."**

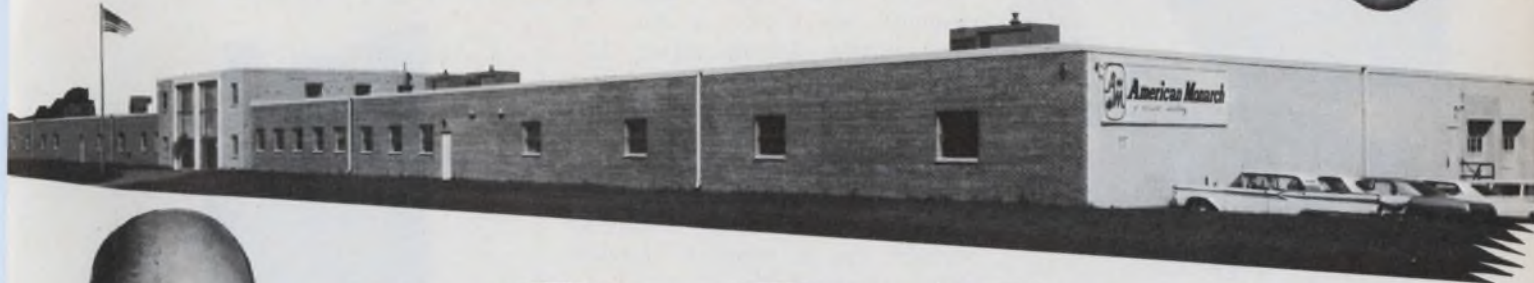
**ISN'T THAT A GREAT IDEA, SNOOPY?**



**THE PRESIDENT'S COMMITTEE ON EMPLOYMENT  
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"**HIGH TEMPERATURE INSULATION** systems have been and are being developed by our engineering department. At the present time all materials used are Class F or better. Work is being done to qualify our system with U/L as Class F or better.

"**METAL STAMPING** is done by American Monarch in a completely equipped shop to provide low cost for large or small orders resulting in exceptionally fast delivery to our cus-

tomers when special hardware is needed. This also allows us to optimize a design and offer a customer an economical transformer while maintaining desired hole centers.

"**BATTERY CHARGERS** using a special CVT design were developed by American Monarch eight years ago. At the present time we are the largest supplier of this type of transformer in the country, serving both the golf car industry and the new garden tractor market. The latest design batteries of the major manufacturers are used to test charging equipment against actual battery use during design and development stages.

"**A UNIQUE TRANSFORMER ASSEMBLY PROCEDURE** has been developed by American Monarch. We simultaneously assemble in volume many different sized transformers to provide custom designs at off-the-shelf cost.

"**COMPLETE WINDING CAPABILITIES** matched by few manufacturers in the country are available at American Monarch. We multiple-wind the standard coils wound by most transformer manufacturers. Our hand-winding capability includes copper and aluminum foil and square wire in addition to the normal round wire coils.

"**THE LARGEST MULTIPLE WINDER** in the Northwest is used to simultaneously wind up to 10 coils of 7 gauge wire at high speed. It can layer-wind or bobbin-wind coils of any configuration.

"**AUTOMATIC MACHINE STACKING CAPABILITIES** reach from 1 1/8 inch through 2 1/2 inch, 29 gauge laminations providing higher grade transformers at a lower cost. Most other manufacturers do not have this capability.

"**OUR IMPREGNATION FACILITIES** consist of the newest available vacuum equipment. We are able to draw a vacuum of 29.5 inches and apply a positive pressure of twenty pounds in a minimum cycle time of five minutes in a 30 cubic foot rectangular tank. This guarantees high volume, quality impregnation of all our transformers. The modern vacuum impregnation system is complimented by our temperature controlled walk-in baking ovens.

"**WELDING** of transformer laminations to accommodate stringent transformer grounding requirements is accomplished in volume production by our unique process.

"**SPECIAL PACKAGING** methods for transformers have been developed, including a high volume unit pack, which enables large quantities of transformers to be shipped on one skid and safely handled by fork lift for long over-the-road hauls.

"**OUR QUALITY ASSURANCE SYSTEM** has been approved by many of the volume users of transformers including the largest computer manufacturers. 100 percent testing including non-destructive hi-pot is done using the latest test equipment.

"**COMPLETE QUALIFICATION TESTING** to all customer specifications including recorded temperature rise tests is accomplished in our well-equipped engineering lab.

"**COMPLETELY AIR-CONDITIONED MODERN FACILITIES** provide an ideal environment to insure uniform production throughout the year."



"ANY MORE QUESTIONS?"

"GEEZ, NO!"

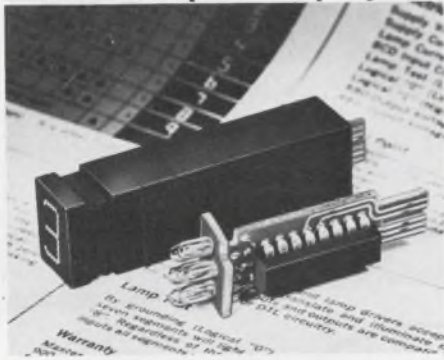


Send us your specs and requirements for our quotation. (or phone 612-788-9161)

**AMERICAN MONARCH, 2801 37TH AVENUE NORTHEAST, MINNEAPOLIS, MINNESOTA, 55421**



### Self-contained readouts use fiber-optic display

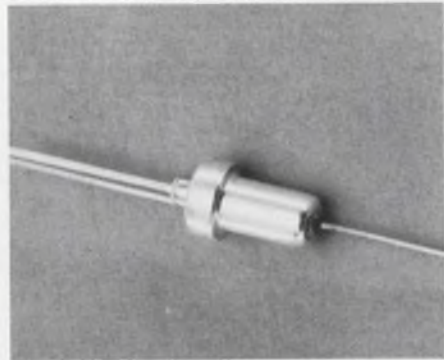


Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. Phone: (714) 642-2427.

Series 901 D2-D8 fiber-optic readouts, which offer a choice of five built-in decoder/driver ICs, are designed to reduce mounting, wiring and PC-board requirements as well as equipment size. All inputs and outputs of the seven-segment displays are compatible with TTL or DTL circuitry. A decade-counter and a memory decoder/driver are available.

Booth No. 2320 Circle No. 268

### Electrolytic cell has dual electrodes

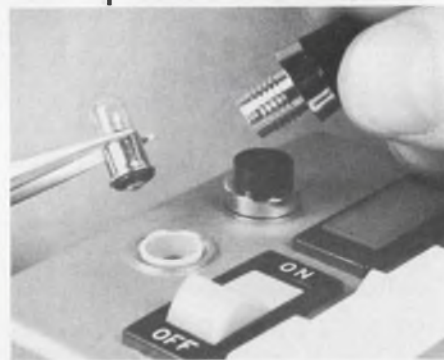


Gibbs Manufacturing & Research Corp., sub. of Hammond Corp., 450 N. Main St., Janesville, Wis. Phone: (608) 754-4467.

The dual-electrode Coul Cell 590 is an impedance-changing device that combines the function of two coulometers in a single package. Each electrode in this new coulometer or electrolytic cell has a distinct and separate function—one provides a capacity of three microampere-hours while the other is for 3000 microampere-hours.

Booth No. 1308 Circle No. 299

### Multi-use panel lights relamp from the front

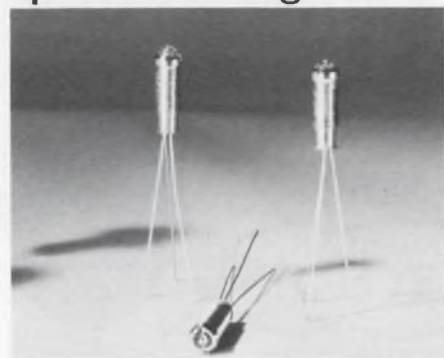


Chicago Switch, Inc., 2035 Wabansia Ave., Chicago, Ill. Phone: (312) 489-5500. Price: \$1.45 typical.

Incorporating T-1-3/4 midget flange-based lamps, a new line of panel lights can be relamped from the front of the panel. Series 33-89 units are available in nine different lens styles, three different body styles, and ten different lens colors, plus models with no lens. All lens styles are interchangeable with each other, and include side-lighting fan-shaped versions.

Booth No. 1411 Circle No. 264

### Indicator lights operate from logic

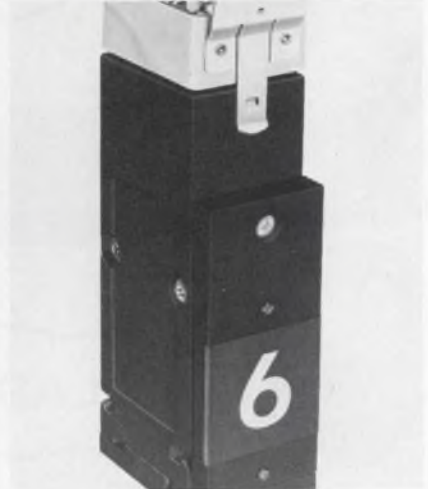


Industrial Control Systems Ltd., 78/90 Clarke Rd., Northampton, England.

Called Logicclamps, a new line of panel indicator lights can be driven directly from logic-level circuits without lamp drivers. There are three basic series, which can be mounted at minimum center-to-center spacings of 5/8, 3/8 and 5/16 in. The largest units can be supplied to operate from pnp or npn systems; the two smaller sizes operate from npn systems.

Booth No. 2332 Circle No. 262

### Projection readouts display at 90 degrees

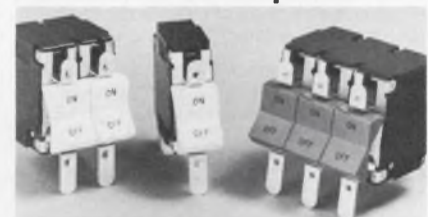


Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, Calif. Phone: (213) 787-0311. P&A: \$52; 6 wks.

Conserving behind-the-panel space, series 140 rear-projection readouts have a vertical case configuration that is at a right angle to their display. The units provide 12 message areas, either symbols, numbers, letters or colors. Their average character brightness is 100 ft-L, and rated lamp life is 3000 hours.

Booth No. 511 Circle No. 260

### Rocker-handle breakers handle 2 or 3 poles



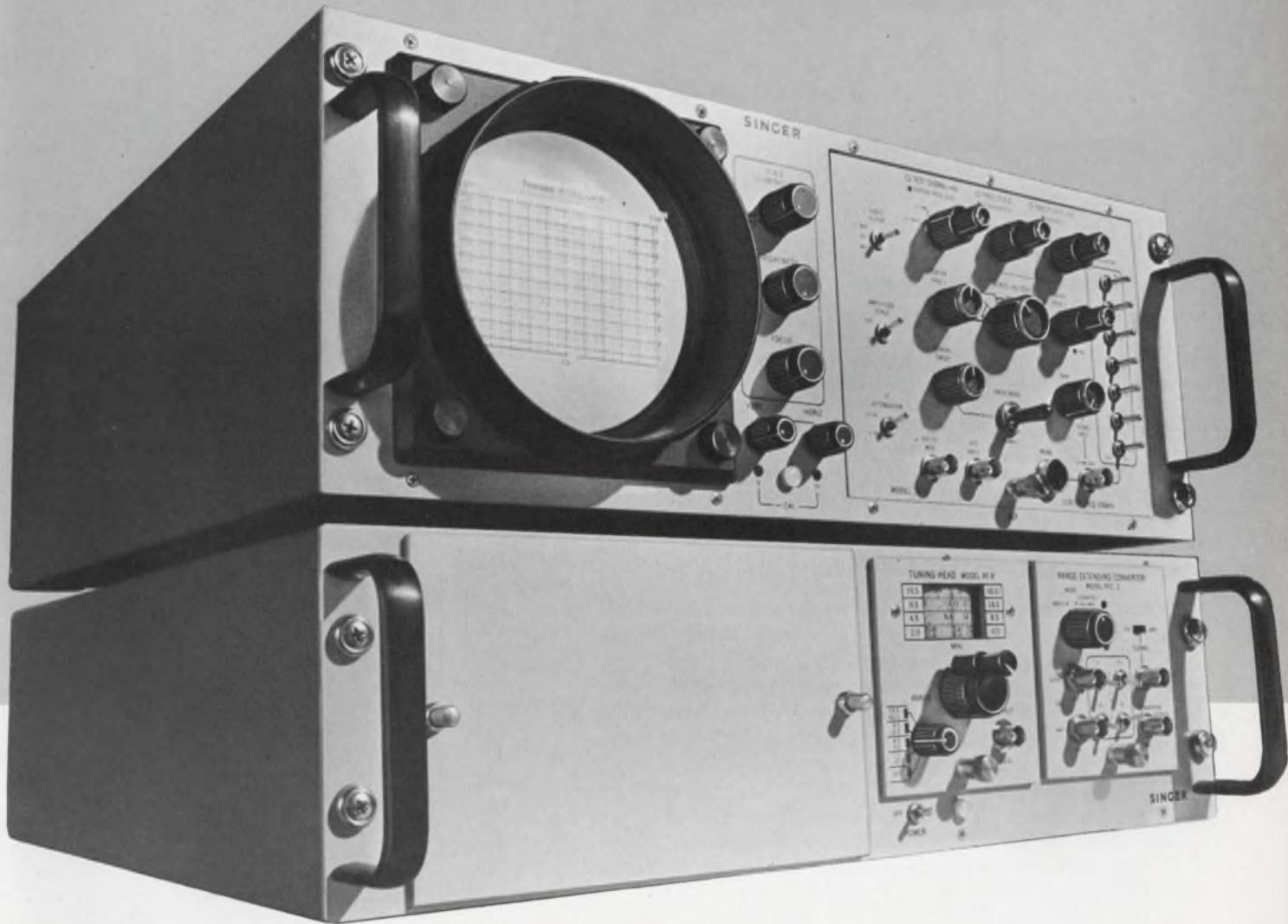
Heinemann Electric Co., 248 Magnetic Dr., Trenton, N. J. Phone: (609) 882-4800.

Two-pole and three-pole miniature circuit breakers are now available with decorative rocker handles. Since series JC units are fully magnetic, using no thermal elements, they are not subject to the adverse effects of ambient temperature variations. They are available in any integral or fractional current rating from 0.02 to 30 A, at up to 65 V dc or 250 V ac.

Booth No. 1221 Circle No. 261



# When we say High Resolution We mean 10Hz in 40MHz



## The Singer SA-51B Spectrum Analyzer offers the unbeatable combination of high resolution with 70 dB dynamic range.

Signals as closely spaced as 10 Hz are clearly visible from 10 Hz to 40 MHz (and even out to 200 MHz with slightly reduced sensitivity).

■ Now you can measure in-band distortion products down to 70 dB below peak levels. You get this exceptionally wide dynamic range with uniform 5 microvolt sensitivity from 2 to 40 MHz; usable to beyond 200 MHz.

■ This measuring system's high stability permits 10 Hz resolution, with steep skirt selectivity, over the full frequency range.

■ An image and spurious free up-converter extends the frequency range to 10 Hz and provides unambiguous displays of audio, base-band or IF signals.

■ A low distortion two-tone audio signal generator supplies modulating signals to equipment under test. (optionally available)

■ The highly linear response of the completely solid-state Model SA-51B High Resolution Spectrum Analyzer makes it ideal for monitoring and "dynamically" analyzing odd- or

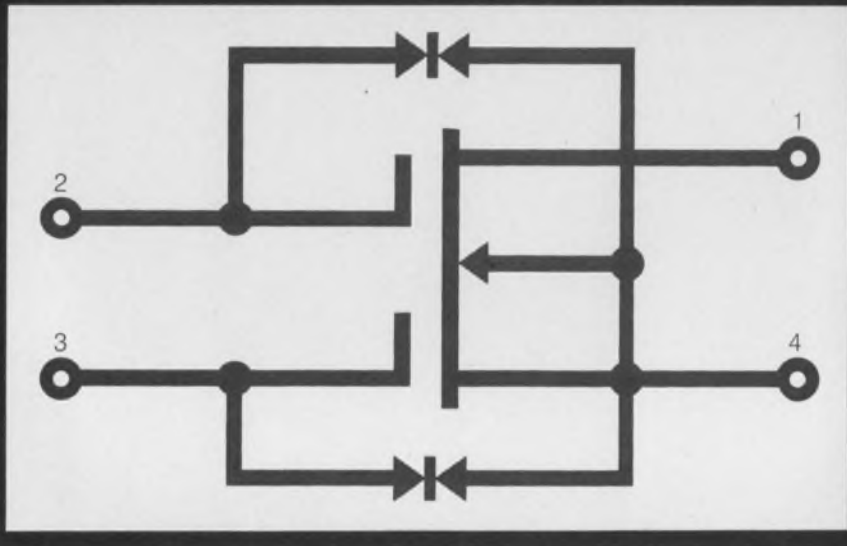
even-order AF/RF components of narrow-band SSB, AM, FM and multiplexed FSK signals.

Basic instrument price, \$6060

The Singer Company,  
Electronic Products Division,  
915 Pembroke Street, Bridgeport,  
Conn. 06608. In Europe contact:  
Singer Sewing Machine Company,  
Electronic Products Division,  
P.O. Box 301, 8034 Zurich, Switzerland,  
Telephone: (051) 47 25 10.

**SINGER**  
INSTRUMENTATION

# HIGH PERFORMANCE MOSFETs TO 500 MHz



## Another RCA breakthrough: dual-gate-protected MOSFETs for 300 and 500 MHz

You bet it's a breakthrough! The electronics industry, communications in particular, has been waiting a long time for an exceptionally high-performance, VHF MOSFET. Now RCA has two of them—the 3N187 dual-gate MOSFET for space, military, and industrial applications up to 300 MHz, and the 3N200 dual-gate MOSFET for similar applications up to 500 MHz.

RCA dual-insulated-gate MOSFETs are protected by special back-to-back diodes diffused directly into the MOS pellet. These diodes protect against voltage transients encountered in normal handling and usage.

Here are two more bonus features:

Low VHF noise figure

3N187—3.5 dB (typ) at 200 MHz

3N200 { 3.0 dB (typ) at 200 MHz  
4.5 dB (typ) at 400 MHz

High RF power gain—Gps—(No neutralization required)

3N187—18.0 dB (typ) at 200 MHz

3N200 { 12.5 dB (typ) at 400 MHz  
19.0 dB (typ) at 200 MHz

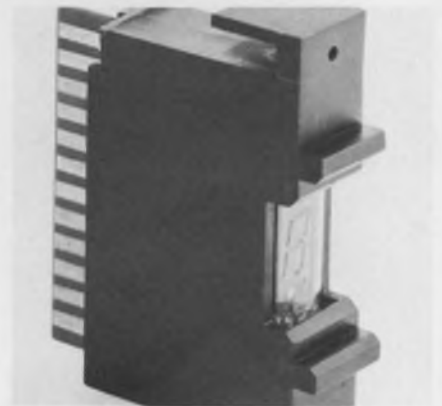
For further information, see your local RCA Representative or your RCA Distributor, or write: RCA, Commercial Engineering, Section 57H-16/ZT3, Harrison, New Jersey 07029. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P. O. Box 112, Hong Kong.

# RCA

INFORMATION RETRIEVAL NUMBER 144

## COMPONENTS

### Plug-in neon displays have decoder/drivers



Alco Electronic Products, Inc., P.O. Box 1348, Lawrence, Mass. Phone: (617) 686-3887. P&A: \$24.45 to \$29.80; stock.

Series DM-17G compact plug-in display modules are ready-to-use readouts with a miniature Elfin neon display and an integral decoder/driver. The neon display is front-mounted on a PC board which contains the decoder/driver and the logic required to accept four-line BCD inputs. All input-output contacts appear at the PC connector.

Booth No. 1720 Circle No. 266

### Square-button switches are only 2-in. long



Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill. Phone: (312) 354-1040. Price: \$3.40 or \$4.85.

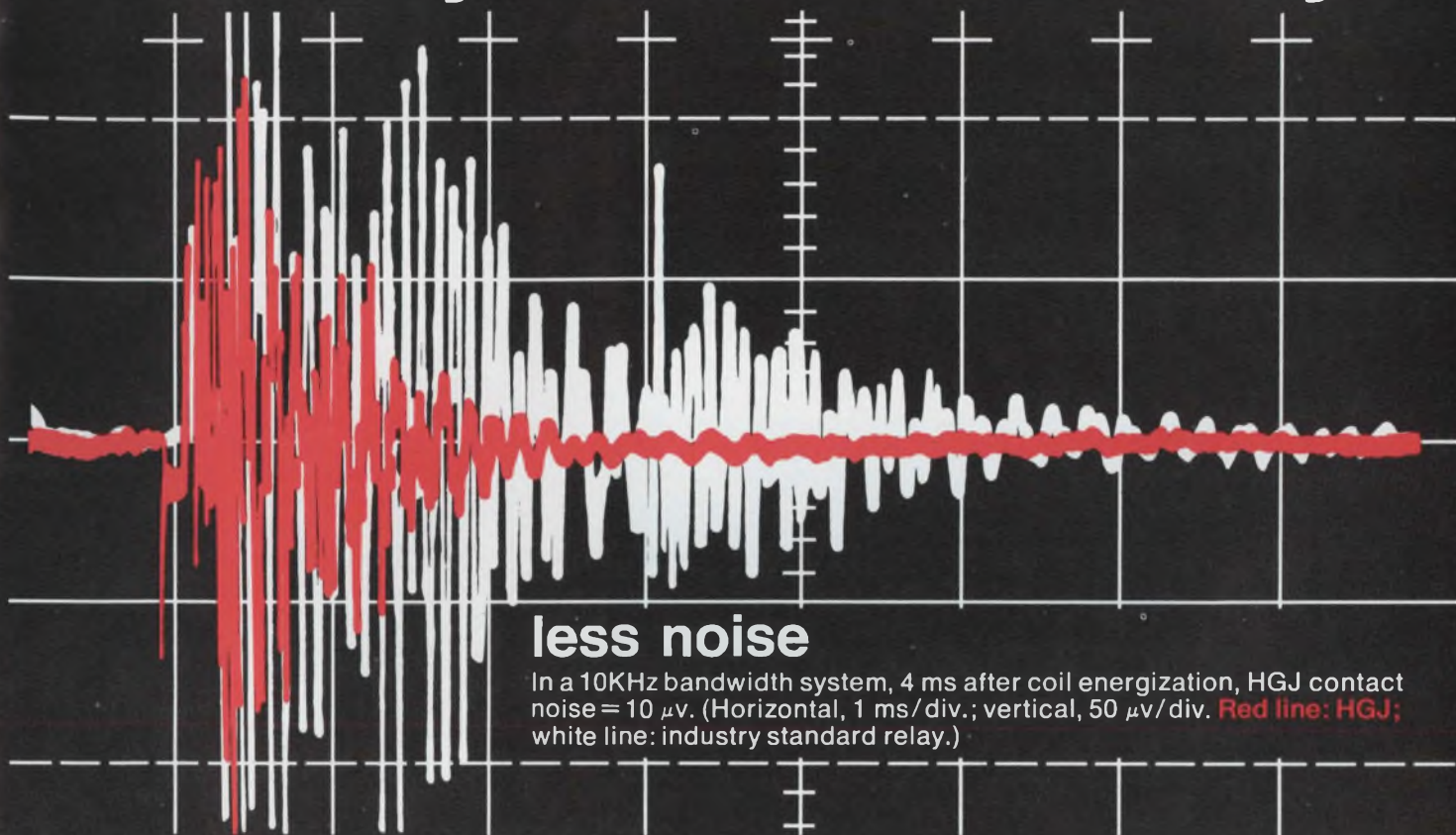
Two new square-button bezel-mounted switches feature a behind-the-panel dimension of less than 2 in. from the mounting surface. The model 46-230 is a momentary-contact unit, while the model 46-430 is an alternate-action (push-on/push-off) one. Both switches offer dpdt (break-before-make) circuits and wiping contacts to maintain a low contact resistance.

Booth No. 2501 Circle No. 263



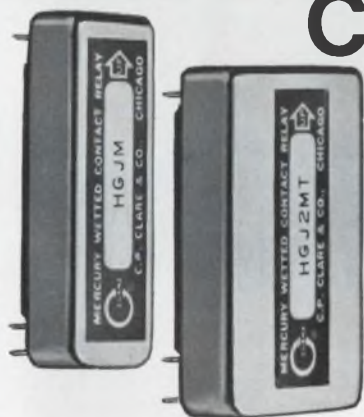
# BREAKTHROUGH

## in mercury wetted contact relays

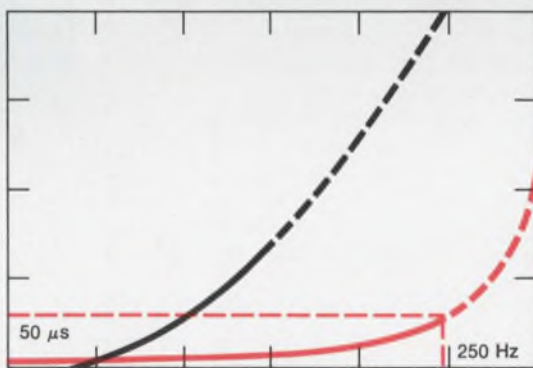


## CLARE HGJ RELAYS

### shatter industry standards



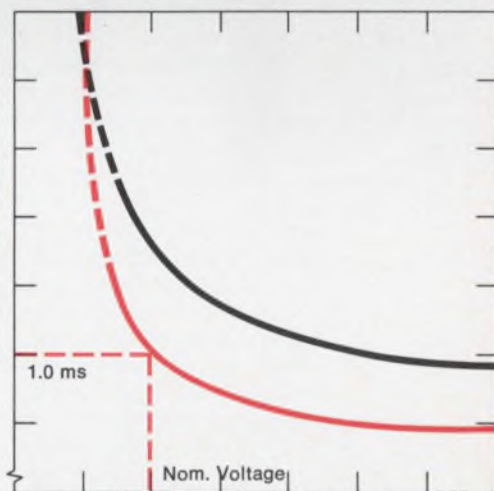
Compare the new Clare HGJ Relays with any other mercury-wetted contact relays. You'll get more speed, less noise, and less jitter — in less space than any other! Take your choice: 0.340" profile for true half-inch pcb spacing, 0.400" profile for higher sensitivity. Single-pole HGJM, two-pole HGJ2MT. Both are capable of switching low level to 2 amp max, 500 v max (100 va max, ac or dc).



### less jitter

At drive frequency of 250 Hz, HGJ jitter =  $50 \mu\text{s}$ .

— HGJ — Industry standard



### faster response

At nominal voltage, HGJ response time = 1 ms.

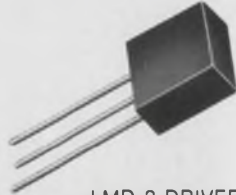
For full information, circle the Reader Service Number.



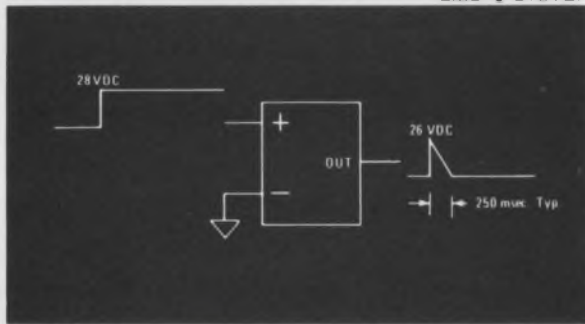
C. P. CLARE & CO.  
Chicago 60645 and worldwide.  
A General Instrument company.

# Fast custom design hybrid microelectronics

... like a 1.5 amp  
pulse differentiator  
driver



LMD-3 DRIVER



Typical Application and Connection Diagram

### Absolute Maximum Ratings

Parameter	Symbol	Value
Maximum input voltage	V+	35 VDC
Maximum output current	I <sub>out</sub>	1.5 Amp
Maximum pulse rate	PRF	2 PPS
Maximum V on drop	V <sub>on</sub>	3 V
Operating temp range	T <sub>o</sub>	0 to +100° C
Storage temp range	T <sub>s</sub>	-55 to +150° C

We designed this hybrid microcircuit to convert a positive step voltage into a differentiated positive output pulse.

It is used as a driver for stepping switches and latching relays to reduce the average power or hold-in current, when driving the units with pulses of long duration.

We're equipped to give you fast design and prototype service on any custom hybrid microelectronics package. Our engineers will come to you, if that's what you need.

You'll find our delivery dependable and our production standards among the highest in the industry.

The circuit described above is now stocked. Ask for catalog sheet. Or, for the whole story on our capability, write for brochure, "Custom Hybrid Microcircuits."

Specialists in hybrid microelectronic circuits



LEDEX MICROELECTRONICS, LEDEX INC.  
123 Webster Street, Dayton, Ohio 45401 phone (513) 222-6992

INFORMATION RETRIEVAL NUMBER 146

## COMPONENTS

### Reed relay stays latched

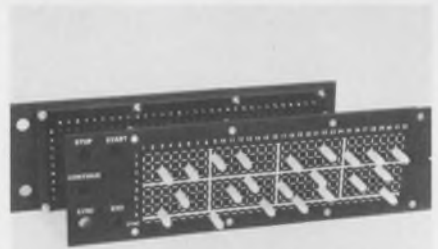


Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. Phone: (312) 282-5500. P&A: \$8.93; stock.

Without using permanent-magnet biasing or standby power, a new magnetic latching reed relay does not change its latched position because of normal vibration or shock, power interruptions or transients. Model 101LMPC has spst contacts rated for 10 V dc at 0.01 A. It operates at coil voltages up to 48 V dc, including low-level IC-compatible voltages.

Booth No. 1216 Circle No. 265

### Matrix program boards highlight versatility



Info-Lite Corp., sub. of Systems & Components, Inc., 2337 Lemoine Ave., Fort Lee, N. J. Phone: (201) 947-6646. P&A: 20¢ per cross-point; 4 to 6 wks.

Offering special crosspoint arrangements and front panels for mounting accessory components, a new line of matrix boards can be programmed with diode pins and can function as programmable word generator memories. Other applications include circuit/component test programmers, communications distributors, logic memories and batching programmers.

Booth No. 1313 Circle No. 258



# 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.

## UNIPULSE LATCH

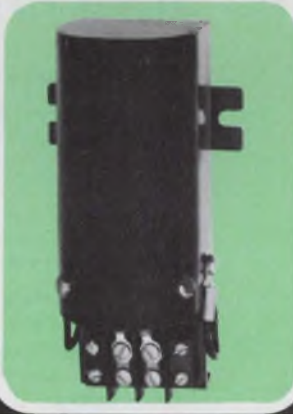
The Unipulse Latch is a solid-state bistable relay of advance design which controls loads in excess of 3 amps (8-200 Volts). Positive input pulses as narrow as 100 usec. to the same terminal will alternately latch the two outputs. Switching rates as high as 2 kHz are attainable, depending on output loading.



The Unipulse Latch is unaffected by shock or vibration and is internally suppressed against voltage transients. Many standard models are available. Unipulse 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.

Stop in at WESCON BOOTH 1707-08.



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1025 North Michigan Street, Elkhart, Indiana 46514

INFORMATION RETRIEVAL NUMBER 147



## This seal is worth money.

You've never seen this symbol before.

But if you're interested in buying interface and memory components for less, yet retaining high quality manufacturing processes, you won't forget it.

This seal is the symbol for Tailored Wafer Fabrication, a unique Qualidyne innovation in semiconductor manufacturing.

This proprietary process makes possible a wafer yield nearly twice the industry average.

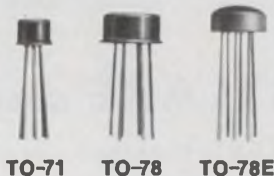
That in itself is only part of the story. Quality hasn't been sacrificed for price. The process lets us produce components of unusually high quality.

Hard to believe? Just for comparison's sake, see if your present dual transistors match these monolithic NPN and PNP specs and prices:

**The NPN-QD-100 Series** (In TO-71, 78, 78 epoxy cans) exhibit DC current gains ( $h_{FE}$ ) of 200 min. from 10  $\mu$ A to 1 mA with the Base-Emitter Voltage ( $V_{BE1}$ - $V_{BE2}$ ) of 5 mV, 3 mV and 1.5 mV. The 100 piece price is \$1.00 to \$3.68, depending upon the package and model you choose.

**The PNP-QD400 Series** (In TO-71, 78, 78 epoxy cans) have DC current gains ( $h_{FE}$ ) of 100 min. from 10  $\mu$ A to 1 mA with Base-Emitter Voltage ( $V_{BE1}$ - $V_{BE2}$ ) of 5 mV, 3 mV and 1.5 mV. The 100 piece price is \$1.10 to \$4.05, depending upon the package and model you choose.

**The NPN 2N Series** in TO-71 and TO-78 cans.  
2N2913-2N2920—General Purpose—\$1.75 to \$5.50  
2N3423-2N3424—High Frequency—\$5.00 to \$7.30  
2N4044-2N4880—Dielectric Isolation—\$3.00 to \$8.00



**Qualidyne  
Corporation**

Demonstration, not conversation, sells Qualidyne TWF components. For information on our line of diode arrays, monolithic duals, linear ICs, drivers/receivers and custom semiconductor memories, contact your Qualidyne representative, or contact us directly.  
Qualidyne Corporation, 3699 Tahoe Way, Santa Clara, Calif. 95051. (408) 738-0120.



**Cassette recorder consumes but 1 W**



*Intermed Corp., 2710 Forest Lane, Dallas, Tex. Phone: (214) 241-6831. P&A: \$3700 to \$5000; 30 to 45 days.*

Contained in a three-pound package, a new battery-operated analog cassette tape recorder provides up to four hours of four-channel dc to 100-Hz data-taking capability while consuming only 1 W of power. Model IMR-14 uses a C-120 type cassette as the recording medium. Tape speed is 15/32 inches per second, and signal noise ratio is 33 dB.

*Booth No. 514      Circle No. 254*

**Data transfer system interfaces instruments**



*Data Graphics Corp., 8402 Speedway Dr., San Antonio, Tex. Phone: (512) 342-9486. P&A: from \$2500; 60 to 90 days.*

Designed to couple various instruments to a remote computer via a time-sharing terminal, the DGC-301 data transfer system accepts BCD data from various instruments, stores the data, decodes it and then presents it to the time-sharing terminal. Input data is accepted in parallel, formatted, and presented sequentially.

*Booth No. 101      Circle No. 291*

**Transduced typewriter boasts \$300 price tag**



*Smith-Corona Marchant, div. of SCM Corp., 3210 Porter Dr., Palo Alto, Calif. Phone: (415) 326-9500. P&A: \$300; October, 1970.*

Selling for approximately \$300, the TMP-250 transduced alphanumeric printer and the RSK-250 keyboard combine to provide typewriter-quality copy at low cost. The keyboard can be mechanically or electrically coupled to the printer to drive the character inputs and auxiliary functions. Coupling selection is dependent on over-all system requirements.

*Booth No. 167      Circle No. 252*

**Desktop calculators have 248 data registers**



*Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. Phone: (617) 851-7311. P&A: \$6700 (A), \$6800 (B); 6 months.*

Narrowing the gap between the calculator and the computer, two new programmable calculators offer a capacity of 1984 program steps or 248 data storage registers. The model 720A and the model 720B are compatible with the peripherals, such as typewriter and plotter units, for the company's earlier 700 series calculators.

*Booth No. 125      Circle No. 255*

**Now the famous 829 has a "G" for good measure!**



**Calibrate or Measure with the**

**RFL Model 829G**

RFL's famous 829, for 15 years the industry calibration standard, now gives way to the new 829G — still the industry calibration standard, but now it's twice as useful. The 829G provides a precision source of AC and DC volts, amps and ohms — plus precision measurements of these parameters from external sources. It offers four-terminal sensing in both source and measurement modes, and high accuracy, resolution and regulation, with 5-digit readout. 5 ranges of AC or DC, 0.1 to 1000V. 6 ranges of current, 100 uA to 10A. 50, 60, 400, 1000 Hz AC plus EXT. And many other features — all for just \$3,350. □ Write for complete data today. RFL Industries, Inc., Instrumentation Div., Boonton, New Jersey 07005. Tel: (201) 334-3100 / TWX: 710-987-8352 / CABLE RADAIRCO, N. J.



**RFL Industries, Inc.**

See us at Booth 456





**call  
us...**

## the answer is yes!

**Yes**, you can get Digital Panel Meters on an **immediate delivery basis** from Datascan. Yes, immediate. We have 3½ digit in stock right now. The 4½ digit is on a two to four week cycle.

**Yes**, you can get the best specified DPM from Datascan . . . with features associated with more expensive DPM's.

**Yes**, you can get the 3½ digit for below \$150 in quantities of 100.

**Yes**, you can get the Bi-Polar 4½ digit for below \$300 in 100 quantities.

**Yes**, you can get A/D converters at prices starting at less than \$115 . . . and get them delivered two to four weeks.

**Yes**, we've tried to anticipate what you want . . . we're engineers too.



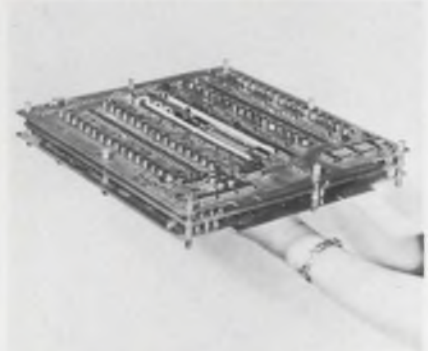
*Write for complete information*

# Datascan

1111 Paulison Avenue, Clifton, N.J. 07013  
Telephone 201-478-2800

## DATA PROCESSING

### Random-access memory cycles fully in 900 ns



*Information Control Corp., 9610 Bellanca Ave., Los Angeles, Calif. Phone: (213) 641-8520. P&A: \$1800 typical; stock.*

The new Comrac 90 random-access core memory for minicomputers and terminals features a full cycle time of 900 ns. The unit's read/restore and clear/write modes are full-cycle operations and are completed in 0.9  $\mu$ s. The basic memory (up to 8k by 9 or 4k by 18) is composed of three boards—a drive board, a data board and a core array.

*Booth No. 150      Circle No. 250*

### Small digital computer solves analog problems



*Ceta Electronics Ltd., 45 Richmond Rd., Poole, Dorset, England.*

A new desktop real-time computer replaces conventional analog and hybrid equipment with an all-digital system. Basically, model 1600 consists of a set of operational units, including integrators, multipliers, iterative logic units and arbitrary function units. These may be interconnected to solve differential equations by means of a removable patchboard.

*Booth No. 502      Circle No. 253*



## 20 MILLIWATTS KEEP YOU IN CONTROL WITH CONTROL-PAK.<sup>TM.</sup>



Solid state control handles up to 25 amps but can be controlled by I.C. logic input . . . without amplification. And it's fast—operates in a millisecond, releases within 1/2 cycle. No noise—electrical or acoustical. Zero switch-line for minimum EMI and RFI. It's completely encapsulated; immune to environment and shock-resistant. Controls all types of loads with reliable, arcless operation. Never needs maintenance. Write for catalog. Hamlin Electronics, Inc., 3066 West Clarendon, Phoenix, Arizona 85017. Or call, 602/277-4834.

**HAMLIN**  
ELECTRONICS, INC.

INFORMATION RETRIEVAL NUMBER 151

## REED SWITCH SPEEDS WITH NO CONTACT BOUNCE.



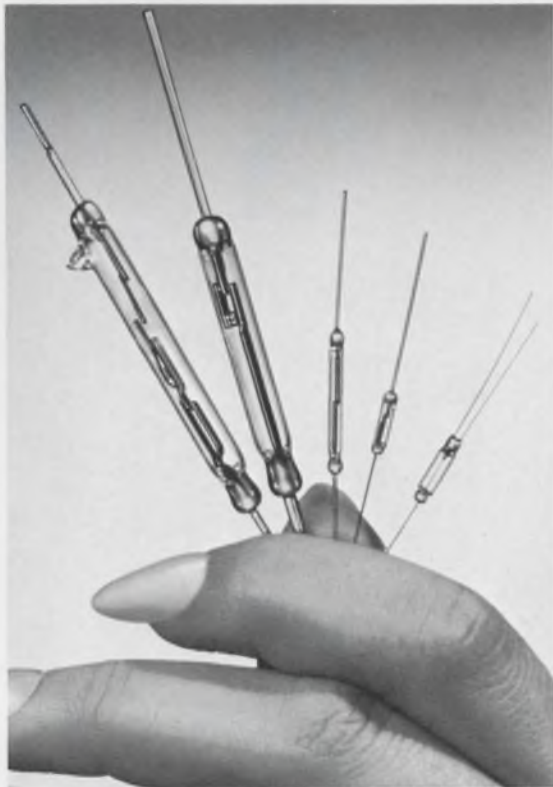
1/4 actual size.

Hamlin's miniature, mercury-wetted switches offer all the advantages of high-speed, reed switches with the low contact resistance and high-power capacities of mercury switches. Precise, "on-off" actuation makes mercury-wetted switches ideal for applications where contact bounce cannot be tolerated. Available in form A (100 VDC) and form C (28 VDC). Useable length as low as .835" Write for catalog. Hamlin, Inc., Lake Mills, Wis. 53551. Or call 414/648-2361.

**HAMLIN**  
INCORPORATED

INFORMATION RETRIEVAL NUMBER 152

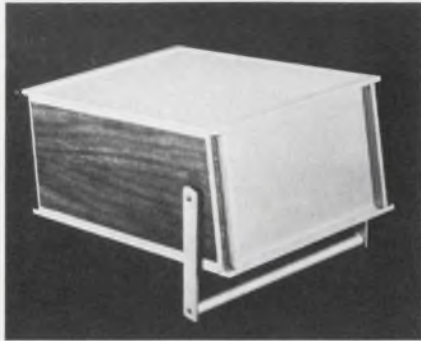
## YOU PAY FOR RELIABILITY IN HAMLIN REED SWITCHES. JUST ONCE.



The cost difference between a Hamlin reed switch and another of comparable rating is pennies—sometimes just mills. And it pays off. A switch failure may go unnoticed until it's too late. Then the cost of a malfunction is probably hundreds of times the cost of Hamlin reliability. Rhodium contacts, for example, precision assembly in white room conditions, the industry's most effective hermetic seal, rigid electrical inspection on a 100% basis—these are the things that will make you glad you specified Hamlin reed switches, even after 50 million safe, dependable closures. And you can choose from nearly 2,000 models, from 660 watt capacity down to a 3/10 watt, "grain of wheat" size. You get Hamlin reliability in every one and you pay for it only once. Write for free evaluation samples and catalog. Hamlin, Inc., Lake Mills, Wisconsin 53551. Or call 414/648-2361.

**HAMLIN**  
INCORPORATED

### Portable cabinets enhance designs

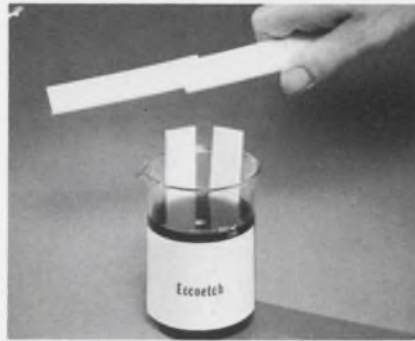


Techmar Corp., 2232 S. Cotner Ave., Los Angeles, Calif. Phone: (213) 478-0046. P&A: \$81.37 to \$105.97; stock.

In addition to their smart appearance, Omniclosure portable instrument cabinets have internally grooved sides to accept printed circuit boards and component mounting plates. Eighteen sizes are available with heights of 3-1/2 or 5-1/4 in., widths of 8-1/2, 12-3/4 or 17 in., and depths of 5, 8, or 12 in.

Booth No. 3017 Circle No. 282

### Fast etching fluid makes Teflon bondable



Emerson & Cuming, Inc., Dielectric Materials Div., Canton, Mass. Phone: (617) 828-3300. Price: \$12/pint.

Eccoetch etching fluid makes it possible to bond fluorocarbon plastics, like Teflon, together or to other materials with the same ease and with the same bonding agents as other plastics. When dipped into Eccoetch for 5 to 10 seconds, the exposed fluorocarbon surface displays a uniform light brown color. Eccoetch is dark blue-green.

Booth No. 368 Circle No. 280

### Aerosol cleaner leaves no residue



LPS Research Laboratories, Inc., P. O. Box 25964, Los Angeles, Calif. Phone: (213) 478-0095.

Intended for use on precision electrical and electromechanical equipment, a new aerosol contact cleaner is a non-toxic, non-conductive, fluorocarbon solvent that leaves no residue. It is said to quickly remove oil, grease and other organic matter from precision instruments and controls with no adverse effect on the article being cleaned.

Booth No. 2208 Circle No. 281

## Ultra critical uses?

Model	Resistance Range	Power Rating @ 70°C	*Max. Oper. Volts	Length Inches	Diameter Inches
<b>MOX-2</b>					
MOX-400	1 - 2500 megohms	.25W	1,000V	.420 ± .050	.130 ± .010
MOX-750	1 - 5000 megohms	.50W	2,000V	.790 ± .050	.130 ± .010
MOX-1125	1 - 10000 megohms	1.00W	5,000V	1.175 ± .060	.130 ± .010
MOX-1	10K - 500 megohms	2.50W	7,500V	1.062 ± .060	.284 ± .010
MOX-2	20K - 1000 megohms	5.00W	15,000V	2.062 ± .060	.284 ± .010
MOX-3	30K - 1500 megohms	7.50W	22,500V	3.062 ± .060	.284 ± .010
MOX-4	40K - 2000 megohms	10.00W	30,000V	4.062 ± .060	.284 ± .010
MOX-5	50K - 2500 megohms	12.50W	37,500V	5.062 ± .060	.284 ± .010

\*Applicable above critical resistance. Maximum operating temperature, 220°C. Encapsulation: Si Conformal.

## Mastermox Resistors are still the best answer.

10K ohms to 10,000 Megohms Resistance

Mastermox resistors bring new accuracy to ultra-precision applications. Advanced metal oxide glaze construction. More watts per cubic inch means twice the performance in equivalent space. Stable? To new limits! Use Mastermox resistors to obtain new performance highs.

Send for Mastermox brochure.

DMA 536

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EUROPE: ANNALDE HOUSE, THE PRECINCT, EGHAM, SURREY, ENGLAND • TEL: EGHAM 4887



## Positive Control... At your finger tip!

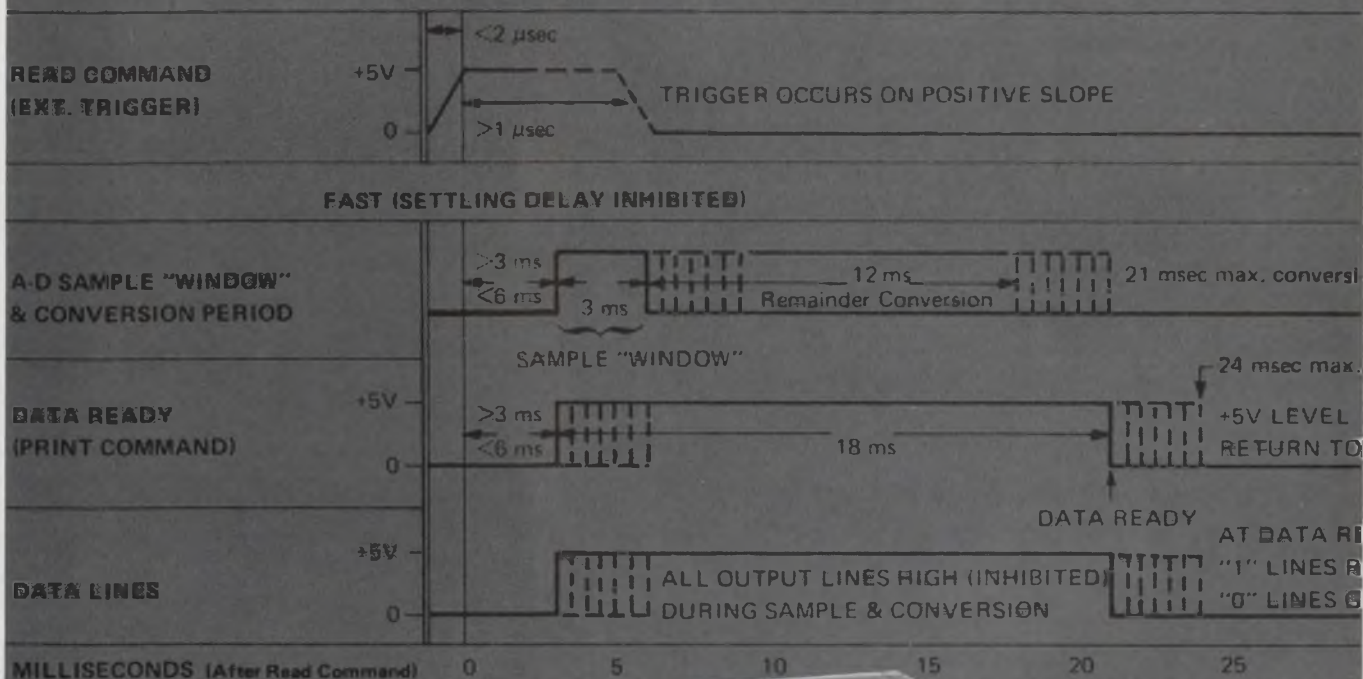
Janco's new Bi-Directional Push-Button Rotary Switch makes switching applications easy for you... with positive control at your finger tip. And what control! Eight, ten, or twelve individual circuits. Or do you require more? If so, let's gang two, three, four or more switches together. **NOW THAT'S CONTROL!**

## JANCO CORPORATION

3111 Winona Ave., Burbank, Calif. 91504  
Phone 213-845-7473 • TWX 910-498-2701



## DATA OUTPUT TIMING DIAGRAMS



# The DVM to beat the system!

Here are 10 reasons why Fluke's 8300A is easy to use, easy to interface, and easy to program. 10 reasons why it's *the* systems digital voltmeter.

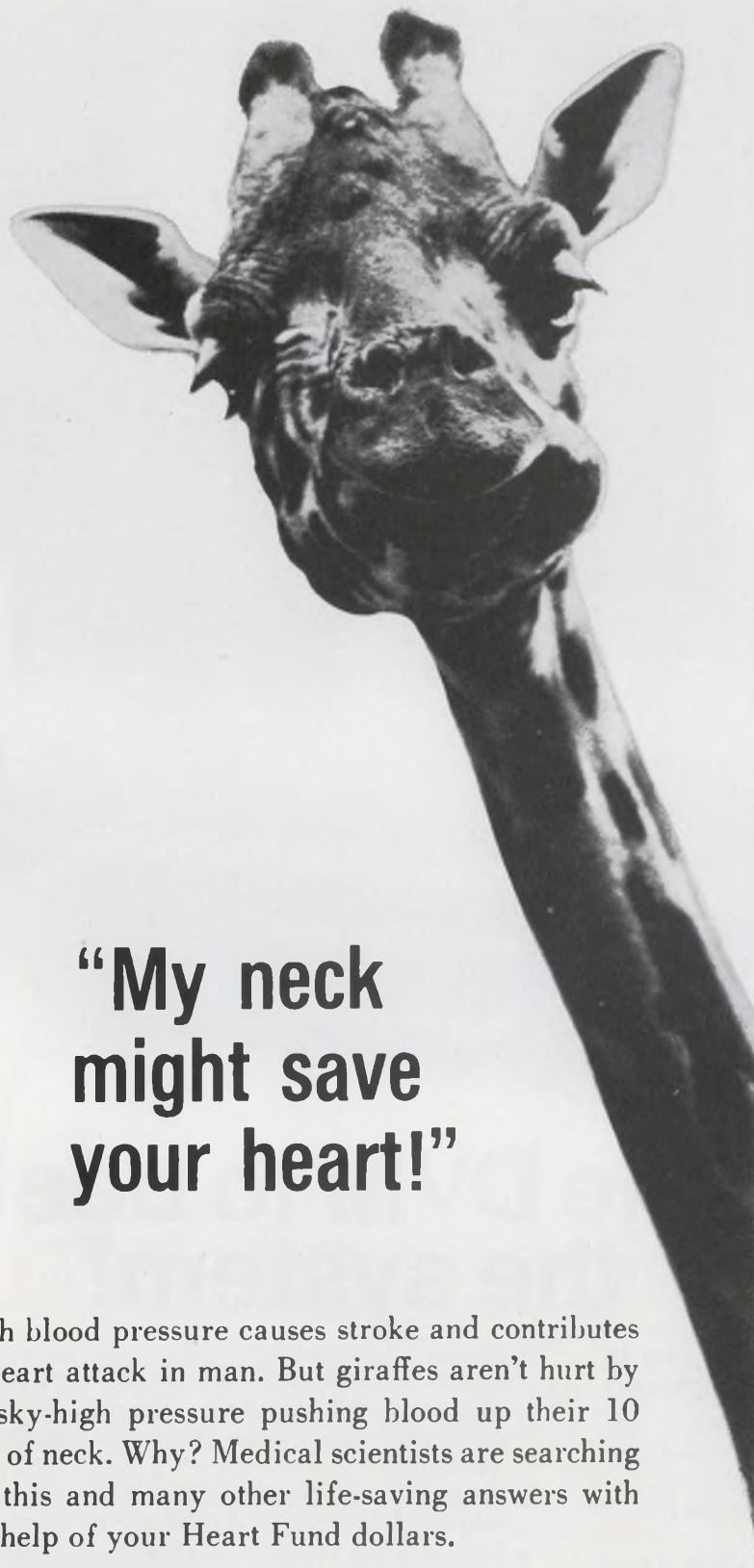
1. We blank the data output during conversion and time out to keep random signals out of the system.
2. A "device busy"/"ready" flag inhibits acquisition of readout until data is ready.
3. Programmable, on-call time-outs allow settling of analog options and auto-ranging, then call up a final conversion which is the only reading presented.
4. An automatic overload flag acts independently of the system.

5. Data may be acquired serially so that you can interface directly with an 8, 12 or 16 bit computer.
6. Because the DVM can take large overloads, problems caused by switch timing and large transients are eliminated.
7. Signal input is completely isolated from data out and remote control circuits without use of relays.
8. Fully guarded "box in box" construction gives you totally uncompromised input isolation.
9. DTL-TTL compatibility.
10. High accuracy/low price...0.005% with prices from \$1395.



Fluke, Box 7428, Seattle, Washington 98133. Phone: (206) 774-2211. TWX: 910-449-2850/  
 In Europe, address Fluke Nederland (N.V.), P. O. Box 5053, Tilburg, Holland.  
 Phone: (04250) 70130. Telex: 884-50237/ In the U. K., address Fluke International Corp.,  
 Garnett Close, Watford, WD2 4TT. Phone: Watford, 27769. Telex: 934583.

INFORMATION RETRIEVAL NUMBER 156



**“My neck  
might save  
your heart!”**

High blood pressure causes stroke and contributes to heart attack in man. But giraffes aren't hurt by the sky-high pressure pushing blood up their 10 feet of neck. Why? Medical scientists are searching for this and many other life-saving answers with the help of your Heart Fund dollars.

**GIVE...**  
so more will live  
**HEART FUND**

*Photo courtesy World Health Organization*



## TOOLS & ENGINEERING AIDS

### Pop-up DIP extractor simplifies desoldering



*Ungar, div. of Eldon Industries, Inc., 233 E. Manville, Compton, Calif., Phone: (213) 774-5950. Availability: stock.*

Two new desoldering products make the removal of up-to-16-pin DIPs easier and safer for circuit boards and for the components themselves. The 6982 pop-up extractor teams up with the 6948 desoldering bar to automatically remove DIPs from the board at the precise moment of solder melt. The new slotted bar applies heat simultaneously to both sides of each DIP lead.

*Booth No. 2225 Circle No. 251*

### Wafer probing station controls temperature

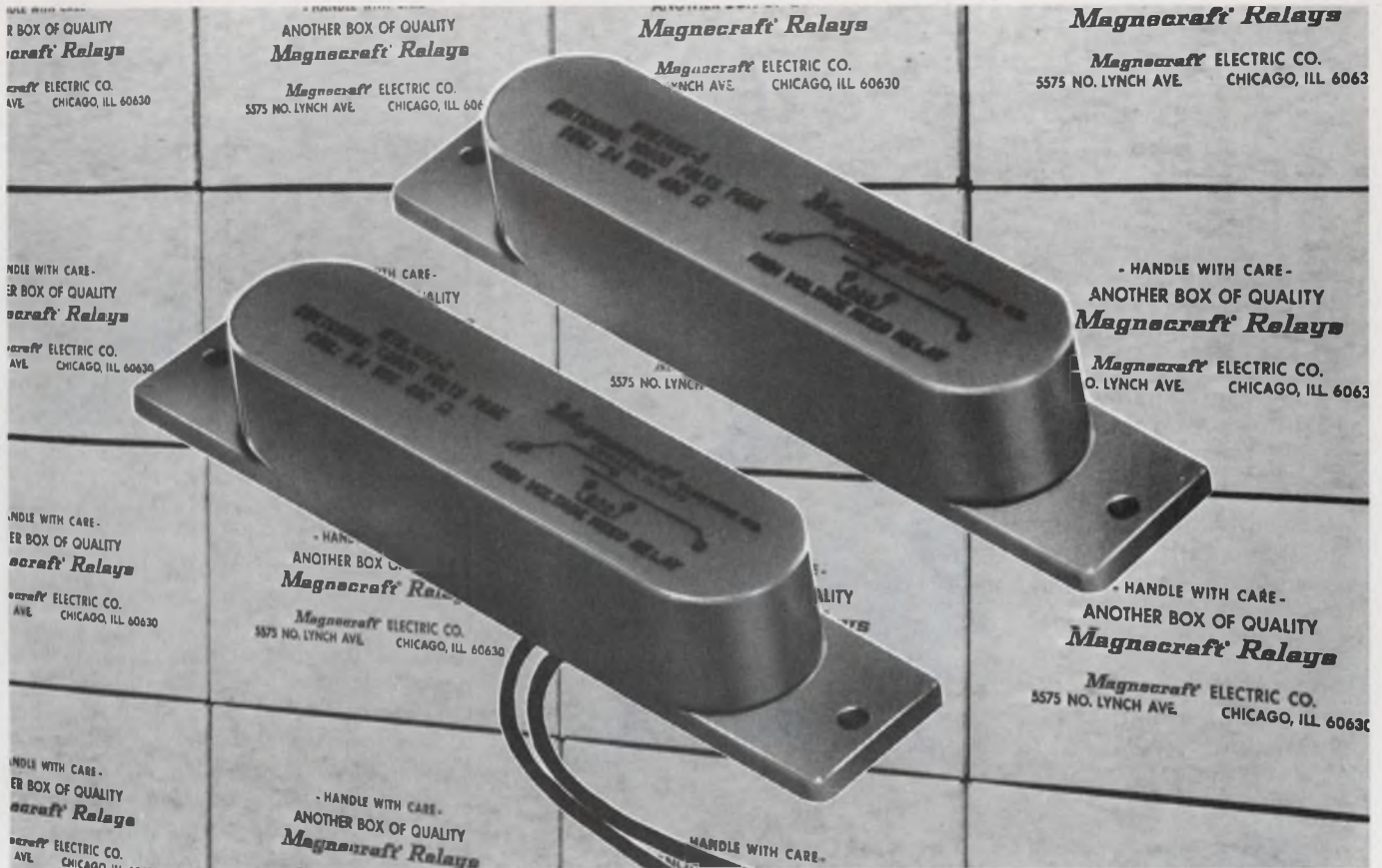


*EG&G, Inc., 160 Brookline Ave., Boston, Mass. Phone: (617) 267-9700.*

Thermochuck series TP3000 wafer probers feature temperature-controlled vacuum chucks, which can be preset anywhere within the range of  $-30$  to  $+180^{\circ}\text{C}$ . This means that many poor circuits can be eliminated in the wafer stage, while their cost is only 5% of the final value of a finished product. The prober is also useful for failure analysis work on integrated circuits and hybrid circuits with the case open.

*Booth No. 374 Circle No. 285*





Shown actual size — Available for off-the-shelf delivery.

**Magnecraft achieves a breakthrough  
in reed relay technology...  
NOW...20,000 VOLT SWITCHING!**

The Class 102HV, 10,000 volt relay and the Class 102UHV, 20,000 volt relay are natural additions to the growing line of Magnecraft's high voltage reed relays.

To assure 1 million operations at rated load and longer life at reduced loads, these relays incorporate contacts of a special material plus the inherent reliability of a reed relay. Standard operating coil voltages are 6, 12 and 24 VDC.

Safety for the user and maximum dielectric strength are provided through the uniquely designed insulation system, offering insulation resistance in the range of  $10^{10}$  megohms.

For immediate off-the-shelf delivery, these relays are stocked in depth by Magnecraft and its nationwide network of distributors. The 10,000 volt, Class 102HV is priced as low as \$19.88 in single quantity and even lower in larger quantities.

To get all the facts on these relays and our full line of 512 stock relays, contact your local Magnecraft distributor or send for Stock Catalog No. 272.

© Magnecraft Electric Co., 1970

See our product data in EEM

**Magnecraft<sup>®</sup> ELECTRIC CO.**

5575 NORTH LYNCH AVENUE • CHICAGO, ILLINOIS 60630 • 312 282-5500 • TWX-910-221-5221

See us in Booth #1216 at WESCON

INFORMATION RETRIEVAL NUMBER 158

# Face up to the flat one!

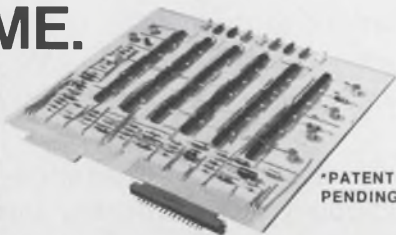
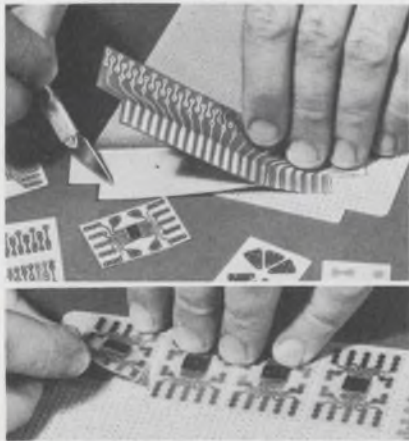
The inherent advantages of Zenith Flat-Face CRTs assure the brightest, clearest display of alpha-numeric and analog data. Parallax errors are minimized. Provides resolution as high as 2500 TV lines. Design variations include single and dual neck configurations. Optional rear projection ports and laminated implosion shields. For details, write or call (312) 674-8000.



**ZENITH RADIO CORPORATION**  
THE RAULAND DIVISION  
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INFORMATION RETRIEVAL NUMBER 159

## AN INSTANT CIRCUIT BOARD SYSTEM\* THAT WILL SAVE YOU MONTHS OF SCHEDULE TIME.



From schematic drawings to card cage systems — IN ONE STEP!

**ELIMINATES:**  
DESIGN • DRILLING • ART WORK • PHOTO WORK & ETCHING

All types of circuit-element configurations may be mixed and combined on the same board.

**SEND FOR YOUR FREE CATALOG AND SAMPLES**

# circuit-stik<sup>INC.</sup>

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SEE THIS NEW PRODUCT AT THE WESCON SHOW, AUG. 25-28, BOOTH #3129

INFORMATION RETRIEVAL NUMBER 160

## TOOLS & ENGINEERING AIDS

### Measuring system reads out digitally



*Ideal Aerosmith, Inc., 1505 E. Fox Farm Rd., Cheyenne, Wyo. Phone: (307) 634-7714.*

Digitally displaying the dimensional settings of manufacturing and testing equipment, the Koder II digital measuring system offers accuracies of  $\pm 0.0005$  in. for any 20 in. of travel or  $\pm 0.001$  in. over the full range of 100 in. The system may be installed on existing equipment with relative ease since no critical alignment is required. It has an electronic digital readout. *Booth No. 501 Circle No. 284*

### Ultrasonic bonder uses photocells



*GTI Corp., Dix Engineering Div., 1399 Logan Ave., Costa Mesa, Calif. Phone: (714) 546-0411. Availability: 6 to 8 wks.*

The model 2000 Bondsonic ultrasonic wire bonder features photocell switching, thereby eliminating four cams and all electrical and mechanical switches—a probable major cause of malfunction in conventional bonders. The unit carries a five-year warranty on its power supply and transducer. It is equipped with a 45-degree microscope.

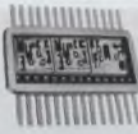
*Booth No. 2026 Circle No. 283*



# We'll hybrid thick-film your circuit in our new $\frac{1}{4}$ " x $\frac{3}{4}$ " flat pack, and get you into some tight spots.

Getting you into tight spots is one way of getting you out of them. For now you can design your circuit confident that everything will fit. And we can produce that custom circuit flawlessly.

Our exclusive  $\frac{1}{4}$ " x  $\frac{3}{4}$ "



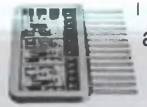
T3 configuration enables you to do just about anything with the available area. First, because of its unique dimensions. Also,

because it comes in 3 basic variations. With all 14 leads coming out of one side, it can lay flat or stand. It is also available with leads on both sides. Or, in a dual in-line configuration. Name it. You've got it. Just about.

But we've got more than just a nice new shape for you. We have the facilities to produce prototypes or

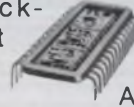
large quantities fast. In a high reliability environment.

Our people, materials and equipment conform to the highest standards. For instance, we test, check and control every Std-883. We test, check and control every component and component room production atmosphere.



What's more, if you need it, we'll help you solve your design problems.

We can produce your design in our  $\frac{1}{4}$ " x  $\frac{3}{4}$ " hybrid thick-film flat packs now. Find out how it can fit into your plans. Write or call.



Columbia Components Corporation  
Madison Avenue, Hempstead, New York  
11550 (516) 483-8200. On the West Coast: (415) 272-9525.



**COLUMBIA COMPONENTS CORP.**

A SUBSIDIARY OF COMPUTER INSTRUMENTS CORP.

## Two-input counter spans dc to 3 GHz



Systron-Donner Corp., Concord Div., 888 Galindo St., Concord, Calif. Phone: (415) 682-6161. Price: \$2295.

Covering the frequency range from dc to 3 GHz, a new microwave counter offers remote programmability plus a BCD recorder output. Model 6053 is a seven-digit instrument, which receives its input on one of two channels—either 20 Hz to 200 MHz or 200 MHz to 3 GHz. Its sensitivity is 10 mV rms for the low input and 100 mV rms for the high input.

Booth No. 521 Circle No. 276

## Solid-state VCOs put out 150 mW



Texscan Corp., 2446 N. Shadeland Ave., Indianapolis, Ind. Phone: (317) 357-8781. P&A: \$600; 3 to 4 wks.

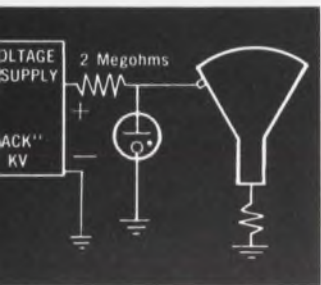
Series VTO solid-state voltage-tuned microwave oscillators deliver power outputs of 20 to 150 mW over the frequency range of 1 to 6.6 GHz. Their harmonic distortion content is guaranteed to be more than 25 dB from rated output. Input requirements are a bias supply of -24 V at 150 mA and a tuning voltage of 0 to -65 V dc.

Booth No. 517 Circle No. 278

...ering, Gaithers-  
...: (301) 948-3434.  
...5 miniature power  
...the dc to 18-GHz  
...ge and provides a  
...nt power division of  
...its full band. The  
...power rating is 1 W  
...s are matched and are  
...eable for use as input  
...s. Maximum VSWR is  
...n dc to 10 GHz and 1.35  
...to 18 GHz. The new power  
...is a 50-Ω coaxial device  
...No. 305 Circle No. 277

## Circuitry Breakthrough!

### One Victoreen Corotron Acts As 200-Zener Equivalent Regulator



In this circuit example, a Corotron M42D-9.7 (9,700 volts) regulates a high voltage power supply for a computer data display system cathode ray tube. The Corotron provides reliable line and load regulation, and clarity of the CRT display.

Using one Victoreen Corotron is like gaining the equivalent performance of hundreds of zener diodes. "failsafe" reference voltage in 400 to 25,000 volt range. This circuitry to hold constant high voltage. Operating -65°C to 200°C. Shock resistant to 2000G. Easy to fit into circuits. Important size, weight, and cost savings. See Design Manual or call.

#### Free Design Manual

40-page manual contains specs and design data for circuit engineers. Request Corotron Manual.

VICTOREEN INSTRUMENT DIV. of VLN  
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DMA 554



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AS \$1.85



Model E2B7

Economy of this 7-digit device makes it ideal as a warranty counter where use is more critical than time. Stationary zero seventh digit is compensated by 10-1 internal reduction. Ten impulses automatically accumulate before indicating change of 10 counts.

Figures: 7-digits, black on white.  
Voltages: Wide choice of AC or DC. (6 watts AC, 3 watts DC.)

Drive: Patented reciprocating Delrin verge.

Speed: 600 cpm standard.

Mounting: Base or panel mount.

Size: 1.7" W x 1.2" H x 2.3" D.

Recognition: Meets U.L. standards.

Price: \$1.85 in OEM quantities.

Covered by Patent No. 3470361

Phone or write for details. Application help available.



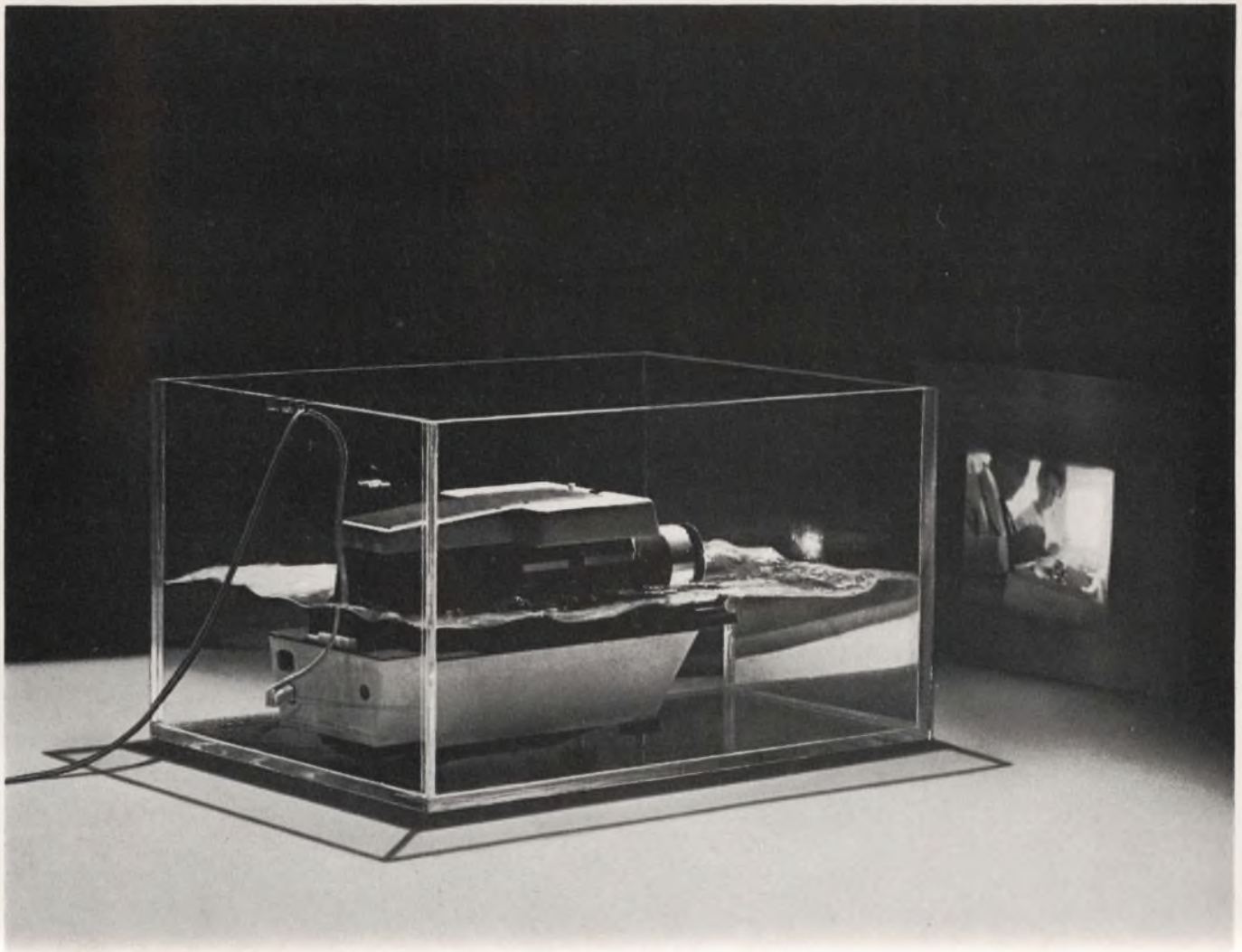
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## Our dry test bath results are completely projectionable.

If ever there was a dry liquid . . . this is it. Stick your hand in, it comes out dry. Not moist but totally dry.

Stick a microelectronic circuit in it and you find out immediately whether it leaks or has other flaws . . . and it comes out dry. Ready to use or ship.

Fluorinert® Brand Electronic Liquids are a whole new generation of testing agents for temperature and gross leak evaluations for all manner of electronic miniature devices.

Wide temperature variations don't affect their performance. They have unique dielectric properties. They don't react with even

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Send the coupon for the whole story. 3M Company, Chemical Division, 3M Center, St. Paul, Minnesota 55101.

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St. Paul, Minn. 55101

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Send me all the details about Fluorinert Brand Electronic Liquids.

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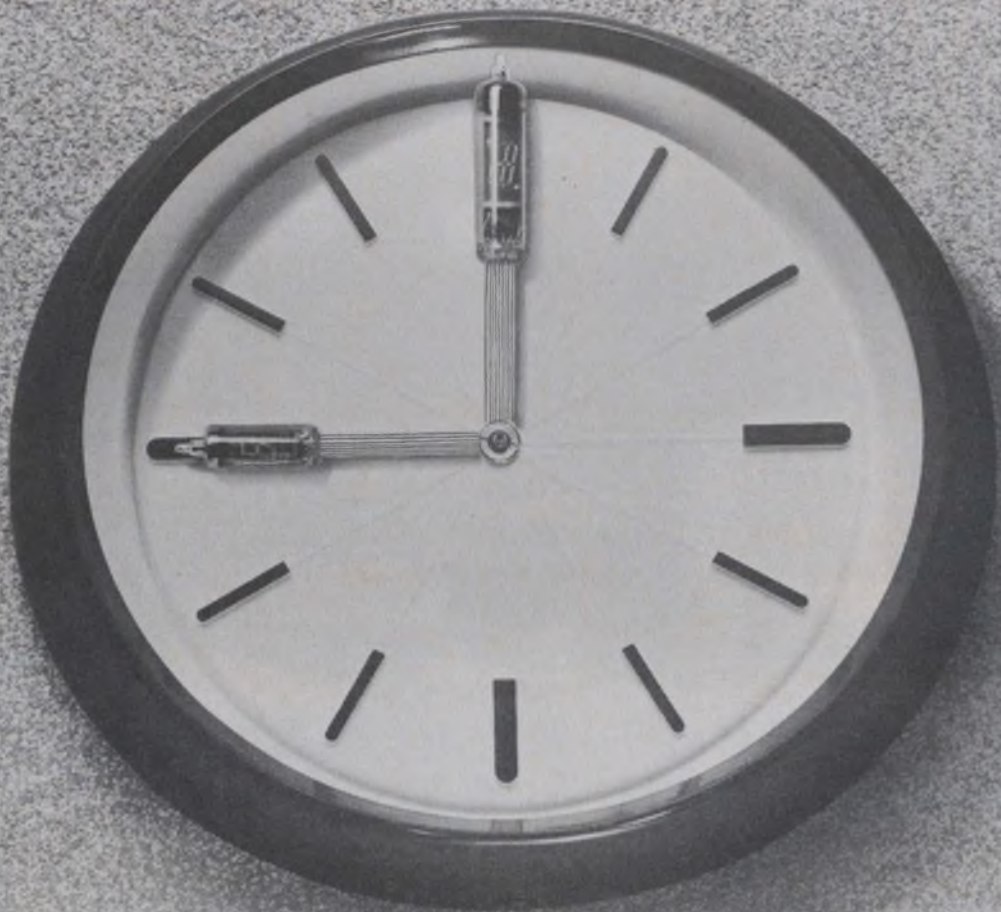
Company \_\_\_\_\_ Title \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

INFORMATION RETRIEVAL NUMBER 164





## IT'S TIME... TO SEE THINGS IN A NEW LIGHT

When multi-faceted display problems dictate 9 to 9 work days, it's high time you saw things in a new light, on a single plane with no "dancing" digits and with no eye strain.

Legi DG 12C numerical indicator tube segments are an eye-easy phosphor green for a readout as bright and clear as day, legible at distances over 35 feet.

These tubes offer low-voltage, low current drain, and high stability advantages so definitive and pack a performance punch so large, you can't afford not to afford to examine full particulars. They fit to the "T" perfectly portable and circuit-board mounting applications and are available at mass production prices. Look at these important particulars, then write for comprehensive data

that show display tube performance in an entirely new light:

### LEGI DG 12C

- Filament voltage at 95mA ..... 0.85 volts  $\pm$  10%
- Phosphor segments & control grid ..... 20Vdc
- Brightness ..... 80 foot-lamberts
- Operating temperature .....  $-10^{\circ}$  to  $+70^{\circ}$  C
- \* Dynamic life expectancy ..... 200,000 hrs.

U.S. PATENT 3508101

*Legi* Sole U.S. Distributor:

### Legi Electronics Corporation

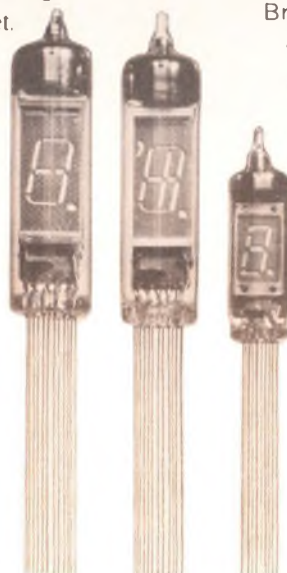
3118 West Jefferson Blvd. Los Angeles, California 90018 U.S.A.  
Phone: RE 3-4508, 733-9105



Manufacturer:

### Ise Electronics Corporation

P.O. Box 46, Ise City Mie Pref., Japan Phone: Mie (059627)-26



DG 12H

DG 10A

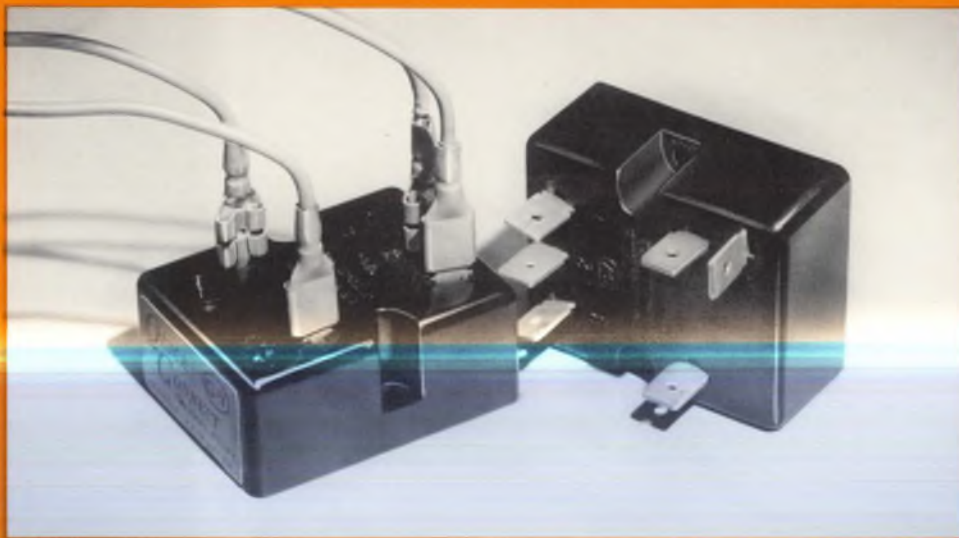
INFORMATION RETRIEVAL NUMBER 165





AVAILABLE AT:  
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 or use the convenient  
 Business Reply Card . . .

*Free Samples of G-V* AIR FLOW  
 SENSING SWITCHES and QUICK CONNECT RELAYS



**one  
 sample  
 is worth a  
 thousand  
 words!**

Here are two outstanding G-V components that you must evaluate for yourself. That's why G-V is making this FREE SAMPLE offer. We will have your sample delivered by a G-V Application Engineer, who is always ready to assist you and your design group.

**AIR FLOW SENSING SWITCHES**  
 . . . constantly monitor the presence of air flow. The G-V Air Flow Sensing Switch operates an alarm or automatic shut-down if the air flow drops below a safe level. It utilizes a thermal principle and operates in any plane. A military version (Type LS) is also available.

**QUICK CONNECT INDUSTRIAL TIMING RELAY . . . features low cost, fast installation:** The G-V Q.C. thermal timing relay is designed for industrial use. Push-on terminals reduce installation time and cost. Only two mounting screws are required and they can be mounted in any position. An Instant Reset Version (Series EM) is also available.

**For Your Free Sample . . .** Complete this convenient Reply Card . . . See us at Wescon . . . or contact your nearest G-V representative or the G-V Sales Department, Okner Parkway, Livingston, N. J. 07039.

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# AIR FLOW SENSING SWITCH

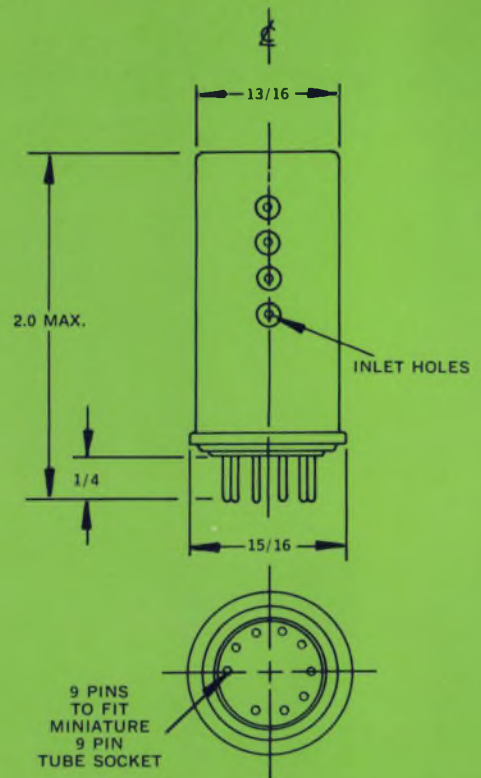
G-V Air Flow Switches, operate at rated voltage, distinguish between normal air flow of any velocity above 300 Feet per minute (about 4 miles per hour) and the cessation of that normal flow.

## Type FS GENERAL PURPOSE

<b>Voltage:</b> .....	115 AC or DC
<b>Power:</b> .....	2.5 Watts
<b>Contact Rating:</b> .....	2 amps resistive @ 115 VAC 1 amp resistive @ 28 VDC
<b>Contact Configuration:</b> .....	N.C.
<b>Useable Voltage Variation:</b> .....	± 10% of nominal
<b>Standard Air Velocity Setting:</b> .....	300 ft. per min. (4 mph)
<b>Response Time:</b> .....	1 to 40 seconds
<b>Temperature Range:</b> .....	0 to 80°C
<b>Mounting:</b> .....	Standard 9 pin miniature tube socket

(The above version is supplied as a free sample. For an Air Flow Switch with other ratings or the LS Military version, see your G-V representative.)

**NOTE:** Other voltages and contact configurations available. For Specs. covering the complete line of G-V Air Flow Sensing Switches, request Publication #70-1.

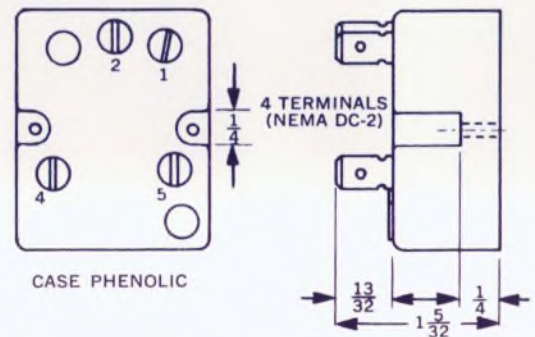


# QUICK CONNECT INDUSTRIAL THERMAL TIMING RELAYS

## Series ET STANDARD TIME DELAY

<b>Contact Rating:</b> .....	2 amps resistive @ 115 V A.C. 1 amp resistive @ 28 V D.C.
<b>Heater Voltage:</b> .....	6.3, 26 or 115 A.C. or D.C.
<b>Heater Power:</b> .....	2.5 watts nominal
<b>Time Delays:</b> .....	2 to 180 seconds in 14 individual ranges
<b>Ambient Temperature:</b> .....	0°C to 80°C
<b>Electrical Connections:</b> .....	4 Push-On 1/4" tinned brass terminals (NEMA DC-2)
<b>Time Delay Tolerance:</b> .....	± 20%

(115 V, 60 second version supplied as free sample. For a Quick Connect Relay with other ratings, see your G-V representative.)



**NOTE:** For detailed specification on all of the G-V Quick Connect Industrial Thermal Timing Relays, request Publication #130-3.

The FS Air Flow Sensing Switches and the ET Quick Connect Thermal Timing Relays are Recognized Under The Components Program Of Underwriter's Laboratories, Inc.

Please have a G-V Application Engineer deliver the following Free Samples:

- G-V Air Flow Sensing Switch       G-V Quick Connect Timing Relay

Application/Design Problem \_\_\_\_\_

I need a unit with ratings different than offered as a free sample. Please have a G-V Application Engineer contact me.

Send following detailed data sheets so that I can better evaluate which unit I need.

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## EDITORIAL



## U.S. scientific leadership threatened by R&D cuts

"Our national apparatus for the conduct of research and scholarship is falling into a shambles . . . the American lead in science is in jeopardy—boding ill both for national security and the American economy."—*Dr. Philip Handler, president of the National Academy of Sciences.*

"Cutbacks in federal support of research and development may cost the U. S. its future leadership in advanced electronics."—*Dr. Harvey Brooks, dean of engineering and applied physics at Harvard University.*

"We have lost already—in three of four important fields—the technological leadership of the world, and in 10 years we will have lost more."—*Frederick R. Eirich, dean of research, Polytechnic Institute of Brooklyn.*

These are just a few of the views expressed recently by leading educators and researchers on the effect of cutbacks in federally supported research and development (see p. 24). Though there was a divergence of opinion, reactions tended to be pessimistic—especially on the long-term effects of R&D cutbacks on technological innovation and leadership in the U. S.

What will these cutbacks mean to the electronics industry?

Probably the most serious consequence will be our inability to compete internationally in new technologies. As Eirich notes, the United States has been leading the world in computers, radio astronomy, supersonic flight and electron microscopy. Japan, Germany, Russia and France are becoming a serious threat in these areas, he comments. "The best computer facilities in a few years will probably be in England. The best electron microscope is not being built here, but in France," says Eirich. Little need be said about the soaring electronics industry in Japan. As one observer noted: "It's not just the cost of labor, it's the fact that they are using more advanced technology in their manufacturing."

Another effect is that, with less federal support of graduate research fellowships, the reservoir of trained engineers coming off the nation's campuses will be seriously reduced, four, five and six years from now.

This year's budget for federal R&D support will amount to about \$1.4-billion. For 1971 this figure is expected to increase by about \$120-million. The increase will be applied to solve social problems rather than to further basic engineering and scientific research.

We are seeking solutions to our ecological and urban problems, but seemingly at the expense of technological research. More money should be spent to help solve the nation's ills and to further basic research. Both are important for the nation's progress. The R&D figure amounts to less than 1% of the total federal budget this year.

Surely we can afford to spend more in an area so important to our technological leadership and growth.

RALPH DOBRINER



# Simplify random-access memory selection

by following these guidelines. Some of the basic aspects of the evaluation process are also revealed.

Monolithic random-access memory (RAM) devices offer new approaches for implementing read/write digital memories, but their use is sometimes overlooked because the design engineer lacks a general knowledge of their operation.

Basically, the RAM is a group of latches or storage flip-flops that store binary data in a digital system when the system is not using that data. Information can be randomly written into or read out of each flip-flop as required, hence the name "random-access" read/write memory. These are also called scratch-pad memories because they are often used for temporary, fast input/output time storage.

Once it has been determined that a random access memory can be used in a particular application, selection of the proper device may be greatly simplified by following the guidelines presented here.

## How the RAM operates

To understand the operation of a RAM, examine the one-bit memory shown in Fig. 1. The one-bit memory is a latch with data input and output lines enabled by the address and write enable lines. The address line must be energized to write data into or read data out of the latch. The write operation is performed only when the write enable is also energized.

This type of addressing, where each bit (or word) has its own address line, is called linear selection.

Another commonly used type of addressing is known as coincident selection. Here the bit is selected by the intersection of an X and a Y line that locates a point in a two-dimensional matrix. The type of on-chip selection used depends upon the manufacturer and the memory configuration.

## Determine word size and configuration

The first step in selecting a random-access memory is defining word length and memory size.

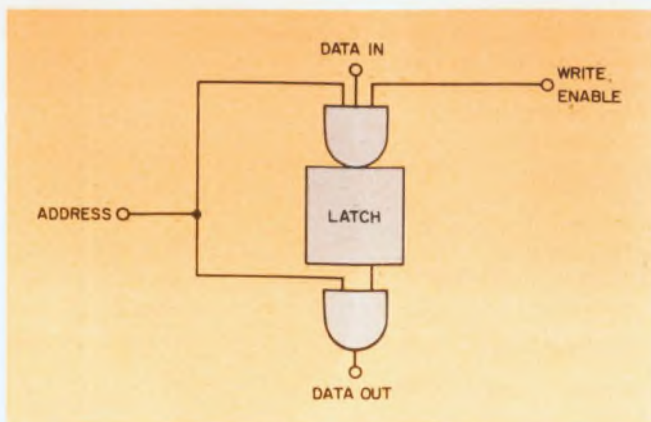
The number of words and the number of bits per word are entirely dependent on the system application. This also sets the upper limit on the size of a RAM configured from a single unit. Once the total memory size has been decided, the various possible configurations that can be selected to make up this memory can be determined. This allows you to design a memory that will not only meet the size requirements but will provide a choice from among memories that will have other significant characteristics, such as speed and power dissipation.

The monolithic RAM is produced in many different configurations by a number of manufacturers. Two of the configurations (16 by 4 and 16 by 1) will be examined to illustrate their basic operation and differences.

The RAM in Fig. 2 is of the 16-by-4 configuration. It is composed of 64 one-bit memory cells and can store 16 four-bit words. Note that the write enable and address lines are common to all four bits in each word (linear select); thus, four bits are written in or read out in parallel.

The 16-bit memory shown in Fig. 3 is a 16-by-1 RAM. 16 one-bit words may be written in or read out in serial at random. Each word (bit) for this configuration is addressed by four X and four Y address lines (coincident selection).

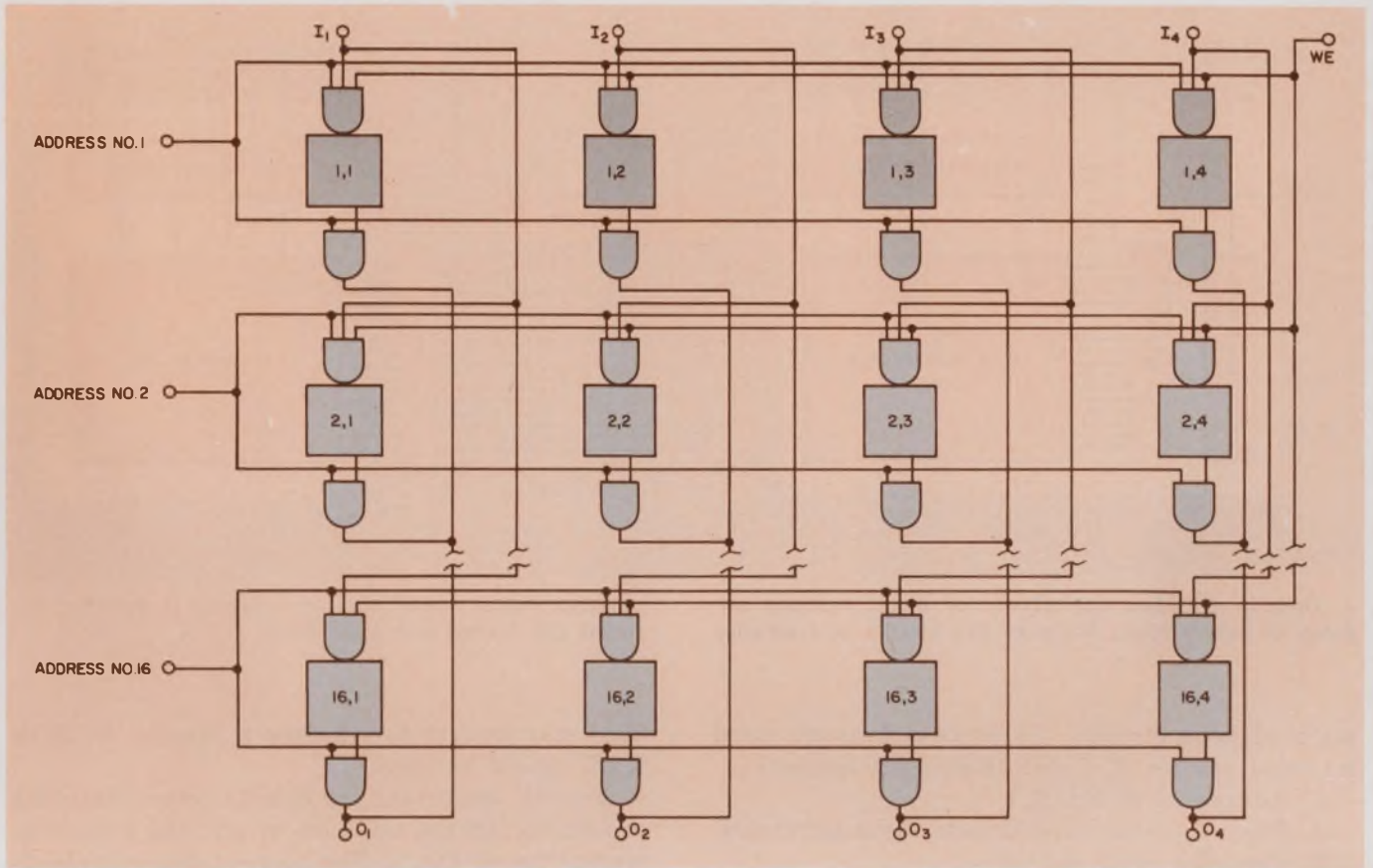
To demonstrate the difference between the two configurations, examine the read and write oper-



1. A basic one-bit read/write memory is simply a latch with input and output control lines.

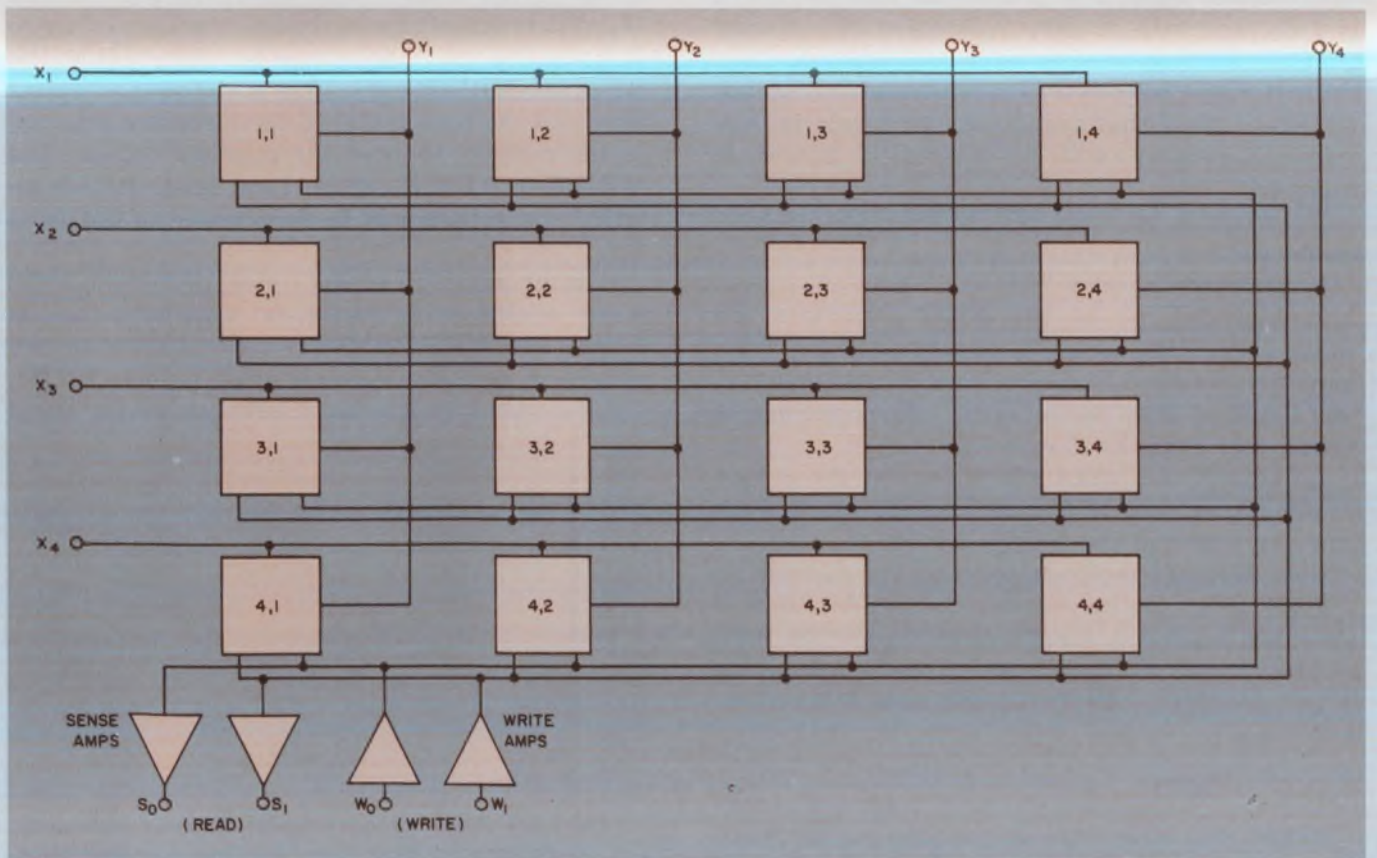
C. D. (Mike) Talbert, Engineer, Avionics Division, Bendix Corp., Fort Lauderdale, Fla.





2. Linear selection is used to address and write-enable each four-bit word in this 16-by-4-bit RAM. One line

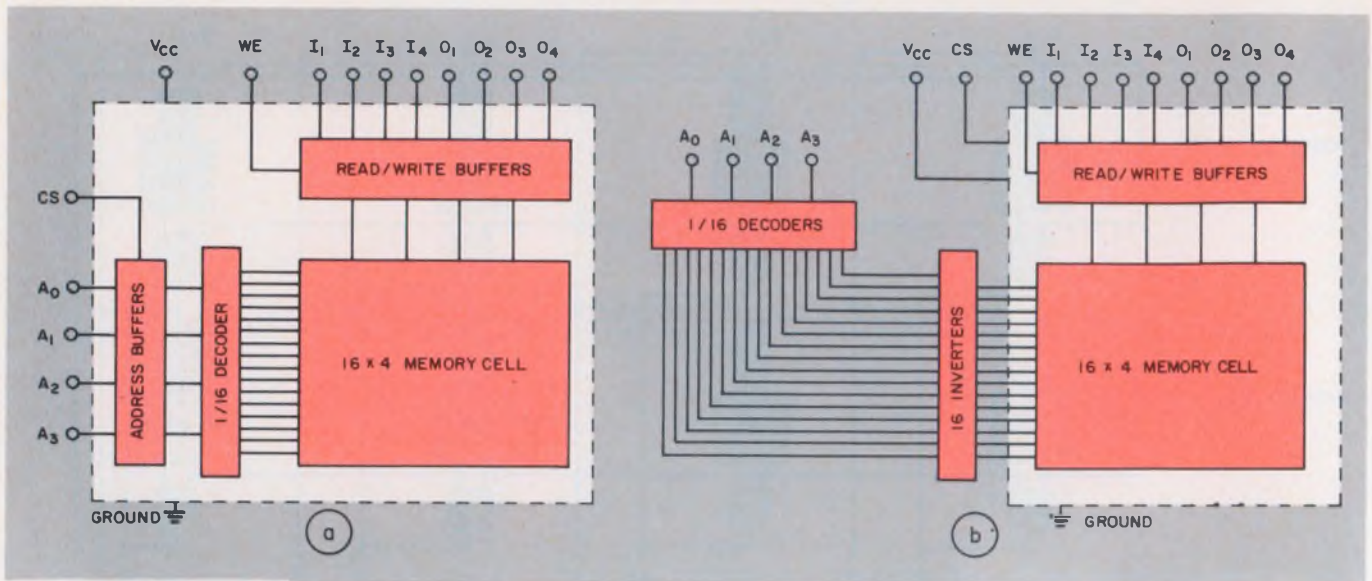
is required to address each word but it is independent of word size.



3. Compare the use of coincident selection for this 16-by-1-bit RAM with the linear selection used in Fig. 2.

Matrix selection reduces the number of address lines required for a given memory size.





4. On-chip decoding (a) allows for direct memory address in binary form. Although this results in a smaller

package, higher speed can be achieved if external decoding (b) is used with MOS RAM.

ation of both circuits. To write a four-bit word into address No. 2 of the 16-by-4-bit memory:

1. Address line No. 2.
2. Place four-bit word at data input terminals.
3. Energize write enable.

When the energizing voltage is removed from the write enable, the word will remain stored in location No. 2. This word will appear at the data output terminals as long as address No. 2 is high, and will remain in location No. 2 until another word is written into this position. This characteristic is known as nondestructive readout (NDRO). Note that semiconductor memories are volatile—memory will be altered if power is removed.

To write a bit into cell 1, 2 of the 16-by-1 memory:

1. Energize  $X_1$  and  $Y_2$ .
2. Activate one of the write amplifiers. To write a "1," the input of the "write one,"  $W_1$ , amplifier is raised to a high level. To write a "0," the input of the "write zero,"  $W_0$ , amplifier is raised to a high level.

As before, this word will appear at the output terminals as long as the  $X_1$ ,  $Y_2$  address is high and also exhibits the NDRO feature.

Two different methods are used for addressing a RAM (Fig. 4). In general, on-chip decoding is provided so that a binary counter may be used to provide the word address. If on-chip decoding is not provided, external decoders and inverters are required.

### Bipolar or MOS?

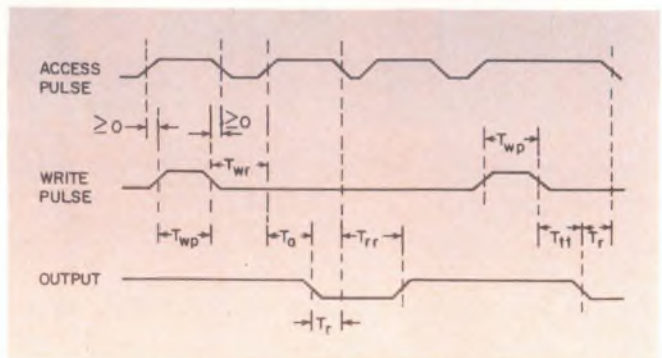
After the word size and configuration have been defined, the next consideration should be the maximum operating speed and access time.

This may determine whether a bipolar or MOS RAM should be used.

Several important switching characteristics are defined by the table below and the switching waveforms of Fig. 5. The access pulse represents the switching of the address lines.

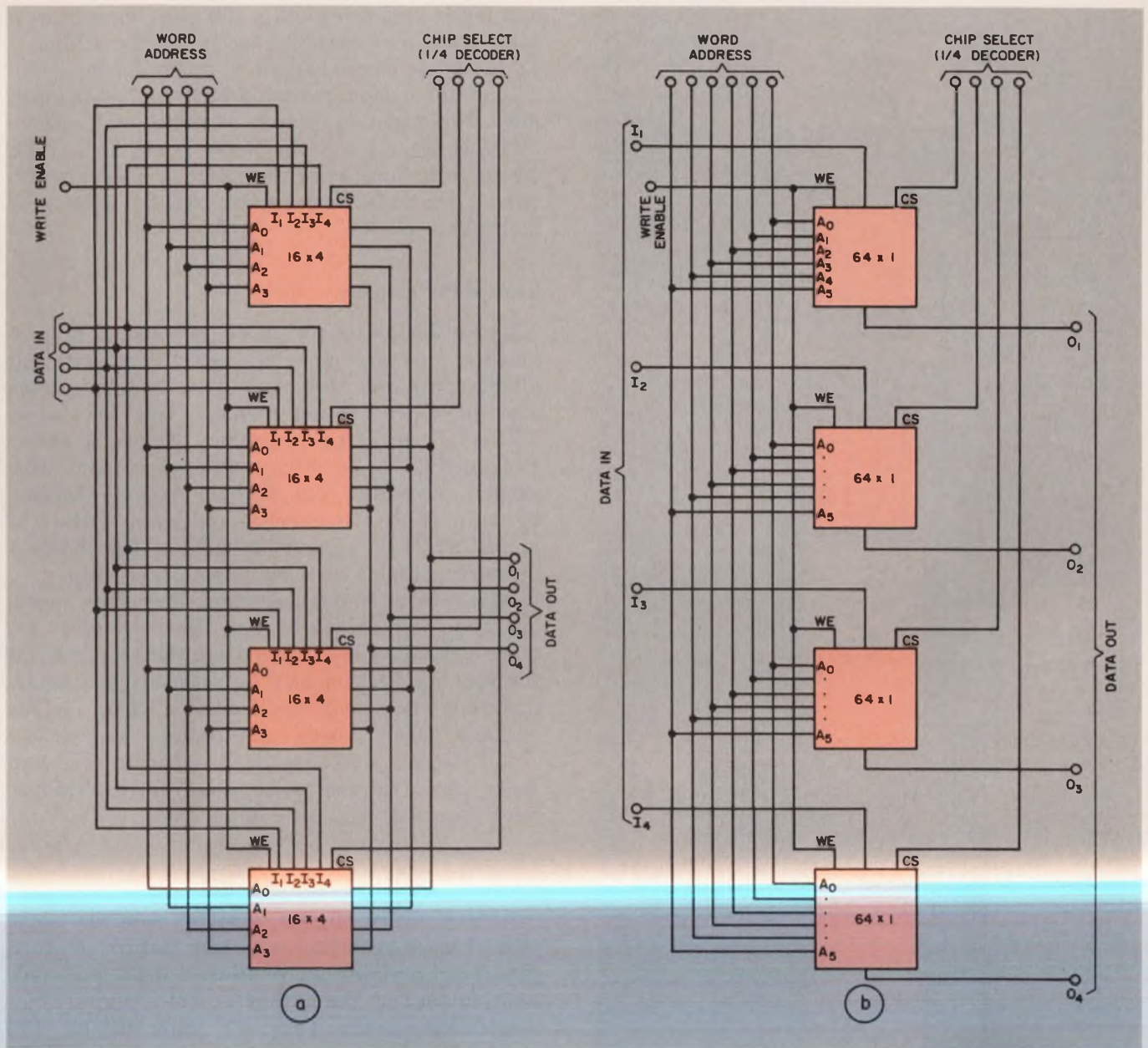
It is possible to determine the cycle times for all possible combinations of memory operation by using the delay times shown in Fig. 5. The WRITE-to-READ cycle time is the sum of write pulse width and the recovery time, while the READ-to-WRITE cycle time is the sum of access time and the time required for circuitry external to the memory to read the memory output. The WRITE-to-WRITE cycle time and READ-to-READ cycle time may be determined in the same way.

A comparison of access times, minimum write pulse widths and maximum operating speeds reveals that MOS RAMs are generally one to two orders of magnitude slower than bipolar RAMs. Typical values of bipolar RAMs are access times



5. The cycle times for all possible memory operations can be determined from the switching characteristics. For example, the WRITE to READ cycle time is the sum of WRITE pulse width ( $T_{wp}$ ) and the recovery time ( $T_r$ ).





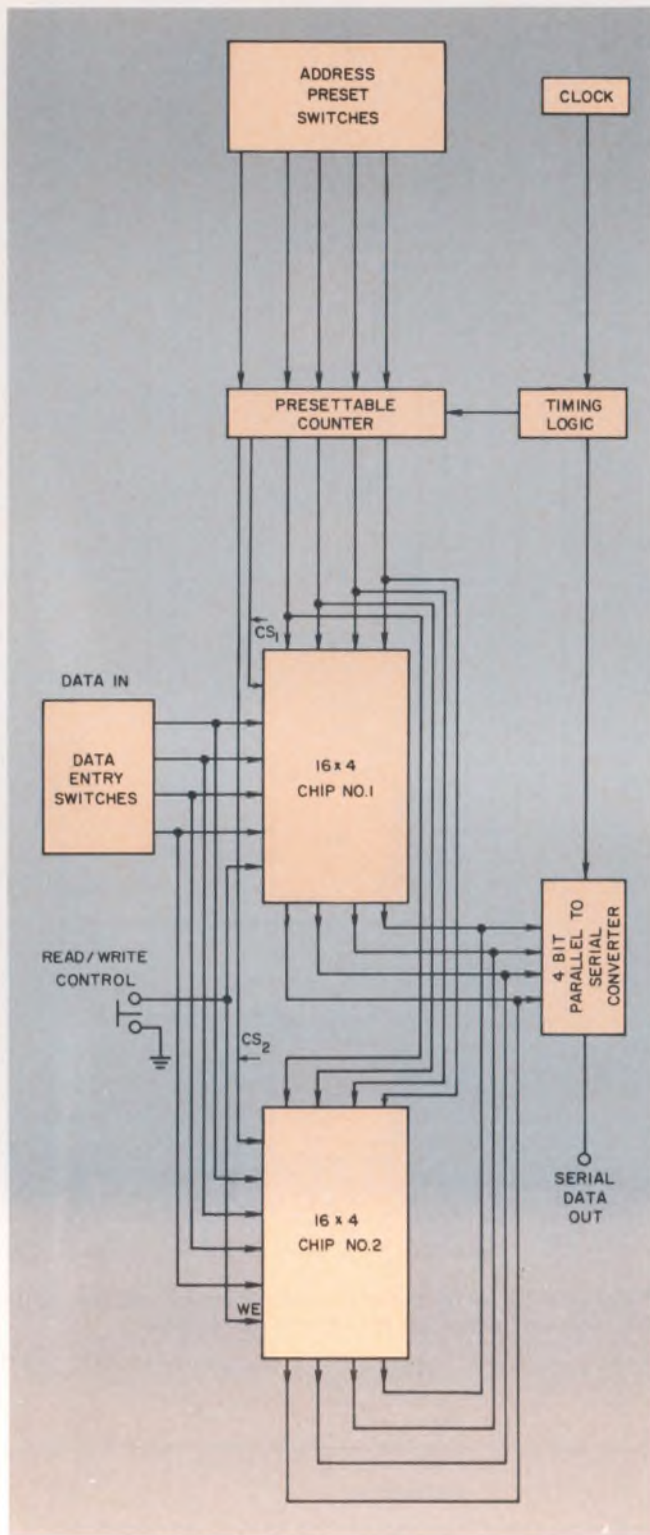
6 Two different approaches to memory expansion are shown by these two 64-by-4 random-access memories.

Word size of (a) is easily increased by adding one chip for each additional bit of information desired.

## Table. Switching characteristics

Characteristic	Definition
Read access time ( $T_a$ )	The time delay between a valid address at the input and the indicated point on the output waveform.
Read recovery time ( $T_{rr}$ )	Time for output to turn off after access pulse goes low.
Write pulse ( $T_{wp}$ )	Minimum pulse guaranteed to write.
Write throughput time ( $T_{tt}$ )	Time from write pulse to read data out from bit just written into.
Write recovery time ( $T_{wr}$ )	Time before another location can be addressed after write pulse.
Read time ( $T_r$ )	Time necessary for external circuitry to read data from memory. SPECIFIED BY USER





7. This 128-bit data generator is being used for testing a digital communication system. The two 16-by-4-bit random-access memories are wire-OR'd together to form a 32-by-4-bit memory.

( $T_a$ ) of 50 ns, write pulse ( $T_{wp}$ ) of 30 ns and write recovery time ( $R_{wr}$ ) of 40 ns. An exception is complementary MOS, which has speeds comparable to the bipolar memories.

What the MOS lacks in operating speed, it makes up in lower dissipation, higher bit density

and lower cost per bit. In 100-piece quantities a MOS RAM may cost 30¢ per bit, while a bipolar RAM will be more than twice as expensive.

A major disadvantage of MOS is the requirement for negative power supplies and special interface circuitry if the RAM is not TTL/DTL compatible. Several of the MOS RAMs are dynamic; that is, they require refresh pulses or multiphase clocks.

### Expand the memory

Great flexibility for word expansion is provided by the uncommitted collector output that allows many cells to be wire-OR'd together. This also allows increasing memory size by "wire-ORing" several chips together. Figure 6 shows two methods for forming a 64-by-4 memory with smaller memories. The 64-by-4 memory formed by four 16-by-4 memories uses wire OR techniques, while the memory formed by four 64-by-1 memories obtains an output from each chip.

After the word configuration, operating speed, operating temperature, and power-supply requirements have been compared, the proper RAM for your application may be selected by comparing other component specifications. These include package size, power dissipation, complexity (multiple chip select required, separate read and write lines, refresh pulse required, multiphase clock required) and, of course, cost.

### Using the RAM

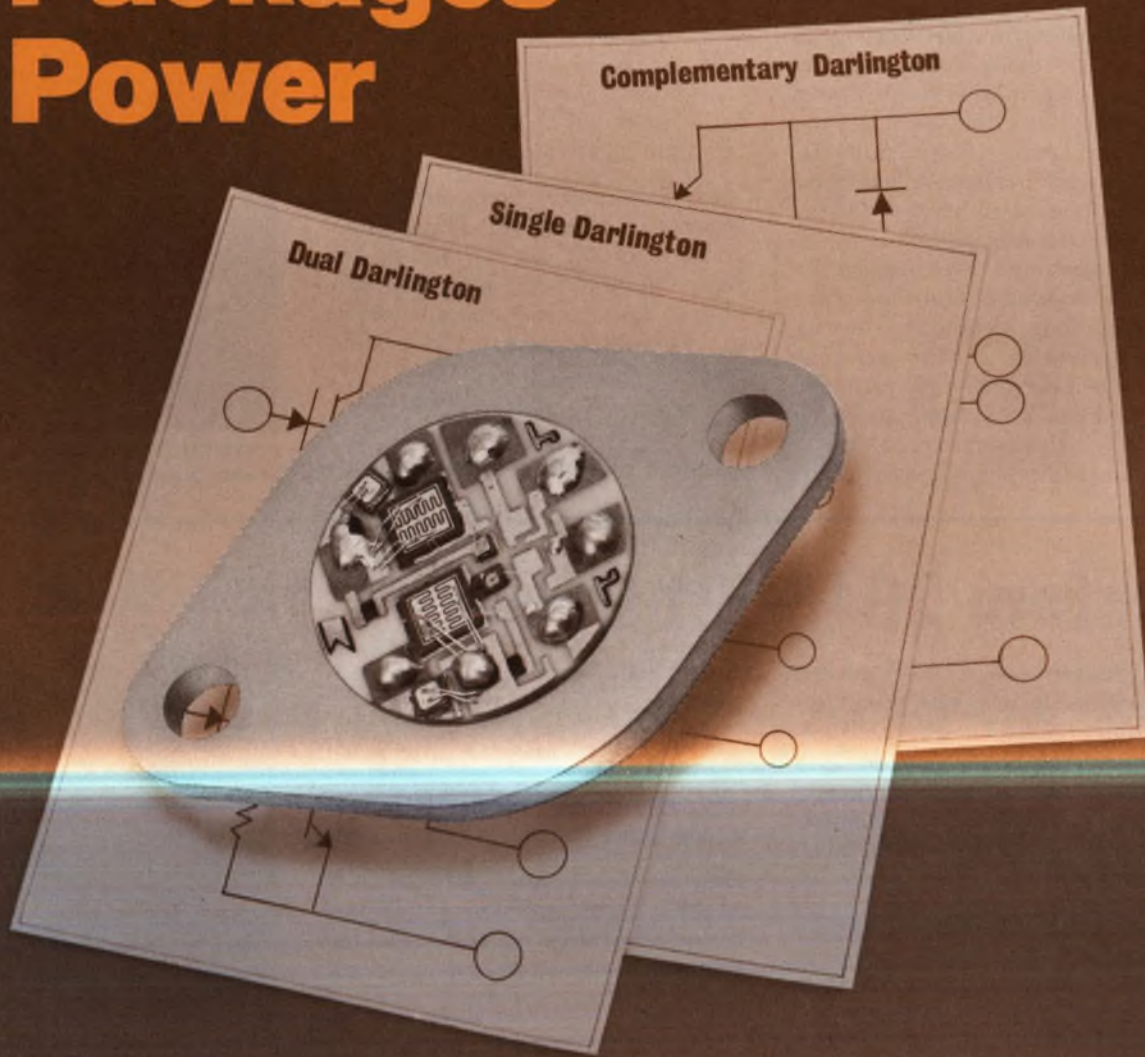
Almost every digital system requires some type of word generator as a test feature. A word generator, containing two 16-by-4 RAM packages is being used by the author to test a digital communication system (Fig. 7). This 128-bit (32 words, four bits per word) data generator could have been configured in one of several methods. The RAM finally chosen was best suited for the particular application.

Data is entered into the memory via a four-bit thumb-wheel switch. The word address is selected in the WRITE operation by the presettable counter, the address thumb-wheel and the chip select. In the READ mode, the entire storage of both memories is read out in serial at intervals determined by the timing logic. The number of bits could be easily doubled by using an 8-bit-parallel-to-serial shift register instead of the four-bit shown. The extra four bits could be a hardwired preamble plus parity, such as used for USACII.

Other applications may be developed from the same example as, for instance, storing a message received in one form (such as BCD) at one bit rate, then retransmitting it in a different form (such as binary) at a different bit rate. ■■



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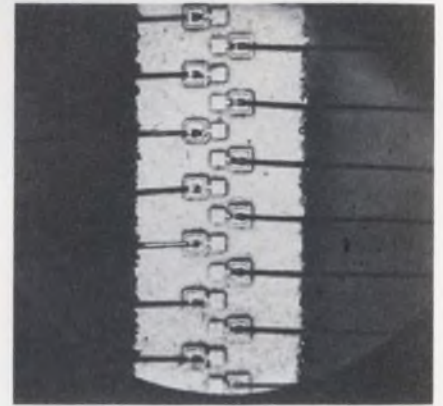
# microtopics

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A Typical Array with .0033" x .0033" InSb Elements Spaced .0033" Apart.

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## Custom 2048-Bit ROMs.

These Philco® custom MOS devices are available in a choice of bit organizations: 256 8-bit words, 512 4-bit words, 1024 2-bit words or 2048 1-bit words. Bit patterns are made to customer specifications by programming a metal mask during the fabrication process.

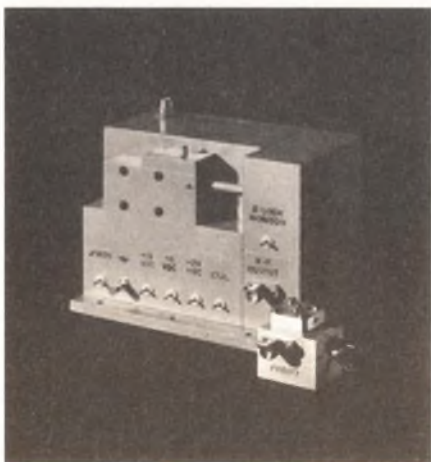
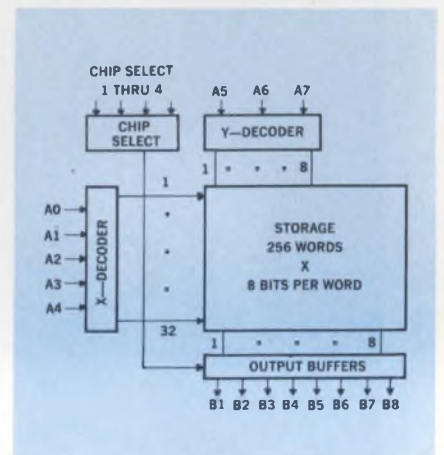
Because the pMS2048C is a static device, output data remains valid as long as an address is present. Perfect for look-up tables, microprogram-

ming, code conversion, and control logic.

Output is compatible with both bipolar and MOS circuits; inputs require MOS or high-voltage T<sup>2</sup>L drive. Access time? Typically 1 microsecond.

Delivery for custom patterns is 6 weeks... with standard ASCII patterns available off-the-shelf for evaluation.

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The GunnLoc puts out 100 milliwatts in X band. It has low AM and FM noise, and it's free from the spurious outputs associated with multiplier chain sources. And it operates from only 15 volts.

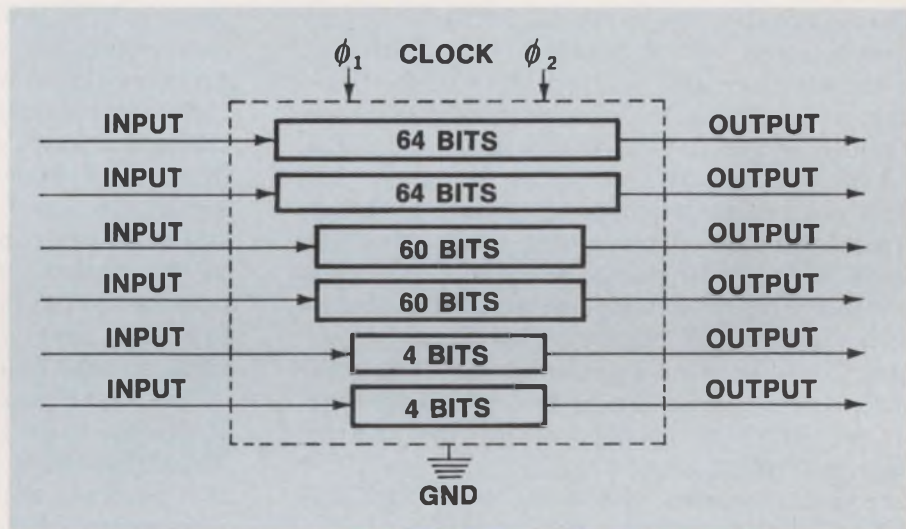
Inside the GunnLoc is our P8600, available separately as a free-running voltage-controlled power source with the best temperature stability on the market:  $\pm 10$  ppm/ $^{\circ}$  C. The P8600 can be supplied for C, X or Ku band. Tunable over 5% bandwidth, the P8600 needs an input of only 12 volts dc, and produces up to 250 milliwatts.

INFORMATION RETRIEVAL NUMBER 193



## Quad 64-Bit Dynamic MOS Shift Register.

This Philco® MOS array has six independent shift registers on one chip: two 64-bit, two 60-bit and two 4-bit registers. Although each register has separate inputs and outputs, the array operates with a common two-phase clock. By varying external connections, you can hook up various combinations in the versatile pL5R64X4C to make dual 128-bit, 4 x 64-bit or 256-bit words. The output buffer is an open-drain MOS transistor; no d-c supply voltage is required. Applications? In digital delay lines and bit-serial arithmetic circuits... ideal for certain calculator systems. Packaged in a 16-lead Cerdip.



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PA7710 differential voltage comparator

PA7711 dual differential voltage comparator

PA7712 (formerly 702A/712) high-gain, wideband amplifier

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INFORMATION RETRIEVAL NUMBER 195



# Use squaring to multiply.

Triangular waves can add up to the square-law function if they are harmonically related and have controlled slopes.

The square-law or parabolic function is very useful because it can perform exponentiation, root-mean-square and multiplication calculations. It can be generated by using many different devices such as varistor-resistor or diode networks, but here is a new wave-shaping technique, that makes use of static components only to create harmonically related triangular waves, that can produce very precise parabolic outputs. It is relatively independent of temperature effects, and its accuracy exceeds all other methods.

Multiplication over four quadrants using the square law is carried out by two parabolic functions of opposite polarity using the quarter square multiplier.

The basic algebraic relation for the multiplier is  $XY = 1/4 [(X + Y)^2 - (X - Y)^2]$ . As a nonlinear function generator this multiplier may be applied to computation, modulation, coordinate transformation and power measurement.

Among the older approaches to generating the square-law function are devices with transfer characteristics of parabolic response or piecewise linear segmental networks of resistors and diodes. The former suffer from low accuracy and temperature dependence, while the latter require the use of a large number of segments to realize the required accuracy. Even with 36 segments, the diode-resistor network cannot do better than 0.05% because of diode defects and resistor balance errors.

But harmonically related triangular waves can be added to generate parabolic functions to an accuracy of 0.005%.

## Adding up triangular waves

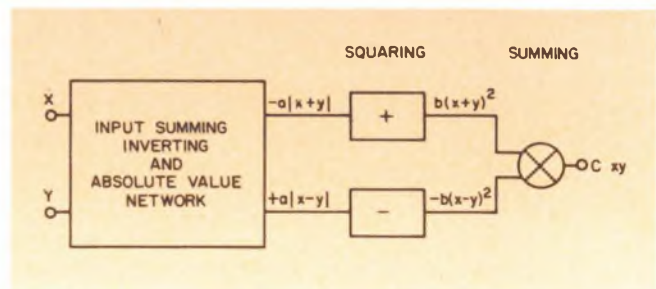
When triangular waves are used, each wave of higher frequency is generated from the next lower frequency. The triangular waves are repeatedly added and subtracted to generate the parabolic function by parallel wave shaping. Harmonic triangular waves of sufficiently high

order can be produced to meet the 0.005% accuracy specified. This precision, in turn, is adequate for a multiplier with an accuracy of 0.01%.

Before considering the means by which the triangular waves are produced, refer to the block diagram of a multiplier in Fig. 1. Two input signals, X and Y, are applied to the inputs of summing, inverting and absolute-value amplifiers to obtain  $(a|X - Y|)$  and  $(a|X + Y|)$ . These two outputs are fed into squaring circuits to produce  $b(X + Y)^2$  and  $-b(X - Y)^2$ . The sum of these signals is the desired product,  $cXY$ .

The squaring network is the critical element. If the inputs are zero, the output should be zero. Thus, the output curve of the squaring network is a parabola that passes through the origin. If a sequence of harmonically related triangular waves with a frequency progression of  $2^j$  where  $j=1,2, \dots$ , as shown in Fig. 2, are added so that the base breakpoint of each triangle coincides with the peak of the next higher harmonic, the segmented parabola of Fig. 3 is the result. If there are  $p$  triangular waves, the parabolic approximation will have  $2^p$  segments.

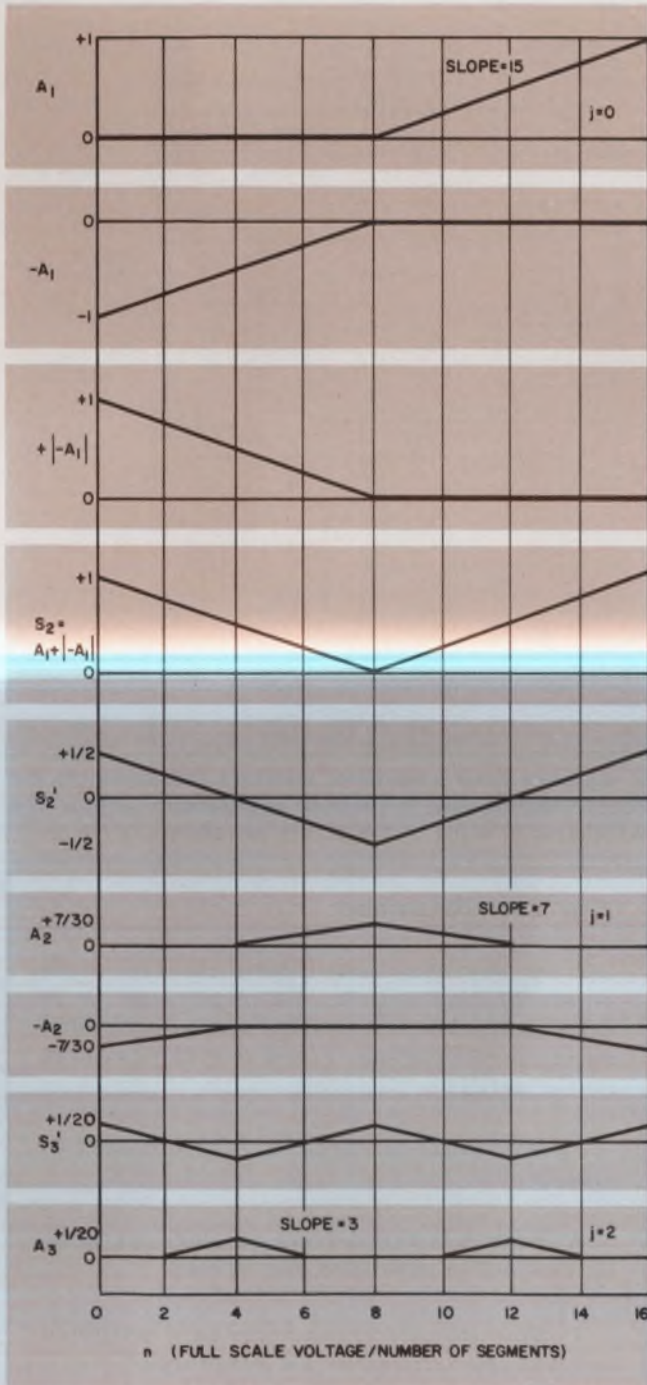
Observe from Fig. 2 that the slope of the successive curves,  $A_1$  to  $A_3$ , decreases in the order 15, 7, 3. The general expression for curve  $A$  (Fig. 3) which is the sum of  $A_1, A_2, A_3$ , and  $A_n$ , is  $A = (n^2 - n)/2$  where  $n$  is full-scale input voltage divided by the number of segments. This generates a generalized parabolic function of the form  $an^2 + bn + c$ . For multiplier applications, however, the linear term  $bn = n/2$  must be



1. An analog multiplier can be based on a squaring circuit. One type of squaring circuit makes use of a parabolic or square-law function derived from harmonically related triangular waves.

Paul Yee, Analog Products Manager, Zeltex, Inc., Concord, Calif.



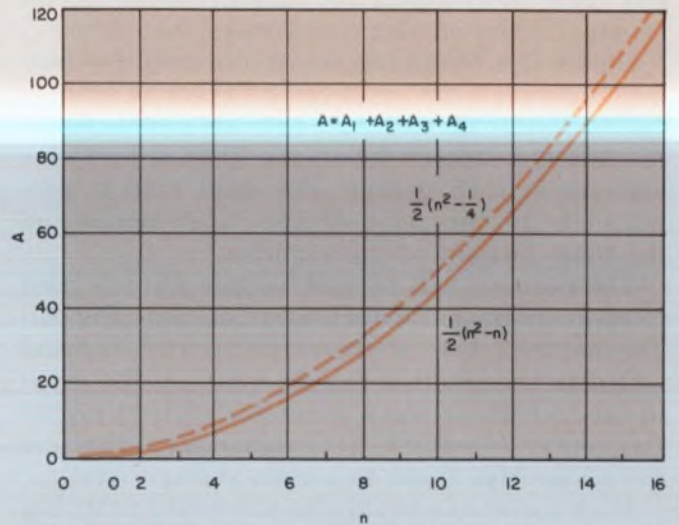


2. The outputs of the triangular-wave generators are  $A_1$ ,  $A_2$  and  $A_3$ . Their slopes decrease in the ratio 15:7:3.  $A_1$  is not shown, but its slope is one. The curves  $S_2^*$  and  $S_2^j$  are input signals in the circuit shown in Fig. 6.

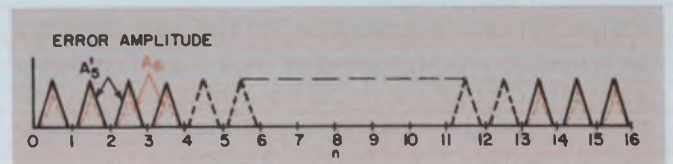
eliminated. One way of accomplishing this is by shifting the base breakpoints of the triangular waves  $A_1$ ,  $A_2$ ,  $A_3$  and  $A_4$   $n/2$  to the left of their positions in Fig. 2.

Once the number of triangular wave forms is selected and the number of segments or breakpoints is established,  $n$  is calculated as the full-scale input voltage divided by the number of segments. Figure 3 is thus approximated by 16 segments. To shift all triangular waves of  $A_1$ ,  $A_2$ ,  $A_3$ , and  $A_4$  by  $n/2$ , only a constant bias of  $-(n/2)$  to the input signal  $n$  is required to arrive at the relation  $A = 1/2 (n^2 - 1/4)$  as shown dashed in Fig. 3.

One of the major advantages of approximating the parabolic function this way is that the num-



3. The sum of the fundamental triangular wave and its harmonics produces the lower parabolic curve. If the right bias is added, the upper parabola, which is suited to use in a multiplier, is the result.



4. A higher-order harmonic, here called  $A_5'$ , can be passed through a diode. The square-law diode characteristic generates an error-correcting parabolic curve,  $A_{ii}$ .



ber of segments and hence the accuracy can be easily increased. Precisely  $2^n$  segments are realized with  $p$  rectifying amplifier circuits that produce  $p$  symmetrical half-wave triangular functions. Parabolic functions of higher accuracy can be approximated simply by using a larger number of component waves.

Further, each successive wave provides a correction to the function generated by the sum of preceding waveforms. The true correction curve at any stage of the progression is equal to the difference between the continuous parabolic function and the sum of the triangular waves. This difference is in itself a repetitive parabolic function.  $A_n$  of Fig. 4 is the error curve between the parabolic function and its  $A_1, A_2, A_3$  and  $A_4$  approximation. This error curve may be approximated by passing  $A'_5$  (Fig. 4), which is a full wave function of  $A_5$ , through a diode.

### Generate the triangular waves

The basic element of the triangular wave generator is the absolute-value amplifier shown in Fig. 5. This amplifier has two possible outputs, one of which is always positive and the other always negative. However, only one output can exist at any given time. A positive output appears at its terminal when the input is less than zero; a negative output appears at its terminal when its signal is greater than zero.

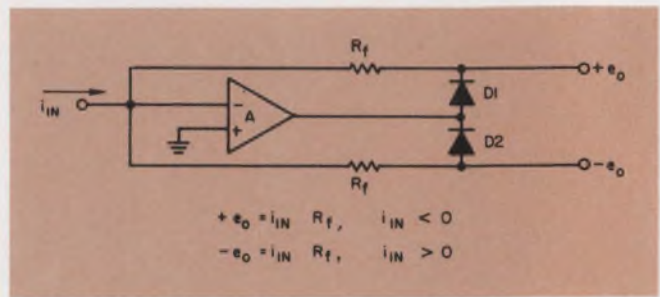
Diodes are connected across the amplifier output to separate the positive and negative outputs and to disable the feedback loop for signals below the forward drop of the diodes. Thus, a dead zone appears in each output. The dead zone is proportional to the slope of the input signal and the time constant of the amplifier.

The positive half of each output wave is used to make up the parabolic approximation (Fig. 6). The negative half of the output is inverted and added to the positive half to make up the input to the triangular wave generator of next higher frequency. A suitable bias signal then displaces the all-positive input to a zero average level.

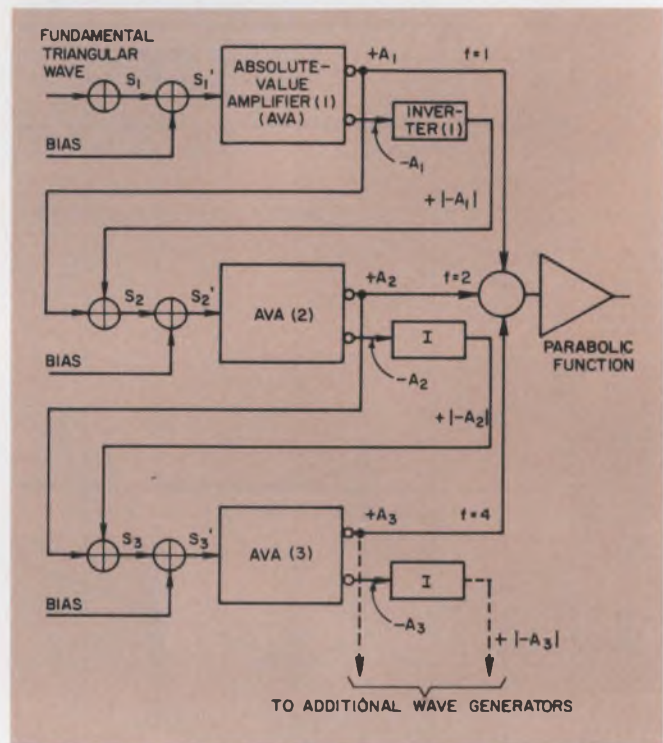
Each successive triangular wave inherently has a frequency precisely twice that of the previous one (Fig. 2). The relative amplitude of each triangular wave is adjusted by setting the gain of its amplifier and the magnitude of the input bias signal. Note that a ramp function is used to initiate the process.

The last wave generator in the sequence has its triangular output shaped to a high-frequency parabolic correction signal by using a diode network. All of the outputs are summed and amplified to produce the desired parabola.

This technique can produce both high speed and high static accuracy. It is the basis for an accurate four-quadrant multiplier. ■■



5. The key element in the generation of the triangular waves is this absolute-value amplifier. It has two output terminals, but only one can have an output signal at any given time.



6. Absolute-value amplifiers, inverters and summers are connected this way to produce a parabolic output. The waveforms at some of the points are shown in Fig. 2.

### Test Your Retention

Here are questions based on the main points of this article. Their purpose is to help you make sure you have not overlooked any important ideas. You'll find the answers in the article.

1. How is the square-law function used to multiply?
2. What are the defects in older methods of producing parabolic functions?
3. How can the error between a parabola and its approximation be generated?
4. How does the absolute-value amplifier produce its dead zone?



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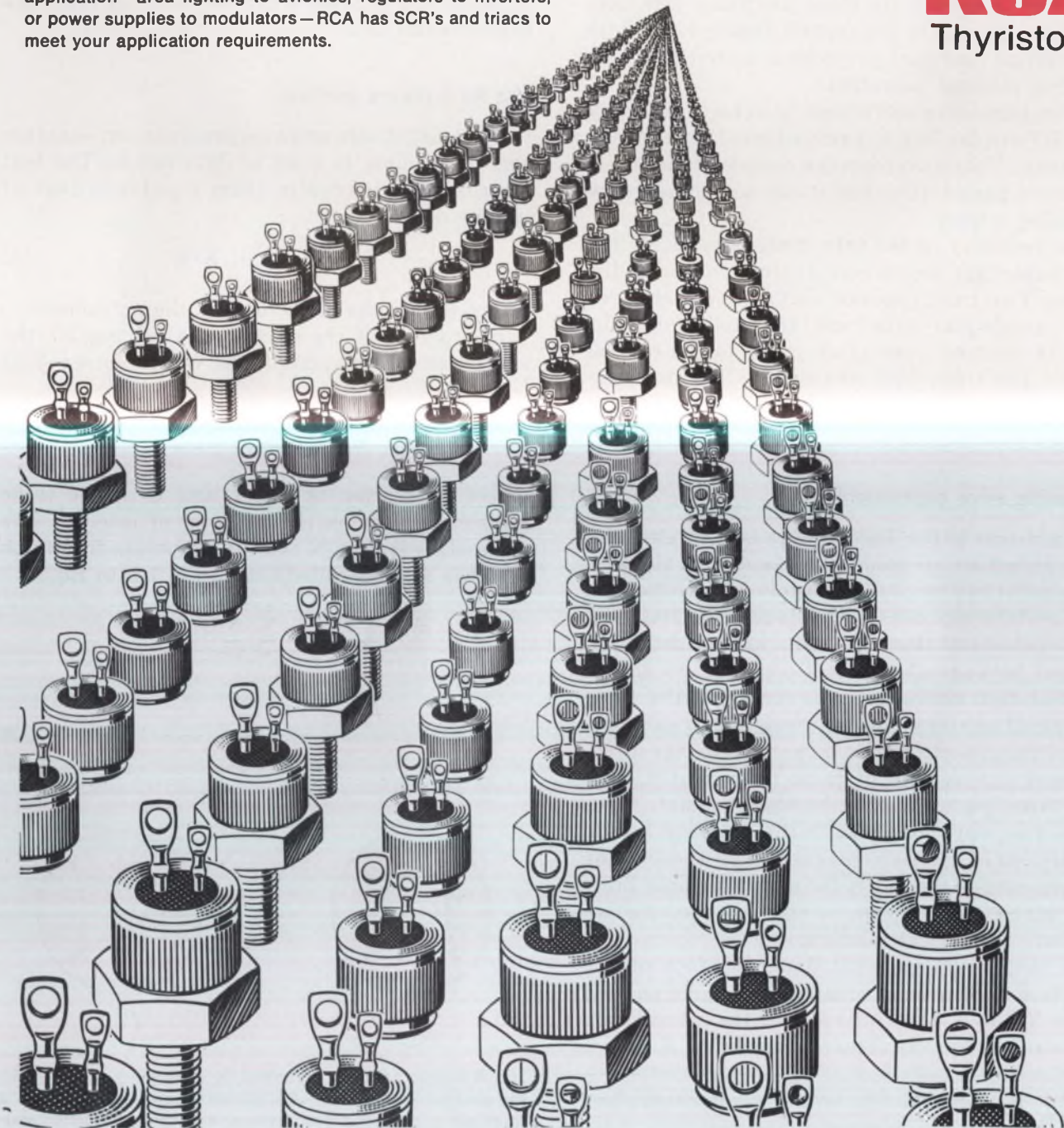
Use these SCR's and triacs in your control applications:

SCR Family	Rating		Triac Family	Rating	
	$I_T(RMS)$	$V_{DROM}$		$I_T(RMS)$	$V_{DROM}$
40740	10 A	600 V	40795	10 A	600 V
40752	20 A	600 V	40797	15 A	600 V
2N690	25 A	600 V	40671	30 A	600 V
2N3899	35 A	600 V	2N5443	40 A	600 V

NOTE: SCR ratings of 100, 200, & 400 volts and triac ratings of 200 & 400 volts are available in each family. Stud packages & isolated-stud packages are also available in each rating.

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**RCA**  
Thyristors



INFORMATION RETRIEVAL NUMBER 45



# Linearize your CRT displays.

Least-square analysis and error-correcting networks permit accurate multi-function registration.

One of the most difficult problems confronting the display engineer occurs when there is a non-linear image on the face of a cathode-ray tube. The problem becomes particularly important when registration is required on the display in conjunction with a second or third auxiliary function. Examples of such multifunction displays are those with optical rear-port projection, screen overlays, and dual channel deflection.

A compensating correction, to achieve linearity in a CRT display, can be summed into the deflection waveform. This waveform is a complex function of numerous parameters, and it can be generated by an analog circuit.

The geometry of the tube itself is probably the most important factor contributing to image distortion. Two basic types of CRTs are encountered—the single-gun tube and the multigun tube with its electron guns at an angle to the central axis of the tube. The single-gun CRT produces pin-cushion effects, while the off-axis multigun tube gives rise to keystone effects (Fig. 1).

## Determine error experimentally

In addition to the distortion caused by electron-beam deflection are such other factors as the gain of the deflection amplifier, the gain of the deflection yoke, and the type of yoke that is used. It is particularly important that the gain of the deflection channel be known, and held constant, so that a compensation network can be specified. Also to be considered are any constant magnetic fields outside of the deflection field. For instance, the direction and flux density of these fields that usually come from ion traps must be held constant.

The two ways to approach this problem are by experiment or by electromagnetic field theory. The experimental technique is far more desirable, however, since the problem is too complex for an adequate theoretical solution.

To collect experimental data, the face of the CRT is divided into an equally spaced grid pattern whose X and Y axes intersect at the central axis of the tube (Fig. 2). The magnitude of X and Y

deflection voltage necessary to deflect the beam to each coordinate position (a, b) is then measured, thereby obtaining data for all the coordinate positions. If each coordinate position is assigned a linear normalized deflection voltage, the amount of correction necessary can be obtained from the experimental data.

## Use least-square analysis

The least-square analysis generates an equation that fits a curve to a set of data points. The best approximation results from a polynomial of infinite order.

$$C_x = \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} B_{jk} X^j Y^k, \quad (1)$$

where  $B_{jk}$  are the coefficients in the polynomial.

In order to fit the data to the polynomial, the sum of the errors squared must be minimized. This is expressed by

$$S = \sum_{L=1}^N (E_x - C_x)^2, \quad (2)$$

where  $C_x$  is given by Eq. 1, and  $E_x$  is the value measured at the particular point of interest. The summation is over N coordinate points for which the fit is desired. Substituting Eq. 1 into Eq. 2,

$$S = \sum_{L=1}^N \left( E_x - \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} B_{jk} X^j Y^k \right)^2.$$



1. A square trace is distorted by a single gun CRT into the pin-cushion of "a." An off-axis gun, as found in a multigun tube, causes additional keystone distortion (b).

Kenneth A. Peterson, ALL Div., Cutler-Hammer, Deer Park, N. Y.



To minimize this sum, the partial derivatives with respect to the various coefficients are taken. The partial derivatives of Eq. 2 are:

$$\frac{\partial S}{\partial B_{st}} = 2 \sum_{L=1}^N (E_x - C_x) \frac{\partial C_x}{\partial B_{st}},$$

where  $s = 0, 1, 2, \dots$ ;  $t = 0, 1, 2, \dots$

Set the partials equal to zero and substitute for  $C_x$  to get:

$$\sum_{L=1}^N E_x \frac{\partial C_x}{\partial B_{st}} = \sum_{L=1}^N \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} B_{jk} X^j Y^k \frac{\partial C_x}{\partial B_{st}} \quad (3)$$

This result is a set of simultaneous equations suited for computer solution. Sub-routines for the solution of simultaneous equations are available in the libraries of most commercial time-sharing services. Either these can be used, or a program can be written to solve this set of equations.

### Determine correction network

Consider the following second-degree polynomial as a typical example of a deflection equation:

$$C_x = \sum_{j=0}^2 \sum_{k=0}^2 B_{jk} X^j Y^k.$$

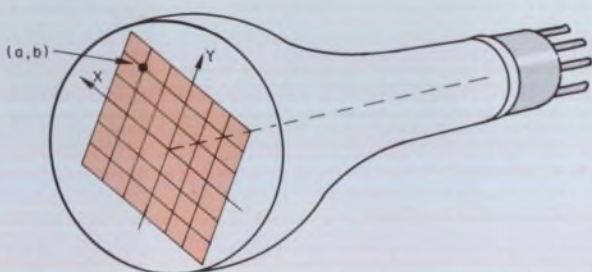
If  $B_{00} = B_{11} = B_{02} = B_{20} = B_{21} = B_{22} = 0$ , this reduces to

$$C_x = B_{01}Y + B_{10}X + B_{12}XY^2.$$

Assume that there are 30 data points to fit ( $N=30$ ). Equation 3 then becomes the three simultaneous equations:

$$\sum_{L=1}^{30} (E_x) Y = \sum_{L=1}^{30} (B_{01}Y^2 + B_{10}XY + B_{12}XY^3)$$

$$\sum_{L=1}^{30} (E_x) X = \sum_{L=1}^{30} (B_{01}XY + B_{10}X^2 + B_{12}X^2Y^2)$$



2. The first step in compensating for distortion is to divide the CRT face into a grid. The X and Y deflection voltages for each point determine the correcting network.

$$\sum_{L=1}^{30} (E_x) XY^2 = \sum_{L=1}^{30} (B_{01}XY^3 + B_{10}X^2Y^2 + B_{12}X^2Y^4).$$

In them  $E_x$  is the experimentally measured X deflection voltage for the given coordinate position, and X and Y are the normalized deflection voltages associated with the same point. The solution of this set of simultaneous equations in the three unknown coefficients  $B_{01}$ ,  $B_{10}$  and  $B_{12}$  is substituted back into Eq. 1 to obtain an equation for the corrected X deflection waveform. A Y deflection equation can be obtained similarly.

The next step is to translate the equation into analog hardware. This can be achieved with two basic building blocks — the analog multiplier and the operational amplifier. The multipliers are used to square and cross-multiply signals, while the op amps are used to obtain the desired coefficients.

For example, consider the equation

$$C_x = B_{10}X + B_{20}X^2 + B_{30}X^3 + B_{21}X^2Y.$$

In order to minimize the distortion in the linear term, it is separated from the other terms and not summed in until the final stage of the network. Therefore the equation is rewritten as

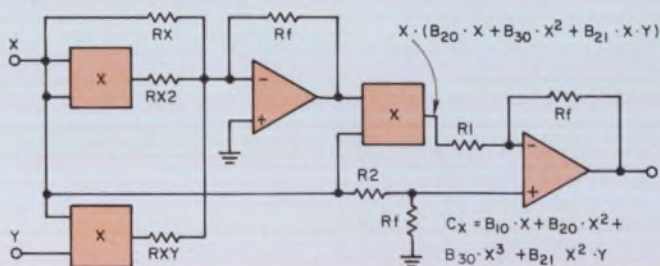
$$C_x = B_{10}X + X (B_{20}X + B_{30}X^2 + B_{21}XY).$$

The hardware representing this equation is shown in a block diagram in Fig. 3.

The resistor values are:

$$R_x = \frac{R_f}{B_{20}}; R_{x^2} = \frac{R_f}{B_{30}}; R_{xy} = \frac{R_f}{B_{21}}; R_1 = R_f$$

$$\text{and } R_2 = \frac{2R_f}{B_{10}} - R_f. \quad \blacksquare$$



3. After the equation for the proper deflection is obtained, the circuit can be designed. This is the block diagram of a network for the X deflection for the equation shown.





GOULD 4800

GOULD 4800



# This is the fastest printer around.

## It also produces both alphanumerics and graphics.

**And printout is 132 columns wide on an 11 x 8-1/2 format!**

The practical continuous speed of the standard line printer is 600 lines per minute. But the new Gould 4800-II will deliver 4800 lines per minute. And it'll produce both alphanumerics and graphics — simultaneously — directly from any source of digital input as data transmission by telemetry, radio microwave, and/or land line.

There's a new character generator, too. With an ultimate capability of three 128 character fonts with dot matrices up to 15 x 15.\* And because it has a 132 character buffer, you don't have to burden your computer's memory banks. The input control lines are built-in, too. Which makes it comparatively simple to interface the 4800 with almost any computer you have in mind.

The 4800 provides programmed control for a

variety of output forms . . . line and letter spacing, paragraphing, columns and so forth. Plus a convenient capability to translate bit mode input into generalized graphics. But speed and versatility are just part of our story. Because it's electrostatic, the 4800 is infinitely quieter than line printers. Because it has fewer moving parts, it's more reliable. And because it's a lot simpler, it's priced well below printers that can't come close to the performance. So there you have it: the Gould 4800 electrostatic hardcopy printer. Isn't it time we talked? Graphics Division, Gould Inc., 3631 Perkins Avenue, Cleveland, Ohio 44114.

\*Supplied standard with unit:  
One 64 character font with  
5 x 7 dot matrix.

### GOULD CLEVITE

The Gould 4800. The next generation of high-speed printers.

INFORMATION RETRIEVAL NUMBER 46



## Appraise with confidence when your employer asks you to interview job applicants. Use this guide to evaluate and compare technical personnel.

Have you appraised an applicant lately? Suppose your company asks you to help recruit technical personnel—don't be surprised, be prepared. Be prepared to interview men, to evaluate them, and to select those who will be able to work effectively in your organization.

The purpose of a technical interview is to examine the applicant's understanding of principles and his ability to tackle new problems.

To help you interview more effectively, we'll consider how to conduct an interview, and we'll also present a system for ranking interviewees.

In preparing for an interview, select useful data from the resume submitted, using this checklist as a guideline:

- Specific areas of interest. Part-time and summer jobs often provide valuable training. Self-initiated projects are very good indicators of curiosity and drive.

- Articles and papers. They can be a sign of excellence, especially when they arise from independent (non-required) work. They provide good clues for questioning the applicant.

- Memberships in technical and honorary societies. These do not offer much information because acceptance in them is based on totally different requirements from those you're looking for. Only if a man shows proof of significant research or leadership should society membership be considered.

- Other extracurricular activities. In general, these will provide only an indication of personality type and personal ambition.

- References. They are useful if they come from someone who has worked with the man in his field and who is willing to make an honest appraisal of his capabilities.

When interviewing college graduates, check their transcripts for the Grade Point Average (GPA). How does this compare to the norm for new hires. Also important is the GPA in the major field alone—is it consistent with the overall average? And what is the trend of grades in

the major? A downward trend might indicate a lessening of interest in that field. Are course sequences completed? If not, this may indicate lack of perseverance. Does the applicant have a good foundation in the basics, or has he taken easier courses that might cause him to become obsolete later? Temper this data with your own opinion of the school. A talk with a graduate of the school in your company might help in evaluating the transcript.

### Interviews aren't automatic

Your attitude toward the applicant will establish the tone of the interview. The following suggestions will help guide you:

1. Greet him by name and show some acquaintance with his record.

2. Chat with him for a while to set him at ease—he'll probably be nervous about the impression he's making. Consider him a fellow engineer who's communicating his understanding of certain technical subjects to you.

3. When you ask him technical questions, give him time to think and paper to figure on.

It's important that you question a man only in areas of his experience. You'll be able to judge him far more accurately if you talk with him about things he knows, rather than having him struggle with unfamiliar concepts. Sometimes, of course, it's appropriate to ask a slightly vague question to check the interviewee's ability to sort facts and seek additional information if necessary, and to work from general guidelines rather than specific instructions.

One good starter is to ask him which courses he liked best in school, which ones he learned the most in, or which ones best increased his insights. Don't expect him to have all the formulas at instant recall; you probably don't either. You're more interested in how the man derives and uses formulas rather than how well he remembers them.

Another good starter is to ask him to describe a project he has worked on.

If you draw a blank in a specific area, don't

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**Thomas H. Baker**, development engineer, Hewlett-Packard, Loveland, Colo.



belabor it; go on to something else. If he seems to get bogged down, a further hint or suggestion of what you're driving at may trigger the candidate so that he will be able to carry on from there. If he gives you a quick answer, ask him to show you the steps involved. Ask him what approximations were made and to show that they are valid. See if he knows what limitations exist for the answer.

As the interview progresses, you should be asking yourself:

- Does he logically attack problems?
- Does he check answers?
- How does he express himself?
- Does he ask about unclear points?
- Does he need specific instructions?

These questions are important since they are the basis for the later evaluation.

A written evaluation must be done soon after the interview to record your impressions before they fade. The report should indicate the areas you covered in the questioning and the applicant's relative performance. You should include an honest evaluation of his strong and weak points and his ability to progress. Finally, a recommendation for or against employment should be given, with specific reasons. These might include whether or not you feel you could work with him and what contributions you think he could make.

### Rating the applicant 10 to 1

One of the best ways to put a bit of objectivity into a basically subjective process is to use a numerical scoring system to establish the relative merit of each man you interview.

Make a list of the job qualifications you are looking for in new men. Now give a weight between 10 (high) and 1 (low) to each qualification to reflect its importance to you. The applicant may be rated by using the following scale:

- |                  |                 |
|------------------|-----------------|
| 10 The very best | 5 Average —     |
| 9 Very high      | 4 Below average |
| 8 High           | 3 Poor          |
| 7 Above average  | 2 Very poor     |
| 6 Average +      | 1 Unacceptable  |

"Average" must apply to the spectrum of candidates you actually see—not what you think the average of all engineers might be.

The final weighted score for each qualification (see Fig. 1) is obtained by multiplying the score you have given the applicant by the qualification weight. The applicant's relative merit is the sum of the weighted scores. This rating system will be a valuable tool in aiding you to be consistent in sorting out your impressions.

As you can see in Fig. 1, a truly average man would score 286 by the rating system. Depend-

ing on the needs of your company, you will establish, over a period of time, a level of probable hire. But this should not be inflexible because the scoring is still largely subjective—based on your impressions.

### Putting the system through its paces

Now that we've established a few guidelines, let's see how they might apply.

Two men have applied for a position as circuit designer at your company. Frank is a recent BSEE graduate from State U, which you know to have a good EE department. George has been at ElectroThing, Inc., for three years after

JOB QUALIFICATIONS	WEIGHT	X SCORE	= WEIGHTED SCORE
TECHNICAL INSIGHT	10	5.5	55
EXPRESSION OF IDEAS	8	5.5	44
INTEREST IN CIRCUIT DESIGN	7	5.5	38 1/2
GROWTH POTENTIAL	7	5.5	38 1/2
TECHNICAL KNOWLEDGE	6	5.5	33
GRADE POINT AVERAGE	5	5.5	27 1/2
SELF MOTIVATION	5	5.5	27 1/2
PERSONALITY	4	5.5	22
		<b>TOTAL</b>	<b>286</b>

1. **Job qualifications and weights** will vary by company needs. This interview rating sheet might be used for an instrument design laboratory.

graduation from Grimbley, a fairly well respected engineering school.

In preparing for the interview, you have learned from Frank's university transcript and resume that his interests run to classical music, mountain climbing, and sailing. He has had few outside activities—perhaps because he has worked 20 hours a week to support himself at school. His grades are adequate, showing an over-all GPA of 3.0/4.0 with an electrical engineering average of 3.4. The grades show no significant trends, and he has finished several solid sequences in communication theory, network synthesis, and feedback control theory. He has worked part time in a lab on campus as a tech-



nician for a professor. His responsibilities included some circuit design and a lot of troubleshooting.

As you greet Frank and chat with him about conditions at State, he seems ill at ease. You wonder how best to begin your questions. The part-time work provides a clue, and he readily responds to a suggestion that he describe his work. One of the experiments required stable voltage supplies, which he designed. He quickly sketches out the schematic and is able to identify the purpose of each element. He seems to be aware of the limitations of the circuit, which is basically simple. When asked what might be done to improve performance, he makes several suggestions involving more feedback and better references. When shown some additional techniques, he seems to grasp how they work.

At this point, you figure that he is fairly familiar with the practical end of electronics and knows the characteristics of basic components. Now you give him a quick tour of communication theory. He shows acquaintance with the various transforms and conditions for their use. He has some trouble figuring out the spectrum created by the time-domain multiplication of two signals, but with a bit of help he gets the feel for the shape of it. Then you change the signals a bit, and he realizes that it is a frequency mixer that you've described. He really lights up when you show him where it was used in a real instrument.

Next you ask about a simple feedback circuit, drawing one that will be unstable without additional compensation. Frank is unable to realize the problem designed in at first. He feels that something is wrong with the circuit but isn't able to put his finger on it. When the problem is pointed out, he recognizes it but admits that he doesn't know how to correct it.

Upon further questioning Frank tells you that it has been a year since the sequence was studied, that the course had a reputation for being poorly taught with no practical value, and that he took it only because of pressure from his advisor. He has not had a chance to use any of the material since then. You ask him to derive the gain of a simple operational amplifier with feedback (stable this time). He writes out the equations and obtains the relation for the gain and is able to work out frequency responses for reactive feedback components.

His synthesis courses did not cover active synthesis, but he sees immediately that op amps are extremely useful circuit-design elements. Near the end of your time with Frank, he asks you about continuing education opportunities. He is just finishing an introductory course in semiconductor physics and finds it very intriguing. He wants to continue to learn in that field particularly by taking additional courses.

The interview is over. How would you rate Frank? Try filling out a rating sheet and writing an evaluation; then compare yours with the one given below.

### Now it is George's turn

George's present job is in the R&D lab of ElectroThing, Inc., a company in the avionics field, handling both military and commercial systems. He indicates that he feels restricted in this field and wants the opportunity for broader experiences offered by your company.

His resume states that he has done circuit design and that he has had project responsibility. His school record was good with a 3.5 4.0 aver-

JOB QUALIFICATIONS	WEIGHT	x SCORE	= WEIGHTED SCORE
TECHNICAL INSIGHT	10	7	70
EXPRESSION OF IDEAS	8	7	56
INTEREST IN CIRCUIT DESIGN	7	8	56
GROWTH POTENTIAL	7	8	56
TECHNICAL KNOWLEDGE	6	6	36
GRADE POINT AVERAGE	5	30/4.0 = 7.5	38
SELF-MOTIVATION	5	9	45
PERSONALITY	4	5	20
		TOTAL	377

### 2. Rating sheet for Frank

age. A closer look at the transcript reveals that, although he did well in the required EE core courses, they were not followed up with electives. Most of his electives were in business and economics. He was involved in numerous activities and had several positions of leadership. He is now active in an IEEE group, and has had a paper published on considerations for a new satellite navigation system.

George comes on strong at the greeting and after a few minutes you begin to wonder who's interviewing whom. In answer to your question about his present work, he describes a system for aerial navigation involving both digital and analog elements and display modules. The system is being proposed to a major contractor, and



George is proud of his part in it. His responsibility involved a signal processor that was driven from a vhf receiver. He draws a block diagram and explains its operation fairly well.

You ask him about specific elements in the diagram, such as phase detectors, amplifiers, and digital-control circuits. He shows some reluctance to answer specifically, saying that these are fairly standard elements. However, he is familiar with the configuration of an amplifier and can show you how it operates. You ask how it might be modified to meet a new set of specs with tighter tolerances and broader frequency range. He is able to make a few suggestions but can't come close to meeting the new requirements. When you make a few additions to the

est in engineering and wanted to switch to business. He decided to stick it out and has not really regretted it. He says that he enjoys his work. You ask some more questions about specific transistor circuits, and he shows a reasonable feel for their characteristics.

Your time is up, and you must evaluate George. How would you rate him? How would you compare him with Frank? Would you hire George or Frank or both?

### Who gets the job?

Frank's strong point is curiosity and good insight into things that he has worked with. He is weak on experience with a broad range of circuit problems, but you think that he has the ability to learn quickly and grasp new ideas. He is not reluctant to dig in and solve a problem. You checked with Henry L., who also attended State U, and he confirmed that the course on feedback theory is worthless. The interview covered a power-supply circuit he designed, communication theory, and operational amplifiers.

Recommend hire. Frank should progress well, and you would like to work with him.

George is good at handling systems concepts, but is impatient with details. He is intelligent and can do anything he wants to well. You question his desire to design circuits; most of his work used standard designs. He showed no desire to improve on them or to understand them. You rated him low on growth because you don't think he will be able to progress.

In several instances, George has had the opportunity to gain further understanding of circuits but has passed it up. The interview covered navigation systems, amplifiers, logic and simple transistor circuits.

Recommend reject. George's basic orientation is not compatible with the company's needs.

The two rating sheets show up the difference in the two men. Both rated higher than average, but you know from experience that your company has hired only men rated considerably above 300 in your rating system.

Frank comes out with a much higher score because of his drive and eagerness to learn. George shows up as one with some technical knowledge but no desire for deeper insights. He will be able to continue to do routine design work but will probably never make any significant contributions.

At this point, depending on your company's recruiting policy, you should decide whether George might be suitable for another department. Remember his earlier desire to go into Business Administration. If he seems to have other talents, you should recommend an interview with that department. ■■

JOB QUALIFICATIONS	WEIGHT	x	SCORE	=	WEIGHTED SCORE
TECHNICAL INSIGHT	10		5		50
EXPRESSION OF IDEAS	8		7		56
INTEREST IN CIRCUIT DESIGN	7		3		21
GROWTH POTENTIAL	7		4		28
TECHNICAL KNOWLEDGE	6		6		36
GRADE POINT AVERAGE	5		3.5/4.0 = 87.5		44
SELF-MOTIVATION	5		6		30
PERSONALITY	4		8		32
			TOTAL		297

### 3. Rating sheet for George

circuit to improve it, he comments that he has seen that done before. He is not able to explain what improvements could be expected from use of feedback.

You now ask about the project in which he had leadership, and he tells you about a small digital processor that monitors a number of quantities and drives appropriate displays. He answers the simple questions you propose. The design was done with standard ICs, but he doesn't know much about their internal structure. The little he knows he picked up in an in-plant seminar held by a semiconductor maker.

Although it has been a few years, you ask George about his course work. He admits that, toward the end of his junior year, he lost inter-



# Staggered-finger heat sink design is more efficient, saves space and weight

**Unique design is causing circuit designers to re-think their thermal theory.**

Design engineers are learning daily that power ratings of power transistors are often not at all what they appear to be at first glance. For example, the data sheet on a transistor may state, "maximum power dissipation — 50 watts." But the fine print — if there is any — says, "at 25°C case temperature." Actually, the transistor alone will dissipate only 3 to 4 watts before the maximum allowable junction temperature is reached!

Obviously, something must be done to maintain the specified case temperature when more than 3-4 watts are to be dissipated. This is normally accomplished by mounting the transistor case to a dissipator or heat sink, but dissipator state-of-the-art has been such that these devices are too bulky, too heavy — just plain inefficient. Now you needn't tolerate these size and weight penalties in your design because IERC has achieved a major breakthrough in heat sink design: The IERC Staggered Finger Dissipator.

International Electronic Research Corporation has developed a broad line of these smaller, lighter, much more efficient heat dissipators based on the unique, multiple staggered finger design which has proven to be 30% more efficient overall, and in some

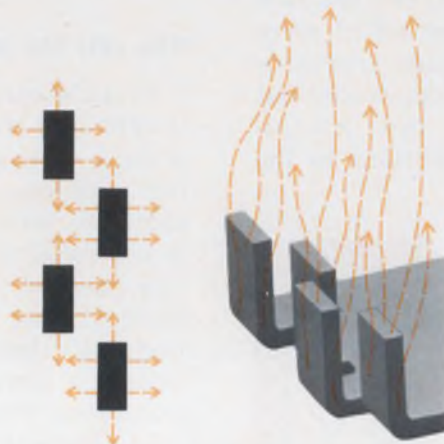


FIGURE 2



FIGURE 3

cases up to 500% more effective than many conventional designs now in wide use. An example of the staggered finger design is shown in Figure 1. This is an IERC HP3 Heat Dissipator. To show how efficient this device is, it is shown compared to a common finned extrusion. The HP3 and the extrusion are virtually equivalent in their heat dissipating ability; however, the HP3 is only 1/3rd the weight and 2/3rd the volume of the extrusion.

The secret to the efficiency of the new dissipators is the staggered fingers. (Figure 2) Note how the fingers are positioned so they do not radiate to each other and the configuration is so arranged that natural convection takes place very readily.

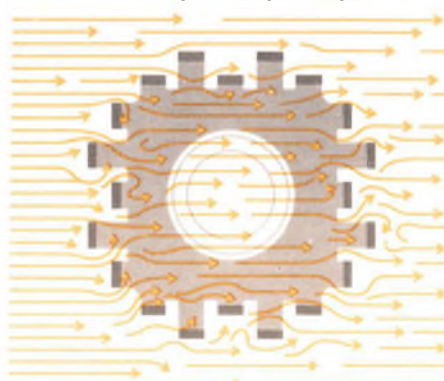


FIGURE 4

In a finned extrusion the fins radiate to each other and it is difficult for natural convection to take place in the confined area between the fins. (Figure 3)

In a forced air environment the staggered finger configuration is even more effective. The air can be from any direction. (Figure 4) As it hits the fingers, turbulence causes it to move around each of the fingers, striking many surfaces in its flow past the part. The turbulent air against these surfaces disturbs their surface barrier and is the principal reason for the significant improvement in the forced air heat dissipating properties of these parts.

Compare this turbulent air flow over the staggered fingers of the IERC part with the air flow conditions when directed at a finned extrusion. Here laminar air flow, rather than turbulent air flow, takes place. The air must be directed in one direction only, (Figure 5) parallel to the fins. The air enters the space between the fins; but because of this restricted space, it immediately tries to leave. Shortly after entering, it is not flowing against the bottom of the fin surfaces. Since the air flow is laminar, not turbulent, and it is not disturbing the surface barrier at the bottom of the fins shortly after entering, the surface areas of the fins are only partially effective.

The old rule-of-thumb which considers only the surface



FIGURE 5

area relative to heat dissipation is not valid. The effectiveness of the area must also be considered. The staggered finger concept is a significant breakthrough in heat dissipating devices and is the first improvement in heat dissipator design since the flat fin or extrusion design.

**Broad line accommodates all lead and case mounted semiconductors.**

During the past several years, IERC has developed numerous heat dissipating devices

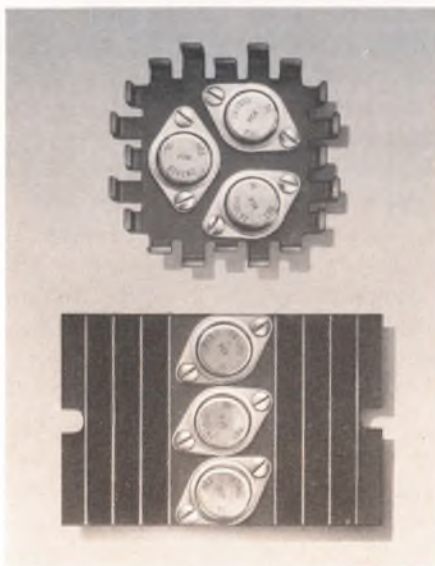


FIGURE 1



"See us at WESCON Booth Nos. 1126 and 1127"

using the staggered finger configuration.

The UP style (Figure 6) is just 1.78 inches square and is available in various heights up to one inch. It was designed particularly to accommodate a single power transistor such as a TO36, TO3, TO15, etc. However, it will also accommodate more than one smaller semiconductor, including the newer plastic case power transistors.

To really appreciate the efficiency of the UP, refer to the temperature vs. power

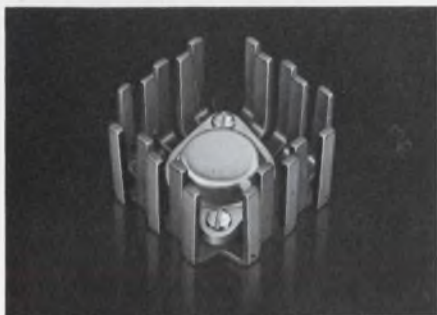


FIGURE 6

curve (Figure 7) showing a 2N1208 power transistor mounted in a UP-TO15-B dissipator. Remember, now, that this UP part weighs *less than one ounce*. Considering a maximum case rise of 100°C, the 2N1208 by itself will dissipate only 3 watts. When mounted in the UP dissipator in natural convection, it will dissipate 14 watts, or

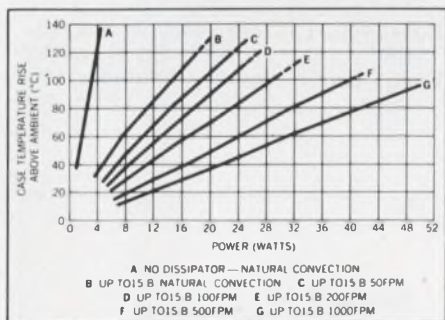


FIGURE 7

more than four times more power at the same case temperature. In a forced air environment of only 200 FPM, 28 watts can be dissipated — more than nine times the power at the same case temperature. With 1000 FPM, the remarkable light weight UP will allow 50 watts of dissipation from the transistor — *seventeen times more power at the same case temperature*.

Think now. You must limit the case temperature rise of a power transistor to 100°C. You need to dissipate 14, 28 or 50 watts. You have three cubic inches of space and are limited to adding one ounce of weight. And you can't spend more than 40 cents for a dissipator or sink in medium quantities. What would your present thinking lead you to do?



FIGURE 8

Another IERC dissipator, the HP1, is a companion to the HP3 shown in Figure 1. The HP1 is 2½ inches square, slightly larger than the UP. At the same case temperature rise of 100°C, it will dissipate 23 watts in natural convection; in a forced air flow of 200 FPM, it will dissipate 33 watts; and 65 watts with 1000 FPM. The HP3, which is 3½ inches square, will dissipate 28 watts in natural convection, 42 watts with 200 FPM, and 74 watts with 1000 FPM. When the HP1 and HP3 are nested, Figure 8, more than 100 watts can be dissipated at the same 100°C case temperature rise with 1000 FPM.

Stop and contemplate the sizes of heat dissipating devices which would have been required to dissipate these powers before the advent of the staggered finger design, and you will appreciate the savings of space and weight which the UP and HP make possible.

The staggered finger design has also been used in heat dissipators for TO5 and TO18 metal case transistors. Models in the LP Series, Figure 9, are available in three lengths and two heights and to accommodate one or two transistors. These parts are so efficient that when a TO5 transistor is mounted in the largest model

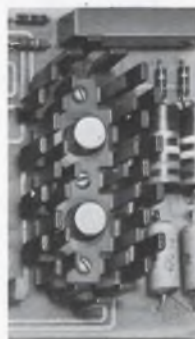


FIGURE 9

LP dissipator (only 2.31 x 1.12 x ½), the dissipator is virtually an infinite heat sink. The case temperature rises only 65°C when 5 watts are being dissipated. When 1000 FPM of air is used at 5 watts dissipation, the case temperature rise is phenomenally low — less than 15°C.

In addition to their thermal efficiency, LP parts are extremely versatile. Almost any application problem where a conduction plane is not available can be solved with these simple, low cost devices.

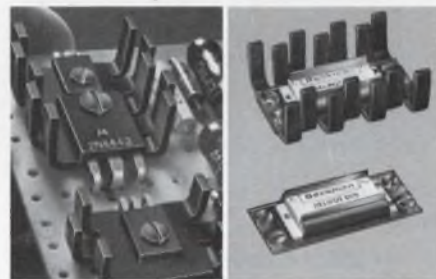


FIGURE 10

The staggered finger concept is also available in dissipators for plastic case power transistors and integrated circuits and microcircuit packages as shown in Figure 10.

The staggered finger concept of heat dissipation is the most significant breakthrough in heat sink technology since the advent of the power transistor. Get specific technical and pricing information on those IERC heat dissipators most applicable to your needs. Write on your company letterhead for Technical Bulletin 149 for more detailed information on the PA and PB series and Technical Bulletin 151 for the LB series. Technical Bulletin 134 and Test Report 172A detail the UP series; Technical Bulletin 139 and Test Report 198 cover the HP series; and for the LP series, ask for Technical Bulletin 135 and Test Report 182. You'll be surprised how substantially these advanced new heat sinks will contribute to the efficiency of your design and your equipment.

International Electronic Research Corporation, a corporate division of Dynamics Corporation of America, 135 West Magnolia Boulevard, Burbank, California 91502.



January — June 1970

# ELECTRONIC DESIGN

## semiannual

### index of articles

The articles in the various sections of this index are grouped under key words that indicate their general topics. Articles are listed more than once if they have to do with more than one general topic.

#### Avionics

- AF air-control network almost ready to travel... NEWS, ED 13, p. 22
- American Airlines uses 3-D navigation... NEWS, ED 1, p. 22
- An anticollision system for all planes... NEWS, ED 13, p. 30
- Complete guide to technical papers... IEEE, ED 6, p. U110
- F-15's missile sensor tests are under way... NEWS, ED 5, p. 21
- Giant C-5A's instrumentation is readied for tests... NEWS, ED 3, p. 26
- Pilots ask FAA for proximity warner—now... NEWS, ED 10, p. 32
- Spring Joint Computer Conference 1970... SR, ED 9, p. C1

#### Circuits & Circuit Theory

- Addition of current source to regulator improves performance... IFD, ED 1, p. 124
- Adjustable time-delay relay is controlled by overload current... IFD, ED 1, p. 126
- An Electronic Design practical guide for synchro-to-digital converters... ART, ED 6, p. 178
- An Electronic Design practical guide for synchro-to-digital converters... ART, ED 7, p. 50
- An Electronic Design practical guide for synchro-to-digital converters... ART, ED 8, p. 76
- An Electronic Design practical guide for synchro-to-digital converters...

- ... ART, ED 9, p. 72
- An Electronic Design practical guide for synchro-to-digital converters... ART, ED 10, p. 98
- Any code goes with IC decoder/drivers... ART, ED 13, p. 74
- Assemble a sequential counter... ART, ED 3, p. 60
- Astable multivibrator always starts in same state... IFD, ED 9, p. 94
- BASIC program designs bias circuits... IFD, ED 13, p. 92
- Boost discriminator performance with a differential capacitor... IFD, ED 3, p. 71
- Boost your DTL efficiency with wired-OR... ART, ED 8, p. 89
- Build better source followers 10 ways... ART, ED 12, p. 80

#### Departments key

ART	Technical Article
EDIT	Editorial
ENG DATA	Engineering Data
FOREIGN	Foreign News
IEEE	IEEE Section
IFD	Idea for Design
NEWS	News
PF	Product Feature
SR	Special Report

#### Subject Listing

Avionics	Management
Circuits & Circuit Theory	Materials & Packaging
Communications	Medical Electronics
Components	Microelectronics
Computer-Aided Design	Microwaves & Lasers
Computers & Data Processing	Military & Aerospace
Consumer Electronics	Product Source Directories
Displays	Semiconductors
General Industry	Systems
Industrial Electronics	Test & Measuring



- Cascading of broadband amplifiers made easy. NEWS, ED 3, p. 22
- Chart speeds the design of single-layer air-core coils. IFD, ED 6, p. 216
- Check flip-flops automatically. ART, ED 7, p. 66
- Choose magnetic deflection. ART, ED 9, p. 80
- Clock and control with TTL. ART, ED 10, p. 82
- Comparator uses NAND gate to prevent oscillation. IFD, ED 9, p. 96D
- Data-system activator has hold feature. IFD, ED 13, p. 96
- Decipher the Gray code. ART, ED 4, p. 70
- Decrease driver turn-off time without sacrificing efficiency. IFD, ED 2, p. 84
- Design filters in minutes. ART, ED 11, p. 86
- Diagram sequential logic on a cube. ART, ED 5, p. 54
- Diode protects power supply from short circuits. IFD, ED 8, p. 105
- Diodes make good gain-control devices. ART, ED 3, p. 54
- DTL circuit triggers multivibrator and insures starting. IFD, ED 8, p. 105
- Dual-channel i-f strip tracks without gain matching. IFD, ED 13, p. 94
- Electromagnetic interference worry you? ART, ED 6, p. 199
- Electronically tuned notch filter uses FET as a resistor. IFD, ED 6, p. 212
- Exclusive-OR gate doubles VCM output frequency. IFD, ED 13, p. 98
- EXCLUSIVE-OR gates replace choppers in phase-lock loop. IFD, ED 3, p. 73
- Feedback and clamping circuits improve comparator one-shot. IFD, ED 8, p. 103
- For circular polarization, try a bifilar helix. ART, ED 13, p. 78
- Gate your op amp. ART, ED 11, p. 90
- Go/no go circuit gives visual indication of RTL logic level. IFD, ED 4, p. 88
- Go push-pull for magnetic deflection. ART, ED 2, p. 70
- High-frequency VCO uses TTL gates. IFD, ED 11, p. 112
- High-speed zero crossing detector uses tunnel diodes. IFD, ED 6, p. 214
- Improve receiver frequency stability. ART, ED 2, p. 76
- Improved sawtooth generator has grounded reference point. IFD, ED 4, p. 80
- Improved SCR speed control achieves 100% motor regulation. IFD, ED 2, p. 90
- Improved switch-contact-bounce eliminator uses fewer parts. IFD, ED 1, p. 128
- Inexpensive interface works with both DTL and EIA levels. IFD, ED 2, p. 90
- Integrated op-amp pulse circuit has 18-second time constant. IFD, ED 11, p. 108
- Level-shifting circuit uses analog and digital design. IFD, ED 8, p. 107
- Liberate your FET amplifier. ART, ED 11, p. 78
- Linear temperature monitor uses silicon diodes as sensor. IFD, ED 1, p. 124
- Linear temperature sensor uses only a single transistor. IFD, ED 4, p. 86
- Low-power Schottky-clamped TTL circuits boast propagation delays of just 3 ns. PF, ED 10, p. 129
- Low-voltage shunt regulator can power tunnel diodes. IFD, ED 11, p. 110
- Modified one-shot provides long delay time. IFD, ED 9, p. 94
- Monolithic circuits provide inexpensive dual regulation. IFD, ED 11, p. 110
- MOS/bipolar memories store up to 4096 bits. PF, ED 9, p. 101
- Need low-voltage dc converter? ART, ED 4, p. 66
- Need to design a switching regulator? ART, ED 1, p. 106
- Neon-bulb circuit doubles as pilot light and trouble light. IFD, ED 1, p. 130
- New starting circuit requires little power. IFD, ED 9, p. 90
- Noise generator simulates radar return-signal 'grass'. IFD, ED 11, p. 114
- Noise spikes trigger random-pulse generator. IFD, ED 12, p. 102
- Over/under voltage monitor is inexpensive and stable. IFD, ED 3, p. 75
- Perform frequency scaling without rate multipliers. IFD, ED 2, p. 86
- Phase-locked loop utilizes current-controlled oscillator. IFD, ED 10, p. 114
- Predict intermodulation distortion. ART, ED 10, p. 76
- Presetable up/down counter needs no inhibits or one-shots. IFD, ED 10, p. 116
- Program designs active filters. ART, ED 6, p. 188
- Programmable design gives gating timer line immunity. IFD, ED 9, p. 90
- Pulse stretcher remembers level of narrow spike. IFD, ED 12, p. 96
- Schmitt trigger program uses standard resistor values. IFD, ED 12, p. 100
- Select the right op amp for the job. ART, ED 13, p. 106
- Simple ramp generator uses five components. IFD, ED 5, p. 83
- Simple transistor checker boasts speed and versatility. IFD, ED 12, p. 96
- Simple zero crossing detector minimizes power-line RFI. IFD, ED 5, p. 81
- Single transformer provides positive and negative voltages. IFD, ED 2, p. 86
- Single transistor AND gate needs no power supply. IFD, ED 9, p. 92
- Solid-state isolation relay has non-polarized terminals. IFD, ED 7, p. 77
- Solve op-amp slew-rate requirements. ENG DATA, ED 13, p. 82
- Speed up the fast Fourier transform. ART, ED 9, p. 66
- Spring Joint Computer Conference 1970. SR, ED 9, p. C1
- Three-transistor circuit functions as a one-shot SCR. IFD, ED 5, p. 81
- Transformer temperature found from winding resistance. IFD, ED 13, p. 94
- Two-transistor circuit blocks wrong voltage polarity/level. IFD, ED 4, p. 90
- Use a complementary stage to extend IC output level. IFD, ED 7, p. 75
- Use an audible alarm to indicate a blown fuse. IFD, ED 4, p. 84
- Use ECAP to design transistor models. ART, ED 10, p. 92
- Varactor tuning can be tricky. ART, ED 8, p. 82
- Voltage regulator is a current source or sink. IFD, ED 12, p. 102
- Voltage window detector provides logical output. IFD, ED 10, p. 114
- Why use current-mode flip-flops? ART, ED 3, p. 64
- Wideband frequency doubler from a single MOS IC. IFD, ED 1, p. 128
- Wiring modification improves voltage variable delay circuit. IFD, ED 4, p. 82

## Communications

- Ambulance telemeters information to doctor. NEWS, ED 3, p. 21
- Bell to test waveguide communications system. NEWS, ED 4, p. 21
- Boost discriminator performance with a differential capacitor. IFD, ED 3, p. 71
- Breaking the laser communication barriers. NEWS, ED 4, p. 30
- Cable TV: Slumbering electronic giant—A multibillion industry? SR, ED 8, p. 62
- Casinos find the best 'system' is electronics. SR, NEWS, ED 2, p. 24
- Check peak fm deviation the easy way. ENG DATA, ED 5, p. 70
- Closed-circuit TV sales boom in big-time racing. NEWS, ED 6, p. 22
- Coast-to-coast test for satellite TV. NEWS, ED 2, p. 22
- Complete guide to technical papers. IEEE, ED 6, p. U110
- Computer terminal prints four alphabets. NEWS, ED 7, p. 21
- Data processor to cut communications costs. NEWS, ED 7, p. 22



Electronics scores in sports . . . . . SR, ED 11, p. 36

50% rise asked in satellite circuits . . . . . NEWS, ED 2, p. 37

Giant Swedish antenna to relay telephone calls . . . . . FOREIGN, ED 13, p. 33

Improve receiver frequency stability . . . . . ART, ED 2, p. 76

In data communication, it's LSI . . . . . NEWS, ED 6, p. 24

Intelsat III starts commercial service . . . . . NEWS, ED 4, p. 22

Modular terminal computers talk to any other system . . . . . PF, ED 9, p. C42

NASA's relay satellite faces a wobbly future . . . . . NEWS, ED 4, p. 40

Navy needs telemetry gear in L and S bands . . . . . NEWS, ED 2, p. 22

Navy to computerize its message processing . . . . . NEWS, ED 10, p. 30

New gear improves scuba communications . . . . . NEWS, ED 2, p. 22

Off-line/on-line printers improve copy and cut costs . . . . . PF, ED 9, p. C46

Optical circuits carry laser light . . . . . NEWS, ED 6, p. 22

Portable terminal keeps computer on call . . . . . NEWS, ED 4, p. 36

Solar eclipse to air propagation prediction . . . . . NEWS, ED 5, p. 22

Spring Joint Computer Conference 1970 . . . . . SR, ED 9, p. C1

Stamping out crime by the numbers . . . . . NEWS, ED 8, p. 28

Time marches on—but electronically now . . . . . NEWS, ED 7, p. 25

Varactor tuning can be tricky . . . . . ART, ED 8, p. 82

What role for the FCC in the future of CATV? . . . . . NEWS, ED 7, p. 21

Worldwide network to predict solar EMI . . . . . NEWS, ED 13, p. 34

## Components

A/d and d/a signal conditioning modules set new standards in performance and price . . . . . PF, ED 12, p. 111

Alterable read-only core memory uses plug-in fixed-program boards . . . . . PF, ED 8, p. 133

Ambulance telemeters information to doctor . . . . . NEWS, ED 3, p. 21

An Electronic Design practical guide for synchro-to-digital converters . . . . . ART, ED 6, p. 178

An Electronic Design practical guide for synchro-to-digital converters . . . . . ART, ED 7, p. 50

An Electronic Design practical guide for synchro-to-digital converters . . . . . ART, ED 8, p. 76

An Electronic Design practical guide for synchro-to-digital converters . . . . . ART, ED 9, p. 72

An Electronic Design practical guide for synchro-to-digital converters . . . . . ART, ED 10, p. 98

Avoid the pitfalls of power-supply connections . . . . . ART, ED 4, p. D10

Beam-lead-chip TTL ICs are packaged units too . . . . . PF, ED 13, p. 137

Boost discriminator performance with a differential capacitor . . . . . IFD, ED 3, p. 71

Broadband low-cost rf switch boasts tiny size of 0.025 in.<sup>3</sup> . . . . . PF, ED 6, p. 234

Chart speeds the design of single-layer air-core coils . . . . . IFD, ED 6, p. 216

Coin-sized electrochemical storage device gives 50-F capacitance with 0.5-V rating . . . . . PF, ED 6, p. 227

Complete guide to technical papers . . . . . IEEE, ED 6, p. U110

Computer terminal uses photochromic CRT . . . . . NEWS, ED 9, p. 36

Contactless magnetic counter has high accuracy . . . . . NEWS, ED 11, p. 28

Device is an adaptive filter or transformer . . . . . NEWS, ED 4, p. 34

Digital-tape sensor requires no adjustments . . . . . IFD, ED 10, p. 112

Diode protects power supply from short circuits . . . . . IFD, ED 8, p. 105

DTL circuit triggers multivibrator and insures starting . . . . . IFD, ED 8, p. 105

Dynamic 20-bit shift register is 15-MHz n-channel MOS IC . . . . . PF, ED 3, p. 88

Economy 0.1% multiplier spans 100-kHz bandwidth . . . . . PF, ED 6, p. U134

Electromagnetic interference worry you? . . . . . ART, ED 6, p. 199

Electron beam transfers color video tape to film . . . . . NEWS, ED 9, p. 22

Electronically tuned notch filter uses FET as a resistor . . . . . IFD, ED 6, p. 212

Electronics scores in sports . . . . . SR, ED 11, p. 36

Etching improves multilayer board soldering . . . . . IFD, ED 7, p. 77

EXCLUSIVE-OR gates replace choppers in phase-lock loop . . . . . IFD, ED 3, p. 73

F-15's missile sensor tests are under way . . . . . NEWS, ED 5, p. 21

Fluidics still striving for wider acceptance . . . . . NEWS, ED 1, p. 21

Fluidics: Why not try it, specialists suggest . . . . . NEWS, ED 2, p. 32

Four-GHz transistors retail for only \$14 . . . . . PF, ED 13, p. 130

Gate turn-off SCRs switch 5 A in 2 $\mu$ s . . . . . PF, ED 1, p. 145

Half-dollar-sized disc holds up to 50 farads . . . . . NEWS, ED 6, p. 21

Hearing aid uses tiny 1.2-V op amp . . . . . NEWS, ED 5, p. 31

High-speed zero crossing detector uses tunnel diodes . . . . . IFD, ED 6, p. 214

How to cut semiconductor memory costs . . . . . NEWS, ED 4, p. 32

Hybrid transistor-can vhf/uhf amplifiers gain 14 dB minimum from 5 to 500 MHz . . . . . PF, ED 13, p. 129

Impatts continue their trip from lab to field . . . . . NEWS, ED 6, p. 25

Improved SCR speed control achieves 100% motor regulation . . . . . IFD, ED 2, p. 90

Inexpensive interface works with both DTL and EIA levels . . . . . IFD, ED 2, p. 90

Liberate your FET amplifier . . . . . ART, ED 11, p. 78

Linear temperature monitor uses silicon diodes as sensor . . . . . IFD, ED 1, p. 124

Linear temperature sensor uses only a single transistor . . . . . IFD, ED 4, p. 86

Low-cost TTL MSI IC pair enhance arithmetic logic . . . . . PF, ED 7, p. 102

Low-cost 50-MHz counter doubles as a seven-digit DVM . . . . . PF, ED 2, p. 106

Low-cost 100- $\mu$ W op amp holds bias to 3 nA . . . . . PF, ED 10, p. 133

Low-power Schottky-clamped TTL circuits boast propagation delays of just 3 ns . . . . . PF, ED 10, p. 129

Make sure you pick the right power supply . . . . . ART, ED 4, p. D22

Mini-antenna—but what a maxi performance! . . . . . NEWS, ED 8, p. 25

Miniature storage tube for \$500 can hold an image for two weeks . . . . . PF, ED 2, p. 101

Modular a/d and d/a converters boost performance, drop prices . . . . . PF, ED 6, p. U132

Modular 15-bit d/a converters set state-of-art specs . . . . . PF, ED 3, p. 85

Modular \$195 a/d converter handles 10 bits in 30  $\mu$ s . . . . . PF, ED 5, p. 102

Monolithic LED numeric competes with nixie prices . . . . . PF, ED 7, p. 110

Monolithic readout challenges Nixies . . . . . NEWS, ED 6, p. 22

Neon-bulb circuit doubles as pilot light and trouble light . . . . . IFD, ED 1, p. 130

New gas engines offer computer standby power . . . . . NEWS, ED 6, p. 22

New isolator boosts solid-state power . . . . . NEWS, ED 13, p. 25

New progress in ferroelectric ceramics . . . . . NEWS, ED 12, p. 30

Nonexplosive fuze releases mechanical energy . . . . . NEWS, ED 8, p. 26

Optical encoder with remote reflective disc controls speed digitally without adding mass . . . . . PF, ED 9, p. 97

Plug-in IC logic-card system permits customized designs . . . . . PF, ED 6, p. U138

Power tubes making a strong comeback . . . . . IEEE, ED 6, p. U97

Read-only 512-bit memory programs electronically . . . . . PF, ED 10, p. 130

Sensors would inflate car-crash cushions . . . . . NEWS, ED 12, p. 22

Simple ramp generator uses five components . . . . . IFD, ED 5, p. 83



Simple technique removes multilead components from PCs. . . . IFD, ED 1, p. 130

Single transformer provides positive and negative voltages. . . . IFD, ED 2, p. 86

Single transistor AND gate needs no power supply. . . . IFD, ED 9, p. 92

Solid-state isolation relay has non-polarized terminals. . . . IFD, ED 7, p. 77

Spring Joint Computer Conference 1970. . . . SR, ED 9, p. C1

Step up power-supply efficiency. . . . ART, ED 5, p. 66

Symmetrical power supply is adjusted with only one control. . . . IFD, ED 6, p. 210

TTL quad flip-flop with three logic states eliminates need for OR gates on output. . . . PF, ED 7, p. 101

The 1971 watch; No hands, no moving parts. . . . NEWS, ED 11, p. 30

Three-transistor circuit functions as a one-shot SCR. . . . IFD, ED 5, p. 81

Time marches on—but electronically now. . . . NEWS, ED 7, p. 25

Tiny four-bit converter is fast thin-film hybrid. . . . PF, ED 1, p. 146

Transistor chips for 60¢ dissipate up to 117 W. . . . PF, ED 12, p. 116

Trimmed chopperless op amp minimizes drift to 0.25  $\mu\text{V}/^\circ\text{C}$ . . . . PF, ED 10, p. 136

Use ECAP to design transistor models. . . . ART, ED 10, p. 92

Use piezoelectric ceramics. . . . ART, ED 5, p. 60

Varactor diode is the key to a simple frequency divider. IFD, ED 4, p. 88

Wideband frequency doubler from a single MOS IC. IFD, ED 1, p. 128

### Computer-Aided Design

Active filter design uses BASIC language. . . . IFD, ED 5, p. 83

BASIC program designs bias circuits. . . . IFD, ED 13, p. 92

Complete guide to technical papers. . . . IEEE, ED 6, p. U110

Design filters in minutes. . . . ART, ED 11, p. 86

Design MOS circuits on a computer. . . . ART, ED 13, p. 68

Make tables with a time-shared computer. . . . IFD, ED 4, p. 88

Program designs active filters. . . . ART, ED 6, p. 188

Program determines worst-case part values. . . . IFD, ED 7, p. 81

Programmable design gives gating timer line immunity. . . . IFD, ED 9, p. 90

Schmitt trigger program uses standard resistor values. . . . IFD, ED 12, p. 100

Speed up the fast Fourier transform. . . . ART, ED 9, p. 66

Spring Joint Computer Conference 1970. . . . SR, ED 9, p. C1

Use ECAP to design transistor models. . . . ART, ED 10, p. 92

### Computers & Data Processing

A/d and d/a signal conditioning modules set new standards in performance and price. . . . PF, ED 12, p. 111

Alterable read-only core memory uses plug-in fixed-program boards. . . . PF, ED 8, p. 133

Automation revolution sweeps Europe. . . . NEWS, ED 12, p. 24

British urged to merge computer software firms. . . . NEWS, ED 11, p. 22

Business-machine trade soars to new heights. . . . FOREIGN, ED 13, p. 33

Canon and TI develop LSI pocket calculator. . . . NEWS, ED 11, p. 22

Complete guide to technical papers. . . . IEEE, ED 6, p. U110

Computer functions as ship's doctor. . . . NEWS, ED 1, p. 22

Computer terminal prints four alphabets. . . . NEWS, ED 7, p. 21

Computer terminal uses photochromic CRT. . . . NEWS, ED 9, p. 36

Computers can spot offshore oil leaks. . . . NEWS, ED 4, p. 22

Computers to sort mail at 210 post offices. . . . NEWS, ED 9, p. 21

Contactless magnetic counter has high accuracy. . . . NEWS, ED 11, p. 28

Content addressable memories match input to stored data. . . . PF, ED 11, p. 117

Data processor to cut communications costs. . . . NEWS, ED 7, p. 22

Data-system activator has hold feature. . . . IFD, ED 13, p. 96

Digital computer with 16-bit capacity boasts basic cycle time of 100 ns. . . . PF, ED 9, p. C36

Digital Equipment adds 16-bit minicomputer. . . . NEWS, ED 3, p. 22

Digital system locates vehicles in seconds. . . . NEWS, ED 3, p. 22

Digital-tape sensor requires no adjustments. . . . IFD, ED 10, p. 112

Display converts for radar or computer use. . . . NEWS, ED 13, p. 28

Electronics scores in sports. . . . SR, ED 11, p. 36

From machine tools to minicomputers. . . . NEWS, ED 4, p. 21

Gigabit technology picking up speed. . . . IEEE, ED 6, p. U86

High-speed plated-wire read-only memories can electronically alter stored-program data. . . . PF, ED 5, p. 95

Lasers show promise as computer memories. . . . NEWS, ED 12, p. 22

Memory devices to be explored at conference. . . . NEWS, ED 5, p. 22

Minicomputer to do skyscraper chores. . . . NEWS, ED 10, p. 22

Mini-machines and mini-firms marked this year's SJCC. . . . NEWS, ED 11, p. 21

Modular terminal computers talk to any other system. . . . PF, ED 9, p. C42

MOS/bipolar memories store up to 4096 bits. . . . PF, ED 9, p. 101

Navy to computerize its message processing. . . . NEWS, ED 10, p. 30

New computer firm pushes modular concept. . . . NEWS, ED 10, p. 22

New field-programmable ROM slated for debut. . . . NEWS, ED 13, p. 22

New gas engines offer computer standby power. . . . NEWS, ED 6, p. 22

Novel storage terminal slashes graphics costs. . . . PF, ED 9, p. C51

Off-line/on-line printers improve copy and cut costs. . . . PF, ED 9, p. C46

Portable terminal keeps computer on call. . . . NEWS, ED 4, p. 36

'Second-sourcing' starts in minicomputer market. . . . NEWS, ED 7, p. 21

\$71-million in computers ordered by Government. . . . NEWS, ED 9, p. 21

Shakeout is rattling time-sharing business. . . . NEWS, ED 3, p. 21

Solid-state memories cost less than 2¢ per bit. . . . PF, ED 6, p. 238

Speed up the fast Fourier transform. . . . ART, ED 9, p. 66

Spring Joint Computer Conference 1970. . . . SR, ED 9, p. C1

Stamping out crime by the numbers. . . . NEWS, ED 8, p. 28

System design means trade-offs. . . . ART, ED 7, p. 60

The computer and its growing pains. . . . SR, ED 1, p. 80

The minicomputer: machine with an endless future. . . . SR, ED 9, p. C6

3-way struggle looming for No. 2 computer spot. . . . NEWS, ED 12, p. 21

2 new minicomputers to be shown at SJCC. . . . NEWS, ED 9, p. 22

Urgently wanted: A data terminal. . . . SR, ED 1, p. 90

Utilities discover the power of computers. . . . NEWS, ED 5, p. 30

Wanted: Memory for sledding at Mach 7. . . . NEWS, ED 6, p. 41

World stock quotations offered in real time. . . . NEWS, ED 13, p. 22

### Consumer Electronics

All-IC consumer products edge a little closer. . . . NEWS, ED 6, p. 26

Cable TV: Slumbering electronic giant—A multibillion industry? . . . SR, ED 8, p. 62

Canon and TI develop LSI pocket calculator. . . . NEWS, ED 11, p. 22

'Cities are the growth industry of the future'. . . . IEEE, ED 6, p. U89

Coast-to-coast test for satellite TV. . . . NEWS, ED 2, p. 22

Desk-top calculators close the gap. . . . ART, ED 1, p. 114

Electronics scores in sports. . . . SR, ED 11, p. 36



Expansion plan cheers cable-TV industry. . . . NEWS, ED 12, p. 22  
 FCC official warns of dangers of EMI . . . . NEWS, ED 8, p. 22  
 For the consumer it's solid state. . . . SR, ED 1, p. 76  
 Hearing aid uses tiny 1.2-V op amp . . . . NEWS, ED 5, p. 31  
 New gear improves scuba communications. . . . NEWS, ED 2, p. 22  
 Improved SCR speed control achieves 100% motor regulation. . . . IFD, ED 2, p. 90  
 Reserve train seats with vending machine. . . . NEWS, ED 1, p. 22  
 Sensors would inflate car-crash cushions. . . . NEWS, ED 12, p. 22  
 Soviet puts lasers in telephone links . . . . NEWS, ED 8, p. 21  
 Spring Joint Computer Conference 1970. . . . SR, ED 9, p. C1  
 The 1971 watch: No hands, no moving parts. . . . NEWS, ED 11, p. 30  
 Time marches on—but electronically now. . . . NEWS, ED 7, p. 25  
 What role for the FCC in the future of CATV? . . . . NEWS, ED 7, p. 21

### Displays

Choose magnetic deflection. . . . ART, ED 9, p. 80  
 Closed-circuit TV sales boom in big-time racing. . . . NEWS, ED 6, p. 22  
 Desktop \$500 data display is self-contained terminal. . . . PF, ED 9, p. C41  
 Display conference sees need for more color. . . . NEWS, ED 13, p. 21  
 Display converts for radar or computer use. . . . NEWS, ED 13, p. 28  
 Electron beam transfers color video tape to film. . . . NEWS, ED 9, p. 22  
 Electronics scores in sports. . . . SR, ED 11, p. 36  
 Giant C-5A's instrumentation is readied for tests. . . . NEWS, ED 3, p. 26  
 Go/no circuit gives visual indication of RTL logic level. IFD, ED 4, p. 88  
 Go push-pull for magnetic deflection . . . . ART, ED 2, p. 70  
 Hexidecimal display uses MSI package to drive Nixie readout. . . . IFD, ED 2, p. 88  
 Miniature storage tube for \$500 can hold an image for two weeks. . . . PF, ED 2, p. 101  
 Monolithic LED numeric competes with nixie prices. PF, ED 7, p. 110  
 Monolithic readout challenges Nixies . . . . NEWS, ED 6, p. 22  
 New terminal displays radar, computer data. . . . NEWS, ED 12, p. 22  
 Novel storage terminal slashes graphics costs. . . . SR, ED 9, p. C51  
 Off-line/on-line printers improve copy and cut costs. . . . PF, ED 9, p. C46  
 Spring Joint Computer Conference 1970. . . . SR, ED 9, p. C1  
 The 1971 watch: No hands, no mov-

ing parts. . . . NEWS, ED 11, p. 30  
 Time marches on—but electronically now. . . . NEWS, ED 7, p. 25  
 World stock quotations offered in real time. . . . NEWS, ED 13, p. 22

### General Industry

A new show helps launch 'the spectacular 70s'. . . . IEEE, ED 6, p. U85  
 As goes the economy; so goes IEEE show. . . . NEWS, ED 8, p. 22  
 Avoid the pitfalls of power-supply connections. . . . ART, ED 4, p. D10  
 Belgian manufacturers set up New York office. . . . NEWS, ED 4, p. 22  
 Big show with an eye for the tiny. . . . NEWS, ED 10, p. 25  
 Business-machine trade soars to new heights. . . . FOREIGN, ED 13, p. 33  
 By 1980, you may need a doctorate . . . . SR, ED 1, p. 94  
 'Cities are the growth industry of the future'. . . . IEEE, ED 6, p. U89  
 Complete guide to technical papers . . . . IEEE, ED 6, p. U110  
 Demand for engineers declined again in 1969. . . . NEWS, ED 6, p. 22  
 Electronics—it follows you everywhere nowadays. . . . EDIT, ED 4, p. 55  
 Electronics scores in sports. . . . SR, ED 11, p. 36  
 Engineers' problems are also industry's problems. EDIT, ED 8, p. 61  
 For Sales/EE interface: Sell—don't tell. . . . ED 4, ART, p. 76  
 Get to know your local SBA agent. . . . ART, ED 10, p. 106  
 IEEE chief sees industry facing tough pull in 70s. . . . NEWS, ED 12, p. 21  
 Israelis double electronics output. . . . NEWS, ED 9, p. 21  
 Item 807: A boon—or bust for electronics? . . . . NEWS, ED 9, p. 24  
 Japan's electronic sales rocket to new heights. . . . IEEE, SR, ED 6, p. U162  
 Job market dark for June EE grads. . . . NEWS, ED 4, p. 22  
 Made in Japan. . . . IEEE, SR, ED 6, p. U161  
 Money isn't everything to a Japanese engineer. IEEE, SR, ED 6, p. U174  
 NASA's job picture—a continuing decline. . . . NEWS, ED 10, p. 22  
 Needed: a quality design for living. . . . ART, ED 12, p. 90  
 Private R&D supported. . . . NEWS, ED 3, p. 22  
 '71 budget will separate the men from the boys. . . . EDIT, ED 6, p. 63  
 Simple technique removes multilead components from PCs. . . . IFD, ED 1, p. 130  
 '69 electronics profits up, sales down survey shows. . . . NEWS, ED 13, p. 21  
 Smallest electronics advance in years . . . . NEWS, ED 1, p. 25  
 Spring Joint Computer Conference 1970. . . . SR, ED 9, p. C1

Technology in the 70's. . . . SR, ED 1, p. 68  
 Technology in the Seventies: it's how it's used that counts. . . . EDIT, ED 1, p. 51  
 Technology: Present and future. . . . IEEE, ED 6, p. U86  
 That 'dream' job might be a nightmare! . . . . ART, ED 6, p. 204  
 The automation revolution sweeps Europe. . . . NEWS, ED 12, p. 24  
 \$200.8-billion U.S. budget shuffles priorities. . . . ED 5, NEWS, p. 24  
 U.S. Budget for fiscal 1971; A mixed anti-inflation bag. . . . NEWS, ED 4, p. 21  
 U.S. Commerce Dept. sponsors show in Japan. . . . NEWS, ED 10, p. 21  
 U.S. electronics may be hit by European trade agreement. . . . NEWS, ED 6, p. 21  
 U. S. sales at Mesucora exceed \$100,000 mark. . . . NEWS, ED 13, p. 22  
 U.S. technology stars at 20-nation Paris show. . . . NEWS, ED 9, p. 21  
 Urban engineering: Help for U.S. cities. . . . SR, ED 1, p. 71  
 Workshops in the sky, then factories . . . . NEWS, ED 1, p. 30

### Industrial Electronics

A/d and d/a signal conditioning modules set new standards in performance and price. . . . PF, ED 12, p. 111  
 An Electronic Design practical guide for synchro-to-digital converters. . . . ART, ED 6, p. 178  
 An Electronic Design practical guide for synchro-to-digital converters. . . . ART, ED 7, p. 50  
 An Electronic Design practical guide for synchro-to-digital converters. . . . ART, ED 8, p. 76  
 An Electronic Design practical guide for synchro-to-digital converters. . . . ART, ED 9, p. 72  
 An Electronic Design practical guide for synchro-to-digital converters. . . . ART, ED 10, p. 98  
 Any code goes with IC decoder/drivers. . . . ART, ED 13, p. 74  
 Automatic caller reads meters by telephones. . . . NEWS, ED 8, p. 22  
 Automation revolution sweeps Europe. . . . NEWS, ED 12, p. 24  
 Cable TV: Slumbering electronic giant—A multibillion industry? . . . . SR, ED 8, p. 62  
 Casinos find the best 'system' is electronics . . . . SR, NEWS, ED 2, p. 24  
 'Cities are the growth industry of the future'. . . . IEEE, ED 6, p. U89  
 Coast-to-coast test for satellite TV. . . . NEWS, ED 2, p. 22  
 Complete guide to technical papers . . . . IEEE, ED 6, p. U110  
 Computers to sort mail at 210 post offices. . . . NEWS, ED 9, p. 21



Computing \$750 counter measures 1 Hz to 1 MHz. PF, ED 4, p. 98  
 Digital system locates vehicles in seconds. NEWS, ED 3, p. 22  
 Digital-tape sensor requires no adjustments. IFD, ED 10, p. 112  
 Electron beam transfers color video tape to film. NEWS, ED 9, p. 22  
 Electronics makes ski slopes safer. NEWS, ED 1, p. 21  
 Electronics scores in sports. SR, ED 11, p. 36  
 Environment pollution calls for a team cure. IEEE, ED 6, p. U100  
 Expansion plan cheers cable-TV industry. NEWS, ED 12, p. 22  
 Fast image analyzer for materials research. NEWS, ED 1, p. 22  
 FCC urges control of 'electronic smog'. NEWS, ED 1, p. 36  
 Fluidics still striving for wider acceptance. NEWS, ED 1, p. 21  
 Fluidics: Why not try it, specialists suggest. NEWS, ED 2, p. 32  
 Improved SCR speed control achieves 100% motor regulation. IFD, ED 2, p. 90  
 Industry can help solve postal chaos. EDIT, ED 9, p. 63  
 Laser makes air visible to aircraft designers. NEWS, ED 11, p. 32  
 Linear sweep generator uses zener diode. IFD, ED 12, p. 98  
 Low-cost tape copying developed in Japan. NEWS, ED 9, p. 22  
 Minicomputer to do skyscraper chores. NEWS, ED 10, p. 22  
 MIT Alumni Center attacks urban problems. NEWS, ED 4, p. 22  
 Monitor keeps tab on noisy vehicles. NEWS, ED 1, p. 34  
 New electron microscope can "see" heavy atoms. NEWS, ED 12, p. 21  
 New holographic system foils credit-card frauds. NEWS, ED 13, p. 21  
 New radar will solve mysteries of storms. NEWS, ED 4, p. 31  
 Pollution control needs more technical push. NEWS, ED 8, p. 22  
 Process squeezes out wire like toothpaste. NEWS, ED 11, p. 26  
 Simple technique removes multihead components from PCs. IFD, ED 1, p. 130  
 Soviet puts lasers in telephone links. NEWS, ED 8, p. 21  
 Spring Joint Computer Conference 1970. SR, ED 9, p. C1  
 Stamping out crime by the numbers. NEWS, ED 8, p. 28  
 Time marches on—but electronically now. NEWS, ED 7, p. 25  
 Tug operation made easy. NEWS, ED 8, p. 26  
 U. S. Center in Frankfurt to show clean-air devices. FOREIGN, ED 13, p. 33  
 U. S. Post Office buys Japanese mail handler. FOREIGN, ED 13, p. 33  
 What role for the FCC in the future

of CATV? NEWS, ED 7, p. 21  
 World stock quotations offered in real time. NEWS, ED 13, p. 22

### Management

A labor guild for engineers? The idea has possibilities. EDIT, ED 5, p. 45  
 Anxious about the sale of your design? ART, ED 1, p. 118  
 Appraisal programs can be effective. ART, ED 2, p. 80  
 Are you your own worst enemy? EDIT, ED 7, p. 49  
 Be your own boss this year—you and your job will benefit. EDIT, ED 2, p. 49  
 Casinos find the best 'system' is electronics. SR, NEWS, ED 2, p. 24  
 'Cities are the growth industry of the future'. IEEE, ED 6, p. U89  
 Complete guide to technical papers. IEEE, ED 6, p. U110  
 Curing engine failures BEFORE they occur. NEWS, ED 7, p. 30  
 Electronic network proposed to monitor pollution. NEWS, ED 5, p. 21  
 Engineers' problems are also industry's problems. EDIT, ED 8, p. 61  
 Engineers want more challenges. ART, ED 11, p. 96  
 Environment pollution calls for a team cure. IEEE, ED 6, p. U100  
 Explore the 'now' meaning of innovation. ART, ED 9, p. 84  
 FCC official warns of dangers of EMI. NEWS, ED 8, p. 22  
 For Sales/EE interface: Sell—don't tell. ED 4, ART, p. 76  
 Get to know your local SBA agent. ART, ED 10, p. 106  
 Job market dark for June EE grads. NEWS, ED 4, p. 22  
 Management is in metamorphosis. ART, ED 7, p. 70  
 Microwaves may reduce sewage-treatment cost. NEWS, ED 10, p. 22  
 Minicomputer to do skyscraper chores. NEWS, ED 10, p. 22  
 MIT Alumni Center attacks urban problems. NEWS, ED 4, p. 22  
 Money isn't everything to a Japanese engineer. IEEE, SR, ED 6, p. U174  
 Semianual index of articles. ED 4, p. 92  
 Spring Joint Computer Conference 1970. SR, ED 9, p. C1  
 Sure, it's a down year, but what are you going to do about it? EDIT, ED 13, p. 67  
 System design means trade-offs. ART, ED 7, p. 60  
 That 'dream' job might be a nightmare! ART, ED 6, p. 204  
 There's no magic to managing Intel-sat IV. ART, ED 5, p. 72  
 Think sales engineering is your thing? ART, ED 13, p. 86

Why not give your Congressman some lessons in engineering? EDIT, ED 12, p. 69  
 Wired for the 'electric' generation? ART, ED 8, p. 94

### Materials & Packaging

Complete guide to technical articles. IEEE, ED 6, p. U110  
 Computer terminal uses photochromic CRT. NEWS, ED 9, p. 36  
 Electronic system stops corrosion of metals. NEWS, ED 13, p. 32  
 Etching improves multilayer board soldering. IFD, ED 7, p. 77  
 Monolithic LED numeric competes with nixie prices. PF, ED 7, p. 110  
 Multi-layer IC wiring structure packs 4 chips in standard DIP. PF, ED 4, p. 116  
 New ceramic promises to be useful in devices. NEWS, ED 11, p. 21  
 New computer firm pushes modular concept. NEWS, ED 10, p. 22  
 New devices developed at Bell Labs. NEWS, ED 9, p. 37  
 Simple technique removes multilead components from PCs. IFD, ED 1, p. 130  
 Spring Joint Computer Conference 1970. SR, ED 9, p. C1

### Medical Electronics

Automated heart care shown in N.J. hospital. NEWS, ED 10, p. 22  
 Complete guide to technical papers. IEEE, ED 6, p. U110  
 Designers still grope for efficient 'limbs'. IEEE, ED 6, p. U92  
 Electronics tunes in on muscle fatigue. NEWS, ED 7, p. 34  
 Hospital data system designed by an MD. NEWS, ED 9, p. 30  
 Medical electronics to be legislated? NEWS, ED 5, p. 21  
 NASA scientist offers new cancer theory. NEWS, ED 8, p. 21  
 Rx for progress in medical electronics: Communicate! NEWS, ED 6, p. 30  
 Ultrasound used to check for heart disease. NEWS, ED 6, p. 22  
 Where EE and MD link up to prolong life. SR, ED 4, p. 24

### Microelectronics

A changing world with microcircuits. SR, ED 1, p. 84  
 All-IC consumer products edge a little closer. NEWS, ED 6, p. 26  
 Any code goes with IC decoder/drivers. ART, ED 13, p. 74  
 Beam-lead-chip TTL ICs are packaged units too. PF, ED 13, p. 137  
 Boost your DTL efficiency with wired-OR. ART, ED 8, p. 89  
 Can you build a system with off-the-



- shelf LSI? . . . . . SR, ED 5, p. 46
- Clock and control with TTL . . . . . ART, ED 10, p. 82
- Commercial-price ICs are 100% MIL-tested . . . . . PF, ED 9, p. 103
- Complete guide to technical papers . . . . . IEEE, ED 6, p. U110
- Costs of ICs reduced by new BTL technique . . . . . NEWS, ED 5, p. 22
- Design MOS circuits on a computer . . . . . ART, ED 13, p. 68
- DTL circuit triggers multivibrator and insures starting . . . . . IFD, ED 8, p. 105
- Dynamic 20-bit shift register is 15-MHz n-channel MOS IC . . . . . PF, ED 3, p. 88
- Electronics scores in sports . . . . . SR, ED 11, p. 36
- EXCLUSIVE-OR gates replace choppers in phase-lock loop . . . . . IFD, ED 3, p. 73
- Extend standard cell design to bipolars . . . . . NEWS, ED 6, p. 42
- Fairchild looks into its IC future . . . . . NEWS, ED 1, p. 21
- Find the absolute value of bipolar pulses . . . . . IFD, ED 4, p. 84
- For the consumer it's solid state . . . . . SR, ED 1, p. 76
- Frequency-shift oscillator uses DTL circuits throughout . . . . . IFD, ED 3, p. 77
- Gate your op amp . . . . . ART, ED 11, p. 90
- Go/no go circuit gives visual indication of RTL logic level . . . . . IFD, ED 4, p. 88
- Hearing aid uses tiny 1.2-V op amp . . . . . NEWS, ED 5, p. 31
- Hexidecimal display uses MSI package to drive Nixie readout . . . . . IFD, ED 2, p. 88
- High-frequency VCO uses TTL gates . . . . . IFD, ED 11, p. 112
- His IC brainchild is no baby any more . . . . . EDIT, ED 3, p. 43
- How to cut semiconductor memory costs . . . . . NEWS, ED 4, p. 32
- Huge market growth forecast for British ICs . . . . . NEWS, ED 6, p. 32
- Hybrid transistor-can vhf/uhf amplifiers gain 14 dB minimum from 5 to 500 MHz . . . . . PF, ED 13, p. 129
- IC complexity due to double yearly . . . . . IEEE, ED 6, p. U93
- ICs play a heavy role in Japanese success . . . . . IEEE, SR, ED 6, p. U164
- Improved current source uses linear IC as a design element . . . . . IFD, ED 5, p. 79
- In data communication, it's LSI . . . . . NEWS, ED 6, p. 24
- Integrated op-amp pulse circuit has 18-second time constant . . . . . IFD, ED 11, p. 108
- Ion-implanted 64-bit register works at 20-MHz clock rates . . . . . PF, ED 1, p. 144
- Inexpensive interface works with both DTL and EIA levels . . . . . IFD, ED 2, p. 90
- LSI poses dilemma for systems designers . . . . . SR, ED 3, p. 44
- Laser beam draws quick and clean patterns for ICs . . . . . NEWS, ED 10, p. 36
- Low-cost TTL MSI IC pair enhance arithmetic logic . . . . . PF, ED 7, p. 102
- Low-power Schottky-clamped TTL circuits boast propagation delays of just 3 ns . . . . . PF, ED 10, p. 129
- Major advances predicted for thin-film ICs . . . . . NEWS, ED 12, p. 36
- Monolithic circuits provide inexpensive dual regulation . . . . . IFD, ED 11, p. 110
- Monolithic LED numeric competes with nixie prices . . . . . PF, ED 7, p. 110
- Monolithic readout challenges Nixies . . . . . NEWS, ED 6, p. 22
- MOS/bipolar memories store up to 4096 bits . . . . . PF, ED 9, p. 101
- Motorola optimistic about MOS and ECL . . . . . NEWS, ED 11, p. 22
- Cards A1 to T48 . . . . . 6-22-70
- Multi-layer IC wiring structure packs 4 chips in standard DIP . . . . . PF, ED 4, p. 116
- New devices developed at Bell Labs . . . . . NEWS, ED 9, p. 37
- New field-programmable ROM slated for debut . . . . . NEWS, ED 13, p. 22
- Plug-in IC logic-card system permits customized designs . . . . . PF, ED 6, p. U138
- Read-only 512-bit memory programs electronically . . . . . PF, ED 10, p. 130
- S-band IC flatpack amplifiers can be soldered together . . . . . PF, ED 4, p. 108
- Solid-state memories cost less than 2¢ per bit . . . . . PF, ED 6, p. 238
- Spring Joint Computer Conference 1970 . . . . . SR, ED 9, p. C1
- The 1971 watch: No hands, no moving parts . . . . . NEWS, ED 11, p. 30
- Thick-film circuits find increasing uses . . . . . NEWS, ED 3, p. 21
- TI predicts worldwide boom in semiconductors . . . . . NEWS, ED 10, p. 21
- Tiny four-bit converter is fast thin-film hybrid . . . . . PF, ED 1, p. 146
- TTL quad flip-flop with three logic states eliminates need for OR gates on output . . . . . PF, ED 7, p. 101
- Use a complementary stage to extend IC output level . . . . . IFD, ED 7, p. 75
- Microwaves & Lasers**
- Antenna design aid rises in the desert . . . . . NEWS, ED 7, p. 32
- Amy favors beam scan for helicopter lander . . . . . NEWS, ED 7, p. 22
- Bell to test waveguide communications system—NEWS, ED 4, p. 21
- Breaking the laser communication barriers . . . . . NEWS, ED 4, p. 30
- Broadband low-cost rf switch boasts tiny size of 0.025 in.<sup>3</sup> . . . . . PF, ED 6, p. 234
- Cable TV: Slumbering electronic giant—A multibillion industry? . . . . . SR, ED 8, p. 62
- Check peak fm deviation the easy way . . . . . ENG DATA, ED 5, p. 70
- Closed-circuit TV sales boom in big-time racing . . . . . NEWS, ED 6, p. 22
- Designing with microstrip is easy . . . . . ART, ED 1, p. 100
- Display converts for radar or computer use . . . . . NEWS, ED 13, p. 28
- Dual-channel i-f strip tracks without gain matching . . . . . IFD, ED 13, p. 94
- Electron beam transfers color video tape to film . . . . . NEWS, ED 9, p. 22
- Electronics scores in sports . . . . . SR, ED 11, p. 36
- Elliptic-filter design advances in two areas . . . . . NEWS, ED 13, p. 26
- FCC official warns of dangers of EMI . . . . . NEWS, ED 8, p. 22
- For circular polarization, try a bifilar helix . . . . . ART, ED 13, p. 78
- Giant Swedish antenna to relay telephone calls . . . . . FOREIGN, ED 13, p. 33
- Impatts continue their trip from lab to field . . . . . NEWS, ED 6, p. 25
- Improve receiver frequency stability . . . . . ART, ED 2, p. 76
- Invisible, corner-turning IR detects thieves . . . . . NEWS, ED 11, p. 25
- It's time to consider CW chemical lasers . . . . . NEWS, ED 9, p. 28
- Laser beam draws quick and clean patterns for ICs . . . . . NEWS, ED 10, p. 36
- Laser makes air visible to aircraft designers . . . . . NEWS, ED 11, p. 32
- Laser or millimeter space communications? . . . . . NEWS, ED 10, p. 34
- Laser radar to pinpoint details of moon's surface . . . . . NEWS, ED 11, p. 22
- Lasers show promise as computer memories . . . . . NEWS, ED 12, p. 22
- Microwaves may reduce sewage-treatment cost . . . . . NEWS, ED 10, p. 22
- Mini-antenna—but what a maxi performance! . . . . . NEWS, ED 8, p. 25
- NASA's relay satellite faces a wobbly future . . . . . NEWS, ED 4, p. 40
- Navy develops radar for shipboard guns . . . . . NEWS, ED 5, p. 22
- Navy needs telemetry gear in L and S bands . . . . . NEWS, ED 2, p. 22
- New-generation radar goes to White Sands . . . . . NEWS, ED 3, p. 22
- New holographic system foils credit-card frauds . . . . . NEWS, ED 13, p. 21
- New isolator boosts solid-state power . . . . . NEWS, ED 13, p. 25
- New magnetrons offer bargain coherent radar . . . . . NEWS, ED 2, p. 21
- New radar will solve mysteries of storms . . . . . NEWS, ED 4, p. 31
- Noise generator simulates radar return-signal 'grass' . . . . . IFD, ED 11, p. 114



Optical circuits carry laser light... NEWS, ED 6, p. 22

Phased arrays: They're great, but... NEWS, ED 6, p. 36

Pilots ask FAA for proximity warner—now... NEWS, ED 10, p. 32

Return-beam vidicon proves versatile... NEWS, ED 6, p. 21

S-band IC flatpack amplifiers can be soldered together... PF, ED 4, p. 108

Satellites may get power from laser on the grounds... NEWS, ED 12, p. 33

Small microwave relays are ready for Air Force... NEWS, ED 7, p. 22

Soviet puts lasers in telephone links... NEWS, ED 8, p. 21

Spring Joint Computer Conference 1970... SR, ED 9, C1

Varactor tuning can be tricky... ART, ED 8, p. 82

What role for the FCC in the future of CATV?... NEWS, ED 7, p. 21

### Military & Aerospace

ABM expansion may lose House committee support... NEWS, ED 8, p. 21

AF air-control network almost ready to travel... NEWS, ED 13, p. 22

AF stretches work on navigation satellite... NEWS, ED 3, p. 25

Air Force ends study of UFOs... NEWS, ED 1, p. 22

Airfield in the ocean... Floating electronic isle... SR, ED 2, p. 58

An anticollision system for all planes... NEWS, ED 13, p. 30

Antenna design aid rises in the desert... NEWS, ED 7, p. 32

Any code goes with IC decoder/drivers... ART, ED 13, p. 74

Army facing cutback in antitank missiles... NEWS, ED 8, p. 22

Army favors beam scan for helicopter lander... NEWS, ED 7, p. 22

British automating Army weather data... FOREIGN, ED 13, p. 33

Coming: portable thermoelectric power... NEWS, ED 11, p. 28

Complete guide to technical papers... IEEE, ED 6, p. U110

Congress generous with NASA, DOD funds—so far... NEWS, ED 10, p. 21

Defense chiefs say restraints on R&D 'cripple' leadership... NEWS, ED 7, p. 21

Display converts for radar or computer use... NEWS, ED 13, p. 28

Experiments for Mars set for 1973 landing... NEWS, ED 2, p. 21

F-15's missile sensor tests are under way... NEWS, ED 5, p. 21

50% rise asked in satellite circuits... NEWS, ED 2, p. 37

Giant C-5A's instrumentation is readied for tests... NEWS, ED 3, p. 26

Industry edgy as NASA and Sylvania shut centers... NEWS, ED 2, p. 21

Intelsat III starts commercial service... NEWS, ED 4, p. 22

Laser or millimeter space communication?... NEWS, ED 10, p. 34

Lesson from Apollo: plan for contingencies... EDIT, ED 11, p. 77

Missile range sharpens reentry techniques... NEWS, ED 8, p. 30

NASA's job picture—a continuing decline... NEWS, ED 10, p. 22

NASA's relay satellite faces a wobbly future... NEWS, ED 4, p. 40

Navy develops radar for shipboard guns... NEWS, ED 5, p. 22

Navy is seeking better electronics... NEWS, ED 5, p. 35

Navy needs telemetry gear in L and S bands... NEWS, ED 2, p. 22

Navy to computerize its message processing... NEWS, ED 10, p. 30

New-generation radar goes to White Sands... NEWS, ED 3, p. 22

Pilots ask FAA for proximity warner—now... NEWS, ED 10, p. 32

Small microwave relays are ready for Air Force... NEWS, ED 7, p. 22

Space-shuttle contracts won by California firms... NEWS, ED 12, p. 21

Space-shuttle studies to begin next month... NEWS, ED 6, p. 22

Spring Joint Computer Conference 1970... SR, ED 9, p. C1

Study finds Omega flaws, but Navy isn't worried... NEWS, ED 9, p. 22

TRW gets contract for Jupiter probes... NEWS, ED 5, p. 22

Wanted: Memory for sledding at Mach 7... NEWS, ED 6, p. 41

Workshops in the sky, then factories... NEWS, ED 1, p. 30

### Product Source Directories

AC Power Supplies and Special Purpose DC Power Supplies... ED 8, p. 114

Frequency Meters... ED 5, p. 87

Frequency Synthesizers... ED 12, p. 107

Function Generators and Square-wave Generators... ED 11, p. 103

Minicomputers... ED 9, p. C25

Multitesters... ED 7, p. 83

Operational Amplifiers... ED 13, p. 103

Oscillators... ED 10, p. 121

Power Supplies... ED 4, p. D1

Pulse Generators... ED 1, p. 133

Random Noise Generators... ED 6, p. 221

Signal Generators... ED 2, p. 93

Slotted Lines... ED 3, p. 79

### Semiconductors

Complete guide to technical papers... IEEE, ED 6, p. U110

Diodes make good gain-control devices... ART, ED 3, p. 54

Electronically tuned notch filter uses FET as a resistor... IFD, ED 6, p. 212

Electronics scores in sports... SR, ED 11, p. 36

Find the absolute value of bipolar pulses... IFD, ED 4, p. 84

For the consumer it's solid state... SR, ED 1, p. 76

Gate turn-off SCRs switch 5 A in 2  $\mu$ s... PF, ED 1, p. 145

High-speed zero crossing detector uses tunnel diodes... IFD, ED 6, p. 214

Improved SCR speed control achieves 100% motor regulation... IFD, ED 2, p. 90

Liberate your FET amplifier... ART, ED 11, p. 78

Linear temperature sensor uses only a single transistor... IFD, ED 4, p. 86

Cards A1 to T48... 6-22-70

Major advances predicted for thin-film ICs... NEWS, ED 12, p. 36

Monolithic readout challenges Nixies... NEWS, ED 6, p. 22

Motorola optimistic about MOS and ECL... NEWS, ED 11, p. 22

New devices developed at Bell Labs... NEWS, ED 9, p. 37

New field-programmable ROM slated for debut... NEWS, ED 13, p. 22

Read-only 512-bit memory programs electronically... PF, ED 10, p. 130

Simple transistor checker boasts speed and versatility... IFD, ED 12, p. 96

Solid-state memories cost less than 2¢ per bit... PF, ED 6, p. 238

Spring Joint Computer Conference 1970... SR, ED 9, p. C1

TI predicts worldwide boom in semiconductors... NEWS, ED 10, p. 21

Transistor chips for 60¢ dissipate up to 117 W... PF, ED 12, p. 116

Two-transistor circuit blocks wrong voltage polarity/level... IFD, ED 4, p. 90

Varactor diode is the key to a simple frequency divider... IFD, ED 4, p. 88

Why use current-mode flip-flops?... ART, ED 3, p. 64

### Systems

A new era beckons systems developers... IEEE, ED 6, p. U87

AF air-control network almost ready to travel... NEWS, ED 13, p. 22

An anticollision system for all planes... NEWS, ED 13, p. 30

Anemometer aids remote weather stations... NEWS, ED 3, p. 30

Bell to test waveguide communications system... NEWS, ED 4, p. 21

Casinos find the best 'system' is electronics... SR, NEWS, ED 2, p. 24

Complete guide to technical papers... IEEE, ED 6, p. U110



Digital system locates vehicles in seconds... NEWS, ED 3, p. 22  
 Electronics scores in sports... SR, ED 11, p. 36  
 Environment pollution calls for a team cure... IEEE, ED 6, p. U100  
 FCC urges control of 'electronic smog'... NEWS, ED 1, p. 36  
 Get to know your local SBA agent... ART, ED 10, p. 106  
 Intelsat III starts commercial service... NEWS, ED 4, p. 22  
 LSI poses dilemma for systems designers... SR, ED 3, p. 44  
 Lesson from Apollo: plan for contingencies... EDIT, ED 11, p. 77  
 Measuring system eases interfacing... PF, ED 7, p. 106  
 Microwaves may reduce sewage-treatment costs... NEWS, ED 10, p. 22  
 Minicomputer to do skyscraper chores... NEWS, ED 10, p. 22  
 MIT Alumni Center attacks urban problems... NEWS, ED 4, p. 22  
 New radar will solve mysteries of storms... NEWS, ED 4, p. 31  
 Spring Joint Computer Conference 1970... SR, ED 9, p. C1  
 System design means trade-offs... ART, ED 7, p. 60  
 Use piezoelectric ceramics... ART, ED 5, p. 60  
 Yes, redundancy increases reliability... ART, ED 12, p. 70  
 Cards A1 to T48 6-22-70

**Test & Measuring**

Anemometer aids remote weather stations... NEWS, ED 3, p. 30  
 Assemble a sequential counter... ART, ED 3, p. 60  
 Automatic caller reads meters by telephones... NEWS, ED 8, p. 22  
 Bell to test waveguide communications system... NEWS, ED 4, p. 21  
 Check flip-flops automatically... ART, ED 7, p. 66  
 Check peak fm deviation the easy way... ENG DATA, ED 5, p. 70  
 Clock and control with TTL... ART, ED 10, p. 82  
 Coast-to-coast test for satellite TV... NEWS, ED 2, p. 22  
 Computerized wiring tester performs 9000 checks/min... PF, ED 2, p. 108  
 Computing \$750 counter measures 1 Hz to 1 MHz... PF, ED 4, p. 98  
 Curing engine failures BEFORE they occur... NEWS, ED 7, p. 30  
 Electronic network proposed to monitor global pollution... NEWS, ED 5, p. 21  
 Electronics makes ski slopes safer... NEWS, ED 1, p. 21  
 Electronics scores in sports... SR, ED 11, p. 36  
 Find the absolute value of bipolar pulses... IFD, ED 4, p. 84  
 Four-digit low-cost multimeter checks

5 functions in 30 ranges... PF, ED 4, p. 97  
 Gate your op amp... ART, ED 11, p. 90  
 Go/no go circuit gives visual indication of RTL logic level... IFD, ED 4, p. 88  
 Growing market seen for test equipment... NEWS, ED 11, p. 21  
 High-frequency VCO uses TTL gates... IFD, ED 11, p. 112  
 Inexpensive generator produces triangle and square waves... IFD, ED 6, p. 208  
 Laser beam draws quick and clean patterns for ICs... NEWS, ED 10, p. 36  
 Laser makes air visible to aircraft designers... NEWS, ED 11, p. 32  
 Linear sweep generator uses zener diode... IFD, ED 12, p. 98  
 Linear temperature monitor uses silicon diodes as sensor... IFD, ED 1, p. 124  
 Linear temperature sensor uses only a single transistor... IFD, ED 4, p. 86  
 Low-cost 50-MHz counter doubles as a seven-digit DVM... PF, ED 2, p. 106  
 Make sure you pick the right power supply... ART, ED 4, p. D22  
 Measuring system eases interfacing... PF, ED 7, p. 106  
 Monitor keeps tab on noisy vehicles... NEWS, ED 1, p. 34  
 New radar will solve mysteries of storms... NEWS, ED 4, p. 31  
 Noise generator simulates radar return-signal 'grass'... IFD, ED 11, p. 114  
 Ordinary 3x5 index card makes a handy ruler... IFD, ED 6, p. 212  
 Over/under voltage monitor is inexpensive and stable... IFD, ED 3, p. 75  
 Pilots ask FAA for proximity warner—now... NEWS, ED 10, p. 32  
 Portable low-cost DMM checks five functions... PF, ED 6, p. U140  
 Simple transistor checker boasts speed and versatility... IFD, ED 12, p. 96  
 Slide rule improves VTVM resolution... IFD, ED 12, p. 98  
 Spring Joint Computer Conference 1970... SR, ED 9, p. C1  
 Symmetrical power supply is adjusted with only one control... IFD, ED 6, p. 210  
 Timer/counters + DVM are systems instruments... PF, ED 5, p. 105  
 Try using VCOs as discriminators... ART, ED 12, p. 86  
 Use an audible alarm to indicate a blown fuse... IFD, ED 4, p. 84  
 Use piezoelectric ceramics... ART, ED 5, p. 60  
 Worldwide network to predict solar EMI... NEWS, ED 13, p. 34  
 Yes, redundancy increases reliability... ART, ED 12, p. 70

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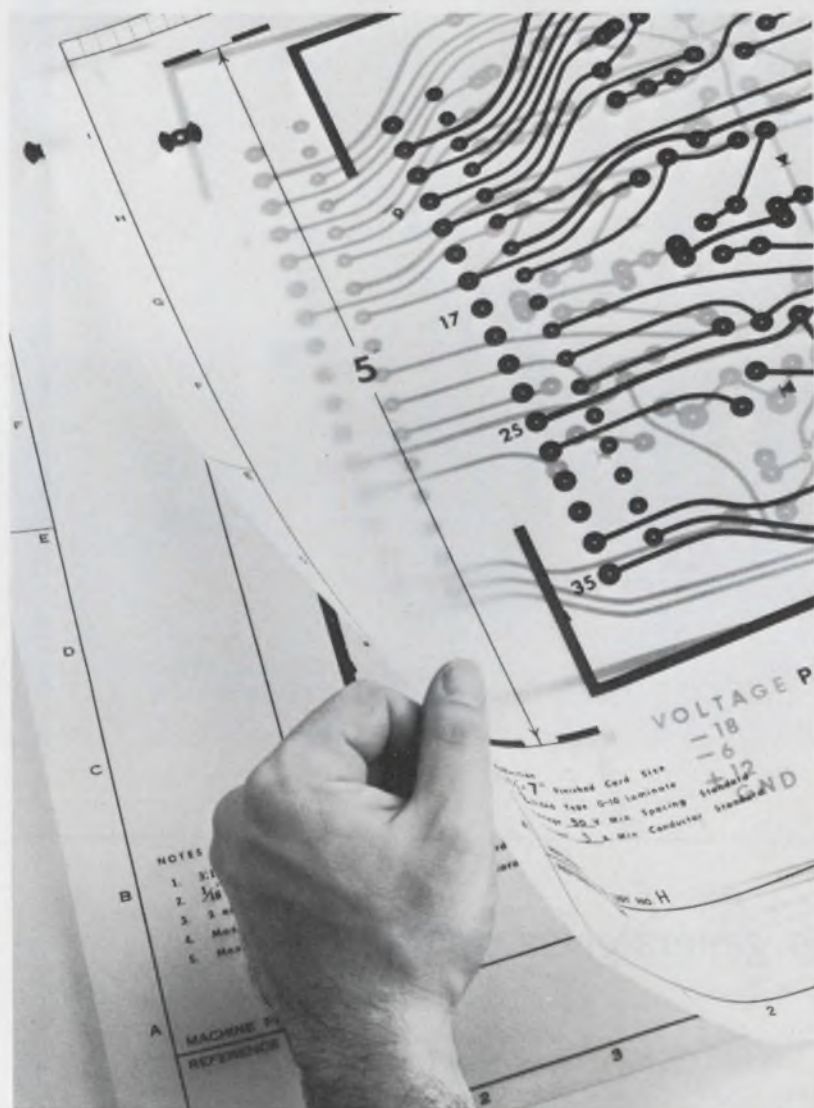
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# Ideas For Design

## Transformerless modulator operates from dc to 1 MHz

This circuit uses inexpensive monolithic operational amplifiers and operates as a full-wave modulator or phase detector from dc to 1 MHz with no component changes. By comparison, most modulator designs use transformers that limit the useful frequency range.

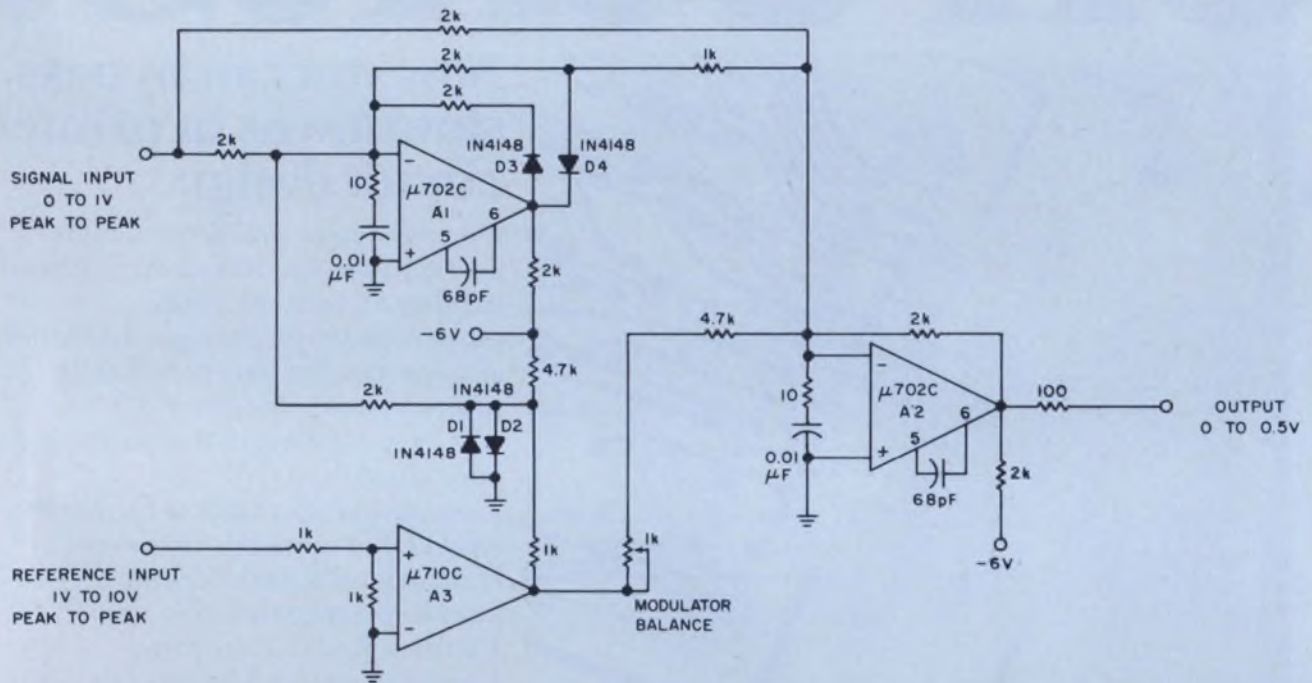
Amplifiers  $A_1$  and  $A_2$  form a full-wave rectifier.  $A_3$  is a zero-crossing detector. The output of  $A_3$  is clipped by  $D_1$  and  $D_2$  and summed into

$A_1$ , which produces gating signal for  $D_3$  and  $D_4$ .

The gating signal is removed from the modulator's output by adjusting the  $A_3$  output into  $A_2$  with the modulator balance potentiometer. The reference input can be sinusoidal or complex, since  $A_3$  converts it to a square wave from zero-crossing information only. The signal input gain is one, and the input should not exceed 1.2 V peak-to-peak (the gating signal level at  $D_1$  and  $D_2$ ) to assure correct operation.

*J. R. Nielsen, Electrical Engineer, Idaho Nuclear Corp., Idaho Falls, Idaho.*

VOTE FOR 311



Modulator's reference input may be a sine function or complex wave shape.  $A_3$  produces a square wave

just from zero-crossing information. The signal input should not exceed 1.2 V peak-to-peak.

## IC design makes stable ramp generator/sawtooth VCO

This ramp generator consists of resistor  $R$  and capacitor  $C$  with associated circuitry to provide constant charging current. The principal advantage over a regular integrator circuit is that the necessary capacitor is referenced to ground, which simplifies the retrace circuit. This design

has the inherent stability and precision afforded by op amps.

Input voltage  $E$  controls the slope of the ramp generator.

Buffer voltage follower  $A_2$  has a gain of 2 to make full use of allowable input and output





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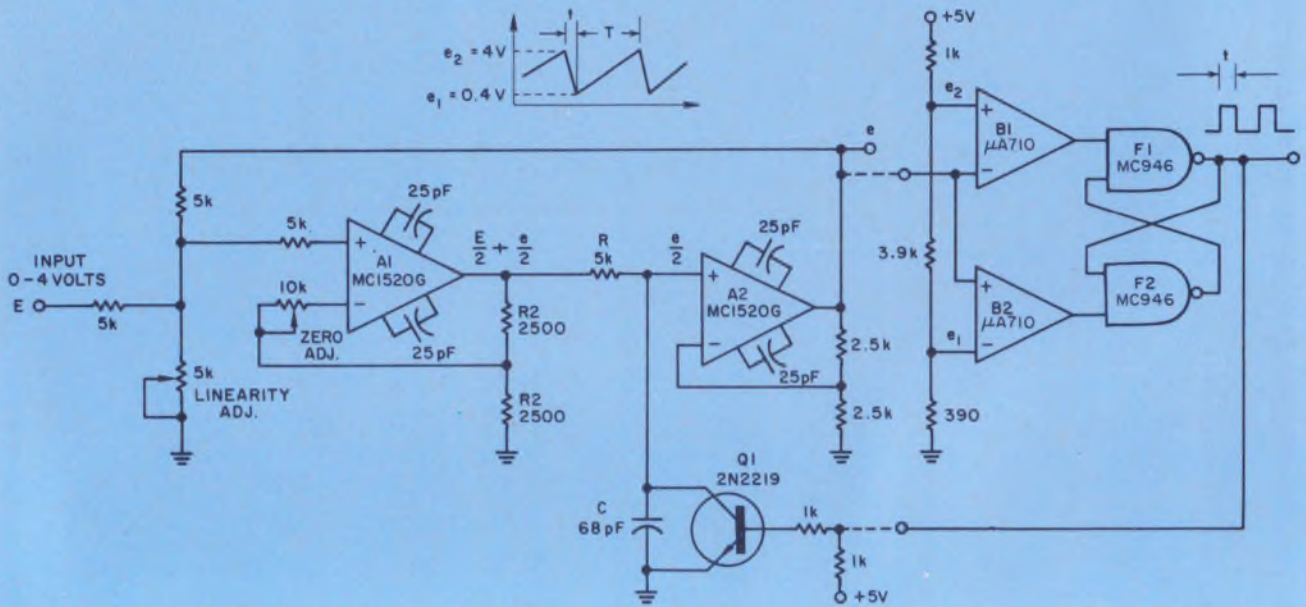
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Ramp generator (left) can be converted to a sawtooth VCO by addition of comparators and a flip-

flop (right). Ground-referenced timing capacitor C simplifies the retrace circuitry.

swing for the particular IC op amp used. Part of the ramp output  $e$  is summed with the input control voltage  $E$  in the noninverting amplifier,  $A_1$ , which also has a gain of 2. Thus, if the output of  $A_1$  equals  $(E/2) + (e/2)$ , and the input to  $A_2$  is  $e/2$ , the voltage across  $R$  must be  $E/2$ , which is constant. This insures a constant current flow into capacitor  $C$ , which produces a linear ramp with a slope proportional to  $E$ .  $T$  is the time needed to go from level  $e_1$  to  $e_2$  and equals  $(RC) (e_2 - e_1) / (E/2)$ . The zero-adjust pot is set to keep  $e=0$  for  $E=0$ . This linearity pot is set to make the voltage across  $R$  constant. Retrace transistor  $Q_1$  should be a high-quality switching transistor with low  $I_{co}$ .

The ramp generator was first built for an application where speed was more important than precision, and the circuit values indicated were

selected to provide a slope variation from 0.075 to 3  $V/\mu s$  for an input range of 0.1 to 4 V. However, the desired 40:1 ratio by no means represents a performance limit.

By adding comparators  $B_1$  and  $B_2$  and flip-flop  $F1/F2$ , the circuit can be converted to a precision voltage-controlled sawtooth oscillator, as indicated by the dashed lines in the figure. Sawtooth frequency  $f = 1/(T+t)$ , which approximates  $(1/T) (1-t/T)$ . The retrace time,  $t$ , should be small, and proportional to  $T$  if possible. (For example, the  $Q$  base current can be roughly proportional to  $E$ .) For a simple version,  $B_1$ ,  $B_2$ ,  $F1$ ,  $F2$  and  $Q$  can be replaced by a single unijunction transistor or four-layer-diode.

Gunnar Richwell, Principal Engineer, Potter Instrument Co., Inc., Plainview, N.Y.

VOTE FOR 312

## Nomographs determine multiwire cable diameter

Here's how to determine the right size grommet hole or cable tubing for large numbers of wires. Figure 1 is for small wire, and Fig. 2 applies to large wire. For values that overlap both nomographs, the small-wire nomograph is more accurate.

The empirical equation relating cable diameter,  $D$ , wire size,  $d$ ; and the number of wires,  $N$ , is

$$D = d [0.94 + \sqrt{(N - 3.7)/0.907}]$$

The  $D^2$  scale shown in each figure is used when there is more than one size of wire involved. The total cable diameter having multisize wire is

$$D_{total} = \sqrt{\sum (D_1^2 + D_2^2 + D_3^2 + \dots + D_n^2)}$$

where  $D_1, D_2, D_3, \dots, D_n$  are the individual cable diameters for each wire size.



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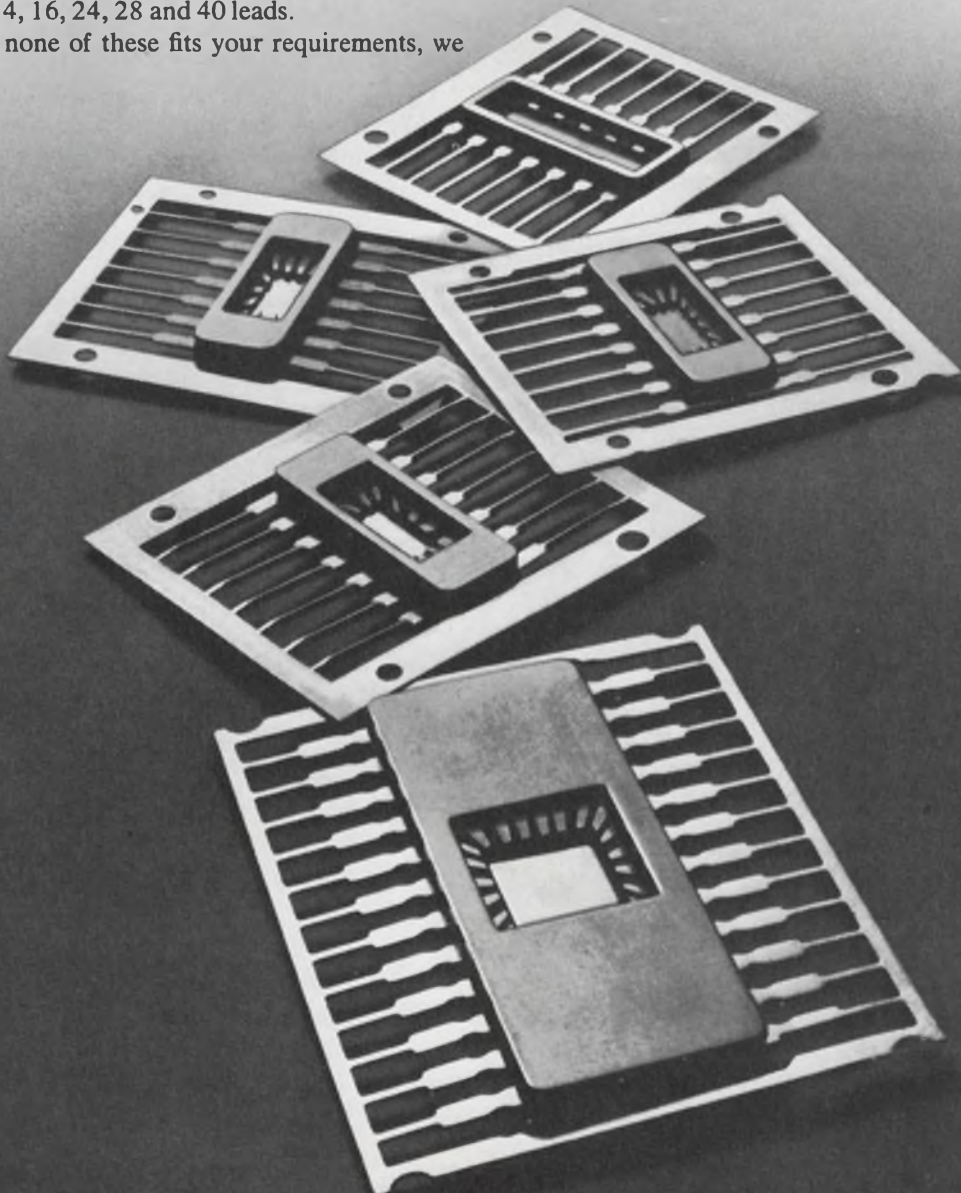
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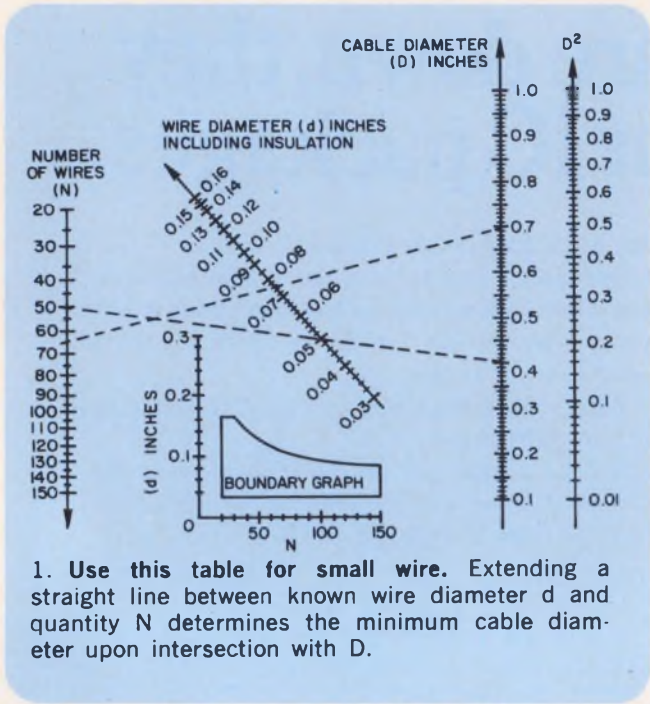
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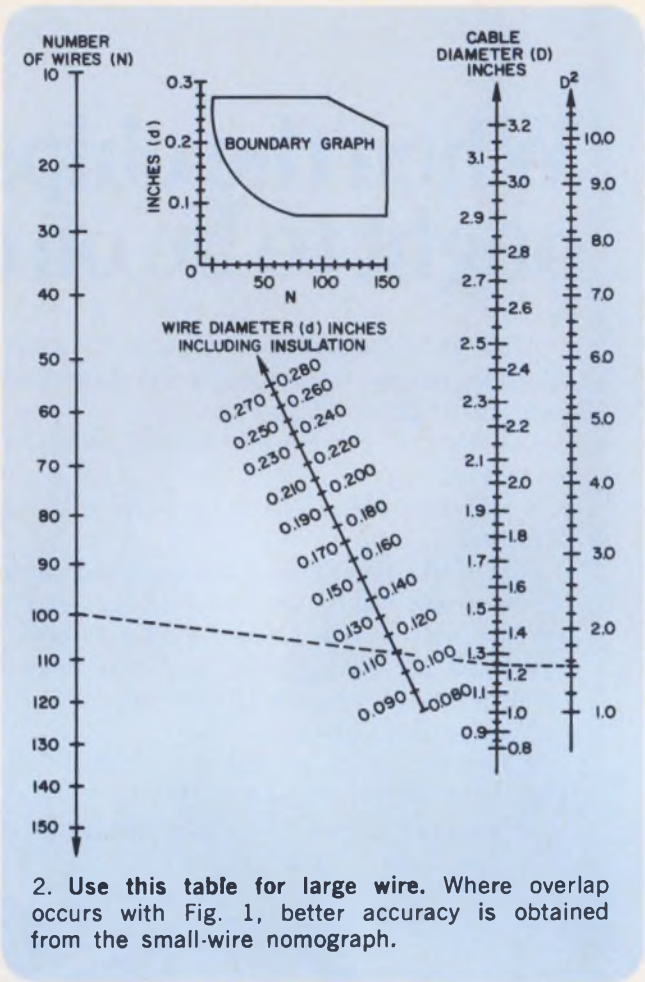
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1. Use this table for small wire. Extending a straight line between known wire diameter *d* and quantity *N* determines the minimum cable diameter upon intersection with *D*.



2. Use this table for large wire. Where overlap occurs with Fig. 1, better accuracy is obtained from the small-wire nomograph.

*Example using Fig. 1:* Find the minimum cable diameter for sixty-five 0.076-inch-diameter wires.

The cable diameter is found by using a straight edge. Locate 65 wires on the *N* scale and 0.076 inches on the *d* scale. Draw a straight line through these points intersecting on the *D* scale. This junction determines the cable diameter of 0.696 inches, or, for practical purposes, 0.70 inches.

*Example for multisize wire:* Find the minimum cable diameter containing sixty-five 0.076-inch wires, fifty 0.050-inch wires and one-hundred 0.100-inch wires.

Determine *D* for each group of wire sizes, using the procedure shown in the first example. Draw a short line perpendicular to the *D* scale for each value of *D* over the *D*<sup>2</sup> scale. Locate the first two groups of wires in Fig. 1 and the third group in Fig. 2.

$D_{total} = \sqrt{0.49 + 0.16 + 1.50} \approx 1.5$  inches, which is the desired minimum cable diameter.

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- Louis F. Caso, Jericho Plant, PRD Electronics, Inc., Jericho, L. I., N. Y.

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## Voltage sensor serves as continuous monitor

When working with high unidirectional voltage systems, which are subjected to transient conditions, it is usually necessary to have continuous voltage level indication for protection

and operation purposes. By providing an output whenever this monitored voltage is over a predetermined value (under steady-state or transient conditions) this circuit discriminates between different unidirectional voltage levels.

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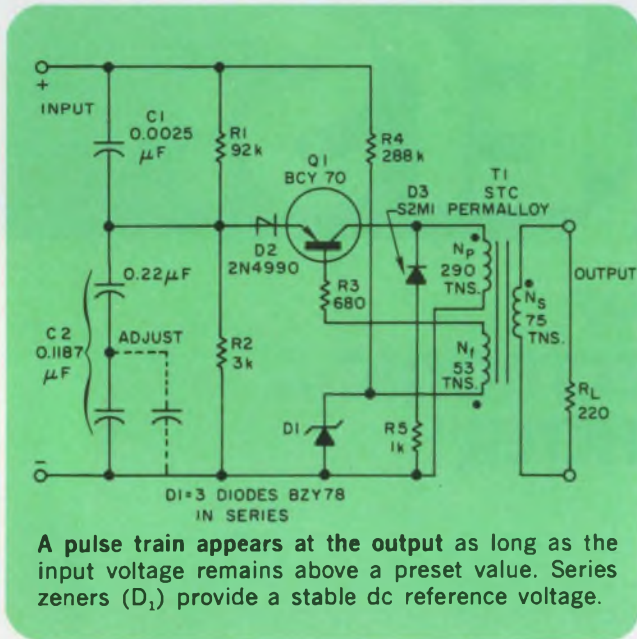
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good temperature stability.

R<sub>1</sub>, C<sub>1</sub>; R<sub>2</sub>, C<sub>2</sub> form a frequency-compensated voltage divider network, while D<sub>1</sub> provides a stable dc reference voltage. Whenever the input level is such that the voltage across R<sub>2</sub>, C<sub>2</sub> is greater than the sum of breakover voltage V<sub>D2</sub>, V<sub>be</sub> of Q<sub>1</sub> and the zener voltage V<sub>D1</sub>, the four-layer diode D<sub>2</sub> breaks over and Q<sub>1</sub> conducts, thereby discharging C<sub>2</sub>. This produces an output pulse at the transformer secondary.

The feedback winding N<sub>f</sub>, with the polarity shown, will increase the base drive to Q<sub>1</sub>. This allows C<sub>2</sub> to discharge through Q<sub>1</sub> to a lower voltage than that across D<sub>1</sub>. As the feedback voltage across N<sub>f</sub> decreases, a point is reached when Q<sub>1</sub> turns off. The current through D<sub>2</sub> will then decrease below the holding level, turning D<sub>2</sub> off.

This process is repeated, and as long as the input voltage remains above the preset value, a pulse train is generated at the output. The repetition period T can be approximately expressed as

$$T = \left[ \frac{R_2 R_1 (C_2 + C_1)}{R_2 + R_1} \right] \ln \left[ \frac{E_1 R_2}{E_1 R_2 - (V_{D1} + V_{D2} + V_{be}) (R_1 + R_2)} \right]$$

where E<sub>1</sub> = input voltage.

The trip level, E<sub>2</sub>, can be set by varying R<sub>2</sub> and/or C<sub>2</sub> so that the product (R<sub>2</sub>)(C<sub>2</sub>) remains constant. E<sub>2</sub> can be expressed as

$$E_2 = (V_{D1} + V_{D2} + V_{be}) (R_1 + R_2) / R_2$$

When trip level E<sub>2</sub> = 840 V, input voltage E<sub>1</sub> = 1000 V (applied at 840 V μs) and the operating temperature is 25°C, the results obtained are:

- Output speed = 0.4 μs delay.
- Width of first output pulse = 1 ms.
- Amplitude of first output pulse = 6 V (max).
- Amplitude of first output pulse = 4 V (min).
- Temperature stability of E<sub>2</sub> = 0.036%/°C.
- Output voltage isolation between primary and secondary = 5 kV.

Arturo Rodriguez, Westinghouse Brake and Signal Co., Ltd., Electrical Research Laboratories, Radlett, Herts, England.

VOTE FOR 314

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**George S. Krause**, Assistant Project Engineer, Bendix, Communications Div., Baltimore, Md. His Idea "Astable Multivibrator Always Starts In Same State" has been voted the Most Valuable of Issue award. **Vote for the Best Idea in this Issue.**

**IFD Winner for April 12, 1970**

**Paul B. Weil**, Member of the Technical Staff, Hughes Aircraft Co., Culver City, Calif. His Idea "Feedback and Clamping Circuits Improve Comparator One-Shot" has been voted the Most Valuable of Issue award. **Vote for the Best Idea in this Issue.**



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- Average forward current to 500 Amperes
- Surge overload ratings up to 8500 Amperes

Controlled avalanche characteristics provide transient handling capability that results in increased reliability.

All units feature ceramic-to-metal seals, mount in any position and are supplied in either polarity.

### 1511 SERIES

Max. av. forward current at 120° C—420 Amperes  
Surge overload rating, 1 cycle—6000 Amperes  
Controlled Avalanche Voltage—1250-3500 Volts

### 1621 SERIES

Max. av. forward current at 120° C—500 Amperes  
Surge overload rating, 1 cycle—8500 Amperes  
Controlled Avalanche Voltage—1100-2300 Volts



### 1611 SERIES

Max. av. forward current at 120° C—470 Amperes  
Surge overload rating, 1 cycle—5200 Amperes  
Controlled Avalanche Voltage—2600-5000 Volts



Write for technical data bulletins—  
Tung-Sol Division, Wagner Electric Corporation  
630 West Mt. Pleasant Ave., Livingston, N.J. 07039  
Twx: 710-994-4865 • Phone: (201) 992-1100; (212) 732-5426

## TUNG-SOL High Power Silicon Rectifiers

Trademark TUNG-SOL Reg U. S. Pat. Off. and Marcas Registradas

INFORMATION RETRIEVAL NUMBER 55



# Product Source Directory

## Word Generators

This Product Source Directory covers Word Generators. For each table the instruments are listed in ascending order of one major parameter. The column containing this parameter is color-coded white.

The following abbreviations apply to all instruments listed: ina—information not available; n/a—not applicable; req—request.

Unless otherwise specified, the power requirements for all instruments listed are 105-125 Vac.

Manufacturers are identified by abbreviations. The complete name of each manufacturer can be found in the Master index below.

An Addendum to Display Devices is located on page 186 and to Operational Amplifiers on pages 187, 188 and 189.

### Word Generator Manufacturers

Abbrev.	Company	Information Retrieval No.
Adar	Adar Associates 73 Union Square Somerville, Mass. 02143 (617) 623-3131	467
Cimron	Cimron Div. 1152 Morena Blvd. San Diego, Calif. 92110 (714) 276-3200	468
CTC	Computer Test Corp. 3 Computer Drive Cherry Hill, N.J. 08034 (609) 424-2400	469
Datapulse	Datapulse Div. 10150 Jefferson Blvd. Culver City, Calif. 90230 (213) 836-6100	470
E-H	E-H Research Labs P.O. Box 1289 Oakland, Calif. 94604 (415) 834-3030	471
GR	General Radio Co. 300 Baker Ave. West Concord, Mass. 01781 (617) 369-4400	472
NLS	Non-Linear Systems P.O. Box N Del Mar, Calif. 92014 (714) 755-1134	473
Signetics	Signetics Measurement/Data 341 Moffett Blvd. Mountain View, Calif. 94040 (415) 961-9384	474

### Operational Amplifier Manufacturers

Abbrev.	Company	Information Retrieval No.
AMD	Advanced Micro Devices Inc. 901 Thompson Place Sunnyvale, Calif. 94086 (408) 732-2400	459
FS	Fairchild Semiconductor 313 Fairchild Drive Mountain View, Calif. 94041 (415) 962-5011	460
Intech	Intech Inc. 1220 Coleman Ave. Santa Clara, Calif. 95050 (408) 244-0500	461
Philco	Philco-Ford Corp. Microelectronics Div. 1400 Union Meeting Rd. Blue Bell, Pa. 19422 (215) 646-9100	462
PM	Precision Monolithics Inc. 1500 Space Park Drive Santa Clara, Calif. 95050 (408) 246-9222	463
Solit	Solitron Devices Inc. 8808 Balboa Ave. San Diego, Calif. 92123 (714) 278-8780	464
TI	Texas Instruments P.O. Box 5012 Dallas, Texas 75222 (214) 238-2011	465
Trans	Transitron Corp. 168 Albion St. Wakefield, Mass. 01880 (617) 245-4500	466

Manufacturer	Model	Clock Rate		Word Length (Bits)	Number of Channels	Bit Width (ns)	Bit Rise & Fall Time (ns)	Output Voltage (V)	Output Impedance (Ω)	Notes	Price \$
		Min Hz	Max MHz								
Datapulse GR	215C	1	1	1-32	1	m	20	6	50	m	4750
Datapulse	1395	2.5	1.2	16	n	n	n	10	150	n	
Datapulse	200M/P903	2	2	1-100	2	f	5	+5, -5	50	f	3980
Datapulse	206	2	2	16	6	50	15	6	50		3590
Datapulse	206M	2	2	72	6	i	10	6	50	i	7170
NLS	22-1	100	2	100	22	NRZ	5	±15	200	p	req
NLS	WG20	100	2	50	20	NRZ	50	0 to -20	200	pp	req
Cimron	3903	0.2	5	1-16	1-9	10ns-100ms	10	0-5, 5-0	50	d	2150
Datapulse	202M/P903	5	5	16	2	f	5	+5, -5	50	f	1990
E-H	1623	1000	5	16	10	30ns-100µs	ina	+2.5	50		7490
Adar H-P	EC-22	1	8	32	8	NRZ/RZ	a	6.5	ina	c	2500
	8006A	0	10	2-16	NRZ/RZ	ina	ina	15	50	s	825
				4-32							
Datapulse	201	0	10	16	1	NRZ	15	10	50	g	680
Datapulse	208A	1	10	1-16	10	j	10	7.5	50	i	6680
Adar	5Q260	10	10	16	12	a	10	a	51		5600
Datapulse	213A	10	10	to 1023	1	NRZ	10	5	50	k	2385
Datapulse	214	1000	10	16	12	50	10	+5	50		5250
Datapulse	203	10	15	1-100	2	h	4	+5, -5	50	h	5700
Adar	5Q280	10	15	16	12	a	10	a	51	a	6600
Signetics	501	50	16	32	NRZ/RZ	30ns-10ms	15	-30 to -5	ina	r	r
CTC	1801	0.01	25	32	16	20-100	10, 20	e	e	e	12,900
Datapulse	217	100	25	1,048, 575	1	NRZ	5	5	50	k	3225
Adar	5Q320	250	25	32	12	20	5	+5	ina	ab	6600
Datapulse	212	10	75	16	1	NRZ	1.3	+5, -5	50		2715

- a. Variable delay width. Output voltage variable 0 to +7V, 0 to -7V simultaneously.
- b. Complete line of pulse shaping equipment for TTL, ECL and MOS are available.
- c. Data can be serial or parallel expanded. Unit allows nested operations. Two data strobes and ASCII format available.
- d. Plug-in word generator, handles maximum of nine plug-ins. Price does not include type 901 at \$240 each and 902 repeat control at \$275 each.
- e. Output voltage, negative going dc pulse +3 to +0.2V. Programmable step-repeat control, sync control. Output impedance, capable of driving 100Ω coax terminated in 100Ω.
- f. Bit width, 50 ns to 2000 µs or NRZ. Output depends on plug-in used.
- g. Requires external clock.
- h. Bit width, 25 ns-50 ms or NRZ. Digital bit and word repeats.
- i. Bit width, 60 ns-5 ms or NRZ. Independent delay and width for each channel.
- j. Bit width, 50 ns-5 ms or NRZ. Output voltage into 50Ω positive or negative. Serial or parallel output.
- k. Pseudo random data. Built-in error detection.
- m. Bit width 50% RZ or NRZ. Output voltage with ±5V offset. Three serial 1-32 bit words for PCM simulation. Common word repeat.
- n. Modular construction permits several word generators in one chassis and selection of clock, delay generator, pulse shapers, power amplifier, NRZ converter/sampler. Price of \$1230 for clock and word generator in main frame, other modules available at \$165-375 each.
- p. Output voltage, independent one and zero level controls.
- q. Includes C4A clock pulse generator.
- r. Data outputs include normal/inverted controls. All bits are programmable by pushbutton. Price approximately \$5000 depending on requirement.
- s. Also external clock, first bit synch pulse. Pseudo-random sequence generation, sequence length variable 7-65535 bits. Word outputs, positive NRZ, RZ; true +5V, false, -0.2V, +0.2V. Current sink capability, 80 mA maximum.

## Display Devices Addendum

Manufacturer	Model	Character Size (Inches)	Viewing Distance (Feet)	Light Output ft-L	Supply Voltage (V)	Current (mA)	Notes	Price/Unit \$
IEE	0010	0.94	20	75	6.3	250	a	20
IEE	0080	3.375	70	45	6.3	910	a	43
IEE	0120	0.59	12	100	6	200	a	35
IEE	0160	1.562	30	45	6.3	500	a	25.50
IEE	0220	0.59	12	100	6	200	a	31.25
IEE	0280	0.375	8	120	6.3	150	ab	20
IEE	0340	0.375	8	30	5	115	a	30
IEE	0345	0.375	8	30	5	115	a	21
IEE	0360	2	40	18	6.3	250	a	38.50
IEE	0400	0.5	10	30	5	115	a	36
IEE	0405	0.5	10	30	5	115	ad	50.50
IEE	0860	0.5	10	20	5	115	acd	50.50
IEE	0865	0.5	10	20	5	115	ac	37
IEE	0880	0.5	10	30	5	115	a	31.25
IEE	6000	0.625	12	100	12	30µA	efgh	20

- a. Total message capability and alpha-numeric capability.
- b. Status Indicator, 12 individual message areas capable of being displayed individually, in section, or all simultaneously.
- c. 24 message position; hexadecimal capability.
- d. Cue-switch.
- e. Letters, numerals, symbols.
- f. Time sharing capability (200,000 hour life).
- g. Anode voltage 1750 at 40 microamps.
- h. Nimo<sup>R</sup> 10 gun crt display.

More information on the devices in the table above can be obtained from Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, Calif. 91405 (213) 787-0311 or by circling 295 on Information Retrieval Card.



# Operational Amplifier Addendum

Mfr.	Device Number	Notes	Differential Input Impedance Typical (ohms)	Differential Output Impedance Typical (ohms)	Output Voltage Swing/Load Resistance Maximum (Volts/ohms)	Input Offset Voltage (mV)	Dc Voltage Gain	Unity Gain Bandwidth (MHz)	Common Mode Input Voltage Maximum (Volts)	Common Mode Rejection Ratio (Decibels)	Supply Voltages (Volts)		Operating Temperature Range (°C)	Package Type	Price per Unit
											+	-			
AMD	101A	(4)(21)	4M	n/a	±13/2k	0.7	160V/mV	ina	ina	96	22	22	-55 to +125	(3)(6)	req
AMD	201A	(4)(21)	4M	n/a	±13/2k	0.7	160V/mV	ina	ina	96	22	22	-25 to +85	(3)(6)	req
AMD	301A	(4)(21)	2M	n/a	±13/2k	2	160V/mV	ina	ina	90	18	18	0 to 70	(3)(6)	req
AMD	101	(4)(21)	0.8M	n/a	±13/2k	1	160V/mV	ina	ina	90	22	22	-55 to +125	(3)(6)	req
AMD	201	(4)(21)	0.8M	n/a	±13/2k	1	160V/mV	ina	ina	90	22	22	-25 to +85	(3)(6)	req
AMD	301	(4)(21)	0.4M	n/a	±13/2k	2	150V/mV	ina	ina	90	22	22	0 to 70	(3)(6)	req
AMD	207	(4)(21)	4M	n/a	±13/2k	0.7	160V/mV	ina	ina	96	22	22	-25 to +85	(3)(7)	req
AMD	107	(4)(21)	4M	n/a	±13/2k	0.7	160V/mV	ina	ina	96	22	22	-55 to +125	(3)(7)	req
AMD	307	(4)(21)	2M	n/a	±13/2k	2	160V/mV	ina	ina	90	18	18	0 to 70	(3)(7)	req
AMD	715C	(4)(21)	1M	75	±10/2k	2	70μV/V	ina	ina	92	18	18	0 to 70	(3)(7)	req
AMD	715	(4)(21)	1M	75	±10/2k	2	70μV/V	ina	ina	92	18	18	-55 to +125	(3)(7)	req
AMD	741C	(4)(21)	2M	75	±10/2k	2	200V/mV	ina	ina	90	18	18	0 to 70	(3)(7)	req
AMD	741	(4)(21)	2M	75	±10/2k	1	200V/mV	ina	ina	90	22	22	-55 to +125	(3)	req
AMD	747C	(4)(21)	2M	75	±10/2k	2	200V/mV	ina	ina	90	18	18	0 to 70	(3)	req
AMD	747	(4)(21)	2M	75	±10/2k	1	200V/mV	ina	ina	90	22	22	-55 to +125	(3)	req
FS	μA702A	(4)(21)	40k	200	±4/10k	0.5	3600	ina	ina	95	21	21	-55 to +125	(1)(6)	req
FS	μA702B	(4)(21)	32k	200	±4/10k	1.5	3400	ina	ina	92	21	21	-55 to +125	(1)(6)	req
FS	μA702C	(4)(21)	32k	200	±4/10k	1.5	3400	ina	ina	92	21	21	0 to 70	(1)(6)	req
FS	μA709	(4)(21)	400k	150	±15/2k	1	45k	ina	ina	90	18	18	-55 to +125	(7)	req
FS	μA709A	(4)(21)	700k	150	±15/2k	0.6	70k	ina	ina	110	36	36	-55 to +125	(1)(6)	req
FS	μA709B	(4)(21)	250k	150	±10/2k	2	45k	ina	ina	90	18	18	-55 to +125	(1)	req
FS	μA709C	(4)(21)	250k	150	±13/2k	2	45k	ina	ina	90	18	18	0 to 70	(1)(6)	req
FS	μA715	(4)(21)	1M	75	±10/2k	2	30k	65	ina	92	18	18	-55 to +125	(3)(8)	req
FS	μA715C	(4)(21)	1M	75	±10/2k	2	30k	65	ina	92	18	18	0 to 70	(3)(8)	req
FS	μA716C	(4)(21)	11k	1	17/5k	8μV	ina	2	ina	ina	27	27	0 to 70	(6)	req
FS	μA725	(4)(21)	3M	n/a	±13/2k	0.5	3M	ina	±14	120	22	22	-55 to +125	(6)	req
FS	μA725B	(4)(21)	3M	n/a	±14/2k	0.5	3M	ina	±14	120	22	22	-20 to +85	(6)	req
FS	μA725C	(4)(21)	3M	n/a	±13/2k	0.5	3M	ina	±14	120	22	22	0 to 70	(6)	req
FS	μA727	(9)(21)	300M	1k	±7V	2	100	ina	±13	100	18	18	-55 to +125	(8)	req
FS	μA727B	(9)(21)	300M	1k	±7V	2	100	ina	-5	100	18	18	-20 to +85	(8)	req
FS	μA730	(9)(21)	20k	70	6.8/100k	1	160	1.5	7	85	15	15	-55 to +125	(6)	req
FS	μA730C	(9)(21)	15k	70	7.5/100k	2	135	1.5	3.5-5.2	80	15	15	0 to 70	(6)	req
FS	μA735	(4)(21)	10M	220	±1.8/5k	1	20k	ina	ina	30μV/V	18	18	-55 to +125	(6)	req
FS	μA735B	(4)(21)	10M	220	±1.2/5k	1	20k	ina	ina	30μV/V	18	18	-20 to +85	(6)	req
FS	μA735C	(4)(21)	10M	220	±1.8/5k	1	20k	ina	ina	30μV/V	18	18	0 to 70	(6)	req
FS	μA739C	(10)(21)	150k	5k	+13, -15V	1	20k	ina	±11	90	18	18	0 to 70	(3)	req
FS	μA740	(11)(21)	1,000,000M	75	±13/2k	10	1M	3	±10-12	80	22	22	-55 to +125	(6)	req
FS	μA740C	(11)(21)	1,000,000M	75	±14/10k ±13/2k ±14/10k	30	1M	1	±12	80	22	22	0 to 70	(6)	req
FS	μA741	(4)(21)	1M	n/a	±13/2k ±14/10k	1	200k	ina	±13	90	22	22	-55 to +125	(6)	req
FS	μA741C	(4)(21)	2M	75	±13/2k ±14/10k	2	200k	ina	±13	90	18	18	0 to 70	(3)(6)	req
FS	μA744	(5)(21)	250k	150	±13/2k ±14/10k	2	45k	ina	±10	90	1.8	1.8	-55 to +125	(6)	req
FS	μA747	(4)(10) (21)	2M	75	±13/2k ±14/10k	1	200k	ina	±13	10	22	22	-55 to +125	(3)	req
FS	μA747C	(4)(10) (21)	2M	75	±13/2k ±14/10k	1	200k	ina	±13	90	18	18	0 to 70	(3)	req
FS	μA748	(4)(21)	2M	75	±13/2k ±14/10k	1	200k	ina	±13	90	22	22	-55 to +125	(6)	req
FS	μA748C	(4)(21)	2M	75	±13/2k ±14/10k	1	200k	ina	±13	90	18	18	0 to 70	(6)	req
FS	μA749	(4)(10) (21)	150k	5k	+13, -15V	1	20,000V/V	ina	+10 to -10	90	18	18	-55 to +125	(1)(3)	req
FS	μA749C	(4)(10) (21)	150k	5k	+13, -15V	1	20,000V/V	ina	+10 to -10	90	18	18	0 to 70	(3)	req
FS	μA749D	(4)(10) (21)	150k	10k	+5, -6V	1	20,000V/V	ina	-4 to +2.5	90	12	12	0 to 70	(6)	req
Intech	A-100	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	(13)	100k	4	±10	66	15	15	-25 to +85	(2)	20
Intech	A-101	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	(13)	100k	4	±10	66	15	15	-25 to +85	(2)	25
Intech	A-102	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	(13)	100k	4	±10	100	15	15	-25 to +85	(2)	33
Intech	A-103	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	(13)	100k	4	±10	100	15	15	-25 to +85	(2)	40
Intech	A-122	(11)(20)	10 <sup>12</sup>	n/a	±10/2k	1.5 (13)	100k	10	±10	94	15	15	-25 to +85	(2)	60
Intech	A-123	(11)(20)	10 <sup>12</sup>	n/a	±10/2k	1.5 (13)	100k	10	±10	94	15	15	-25 to +85	(2)	70
Intech	A-124	(11)(20)	10 <sup>12</sup>	n/a	±10/2k	2 (13)	100k	4	±10	98	15	15	-25 to +85	(2)	95
Intech	A-125	(11)(20)	10 <sup>12</sup>	n/a	±10/2k	2 (13)	100k	4	±10	98	15	15	-25 to +85	(2)	84
Intech	A-126	(11)(20)	10 <sup>13</sup>	n/a	±10/2k	1 (13)	200k	0.1	±10	100	15	15	-25 to +85	(2)	49.50
Intech	A-127	(11)(20)	10 <sup>13</sup>	n/a	±10/2k	1 (13)	200k	0.1	±10	100	15	15	-25 to +85	(2)	58.50
Intech	A-130	(11)(12) (20)	10 <sup>12</sup>	n/a	±10/500	(13)	50k	20	±10	80	15	15	-25 to +85	(2)	68
Intech	A-131	(11)(20)	10 <sup>12</sup>	n/a	±10/500	(13)	50k	20	±10	80	15	15	-25 to +85	(2)	68
Intech	A-136	(11)(20)	10 <sup>12</sup>	n/a	±10/500	1(13)	100k	20	±10	94	15	15	-25 to +85	(2)	75
Intech	A-137	(11)(20)	10 <sup>12</sup>	n/a	±10/500	1(13)	100k	20	±10	94	15	15	-25 to +85	(2)	85
Intech	A-148A	(11)(20)	10 <sup>11</sup>	n/a	±10/500	(13)	50k	15*	±10	72	15	15	-25 to +85	(2)	40
Intech	A-148B	(11)(20)	10 <sup>11</sup>	n/a	±10/500	(13)	50k	15	±10	72	15	15	-25 to +85	(2)	45
Intech	A-148C	(11)(20)	10 <sup>11</sup>	n/a	±10/500	(13)	50k	15	±10	72	15	15	-25 to +85	(2)	50
Intech	A-150	(14)(15) (20)	10M	n/a	±2.5-18/100k	2	100k	0.15	±1.5-15	80	15	15	-25 to +85	(2)	30



# Operational Amplifier Addendum

Mfr.	Device Number	Notes	Differential Input Impedance Typical (ohms)	Differential Output Impedance Typical (ohms)	Output Voltage Swing/Load Resistance Maximum (Volts/ohms)	Input Offset Voltage (mV)	Dc Voltage Gain	Unity Gain Bandwidth (MHz)	Common Mode Input Voltage Maximum (Volts)	Common Mode Rejection Ratio (Decibels)	Supply Voltages (Volts)		Operating Temperature Range (°C)	Package Type	Price per Unit
											+	-			
Intech	A-160	(11)(20)	10 <sup>11</sup>	n/a	±50/10k	1 (13)	200k	6	±50	90	60	-25 to +85	(2)	85	
	A-180A	(14)(20)	5M	n/a	±10/4k	1	300k	1	±10	100	15	-25 to +85	(2)	75	
	A-180B	(14)(20)	5M	n/a	±10/4k	0.1	300k	1	±10	100	15	-25 to +85	(2)	98	
	A-180J	(14)(20)	5M	n/a	±10/4k	0.25	300k	1	±10	100	15	-25 to +85	(2)	72	
	A-180K	(14)(20)	5M	n/a	±10/4k	0.1	300k	1	±10	100	15	-25 to +85	(2)	90	
	A-183J	(14)(20)	2M	n/a	±10/2k	3	200k	0.5	±10	100	15	-25 to +85	(2)	33	
	A-183K	(14)(20)	2M	n/a	±10/2k	0.5	200k	0.5	±10	100	15	-25 to +85	(2)	44	
	A-183L	(14)(20)	2M	n/a	±10/2k	0.5	200k	0.5	±10	100	15	-25 to +85	(2)	62	
	A-190	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	5	1	0.8	±10	80	15	-25 to +85	(2)	18	
	A-191	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	3	1	0.8	±10	86	15	-25 to +85	(2)	23	
	A-300	(11)(20)	10 <sup>11</sup>	n/a	±140/28k	3 (13)	100k	1	±125	100	150	-25 to +85	(2)	80	
	A-401	(11)(20)	10 <sup>11</sup>	n/a	±140/28k	3 (13)	100k	1	±125	100	150	-25 to +85	(2)	30	
	A-401	(16)(20)	10k	n/a	±10/100	200	1	1	±10	n/a	15	-25 to +85	(2)	82	
	A-440	(11)(20)	10 <sup>12</sup>	n/a	±10/100	(13)	50k	20	±10	80	15	-25 to +85	(2)	18.50	
	A-1005	(17)(20)	2M	n/a	±10/500	6	25k	1	±10	86	15	-25 to +85	(2)	85	
	A-1026	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	1 (13)	250k	1.5	±10	94	15	-25 to +85	(2)	85	
	A-1027	(11)(20)	10 <sup>11</sup>	n/a	±10/2k	1 (13)	250k	1.5	±10	94	15	-25 to +85	(2)	65	
	A-240	(18)(20)	400k	n/a	±10/1k	0.010	10 <sup>7</sup>	1	n/a	n/a	15	-25 to +85	(2)	91	
	A-241	(18)(20)	400k	n/a	±10/1k	0.010	10 <sup>7</sup>	1	n/a	n/a	15	-25 to +85	(2)	97	
A-230J	(18)(20)	400k	n/a	±10/2.5k	0.015	10 <sup>7</sup>	1	n/a	n/a	15	-25 to +85	(2)	64		
A-230K	(18)(20)	400k	n/a	±10/2.5k	0.015	10 <sup>7</sup>	1	n/a	n/a	15	-25 to +85	(2)	80		
A-230L	(18)(20)	400k	n/a	±10/2.5k	0.010	10 <sup>7</sup>	1	n/a	n/a	15	-25 to +85	(2)	85		
A-225	(18)(20)	400k	n/a	±10/500	0.050	10 <sup>7</sup>	16	n/a	n/a	15	-25 to +85	(2)	85		
A-226	(18)(20)	400k	n/a	±10/500	0.050	10 <sup>7</sup>	16	n/a	n/a	15	-25 to +85	(2)	95		
A-200	(11)(19)	10 <sup>12</sup>	n/a	±10/2k	(13)	1-1000	1.5	±10	96	15	-25 to +85	(2)	49		
PL9709	(5)(21)	400k	100	±14/2, 10k	±1.5	45k	1	±10	90	18	-55 to +125	(1)	53		
PA7709	(4)(21)	400k	150	±15/2, 10k	1	45k	1	±10	90	18	-55 to +125	(1)(3)(7)	4.60-7.50		
7709A	(4)(21)	750k	150	±13/2k	0.5	45k	1	±8	115	36	-55 to +125	(1)(3)(7)	11-16.20		
PA7709C	(4)(21)	250k	150	±13/2k	2	45k	1	±10	90	18	0 to 70	(7)	req		
PA7712	(4)(21)	60k	200	±4/10k	0.5	3600	60	ina	95	21	-55 to +125	(1)(3)(7)	6.60		
PA7712C	(4)(21)	32k	200	±5.3/100k	1.5	3400	60	ina	86	21	0 to 70	(1)(3)(7)	2.25		
7741C	(4)(21)	2M	75	±5.3/100k	2	200k	1	±13	90	18	0 to 70	(1)(3)(7)	req		
S55747	(4)(10)	2M	n/a	±14/10k	2	100V/mV	ina	ina	80	22	-55 to +125	(1)(3)	60-75		
S55101A	(4)(21)	2M	n/a	±15/10k	1.8	100V/mV	ina	ina	80	22	-55 to +125	(1)(2)(6)	45-60		
S5201A	(4)(21)	1.5M	n/a	±15/10k	2	50V/mV	ina	ina	80	22	-25 to +85	(1)(2)(6)	18-20		
S5107	(4)(21)	2M	n/a	±15/10k	1.8	100V/mV	ina	ina	80	22	-55 to +125	(1)(2)(6)	50-60		
S5207	(4)(21)	1.5M	n/a	±15/10k	2	50V/mV	ina	ina	80	22	-25 to +85	(1)(2)(6)	20-22		
S55741	(4)(21)	2M	n/a	±15/10k	3	100V/mV	ina	ina	80	22	-55 to +125	(1)(2)(6)	40-54		
S55741B	(4)(21)	2M	n/a	±15/10k	3	50V/mV	ina	ina	80	22	-25 to +85	(1)(2)(6)	16-18		
S55747B	(4)(10)	2M	n/a	±15/10k	3	50V/mV	ina	ina	80	22	-25 to +85	(1)(3)	32-42		
S55725	(4)(21)	0.7M	n/a	±12.5/10k	0.5	1M	ina	ina	120	22	-55 to +125	(6)	56-70		
UC4741C	(4)(21)	1M	n/a	±14/10k	1	200k	ina	ina	90	22	-55 to +125	(6)	req		
UC4741	(4)(21)	2M	75	±14/10k	2	200k	ina	ina	90	18	0 to 70	(6)	req		
UC4000	(4)(21)	2.5M	n/a	±10/10k	5	20k	1	±13	90	±5	-55 to +125	(3)(7)	req		
UC4101	(21)	800k	n/a	±14/10k	1	25k	1	±12	90	22	-55 to +125	(1)(7)	req		
UC4201	(21)	400k	n/a	±14/10k	1	25k	1	±12	90	22	0 to 70	(1)(7)	req		
UC4101A	(21)	4M	n/a	±14/10k	0.7	25k	1	±15	96	22	-55 to +125	(1)(3)(7)	req		
UC4201A	(21)	4M	n/a	±14/10k	0.7	25k	1	±15	96	22	-25 to +85	(1)(3)(7)	req		
UC4301A	(21)	2M	n/a	±14/10k	2	15k	1	±12	90	18	0 to 70	(7)	req		
UC4301A	(21)	3M	n/a	±10/10k	6	73k	0.3	±12	70	±1	0 to 70	(1)(3)(7)	req		
UC4250C	(21)	3M	n/a	±10/10k	3	100k	0.3	±12	70	±1	-55 to +125	(1)(3)(7)	req		
UC4250	(21)	3M	n/a	±10/10k	3	100k	0.3	±12	70	±1	-55 to +125	(1)(3)(7)	req		
SN72741	(4)(21)	1M	n/a	±2/13k	2	100k	ina	ina	90	18	0 to 70	(1)	req		
RSN52709	(4)(5)	100k	150	15/10k	1	40k	ina	ina	90	18	-55 to +125	(1)	req		
SN72709	(4)(10)	250k	150	±10/2k	2	45k	ina	ina	90	18	0 to 70	(1)(3)(7)	req		
DN AN	(2)	400k	150	±15/10k	1	50k	ina	ina	90	18	0 to 70	(1)(3)(7)	req		
SN72709	(4)(21)	250k	150	±14/10k	10	45k	ina	ina	90	18	0 to 70	(1)(3)(7)	req		
SN52709A	(4)(21)	185k	150	15/10k	0.6	25-70k	ina	ina	110	18	-55 to +125	(1)(3)(7)	req		
SN52709	(4)(21)	100k	150	15/10k	1	45k	ina	ina	90	18	-55 to +125	(1)(3)(7)	req		
SN72702	(4)(21)	6k	200	±5/100k	1.5	1000	ina	ina	92	21	0 to 70	(1)(3)(7)	req		
SN52702A	(4)(21)	6k	200	±5/100k	0.5-2	1000	ina	ina	65	21	-55 to +125	(1)(3)(7)	req		
SN52702	(4)(21)	3k	200	±5/100k	6.5	800	ina	ina	65	21	0 to 70	(1)(3)(7)	req		



# Operational Amplifier Addendum

Mfr.	Device Number	Notes	Differential Input Impedance Typical (ohms)	Differential Output Impedance Typical (ohms)	Output Voltage Swing/Load Resistance Maximum (Volts/ohms)	Input Offset Voltage (mV)	Dc Voltage Gain	Unity Gain Bandwidth (MHz)	Common Mode Input Voltage Maximum (Volts)	Common Mode Rejection Ratio (Decibels)	Supply Voltages (Volts)		Operating Temperature Range (°C)	Package Type	Price per Unit
											+	-			
Trans	TOA1709	(21)	400K	150	±14/10k	1	45k	n/a	±8	90	15	15	-55 to +125	(1) (3) (6)	5.55 - 7.50
Trans	TOA1741	(13)(21)	1M	75	±14/10k	1	200k	1	±12	90	15	15	-55 to +125	(1) (3) (6)	8.60 - 15
Trans	TOA1747	(10)(13) (17)(21)	1M	75	±14/10k	1	200k	1	±12	90	15	15	-55 to +125	(3) (6)	22.50 - 27
Trans	TOA1748	(13)(21)	1M	75	±14/10k	1	200k	10	±12	90	15	15	-55 to +125	(1) (3) (6)	8.60 - 15
Trans	TOA1809	(10)(21)	400k	150	±14/10k	1	45k	n/a	±8	90	15	15	-55 to +125	(3)	15.75
Trans	TOA2709	(21)	250k	150	±14/10k	2	45k	n/a	±8	90	15	15	0 to 70	(1) (2) (3) (6)	2.25 - 3.45
Trans	TOA2741	(13)(21)	1M	75	±14/10k	2	100k	1	±12	90	15	15	0 to 70	(1) (2) (3) (6)	4.35 - 6.40
Trans	TOA2747	(10)(13) (17)(21)	1M	75	±14/10k	2	100k	1	±12	90	15	15	0 to 70	(2) (3) (6)	4.85 - 8.95
Trans	TOA2748	(13)(21)	1M	75	±14/10k	1	200k	10	±12	90	15	15	0 to 70	(1) (2) (3) (6)	4.35 - 6.40
Trans	TOA2809	(10)(21)	250k	150	±14/10k	2	45k	n/a	±8	90	15	15	-55 to +125	(2) (3)	4.90 - 5.65
Trans	TOA3709	(21)	400k	150	±14/10k	1	45k	n/a	±8	90	15	15	-55 to +125	(1) (2) (3) (6)	3.75 - 5
Trans	TOA3741	(13)(17)(21)	25M	75	±14/10k	0.7	200k	1	±12	96	15	15	-55 to +125	(1) (3) (6)	42.75 - 74.30
Trans	TOA3748	(13)(17)(21)	4M	75	±14/10k	0.7	160k	10	±12	96	15	15	-55 to +125	(1) (3) (6)	req
Trans	TOA4709	(21)	700k	150	±14/10k	1	45k	n/a	±8	110	15	15	-55 to +125	(1) (3) (6)	11.25 - 15.60
Trans	TOA7709	(17)(21)	10M	150	±14/10k	1	45k	n/a	±8	90	15	15	-55 to +125	(1) (3) (6)	19.20 - 20.20
Trans	TOA7741	(13)(17)(21)	10M	75	±14/10k	1	200k	1	±12	90	15	15	-55 to +125	(1) (3) (6)	17.30 - 39.50
Trans	TOA7747	(10)(13)(17) (21)	10M	75	±14/10k	1	200k	1	±12	90	15	15	-55 to +125	(3) (6)	req
Trans	TOA7748	(13)(17)(21)	10M	75	±14/10k	1	200k	10	±12	90	15	15	-55 to +125	(1) (3) (6)	17.30 - 39.50
Trans	TOA7809	(17)(21)	25M	150	±14/10k	1	25k	n/a	±8	90	15	15	-55 to +125	(1) (3) (6)	20.90 - 21.90
Trans	TOA8709	(17)(21)	3M	150	±14/10k	2	45k	n/a	±8	90	15	15	0 to 70	(1) (2) (3) (6)	4.90 - 9.10
Trans	TOA8741	(13)(17)(21)	3M	75	±14/10k	2	100k	1	±12	90	15	15	0 to 70	(2) (3) (6)	8.70 - 9.55
Trans	TOA8747	(10)(13)(17) (21)	3M	75	±14/10k	2	100k	1	±12	90	15	15	0 to 70	(2) (3) (6)	req
Trans	TOA8748	(13)(17)(21)	3M	75	±14/10k	1	100k	10	±12	90	15	15	0 to 70	(2) (3) (6)	8.70 - 9.95
Trans	TOA8809	(17)(21)	50M	150	±14/10k	1	25k	n/a	±8	90	15	15	0 to 70	(1) (2) (3) (6)	8.55 - 12.20

(1) FL - Flat pack

(2) Epoxy

(3) DIL - Dual-in-line package

(4) General purpose

(5) Radiation hardened operational amplifier

(6) TO-99 can

(7) Metal can

(8) TO-100 can

(9) Differential

(10) Dual op amp

(11) FET input op amp

(12) Inverting op amp

(13) Input offset voltage adjustable to zero

(14) Low drift op amp

(15) Low power drain

(16) Current booster

(17) Bipolar input

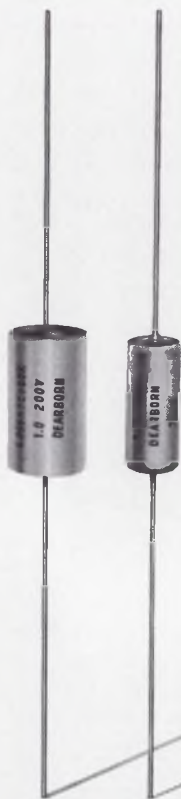
(18) Inverting chopper amplifier, low noise & drift

(19) Also dc comparator

(20) Discrete op amps

(21) Monolithic op amps

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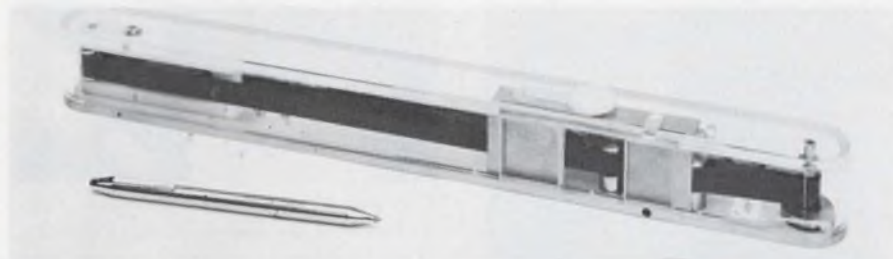
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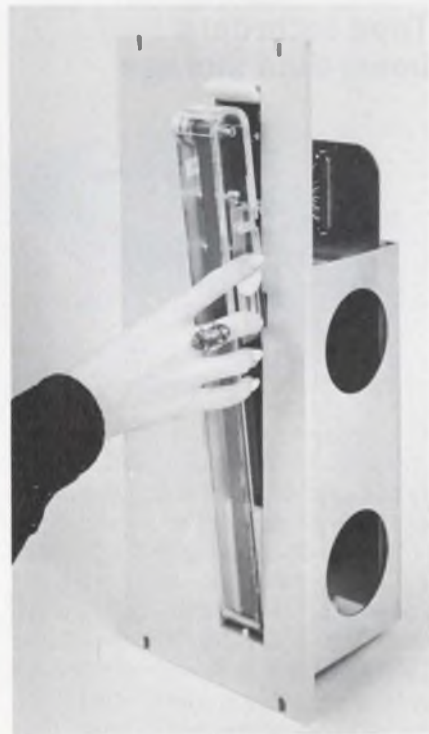
# New Products

## \$1200 tape-loop memory stores 72,000 characters



Compat Corp., 177 Cantiague Rock Rd., Westbury, N.Y. Phone: (516) 822-1320. P&A: \$1200 for system, \$35 for magazines; 60 days.

A new random-access data storage system called Comfile provides the data access and organization styles of disks and drums at the low costs associated with magnetic tape cartridge systems. At the heart of the new system is a 30-in.-long magnetic tape loop capable



Easy loading, low cost and high density are some of the features of a random-access data storage system. A single tape-loop magazine stores up to 72k characters.

of storing up to 72,000 characters of data. This stored data is accessible within an average time of 315 ms. Worst-case access time is only 900 ms.

The magnetic tape loop is completely enclosed in a magazine, which is easily inserted into the drive mechanism. A file-protect mechanism—similar to a write ring in a reel-type tape drive—guards against any inadvertent data recording.

Data is recorded on the loop at a density of 300 bits per inch. This is done serially by bit on one track at a time, as compared with conventional parallel recording in which a single character is written across all nine tracks. Serial recording reportedly provides increased data storage density, while eliminating the problems of tape skew and tape distortion.

The entire Comfile magazine and drive combination has only three moving parts for high reliability. The tape head and tape cleaners are the only parts that touch the oxide side of the tape.

Primary application areas for the new random-access data storage system include minicomputers, CRT display terminals, data acquisition and machine control. For minicomputers, the Comfile system means fast loading programs, individual data files, and the ability to store seldom-used subroutines.

The complete system is priced at \$1200. Additional magazines cost \$35 each.

CIRCLE NO. 340

## Low-profile keyboards sell for 25¢ per key



Chomerics, Inc., 77 Dragon Court, Woburn, Mass. Phone: (617) 935-4850. Price: \$9.50 for 12 keys.

With volume prices approaching 25¢ per key, a new line of low-profile keyboards employ conductive elastomer contacts and encoded outputs that do not require diodes or external logic circuitry. The keyboards are available with any number of keys on 3/4-in. centers; standard 12-key arrays sell for \$9.50 each. The encoded output can have up to 16 bits.

CIRCLE NO. 341

## Slim keyboards encode with MSI

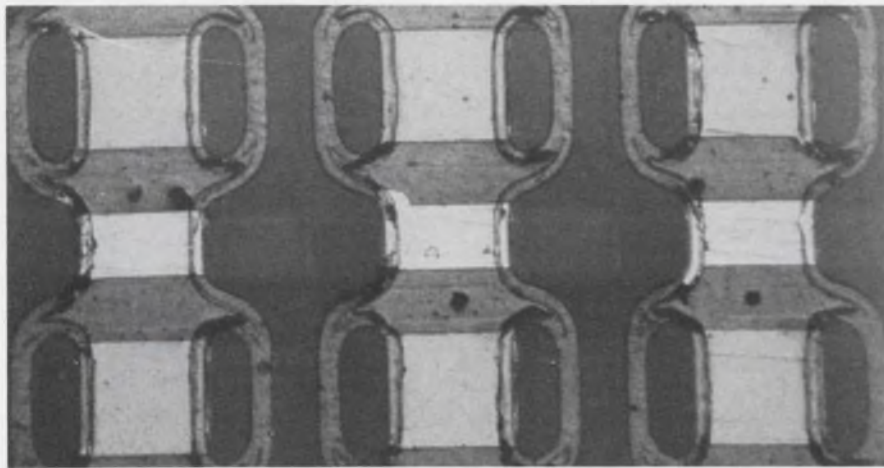


Datanetics Corp., 2828 Spreckels Lane, Redondo Beach, Calif. Phone: (213) 542-4355. Availability: 2 wks.

Five new low-profile MSI-encoded keyboards for communications and data entry terminals incorporate unique elastic diaphragm switching. Series DC units are available with 13 or 15-in. frames, and 49 to 71 keys for dual and tri-mode operation. Their TTL/DTL-compatible MSI encoding circuitry provides up to an eight-bit (plus parity) encoded output.

CIRCLE NO. 342

## Fast thick-film memories reduce storage to 1¢ per bit



*Signal Galaxies, Inc., sub. of the Signal Companies, 6955 Hayvenhurst St., Van Nuys, Calif. Phone: (213) 988-1570. P&A: 0.7¢ to 1¢/bit; fall, 1970.*

Dropping the cost of data storage to 0.7 to 1¢ per bit, a new line of magnetic thick-film memories features a full-cycle time as low as 100 ns. The non-destructive-read-out units, which use a novel memory technique called flux ring, also offer 100% bit redundancy and high packing densities.

Heart of the memories is a planar array of thick-film elements providing storage for 8k to 32k bits with up to 16k elements in a 4-in. square. By late fall, memories will be available for storing up to 64k bits in a single module.

The flux ring, which provides relaxed magnetic characteristics, consists of thick-film planar memory elements deposited in the center of a toroid. Because of the material used, flux from the film element finds a lower reluctance path in the ring than in the air.

This means that the lowest energy state exists when the magnetic vector of the element lines up across the diameter of the ring. A restoring torque is applied by the element's demagnetizing field proportional to the saturation density, the path reluctance, and the angle between the planar magnetic vector and the preferred direction.

Word lines enclose the element

parallel to the preferred direction. The perpendicular magnetic field generated by a unipolar current can be used for readout in the rotational mode and in conjunction with a smaller digit field applied perpendicularly, for storing 0's and 1's. The conductor used for the digit field can also be used for sensing.

Writing is accomplished by rotating the magnetization of the element with the word current so that it is nearly perpendicular to the preferred direction. The application of a digit field tips the magnetization in a 1 or 0 state, depending on the digit current direction.

To read a bit, the word current is applied to the selected line. The magnetization is then rotated away from the preferred direction, and a voltage is induced in the sense (digit) line.

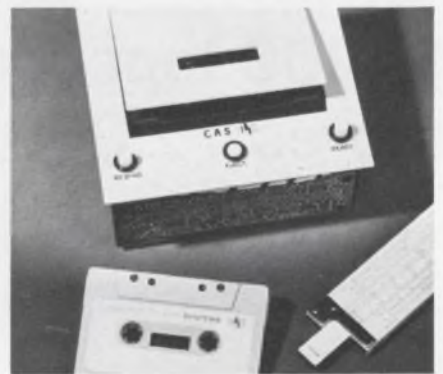
There are two adjacent memory elements per bit in the flux-ring memory resulting in 100% redundancy. Although the failure of one of the two elements will cause a degraded output of that element, the remaining element will still function as a storage unit.

Output voltage is independent of word current direction. In addition, complementary bit structures and plane uniformity insure self-cancellation of common-mode noise.

Rise times in the flux ring are typically less than 10 ns, and word drive currents are 450 mA.

CIRCLE NO. 343

## Cassette transport can read backwards



*Computer Access Systems, Inc., 3050 W. Clarendon Ave., Phoenix, Ariz. Phone: (603) 279-5591. P&A: \$720; 10 days.*

Offering both incremental and continuous operation, the model 350A cassette tape transport has read/write capability over its entire tape speed range plus the ability to read backwards (including search). Packing densities of 5,000,000 bits per cassette are possible depending upon writing techniques and data blocking needs.

CIRCLE NO. 344

## Tape recorders boost data storage



*Borg-Warner Controls, 3300 S. Haladay St., Santa Ana, Calif. Phone: (714) 545-5581. P&A: \$9000 to \$23,000; 60 days.*

Reportedly storing twelve times as much data per cubic inch of space as standard competitive models, the Acculog 2460 magnetic instrumentation recorders offer six operating speeds and 10-1/2-in. reels. The units have only nine rotating parts, eliminating belts and pinch rollers. Coaxially mounted reels allow for a take-up motor in the hub assembly.

CIRCLE NO. 345





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Check 231

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Replaces readout tubes in the "over range" of digital voltmeters; useable as "+" or "-" display where longer illumination is needed. Breakdown: 90 VDC. Overall Length, 1". NE-211

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## Neon Panel Assembly

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## DATA PROCESSING

### Data display terminal stores 1k characters

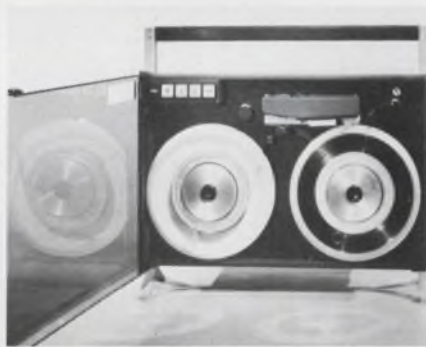


Sanders Associates, Inc., Daniel Webster Highway, South Nashua, N. H. Phone: (603) 885-4241. Price: \$199/month or \$6100.

A self-contained desktop data display system featuring a memory capacity of 1024 characters that can be written at any of 2048 screen locations is now available. Model 622 also offers a dual-intensity option, which permits the user to easily distinguish between entered data and format information appearing on the screen. The display screen can accommodate 32 lines of 64 characters.

CIRCLE NO. 346

### Tape transport is three modules



Anderson Jacobson, Inc. 1065 Morse Ave., Sunnyvale, Calif. Phone: (408) 734-4030.

An IBM-compatible magnetic tape transport is designed around three functional modules: a tape deck, an electronic card cage, and a power supply. Each of the modules is completely unitized and may be manufactured, tested and serviced as separate units. Model 707 has a speed range of 4 to 25 inches per second at densities of 200, 556 or 800 bits per inch.

CIRCLE NO. 347

### Desktop calculator simplifies operation



Cintra Inc., sub. of Physics International Co., 440 Logue Ave., Mountain View, Calif. Phone: (415) 696-9230. Price: \$3780.

Making it unnecessary to learn a complicated machine language, a new self-contained desktop calculator, the Scientist 909, speaks the universal language of mathematics. To operate the machine, the user simply keys his mathematical expression directly on its keyboard—without the preliminaries required by other machines. The unit uses MOS LSI circuits.

CIRCLE NO. 348

### Printing computer accepts 128 steps



Eugene Dietzgen Co., 2425 N. Sheffield Ave., Chicago, Ill. Phone: (312) 549-3300.

Besides a printed tape output, a new desktop computer features a programming capability of 128 steps. The unit prints results with their identifying mnemonic symbols on a 3-7/16-in. paper tape at a rate of 2-1/2 lines per second. The printout shows up to 10 significant digits plus exponent. Dimensions are 15 by 16 by 6 in.

CIRCLE NO. 349



## Glass memories perform at 16 MHz

Corning Glass Works, Electronic Products Div., Raleigh, N. C. Phone: (607) 962-4444. P&A: 2.5¢/bit; stock.

Costing less than 2.5¢ per bit in quantities of 1000 or more, plug-in 4096-bit glass memory modules offer a data rate of 16 MHz and a delay time of 256  $\mu$ s. Power supply conversions are not required because the compact 5.9 by 4.5 by 1-in. modules have high-speed TTL flip-flop input-output interfaces. Operating temperatures can range from 15 to 55°C.

CIRCLE NO. 350

## Modular agc amplifier smooths line signals

Douglas Randall, Inc., div. of Walter Kidde & Co., 6 Pawcatuk Ave., Westerly, R. I. Phone: (203) 599-1750.

A new automatic-gain-control amplifier is intended to maintain signal levels for the reception of Touch-Tone, voice or similar data transmitted over telephone lines. The modular plug-in unit controls input signals from -40 to +10 dBm and provides an output signal of 0 dBm  $\pm$  3 dB. Frequency range is 100 Hz to 20 kHz.

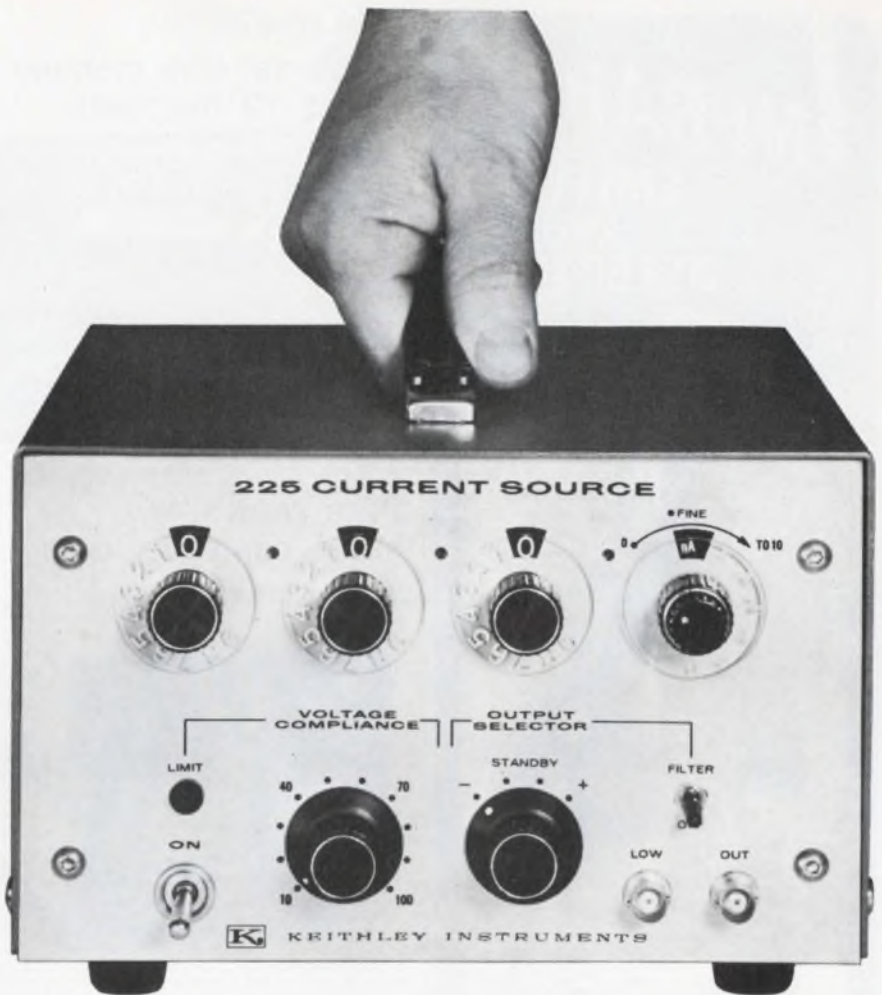
CIRCLE NO. 351

## Printing calculators offer 14 registers

Wang Laboratories Inc., 836 North St. Tewksbury, Mass. Phone: (617) 851-7311. Price: \$1495 to \$2295.

Series 100 statistical, engineering and scientific printing calculators feature either 6 or 14 special registers — each register adds, subtracts, multiplies and divides, performing as a complete and separate calculator. These new calculators can perform simple business calculations, such as mean and standard deviation, up to complex scientific calculations. They are self-contained and incorporate the latest advances in MSI circuitry.

CIRCLE NO. 352



## NEW WAY TO GET A HANDLE ON CONSTANT CURRENT ... 0.1 AMPERE TO 1 NANOAMPERE

Now you can keep tight rein on low level currents for materials research, semiconductor testing and for other areas in science and industry where a reliable current source is needed. The Keithley 225 delivers from 0.1 A to 100 nA full scale with 0.02% resolution on most ranges. It keeps them on target with 0.02% stability and low 0.01% rms noise. Variably selectable compliance voltages from 10 to 100 volts and 0.005% load regulation wrap-up this neat source for really constant currents.

Consider convenience features

like bipolar output, the ability to float 500 volts off ground, an output filter to deal with inductive loads. And, protection from overloads with automatic recovery. Now—can you afford to pass up such capability when it's yours for only \$595?

For technical literature and demonstration, contact your Keithley Sales Engineer. Or, Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139. Telephone: (216) 248-0400. In Europe: 14 Ave. Villardin, 1009 Pully, Suisse. Prices slightly higher outside the U.S.A.



KEITHLEY

INFORMATION RETRIEVAL NUMBER 60

# INFRARED EMITTERS AND DETECTORS



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InSb Detector  
ACTUAL SIZE

SD-9630  
InAs Array  
ACTUAL SIZE



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are available in  
Special Packages.



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Spectronics, Inc. manufactures complete arrays of IR emitters and detectors in standard or special packages. Detectors and emitters available in spectral region from visible light to far infrared (5.5 microns). Spectronics is engaged in R&D and production of optoelectronic infrared systems, infrared test equipment, components and materials.

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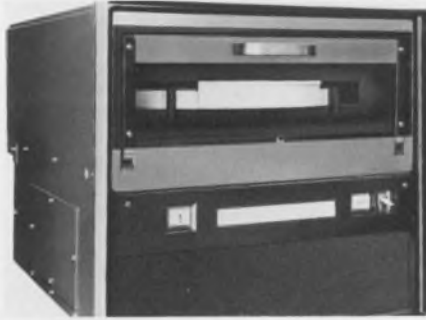
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RICHARDSON, TEXAS 75080  
AREA 214 231-9381

INFORMATION RETRIEVAL NUMBER 61

## DATA PROCESSING

### Universal disk memory stores 12 megabits



*Dynacoustics, Inc., 1980 National Ave., Hayward, Calif. Phone: (415) 783-5614. P&A: \$9950; 60 to 90 days.*

Able to interface to all existing 8, 12, and 16-bit minicomputers, a new 12,000,000-bit disk memory and controller system can store 1.4 million eight-bit words, 950,000 12-bit words, or 700,000 16-bit words. Model 1101 consists of a removable media disk drive and a general-purpose controller. Average access time is 134 ms.

CIRCLE NO. 353

### Data controller saves computer time



*American Data Systems, 8851 Mason St., Canoga Park, Calif. Phone: (213) 882-0020.*

Eliminating the common time-sharing problems of foreign-city and baud-rate fragmentation, a new full-contention programmable data communications controller minimizes mainframe intervention while providing maximum system utilization. Besides accepting up to 150 remote terminals, the ADS-945 is said to save system hardware, free mainframe computer ports, and increase throughput.

CIRCLE NO. 354

### Image processor upholds resolution



*Dicomed Corp., 7600 Parklawn Ave., Minneapolis, Minn. Phone: (612) 920-8980. Price: from \$15,000 (display), \$29,500 (digitizer).*

The Photomation image processing system makes on-line real-time digital image processing a practical reality by maintaining picture integrity through the various phases of processing, storage, recall, and transmission. This new system consists of the model 55 image digitizer, the model 30 image display, and a computer.

CIRCLE NO. 355

### Track ball control directs displays

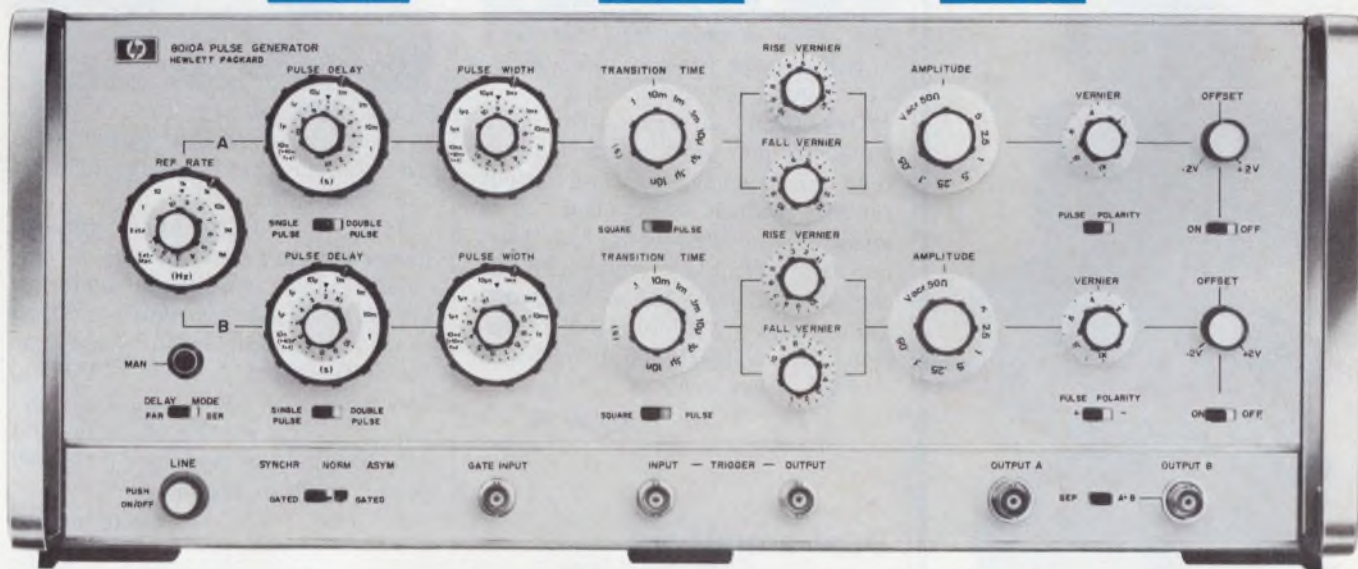
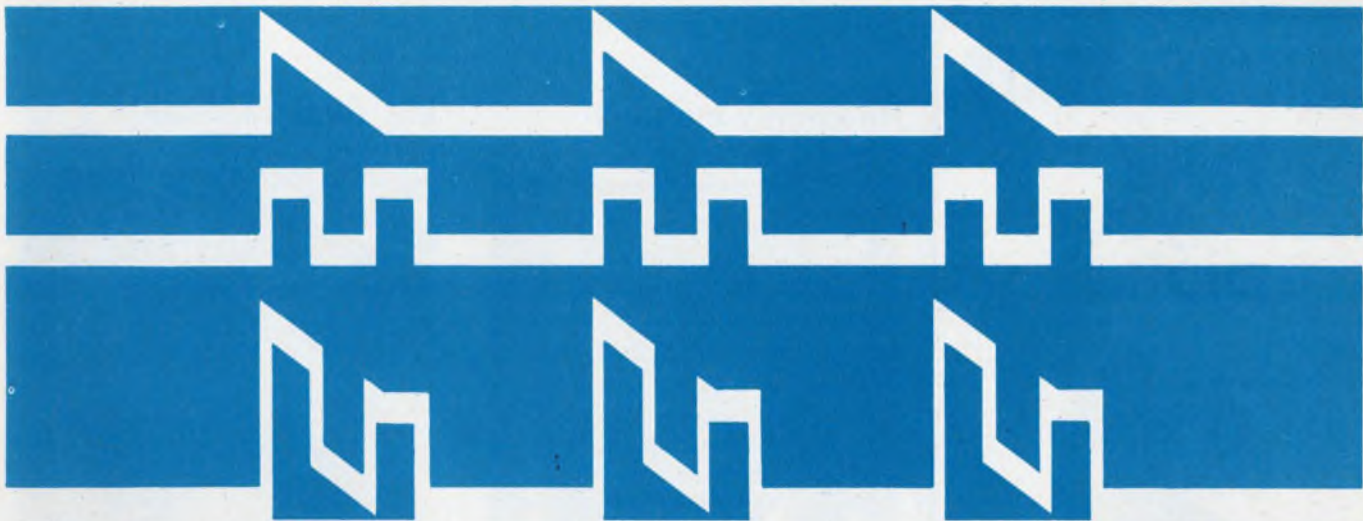


*Singer-Librascope, 1100 Francis Court, Glendale, Calif. Phone: (213) 245-8591.*

Able to be used with a wide variety of data display terminals, for positioning cursors, or for other control applications, a miniature track ball control called the Thumbtracker 10-756-00-01 is less than 3 in. in diameter. When the track ball is manually rotated, two shaft-encoders integrated within the unit provide two-axis control of data outputs.

CIRCLE NO. 356





## For complex waveforms, a new dual-channel pulser — Top of HP's '8000' line

HP's Model 8010A dual-channel pulse generator is a new top-of-the-line addition to our 8000 series. It gives you the ability to produce **two separate pulses**—to vary them independently in all respects but rep rate—and to **combine them to form complex waveforms, without loss of amplitude.**

The rep rate (common to both channels) can be varied from 1 Hz to 10 MHz. Rise and fall times can be varied independently, on both channels, from less than 10 nanoseconds to 1 second. Pulse width, delay, dc-offset and polarity are also independently variable. **Five volt amplitude of each channel can be combined to form a single-channel 10V output, while maintaining 50Ω source impedance.** In addition,

either or both of the two channels can be operated in double-pulse mode (giving an effective rep rate of 20MHz) or in squarewave mode (50% duty cycle).

**If you don't need all the capabilities of the 8010A, then one of the other models in the 8000 series is probably just right for you.** You can get fixed or variable risetimes (ranging down to 1.5 nanosecond on the 8004A), programmability for low-cost remote-control uses (model 8003A), simultaneous positive and negative outputs (model 8005A), and numerous other capabilities, in various combinations.

We can even give you **digital formatting capabilities**, with our 8006A word generator. Word length can be varied from **2 to 32 bits**, with great

versatility in output format. And, it's remotely programmable.

Price of the 8010A is only \$1925; other units in the HP 8000 Series of pulse generators begin as low as \$470. Call your local HP field office to order. For full information on the 8010A, or on the entire 8000 Series, see pages 237-245 in your 1970 HP Catalog, or send for a **free HP 8010A data sheet and brochure on all HP pulse generators.** Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

080/18

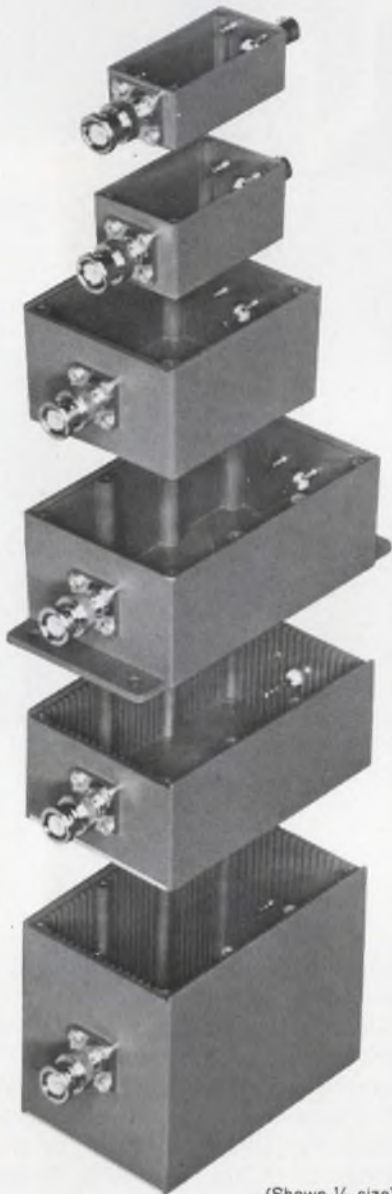
**HEWLETT**  **PACKARD**  
S I G N A L S O U R C E S

INFORMATION RETRIEVAL NUMBER 62



# SHIELDED BOXES

Take  
your  
pick.



(Shown 1/3 size)

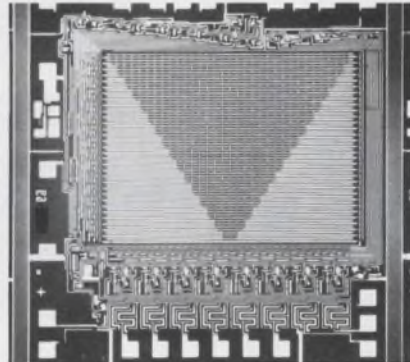
The newly expanded line of Pomona Shielded "Black Boxes" now comes in six different sizes; in cast or extruded aluminum; some slotted to accept circuit boards; in a broad choice of connector combinations or no connectors. There's bound to be one to meet your requirement. Write for complete information in our General Catalog.

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## ICs & SEMICONDUCTORS

### Read-only memory can be wire-OR'd

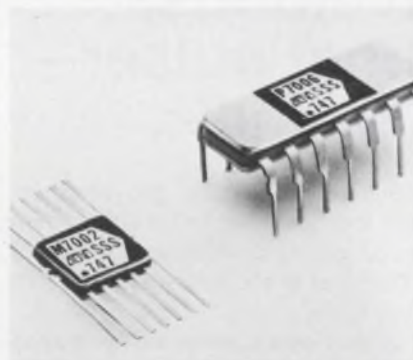


*Electronic Arrays, Inc., 501 Ellis St., Mountain View, Calif. Phone: (415) 964-4321. Price: \$60.*

Organized as 512 words with eight bits per word, a new 4096-bit read-only memory has two output inhibit controls that allow it to operate as a 1024-word, four bits-per-word array. The output inhibit control also allows the use of multiple units in a wire-OR'd configuration. Model EA 3300 provides a typical access time of 1.2  $\mu$ s.

CIRCLE NO. 357

### Dual amplifiers compensate on-chip

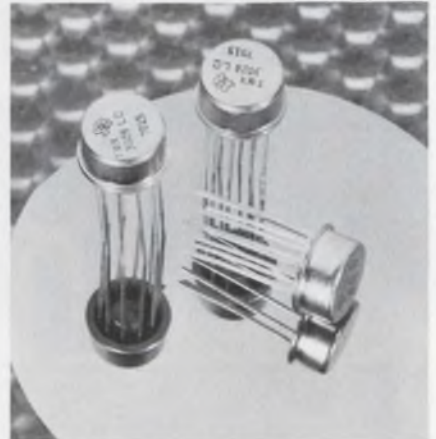


*Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. Phone: (408) 246-9222. P&A: \$24 or \$60; stock.*

Two dual frequency-compensated operational amplifiers, the SSS747 and the SSS747B, provide a maximum input offset voltage of 2 mV or 3 mV, respectively, and a maximum input offset current of 5 nA. Operating temperature range is  $-55$  to  $+125^{\circ}\text{C}$  for the SSS747, and  $-25$  to  $+85^{\circ}\text{C}$  for the SSS747B. Input resistance is 2 M $\Omega$ .

CIRCLE NO. 358

### LSI dual register retains 256 bits

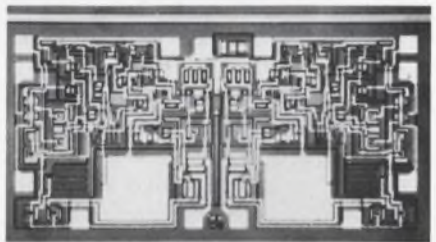


*Texas Instruments Inc., Components Group, P. O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: \$20; 2 to 4 wks.*

Ideal for delay lines, refresh memories, and data storage in calculators and terminals, a dual 128-bit MOS LSI static shift register can store a total of 256 bits. Capable of operation from dc to 1 MHz, the model TMS3028 can be operated at very low frequencies and can be stopped if necessary. Two power supplies are needed.

CIRCLE NO. 359

### Dual IC op amp does not latch-up



*Amelco Semiconductor, 1300 Terra Bella Ave., Mountain View, Calif. Phone: (415) 968-9241. P&A: \$27; stock.*

A general-purpose monolithic dual operational amplifier can be driven without going into a latch-up state. Model 747 also offers internal compensation, short-circuit protection, large common-mode and differential voltage ranges, and offset null points. Applications include active filters, oscillators, integrators and summing amplifiers.

CIRCLE NO. 360



## N-channel JFETs minimize noise

Solitron Devices, P.O. Box 1416, San Diego, Calif. Phone: (714) 239-3471. Availability: stock.

Said to be virtually noise free, three new n-channel JFETs hold maximum noise to as little as 10 nV/ $\sqrt{\text{Hz}}$  at 10 Hz. Types 2N5592, 2N5593, and 2N5594 also offer symmetrical construction with reversible source and drain terminals, square-law transfer characteristics and high breakdown voltages. Typical output admittance is 1  $\mu\text{mho}$  and typical forward transconductance is 4500  $\mu\text{mho}$ .

CIRCLE NO. 361

## MOS shift registers sell for 1.5¢/bit

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. Phone: (408) 732-5000. Price: \$3 or \$5.

Two new MOS shift registers bring costs down to less than 1.5¢ per bit. The MM5016 is a TTL-compatible 512-bit shift register which sells for only \$5 in quantities of 100. The MM5006 is a dual 100-bit shift register priced at \$3 each in 100-unit lots. Both devices operate on +5 and -12-V power supplies, eliminating the need for external interface circuitry.

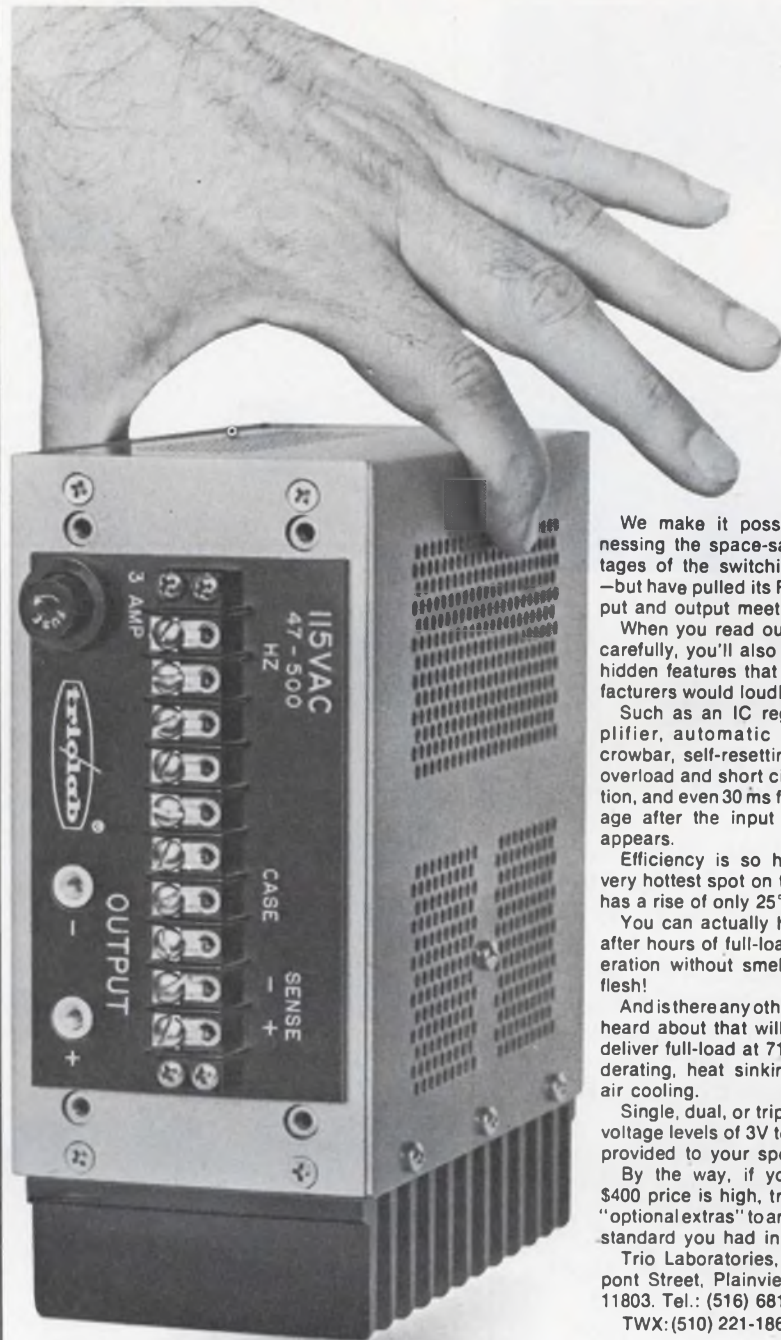
CIRCLE NO. 362

## Counter/divider dissipates 5 $\mu\text{W}$

RCA/Electronic Components, Solid State Div., 415 S. Fifth St. Harrison, N. J. Phone: (201) 485-3900. Price: \$12.80.

A new complementary MOS counter/divider, model CD4017D, keeps its quiescent power dissipation to 5  $\mu\text{W}$  typical with a supply voltage of 10 V. This MSI device consists of a decade counter and output decoder that converts a binary code to a decimal number. It is designed to operate with clock input rates of dc to 3 MHz. The housing is a 16-lead ceramic DIP.

CIRCLE NO. 363



We make it possible by harnessing the space-saving advantages of the switching regulator—but have pulled its RFI fangs (input and output meet MIL-I-6181).

When you read our data sheet carefully, you'll also find it full of hidden features that other manufacturers would loudly acclaim.

Such as an IC regulating amplifier, automatic overvoltage crowbar, self-resetting automatic overload and short circuit protection, and even 30 ms full-load storage after the input voltage disappears.

Efficiency is so high that the very hottest spot on the heat sink has a rise of only 25°C.

You can actually hold our unit after hours of full-load bench operation without smelling burning flesh!

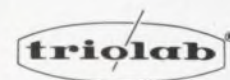
And is there any other unit you've heard about that will continue to deliver full-load at 71°C.—without derating, heat sinking or forced air cooling.

Single, dual, or triple outputs at voltage levels of 3V to 30V can be provided to your specific needs.

By the way, if you think our \$400 price is high, try adding the "optional extras" to anybody else's standard you had in mind.

Triolab, Inc., 80 Dupont Street, Plainview, L. I., N. Y. 11803. Tel.: (516) 681-0400.

TWX: (510) 221-1861.



**Now you can squeeze your  
5V/20A power supply  
down to fit your  
microcircuitry.**





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Tee-up this 4171F IXF Integrated Crystal Filter and be in-bounds on-

**performance:** 4-Pole Response at 75 MHz. Typical 3dB bandwidth - 35 KHz. Stopband attenuation exceeds 60dB.

**size:** Case style F measures .185 x .432 x .450 inches overall.

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**delivery:** Available from stock.

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# Pi

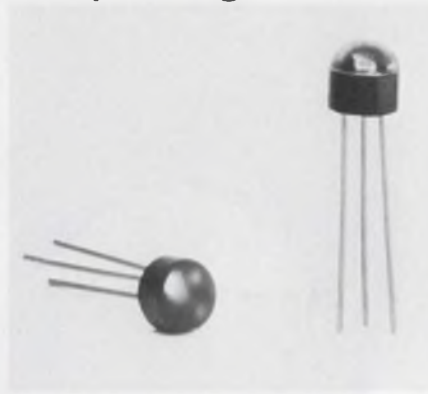
**Piezo Technology Inc.**

2400 Diversified Way  
Orlando, Florida 32804  
305-425-1574

a subsidiary of Walter Kidde & Company, Inc.



## Visible LEDs trim price tags



*Fairchild Camera and Instrument Corp., Microwave and Optoelectronics Div., 2513 Charleston Rd., Mountain View, Calif. Phone: (415) 961-9644. P&A: 99¢ to \$3; stock.*

Two new visible light-emitting diodes, the FLV100 and the FLV101, cost \$3 in quantities of 1 to 99, and 99¢ for quantities of 10,000. Brightness is 1500 foot-lamberts for the FLV100, and viewing angle is 160° for the FLV101. Both units can be driven by standard digital ICs.

CIRCLE NO. 364

## Uhf varactor diode goes out to 200 MHz



*Sarkes Tarzian Inc., 415 N. College Ave., Bloomington, Ind. Phone: (812) 332-1435.*

A new miniature variable-capacitance diode is now available for automatic-frequency-control applications at uhf frequencies to 200 MHz. Type VC-2 provides a Q of 150 at 50 MHz, and a 9-pF capacitance at -4 V and 1 MHz. Its power dissipation is 250 mW at 25°C, and peak reverse voltage is 15 V. The unit is supplied in a hermetically sealed DO-5 glass package.

CIRCLE NO. 365

## Unpackaged chips are fully tested

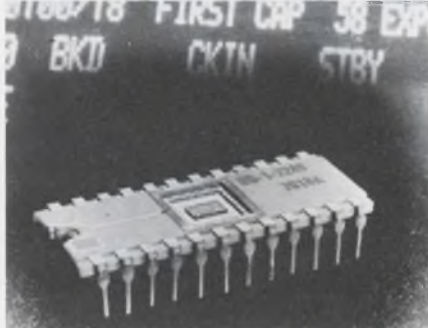


*Advanced Micro Devices Inc., 901 Thompson Place, Sunnyvale, Calif. Phone: (408) 732-2400. Price: \$3 to \$5.90.*

Fully tested complex digital and linear integrated circuit dice are now available. The devices, which are provided in 100-unit carriers, are subjected to complete functional and parametric testing, and can be supplied in full-military-temperature versions. All devices are visually screened to meet the requirements of MIL STD 883.

CIRCLE NO. 366

## Character generator accesses in 500 ns



*General Instrument Corp., 600 W. John St., Hicksville, N. Y. Phone: (516) 733-3000. Price: \$28.*

A new single-package character generator with a 2-MHz (500 ns) character access time replaces conventional multi-unit devices. Model RO-1-2240 is an MTOS (metal-thick-oxide silicon) 2240-bit read-only memory that accepts ASCII-coded inputs for 5 by 7 character selection. It provides asynchronous/synchronous operation.

CIRCLE NO. 367



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## COMPONENTS

### Ceramic FM i-f filter retails as low as \$1.20



*Murata Corp. of America, 2 Westchester Plaza, Elmsford, N. Y. Phone: (914) 592-9180. Price: \$1.20.*

With a nominal center frequency of  $10.7 \pm 0.35$  MHz, a 3-dB bandwidth of 210 kHz and a 50-dB bandwidth of 780 kHz, the SFG-10.7MA ceramic FM i-f filter is priced as low as \$1.20 in production quantities. Insertion loss is 10 dB and ripple is 1 dB. Input and output impedances are 330  $\Omega$ . Operating range is  $-30$  to  $+80^\circ\text{C}$ .

CIRCLE NO. 368

### Alphanumeric displays use split flaps

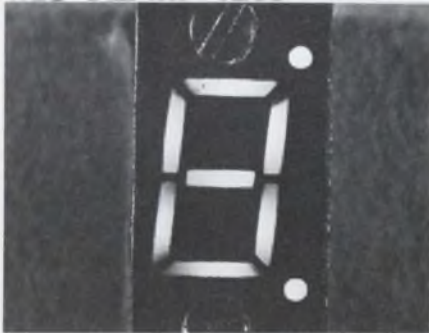


*Conrac Corp., 330 Madison Ave., New York, N. Y. Phone: (212) 687-3330.*

Including single-character and wide-flap units, with up to 64 flaps per module, a new line of modules uses split flaps for alphanumeric displays. A display board can utilize an unlimited number of these modules, positioned in relationship to the information display needs. Characters can be 2-1/2 or 4-in. high and flaps are available in 4, 6, 12, 18, 24 and 30-in. widths.

CIRCLE NO. 369

### 0.32-in.-high readout has 0.2-in.<sup>2</sup> face

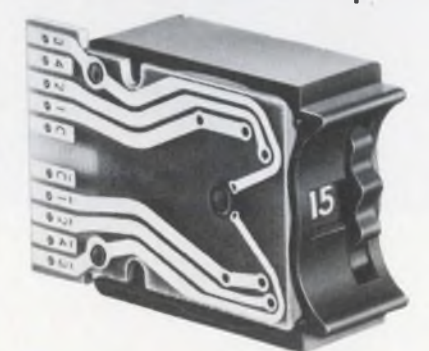


*Oppenheimer, Inc., 2475 Wyandotte Rd., Willow Grove, Pa. Phone: (215) OL9-6000.*

A new incandescent readout provides a 0.32-in.-high display in only 0.2 square inches of panel space. It is bright enough to be read in sunlight yet can be driven directly from IC logic. Relamping is accomplished from the front. A solid-state BCD decoder which permits lamp brightness to be varied is optional.

CIRCLE NO. 370

### Tiny thumbwheel switch has hexadecimal output



*Cherry Electrical Products Corp., 1650 Deerfield Rd., Highland Park, Ill. Phone: (312) 831-2100. Price: \$12.40.*

Designated T20-09A, a new sub-miniature thumbwheel switch contains a hexadecimal coded output, its complement, and two commons. It is designed for back-of-panel mounting applications and can also be supplied for front-panel mounting. In addition to standard numerals of 0 through 9, alpha readouts of A through F are available.

CIRCLE NO. 371



## Cassette-tape dc motor drives at 2 to 100 in./s

TRW Inc., Globe Industries Div., 2275 Stanley Ave., Dayton, Ohio. Phone: (513) 228-3171.

A new dual dc motor, type 69A-161, can directly drive and rewind computer tape cassettes at drive speeds from 2 to 100 in./s without intervening mechanisms. It is designed for a wide range of voltages and can be furnished with or without spindles for engaging cassette hubs. It can be used for reel take up and wind/rewind functions with a capstan drive.

CIRCLE NO. 372

## Stable 1% resistor has TC of 50 ppm

Corning Glass Works, Electronic Products Dept., Corning, N. Y. Price: \$2.05.

Called the NC3, a new NC-style resistor meeting MIL-R-10509F characteristic C standards has a temperature coefficient of 50 ppm and is rated at 1/10 W at 70°C or 1/20 W at 120°C. Its tolerance is 1% and its resistance range is from 49.9  $\Omega$  to 100 k $\Omega$  at 200-V rating. Length (lead-to-lead) is 0.145 in., dia is 0.062 in. and leads are 1 in. long.

CIRCLE NO. 373

## Latching reed switch uses magnetic contacts

Tempress Electronic Corp., 666 Park Ave., East Orange, N. J. Phone: (201) 677-0440. P&A: 85¢; stock to 6 wks.

The Memreed is a latching reed switch whose contacts are made of hard magnetic material to maintain closure without continuous energizing of its operate coil. A control signal of 50  $\mu$ s causes the switch to respond in 1 ms. Rating is 200 V dc at 0.5 A dc and contact resistance is 0.1  $\Omega$  at 1 V dc and 10 mA dc.

CIRCLE NO. 374

# Four reasons why Remex readers cost less.

The lower cost of a Remex will show up in its long life. Simplified maintenance. Adaptability. Our Model RRS 3000 photoelectric reader/spooler is a perfect example:



First, there's the fiber optic distributor and sensor fiber optic face plate. No other reader has it. Fiber optics collimate light so that punched tapes of up to 70% transparency can be read without adjustment. That makes Remex the most perceptive. Most sensitive. Most reliable. The eyes of a complex system have to be sharp.



Then only Remex equips its readers with a self-cleaning, vibration-proof quartz lamp. That means unvarying illumination for 15,000 hours. (And that's just a conservative estimate. Actual calculated life is 60,000 hours.) And during this extra-long life span, no costly downtime.



All I.C. circuitry. Power supplies, drive, brake and read components are mounted on two printed circuit cards. Pluggable. In card cages. With card locks and extractors.



More tape capacity (up to 1,240 feet) on 7½-inch reels than on a standard NAB 8-inch reel.

Call us at 213-772-5321 or write for free literature: Remex Electronics, 5250 W. El Segundo Blvd., Hawthorne, California 90250. Designing computers, numerically controlled systems, or automatic test equipment? Give our best to your customers.



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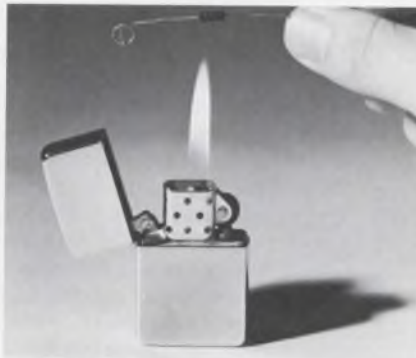


**Plastic Capacitors, INC.**

2620 N. Clybourn • Chicago 14, Ill.  
DI 8-3735

**COMPONENTS**

**Temperature sensors carry 75¢ price tags**



General Resistance, Inc., 500 Nuber Ave., Mount Vernon, N. Y. Phone: (914) 699-8010. P&A: from 75¢; 3 wks.

Featuring temperature coefficients ranging from  $-10$  to  $+6000$  ppm/ $^{\circ}$ C, Temp-Istor temperature sensing or compensating precision wire-element resistors retail from 75¢ in quantities of 100. Resistance value at  $25^{\circ}$ C is  $100 \Omega \pm 0.25\%$  and operating temperature range is  $-55$  to  $+125^{\circ}$ C. Special-order elements can be made.

CIRCLE NO. 375

**Dual-gun storage tube displays in 2 colors**

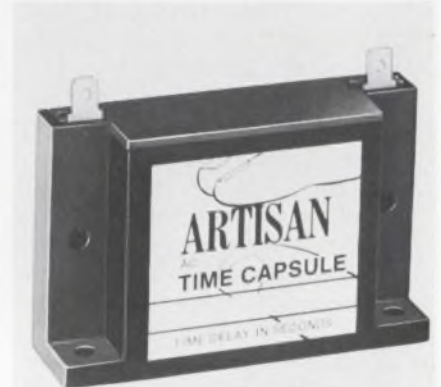


Thompson-CSF Electron Tubes, Inc., 50 Rockefeller Plaza, New York, N.Y. Phone: (212) 245-3900.

The TEI 1347 is a direct-view storage tube which allows simultaneous writing and storage of two input signals, in two colors of green and red. A dual gun used in combination with a ribbon-shaped collector and a strip-pattern screen makes this feature possible. Another feature is a complete half-tone capability for each of the two displayed colors.

CIRCLE NO. 376

**Ac-voltage capsule delays up to 300 s**



Artisan Electronics Corp., 5 Eastmans Rd., Parsippany, N. J. Phone: (201) 887-7100.

Featuring solid-state construction, a new two-lead device delays ac voltages to resistive, inductive or lamp-load circuits from 0.1 to 300 s. It can deliver up to 2 A of ac current to a specific load. Recycling time is 100 ms maximum, after a timing cycle. Transients of up to 2000 V for  $1.5\text{-}\mu\text{s}$  durations will not cause premature operation.

CIRCLE NO. 377

**Solid-state relays isolate input/output**



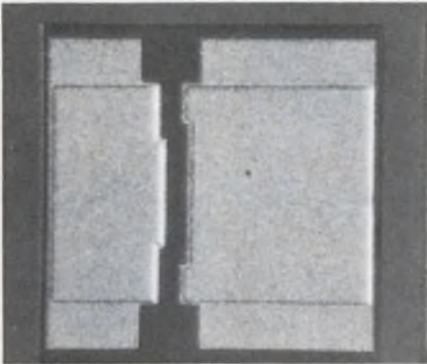
Ebeko GmbH & Co. KG, Dr. E. Wolff, 1241 Welsh Rd., Huntingdon Valley, Pa. Phone: (215) 947-1544.

Introduced from Germany, the new ELR solid-state relays feature complete isolation between input and output circuits, high operating speeds (from microseconds to nanoseconds), and no moving contacts or parts. Isolation is obtained by a magnetoresistor (field-plate) which does not require a separate reference voltage.

CIRCLE NO. 378



## MOS chip capacitors span 0.5 to 220 pF



*Dionics Inc., 65 Rushmore St., Westbury, N.Y. Phone: (516) 997-7474.*

A new line of MOS capacitor chips for hybrid circuits features six case geometries of single and dual units with capacitances from 0.5 to 220 pF and working voltages from 25 to 75 V. Chip sizes range from 20 to 45 mils square and are 6 mils thick. The chips are gold backed for conventional eutectic die bonding and have aluminum pads on the surface.

CIRCLE NO. 379

## 50-mil-square chips give up to 6800 pF

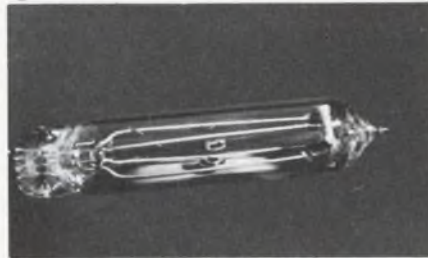


*U.S. Capacitor Corp., 2151 N. Lincoln St., Burbank, Calif. Phone: (213) 843-4222.*

Ceramolithic chip capacitors are now available in a new size—50 by 50 by 40 mils. The units come with NPO or W dielectrics for capacitances from 6 to 6800 pF in 50 and 100-V sizes. Silver-end terminations are standard; gold, palladium-gold, and palladium-silver ones are also available. The chips meet all applicable requirements of MIL-C-11015 and MIL-C-39014.

CIRCLE NO. 380

## Glass-bulb thermistor ignores ambients



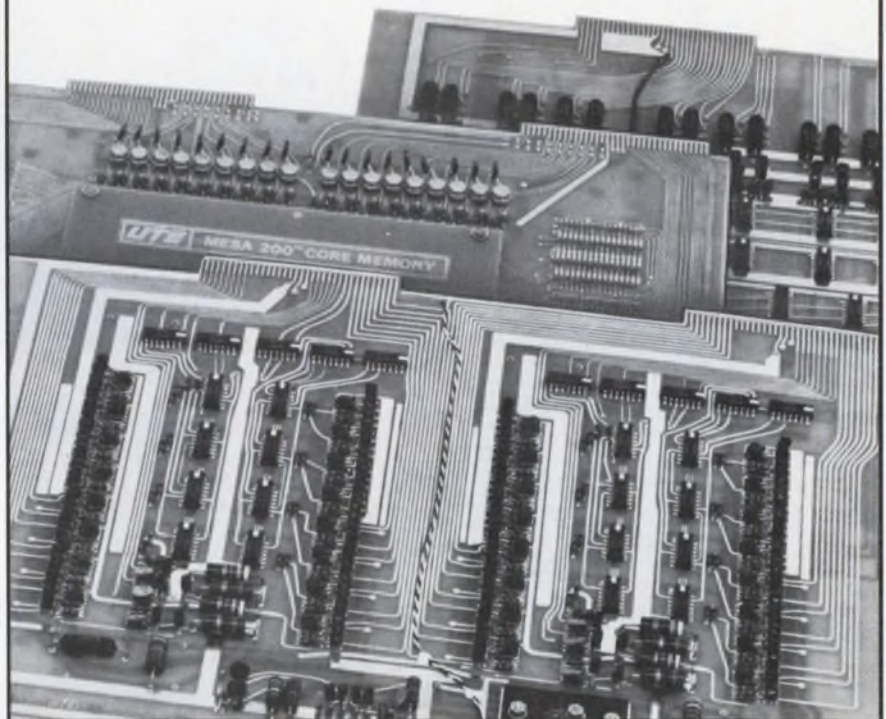
*Fenwal Electronics Inc., 63 Fountain St., Framingham, Mass. Phone: (617) 872-8841.*

The K365 thermistor is a combination of a heating element and a bead enclosed in a glass bulb that is unaffected by changes in ambient conditions. A temperature increase of 1°C changes its resistance from 50,000 to 15,000 Ω.

CIRCLE NO. 381

## CORE MEMORY:

# 2¢ per bit and going down



4k x 18 or 8k x 9 core memory systems at 2 microseconds full cycle. 100 quantity price: \$1,475 ea.



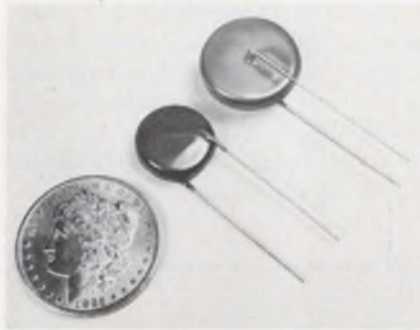
**UNITED TELECONTROL ELECTRONICS**

3500 Sunset Avenue, Asbury Park, New Jersey 07712  
201-922-1000



COMPONENTS

**Disc capacitors accept 10 kV dc**

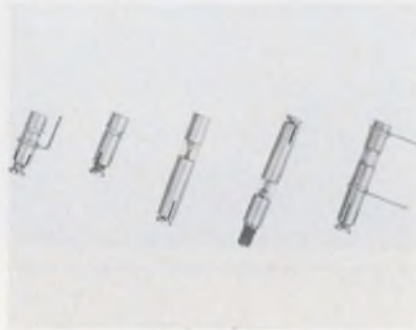


Centralab, 5757 N. Green Bay Ave., Milwaukee, Wis. Phone: (414) 228-2769. P&A: from 21¢; 5 to 7 wks.

Reducing possible sources of radiation in high-voltage circuits, three new ceramic disc capacitors are available with values of 1000 pF (at 9 kV dc), 2000 pF (at 9 kV dc) and 2500 pF (at 10 kV dc). Sizes are 0.85 in. in dia and 0.375-in. thick, 1.1 in. in dia and 0.375 in. thick, and 1.3 in. in dia and 0.375-in. thick, respectively.

CIRCLE NO. 382

**Tiny trimmer capacitor gives up to 2 pF**

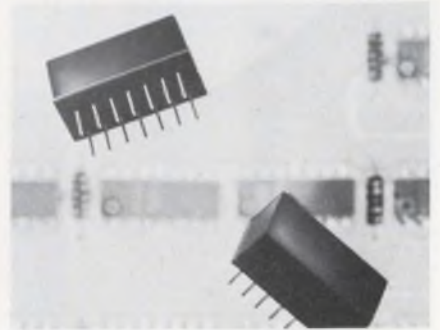


Johanson Mfg. Corp., 400 Rockaway Valley Rd., Boonton, N. J. Phone: (201) 334-2676.

Using a ceramic dielectric, a new miniature trimmer capacitor ranges in capacitance values up to 2 pF, while measuring only half as long as former trimmers of its type. The 7200 series trimmer capacitor has a 10:1 tuning ratio and ranges down to 0.1 pF of capacitance. It is constructed of gold-plated brass and uses high-K glass and alumina ceramics.

CIRCLE NO. 383

**DIP-cased capacitors span 0.001 to 0.047  $\mu$ F**




S&EI Mfg., 18800 Parthenia St., Northridge, Calif. Phone. (213) 349-4111.


Constructed of metalized mylar or polycarbonate dielectrics, new multiple capacitors are available in 14-pin dual-in-line cases with values from 0.001 through 0.047  $\mu$ F and with a tolerance to  $\pm 1\%$ . Operating temperatures are  $-55$  to  $+105^\circ\text{C}$ . Special designs are also available. Applications include integrated circuits where stringent space requirements exist.

CIRCLE NO. 384

**\$275**  
**The ~~\$350~~ DMM**



- AC
- DC
- $\Omega$
- I
- 0.1%



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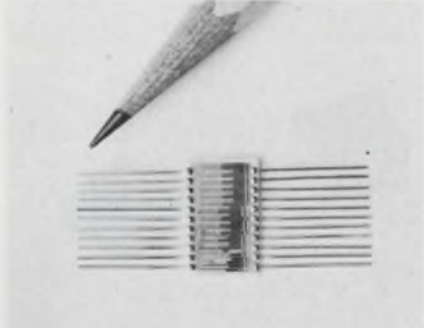
**ELDORADO**

**ELDORADO ELECTRODATA CORPORATION**

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**Flatpack 12-bit ladder is accurate to  $\pm 125$  ppm**

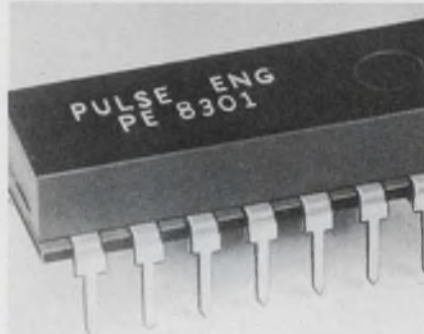


*Halex, Inc., 3500 W. Torrance Blvd., Torrance, Calif. Phone: (213) 370-6175. Price: \$58.50.*

The HX510 12-bit flatpack ladder network has total output accuracy of  $\pm 125$  ppm  $\pm 1/2$  the least significant bit over the temperature range of  $-55$  to  $+125^\circ\text{C}$ . Resistors are made of vacuum-deposited nichrome thin film and conductors are gold thin film. Case size is  $3/8$  by  $5/8$  in. Total power dissipation is 200 mW and maximum input voltage is 20 V dc.

CIRCLE NO. 385

**Transformer 16-pin DIPs decrease leakages**



*Pulse Engineering, Inc., Box 12235, San Diego, Calif. Phone: (714) 453-6010. P&A: \$18.50; stock.*

A new series of modules, each consisting of four transformers in a 16-lead DIP case, features transformers with primary-to-secondary leakage inductance and capacitance of  $0.35 \mu\text{H}$  and of  $6 \text{ pF}$ , respectively. Inductance values from 20 to  $500 \mu\text{H}$  and turns ratios of 1:1 and 2:1 are available. Peak pulse voltage rating is 50 V and insulation resistance is 10,000 M $\Omega$ .

CIRCLE NO. 386

**Temperature stabilizer regulates in 1 minute**

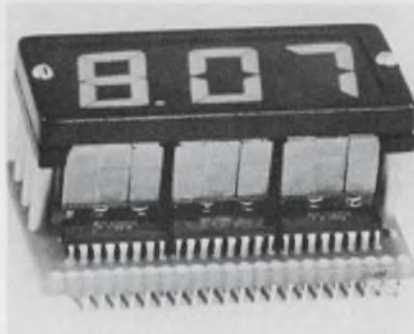


*Texas Instruments, Inc., Control Products Div., Attleboro, Mass. Phone: (617) 222-2800.*

A new solid-state self-regulating TO-5-cased device operates without thermostatic controls to self-stabilize both itself and contained components at  $65^\circ\text{C}$  in less than 1 minute. It draws under 1 W of power in its steady state at room temperature and operates over ambients from  $-55$  to  $+15^\circ\text{C}$  below its control temperature. Operating voltage is 24 V ac or dc.

CIRCLE NO. 387

**Segmented readouts vary brightness equally**



*Readouts, Inc., 215 15 St., Del Mar, Calif. Phone: (714) 755-2641. P&A: \$7 per decade; stock.*

Series 7, 8 and 9 digital readouts are low-cost high-brightness segmented units that can be dimmed from full brightness to 10% of original brightness levels with all segments remaining equally lighted. Lamps used are any T-1 sub-midget flanged-base types (1.5 to 28 V). Lamps are front-panel replaceable. Decimal or degree signs are standard, and a BCD decoder/driver is available.

CIRCLE NO. 388

**variety with ALCOSWITCH**

The greater the variety, the more flexibility you have when designing a miniature ALCO-SWITCH into your quality equipment. The broad ALCOSWITCH line offers over a hundred different models.

Miniature Toggle Switches are available in five series including high performance waterproof types, locking handles, and switches with  $15/32$ " bushings.

Miniature Push Button Switches include the new illuminated series, top-grade SPDT-DPDT-4PDT types,  $15/32$ " bushings, and economy priced miniatures.

$1/2$ " Dia. Miniature Adjustable-Stop Rotary Switches are built to meet the highest reliability standards and are available with or without their own specially mated knobs.

Whether you need one or one thousand switches you have a greater variety to choose from when you specify an ALCOSWITCH.

SEND FOR 20-PAGE ALCOSWITCH CATALOG



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Lawrence, Massachusetts 01843

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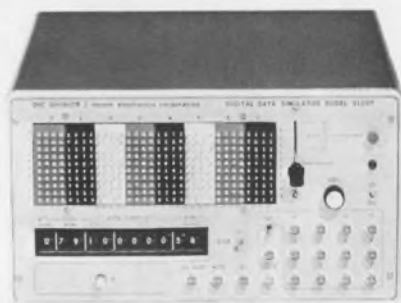
# SRC word generators go to great lengths to test your logic circuits.

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For all the information you'll need, write today. SRC Division, Moxon, Inc., 2222 Michelson Drive, Newport Beach, California 92664 (714) 833-2000.



INFORMATION RETRIEVAL NUMBER 73

### MODULES & SUBASSEMBLIES

#### 10-bit d/a converter settles within 40 ns



Analog Devices, Inc., Pastoriza Div., 221 Fifth Ave., Cambridge, Mass. Phone: (617) 492-6000. P&A: \$370; 3 wks.

Permitting update rates as high as 10 MHz, the model MDA-10F digital-to-analog converter settles to one least-significant bit in 60 ns maximum and settles in 40 ns to one-half the least-significant bit. The new 10-bit converter has its own built-in reference source, ladder network, and current switches. It operates from  $\pm 15$  V.

CIRCLE NO. 389

#### Economy supplies deliver 150 W

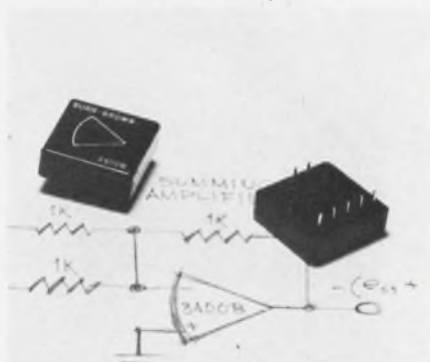


ACDC Electronics Inc., Oceanside Industrial Center, Oceanside, Calif. Phone: (714) 757-1880. P&A: \$51 to \$110; stock.

A new series of OEM low-voltage regulated power supplies provide a wide range of voltage and power requirements for only \$51 to \$110 in production quantities. These supplies are available in three case sizes with voltages from 4 to 32 V and power levels ranging from 30 to 150 W. Features include 0.1% regulation and 2-mV ripple.

CIRCLE NO. 390

#### Wideband op amp slews 1000 V/ $\mu$ s

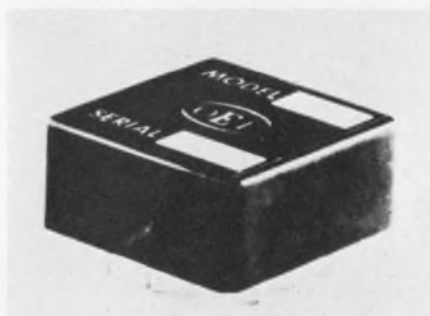


Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: \$55; stock.

Featuring a FET differential input, a new operational amplifier has a 100-MHz small-signal bandwidth and a large-signal slew rate of 1000 V/ $\mu$ s. Because of its differential input, model 3400B can be used as a non-inverting buffer amplifier. Maximum bias current is 100 pA, and minimum open-loop gain is 80 dB.

Booth No. 1135 Circle No. 257

#### High-speed amplifier delivers 10 V at 0.5 A



Optical Electronics Inc., P.O. Box 11140, Tucson, Ariz. Phone: (602) 624-8358. P&A: \$98; stock.

In addition to supplying an output of  $\pm 10$  V at 0.5 A, the model 9695 operational amplifier offers a slewing rate of 100 V/ $\mu$ s and a closed-loop bandwidth of 10 MHz. The unit has a maximum bias current of 100 nA and a maximum input offset voltage drift of 10  $\mu$ V/ $^{\circ}$ C. Minimum open-loop gain is 80 dB, gain-bandwidth product is 20 MHz, and maximum full-output frequency is 1.5 MHz.

CIRCLE NO. 391



# New FET V-O-M features

## 8 Low-Power Ohms Ranges . . .

## 0.005 V AC Full Scale

Triplet's new Model 801 V-O-M offers 73 measurement ranges including 8 low-power resistance ranges that apply only 35 mV to the device under test. There are 22 voltage ranges—10 DC and 12 AC; 24 current ranges divided equally between DC and AC; 15 resistance ranges—including the 8 low-power ranges; and 12 ranges of output measurement.

As if such unsurpassed versatility were not enough, the Model 801 also offers 11 megohm DC and 10 megohm AC input resistances, 2% DC and 3% AC accuracy and a 25  $\mu$ A suspension-type meter with a nearly 7½" long scale. There's no doubt that the new Triplet Model 801 has no equal among analog V-O-M's in terms of sensitivity and versatility.

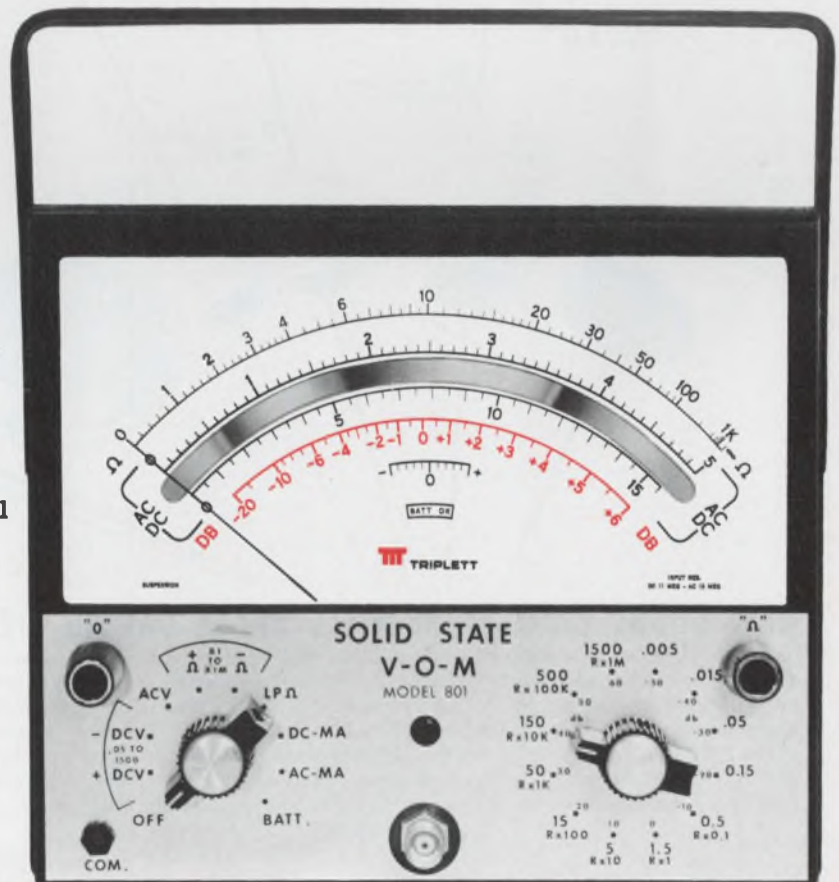
See the remarkable new Model 801 V-O-M—priced at **\$200** suggested USA user net—at your Triplet distributor. For more information—or for a free, no-obligation demonstration—call him or your Triplet sales representative right away. Triplet Corporation, Bluffton, Ohio 45817.



The World's most complete line of V-O-M's . . .  
choose the one that's just right for you

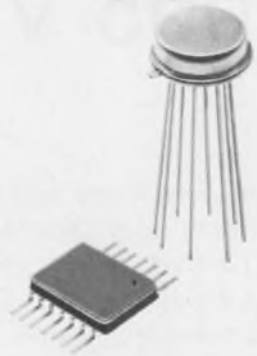
Model 801

1. 8 ranges of low-power ohms at 35 mV with 1 ohm center scale.
2. High sensitivity (0.005 V AC full scale) at 10 megohm input resistance.
3. 8" meter has simplified scale with only 2 arcs for 46 AC/DC ranges.



INFORMATION RETRIEVAL NUMBER 74

### Stable amplifier suits transducers

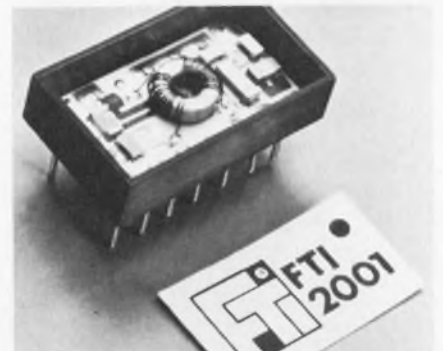


*Kulite Semiconductor Products, Inc., 1039 Hoyt Ave., Ridgefield, N. J. Phone: (201) 945-3000.*

Developed specifically for transducer applications, a new operational amplifier has a frequency response of 100 kHz and a common-mode rejection ratio of 90 dB. The gain of the device is normally set at 50, but can be externally adjusted. Model KH-101 provides an input impedance of 20 kΩ and an input drift of 10 μV/°C. Linearity is 0.1%.

CIRCLE NO. 392

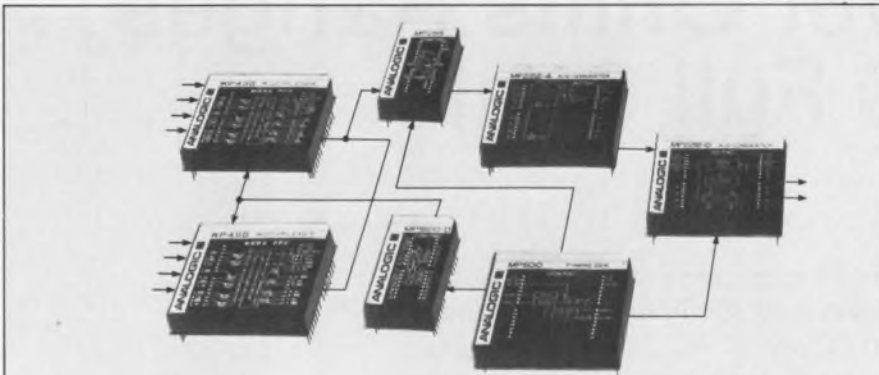
### Data noise filter covers 2.5-MHz band



*Fabri-Tek Micro-Systems, Inc., 1150 N.W. 70th St., Fort Lauderdale, Fla. Phone: (305) 933-9351. Price: \$19.85.*

Designed to eliminate sources of system noise in data transmission applications, a new hybrid digital interface circuit operates at data rates from dc to 2.5 MHz. Since the FTI-2001 data filter derives its power from the input signal, it requires no external dc power connections. Transformer coupling eliminates ground-loop currents.

CIRCLE NO. 393



ANALOGIC INTRODUCES

# the first family

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...The Digitizers

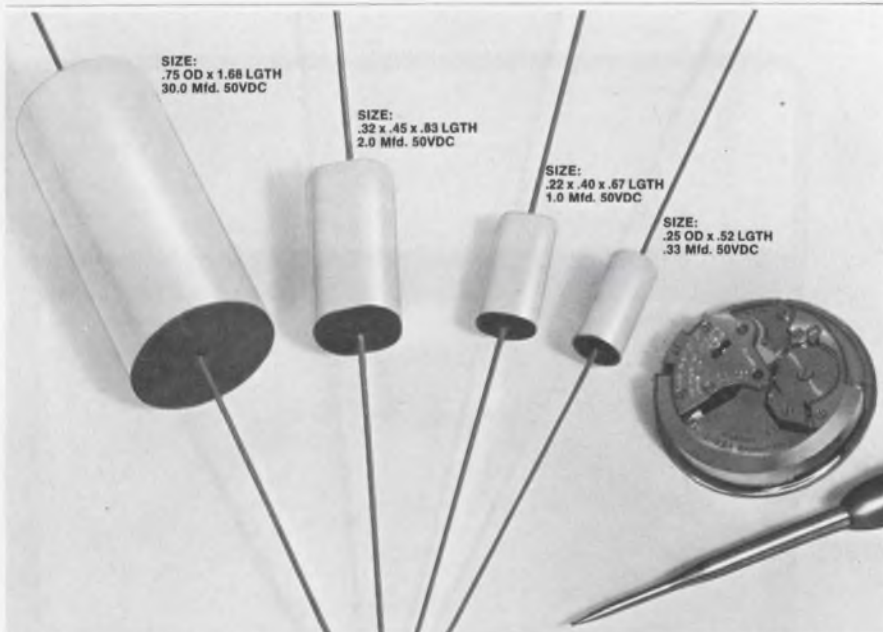
Audubon Rd., Wakefield, Mass. 01880  
Tel. (617) 246-0300. TWX (710) 348-0425

Analogic's new **Modupac™** line is the first complete family of analog-digital-analog signal conversion modules. They're available as independent single units, or in any combination, and easily interconnected to form all or part of a limitless range of systems. However you specify them, Analogic **Modupac™** modules offer you the following advantages:

- Pre-system engineered for maximum performance and high M.T.B.F.
- Both electrostatically and electromagnetically shielded . . . yet easily repairable.
- Standardized terminal arrangement.
- 0.10" pin spacing . . . for P.C. or "DIP" socket mounting.
- 3 plan sizes: 1" x 2", 2" x 2", and 2" x 4"; most are 0.39" high.

Function for function, the best price-performance ratio available.

INFORMATION RETRIEVAL NUMBER 75



SIZE:  
.75 OD x 1.68 LGTH  
30.0 Mfd. 50VDC

SIZE:  
.32 x .45 x .83 LGTH  
2.0 Mfd. 50VDC

SIZE:  
.22 x .40 x .67 LGTH  
1.0 Mfd. 50VDC

SIZE:  
.25 OD x .52 LGTH  
.33 Mfd. 50VDC

### NEW 50VDC CAPACITORS WITH SPACE SAVING SIZES

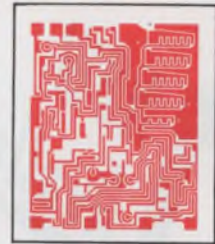
Size check these min-miniature wrap and fill, metalized polycarbonate capacitors. They're compact, and made especially for volumetric utilization. With this major breakthrough in size reduction, S & E I capacitors still maintain superior electrical characteristics of thin film metalized polycarbonate dielectrics. They are designated as the 22W, oval shaped series and the 22R round series. S & E I also produces 50VDC and 100VDC capacitors, in a variety of other space saving encasements. Write for a condensed data sheet, or call factory direct for prompt up-to-date information.

**S&E I** Manufacturing/Capacitors

18800 Parthenia Street, Northridge, California 91324 • (213) 349-4111 • TWX 910-493-1252

INFORMATION RETRIEVAL NUMBER 76





## Modular phase shifter puts out square wave

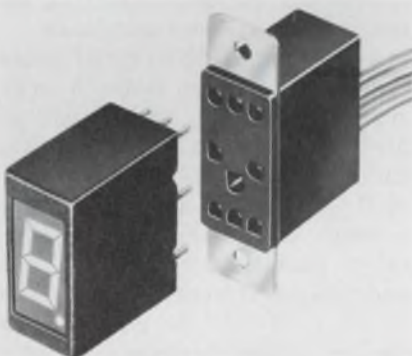


Sensory Devices Co., 1704 Rainier St., Idaho Falls, Idaho. Phone: (208) 523-8132. Price: \$54.

Designed to operate from 10 Hz to 100 kHz with a sinusoidal input, a new phase-shifter provides 0 to 360-degree phase control in four 90-degree segments. Model 102 also features a constant-amplitude square-wave output, and easy selection of operating frequency. The unit is a 1.5 by 1.5-in. encapsulated module with standard pin spacings.

CIRCLE NO. 394

## Display package takes BCD inputs



Alco Electronic Products, Inc., Alco-Display Div., Lawrence, Mass. Phone: (617) 686-3880. P&A: \$29.45; stock.

A seven-segment display (model MS-4000B) and a mating plug-in BCD-input decoder/driver (model DDM-703) are now available. The readout uses standard T-1 incandescent lamps rated at 5 V and 60 mA. The decoder/driver plug-in module provides an 80-mA output, and includes an intensity control and a lamp test input.

CIRCLE NO. 395

# Precision art masters begin with Ulano® films.

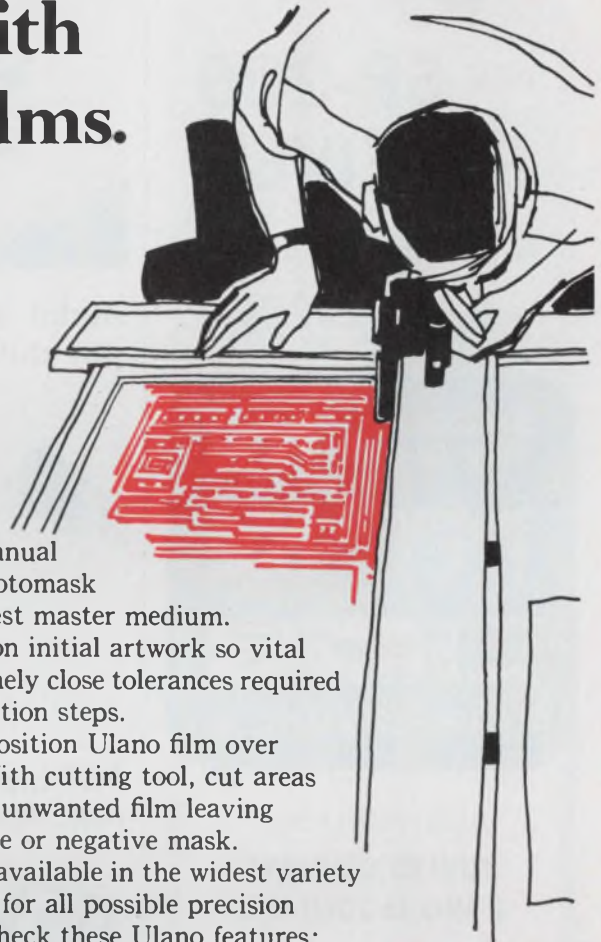
Whether your artwork requires the precision of a coordinatograph or is tolerant enough for manual preparation, Ulano photomask films represent your best master medium.

They permit precision initial artwork so vital in obtaining the extremely close tolerances required after the various reduction steps.

Two simple steps: Position Ulano film over the master artwork. With cutting tool, cut areas to be masked. Peel off unwanted film leaving a camera-ready positive or negative mask.

Ulano materials are available in the widest variety of sizes and variations for all possible precision masking techniques. Check these Ulano features: *Opacity*—lets light through only where you want it. *Easy to repair or modify*—excellent adhesive quality of film permits repairs or modifications by re-applying film to previously peeled areas.

In addition to its use as an art master, Ulano films are also used as exposure masks. And Ulano has a complete line of screen printing stencil films for plants that screen print the circuit or resist directly to a base.



**ulano**  
**Rubylith® &**  
**Amberlith®**  
**hold all your**  
**tolerances**



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CONTAINS SAMPLES OF ULANO RUBYLITH AND AMBERLITH FILMS. WRITE ON YOUR LETTERHEAD FOR SPECIAL PRESENTATION KIT NO. 2516

\*Metalization pattern illustrated above—artwork for one of a series of nine precision masks resulting in a complex integrated voltage regulator utilizing 50 components. Courtesy Motorola Inc., Semi Conductor Products Division

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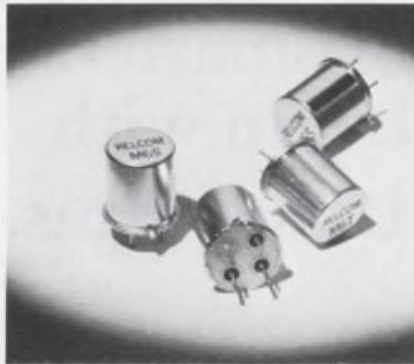
Phone: (301) 948-5210 TWX 710-828-9706

RF Equipment for The Systems Engineer

INFORMATION RETRIEVAL NUMBER 78

MODULES & SUBASSEMBLIES

**Uhf/vhf mixers  
hold down noise**

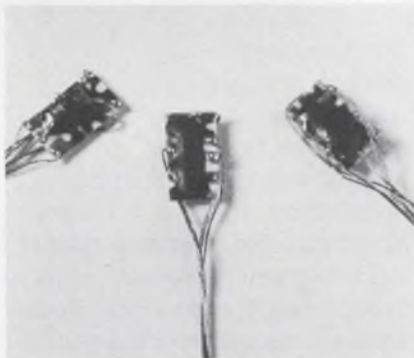


Relcom, 2329 Charleston Rd., Mountain View, Calif. Phone: (415) 961-6265. P&A: \$52 or \$55; stock.

Occupying less than 1/32 cubic inch, two new double-balanced mixers maintain midband noise figures of 5.3 or 5.8 dB. Model M6S covers the frequency range from 400 kHz to 100 MHz, while the model M6T spans the frequency band of 10 to 500 MHz. At low frequencies, typical isolation is better than 60 dB for either mixer.

CIRCLE NO. 396

**Audio amplifiers  
put out 0.5 mW**



ASC Microelectronics, div. of Acousticon Systems Corp., Shelter Rock Lane, Danbury, Conn. Price: \$7.99 to \$10.49.

Three new hybrid integrated audio amplifiers offer a frequency response of 250 to 5000 Hz with power outputs ranging from 0.1 to 0.5 mW rms. The addition of an external volume control completes the amplifiers. Models HA-50, -60, and -70 operate from a 1.5-V battery with a quiescent current of 1 mA.

CIRCLE NO. 397

**FET-input amplifier  
reaches 0.01% in 0.8  $\mu$ s**



Analog Devices, Inc., 221 Fifth St., Cambridge, Mass. Phone: (617) 492-6000. P&A: \$37 or \$47; stock.

Intended for both inverting and non-inverting configurations, a new FET-input differential operational amplifier can settle to an accuracy of 0.01% within 0.8  $\mu$ s. Model 45J provides 50-pA bias current and  $\pm 50\text{-}\mu\text{V}/^\circ\text{C}$  voltage drift; model 45K offers 25-pA bias current and  $\pm 15\text{-}\mu\text{V}/^\circ\text{C}$  voltage drift. Slewing rate is 75 V/ $\mu$ s, and full-power response is 1 MHz.

CIRCLE NO. 398

**Wideband op amp  
slews 1000 V/ $\mu$ s**



DDC, div. of Solid State Scientific Devices Corp., 100 Tec St., Hicksville, N. Y. Phone: (516) 433-5330. P&A: \$125; stock to 2 wks.

Designated as model WB-23, a new operational amplifier has a unity-gain bandwidth product of 150 MHz, a full-power output of 12 MHz, and a slew rate of 1000 V/ $\mu$ s. The unit also offers a settling time of 250 ns to 0.1%, and an output of  $\pm 10$  V at 50 mA. Its voltage stability is 10  $\mu\text{V}/^\circ\text{C}$ , and current stability is 0.3 nA/ $^\circ\text{C}$ .

CIRCLE NO. 399



# Now read this...



Actual Size

## 14 digits in 14 centimetres with the new Philips PANDICON\*!

Putting numbers into electronic calculators, computers and data terminals isn't so difficult these days. But getting numbers out — legibly and economically — can be another matter.

Unless, of course, you've heard about Philips' new PANDICON fourteen-decade integrated readout tube, type ZM 1200.

Its legibility you can see for yourself. No more unnatural spaces between digits. Decimal points and punctuation marks where you expect them to be. Coherent numbers instead of 14 separate digits — all in a

space less than the width of this page. But there are other advantages too. Economy, for example. All 14 digits in one and the same tube. To provide this display with ordinary single tubes, somebody would have to make 168 external connections. The PANDICON needs only 27. Interconnections are inside — protected from damage. You save on drive components because only one decoder-driver is needed for the full 14-digit display. You save on power too — it consumes only 1.5 to 2 W.

Best of all is the reliability. We're not ready to quote Mean-Time-Between-Failure figures yet, because after hundreds of thousands of life-test hours, we haven't had enough failures to make statistically significant conclusions. It may take some time yet, as we anticipate an MTBF of 500,000 hours. Meanwhile, we've given you a full one-year guarantee on this tube — with the strong suspicion it will live 10 times as long! After all we have over 60 years experience in gasdischarge physics.

If 14 digits are too much, we can offer you 8, 10 and 12 digit tubes soon.

Our engineers have also developed a Dynamic Drive Module type DDM 14 to go along with the PANDICON. Everything is described in our new PANDICON data file, which is yours for the asking.

Philips Electronic Components and Materials Division, Eindhoven, the Netherlands.

Distributed and sold in the U. S. by: Amperex Electronic Corporation, Providence Pike, Slatersville, R. I. 02876.

\* Registered trade-mark of N. V. Philips' Gloeilampenfabrieken, Eindhoven, the Netherlands.

INFORMATION RETRIEVAL NUMBER 79

# PHILIPS

## NEW ALTERNATE ACTION PUSH BUTTON SWITCHES (Push-On, Push-Off) ... the Reliable Ones by Grayhill



250,000 operations —  
WITHOUT A MISS.

- SPDT, SPST
- 1/4 Amp., 115 VAC resistive
- Totally enclosed
- Space saving - .937" behind panel
- Momentary action counterpart available

For your Grayhill Engineering Catalog offering complete technical data — contact



565 Hillgrove Avenue  
LaGrange, Illinois 60525  
Area Code 312, Phone 354-1040

... the Difference Between Excellent and Adequate

INFORMATION RETRIEVAL NUMBER 80

## Hi-Ho ASTROplate®



ASTROplate® WILL NOT TARNISH. ASTROplated connectors showed no evidence of corrosion after 400 hours of exposure to laboratory salt spray tests per MIL-STD 202. These tests simulated many years in an atmosphere ten times more severe than an RF connector would encounter under normal conditions.

MIX OR MATCH ASTROplate® with silver or any other finish anywhere in your system (old or new) with no galvanic reaction. Solderability performance meets MIL Spec. QQ-S-365.

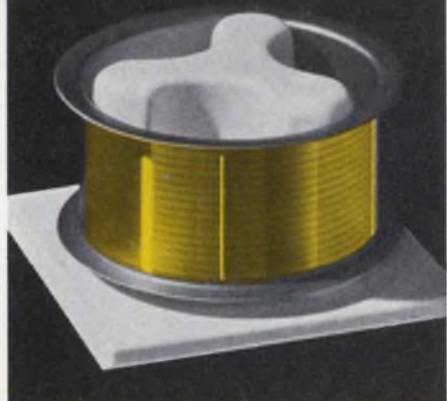
Ask your Amphenol Distributor for ASTROplate® the PERMANENT FINISH for RF connectors.

**AMPHENOL**  
THE BUNKER-RAMO CORPORATION

INFORMATION RETRIEVAL NUMBER 81



# PRECISION WIRE



## for electronic applications

CRM specializes in wire for precision electronic applications. All CRM wires are made with absolute uniformity of composition, smooth surface finish, and freedom from contamination. Packaging on unique platform-mounted spools in vapor-proof double plastic containers protects quality in storage and use.

.. Spectrographically controlled Gold and Aluminum bonding wire

.. Platinum alloys for potentiometers

.. 6-9's aluminum and other metals for vacuum deposition

.. Fine wire for thermistors

.. Custom enameled fine wire

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CRM REACTIVE  
METALS, INC.**

a Division of CONSOLIDATED REFINING CO., Inc.  
118 Hoyt Avenue, Mamaroneck, N.Y. 10543  
Tel: (914) 698-2300 □ TWX 710-566-1112

## INSTRUMENTATION

### DVM costing \$350 is 0.1% accurate



Dana Laboratories Inc., 2401 Campus Dr., Irvine, Calif. Phone: (714) 833-1234. Price: \$350.

A new digital voltmeter, which sells for \$350, provides three-digit measurement capability with fourth-digit 100% overranging. Model 3860A offers a dc accuracy of  $\pm 0.1\%$  of the measured reading and  $\pm 0.05\%$  of full scale for a 90-day period. A three-pole active filter is combined with dual-slope integration for 60 dB of normal-mode rejection at or near line frequency.

Booth No. 365 Circle No. 273

### Low-cost multimeter has 0.1% accuracy

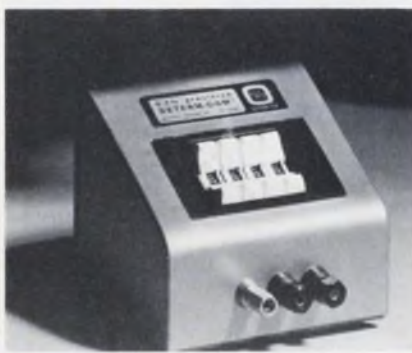


United Systems Corp., 918 Woodley Rd., Dayton, Ohio. Phone: (513) 254-6251. P&A: \$375; 4 wks.

The model 262A digital multimeter for \$375 is a complete test instrument with a basic dc accuracy of 0.1% of reading. Twenty-five ranges are available to measure dc volts, dc current, ac volts, ac current and ohms. All dc ranges feature auto-polarity for in-circuit testing convenience. The unit can be equipped with an optional battery pack.

Booth No. 575 Circle No. 275

### Precise decade boxes readout digitally



Ohmite Manufacturing Co., 3601 Howard St., Skokie, Ill. Phone: (312) 329-9292. Price: \$85 to \$125.

Called Determ-Ohm, a new line of  $\pm 0.1\%$  precision decade boxes feature easily dialed resistance values by means of continuous-rotation (either direction) rocker-type thumbwheel switches. The resistance setting is indicated by a direct in-line numeric readout. There are three four-decade and one six-decade models for resistances from 1  $\Omega$  to 1 M $\Omega$ .

CIRCLE NO. 400

### Self-adjusting DMM runs on batteries



Digilin, Inc., 6533 San Fernando Rd., Glendale, Calif. Phone: (213) 245-6754. P&A: \$445; 6 wks.

A new battery-powered digital multimeter, which sells for \$445, eliminates zero-adjusting and circuit loading. Model 341 is a 3-1/2-digit meter that does not disturb the test circuit because its input amplifier does away with circuit loading. The new DMM automatically zero-adjusts itself by generating a zero-correction signal.

CIRCLE NO. 401



## Transistor analyzer tests gain and leakage



Dantronics Inc., 3175 Hafner Court, Saint Paul, Minn. Phone: (612) 484-2108. P&A: \$695; 3 wks.

Checking both gain and leakage current directly, the Dantec 100 transistor analyzer measures, tests, and analyzes transistors in various operational modes. Gain read-out is direct and on a linear scale. Collector voltage can be preset from 0 to 40 V, thereby permitting the checking of gain as close as desired to saturation. Collector current can range from 10  $\mu$ A to 100 mA.

CIRCLE NO. 402

## 10-MHz amplifier extends scope use



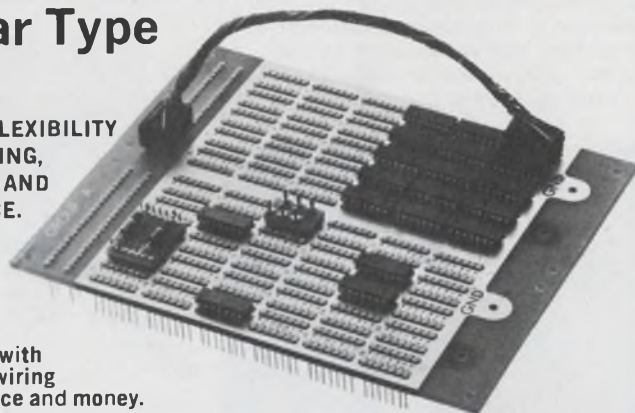
Sycon, 2001 Quail St., Newport Beach, Calif. Phone: P&A: \$95; stock.

Containing a high-frequency video amplifier, the Scope/Amp attaches to an oscilloscope to extend the useability sensitivity range of the oscilloscope's vertical amplifier by 10 times. Output level is  $\pm 1.5$  V minimum and frequency range is dc to 10 MHz (3 dB at 10 MHz). Rise time is 35 ns and slewing rate is 30 V/ $\mu$ s when driving a 100-pF load. Input impedance is 1 M $\Omega$  shunted by 15 pF.

CIRCLE NO. 407

# HIGH DENSITY IC PACKAGING PANEL Modular Type

INCREASES FLEXIBILITY  
IN PROTOTYPING,  
PRODUCTION AND  
FIELD SERVICE.



P Series Panel with  
Point to Point wiring  
saves time, space and money.

- Available in multiples of 30 IC pattern sections up to 180 patterns.
- Two pins of each pattern tied directly to power and ground planes. Different numbers available for different pin assignments.
- IC pattern also accepts I.O. plugs and adaptor plugs for discrete components.
- Excellent contact retention and low contact resistance.
- Wire Wrap terminations with Tri-level connection length.

Request Complete IC Folder

WESCON

**AUGAT**  
INC.

Tel: 617-222-2202

BOOTHS 1380-81

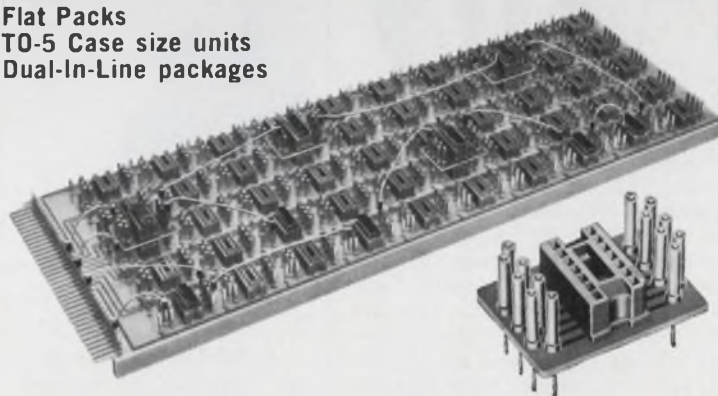
31 Perry Ave., Attleboro, Mass. 02703

INFORMATION RETRIEVAL NUMBER 83

# IC BREADBOARD AND TEST PANELS

TIME SAVING • FLEXIBLE

PANELS FOR:  
Flat Packs  
TO-5 Case size units  
Dual-In-Line packages



- Solderless interconnection concept throughout
- 10,25,50 patterns standard
- Fast loading and operation — easy IC interchangeability
- Single pattern units provide interchangeability of all three packages
- Power and ground connection at each pattern
- Panel plugs into 36 position edge connector with contacts spaced on .156 centers
- 6 $\frac{1}{8}$ " x 17 $\frac{3}{8}$ " panels (50 patterns)

Request IC Folder

Tel: 617/222-2202

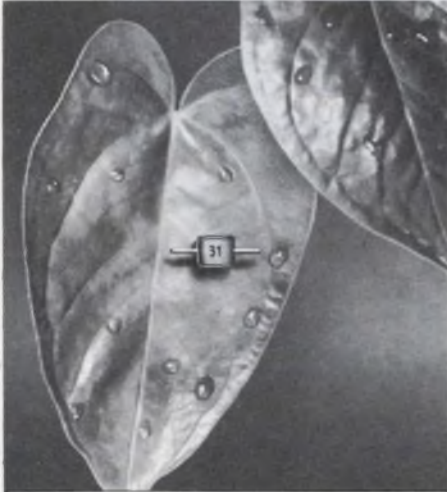
**AUGAT**  
INC.

31 PERRY AVE., ATTLEBORO, MASS. 02703

INFORMATION RETRIEVAL NUMBER 84



High quality capacitors unrivalled in the precision, dependability and compactness. Quality is recognized by ever wider use in measurement equipment, computers, and automatic controllers. "LEAF" the matter of capacitors to MATSUO ELECTRIC CO.

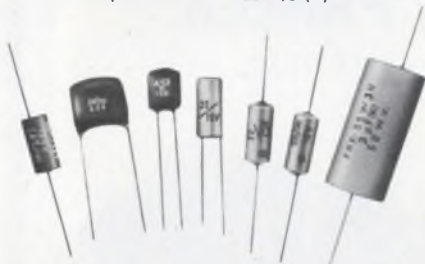


**MATSUO**

**SOLID TANTALUM CAPACITORS FOR HYBRID ICs - "MICROCAP".**

**Specifications:**

Operating Temperature Range: -55°C to +85°C  
 Standard Voltage Rating: 6.3, 10, 16, 20, 25, 35 VDC  
 Standard Capacitance Value: .001 to 22MFD (E6 series)  
 Standard Capacitance Tolerance: ±20% (M)



MATSUO'S other capacitors include:

**Metallized Polyester Film Capacitor:** Type FNX-H mylar wrapped.  
**Solid Tantalum Capacitors:** Type TAX hermetically sealed in metallic case, Type TSX encased in metallic case and sealed with epoxy resin, Type TSL encased in metallic case and sealed with epoxy resin.  
**Polyester Film Capacitors:** Type MFL epoxy dipped, Type MFK epoxy dipped, non inductive, Type MXT encased in plastic tube, non inductive.

For further information, Please write to  
 Manufacturers and Exporters—

**MATSUO ELECTRIC CO., LTD.**

Head Office: 3-5, 3-chome, Sennari-cho, Toyonaka-shi, Osaka, Japan  
 Cable: "NCCMATSUO" OSAKA Telex: 523-4164 OSA  
 Tokyo Office: 7, 3-chome, Nishi-Gotanda, Shinagawa-ku, Tokyo  
 INFORMATION RETRIEVAL NUMBER 85

**Plastic-connector kit makes low-cost mates**

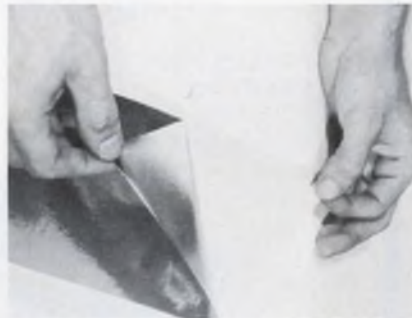


Litton Precision Products, Inc., USECO Div., 13536 Saticoy St., Van Nuys, Calif. Phone: (213) 786-9381.

Using nominally priced polyethylene cartridges and metal contacts, a new connector kit lets the user build his own mating connectors in any configuration for just 50¢ to 60¢—in only minutes. The kit makes a perfect match for the existing connector plug or socket being used. An electric heat gun permits extruding the polyethylene into a pre-shaped reservoir.

CIRCLE NO. 408

**Adhesive-backed Mylar accepts thin films**



Solitron Microwave, Filmohn Div., 37-11 47th Ave., Long Island City, N. Y. Phone: (212) 937-0400.

Metal-film Mylar is now a reality because of a new adhesive-backed Mylar that permits the deposition of thin films onto its surface. The adhesive is protected by a peel-off release paper which remains in place until actual placement of the film. The adhesive-backed Mylar may be cut with scissors or a razor blade to the correct physical dimensions.

CIRCLE NO. 409

**Stripline circuits unitize components**

Rogers Corp., Rogers, Conn. Phone: (203) 744-9605.

Microwave stripline components can now be permanently joined into unitized packages without hardware or adhesives via a novel line of UMD (unitized microwave device) circuits. These new circuits employ heat-and-pressure fusion bonding of dielectric layers to hermetically seal the conductors in their proper position. Air and moisture are permanently eliminated. The circuit components remain bonded together with ground planes spaced correctly above and below the conductor.

CIRCLE NO. 410

**Fiber-optic image tubes are square bundles**

United Optical Systems, Inc., 2644 Buckaroo Ave., Oxnard, Calif. Phone: (805) 485-2191. Availability: stock.

A new line of flexible fiber-optic image transmitting bundles are available in 1/8 and 1/4-in. square bundles in lengths of one to six feet. Bundles may be ordered with 0.002, 0.005, or 0.010-in. diameter fibers. They consist of individually clad, flexible plastic fibers which are precisely aligned. The bundles can transmit full-color information.

CIRCLE NO. 411

**Vinyl-film tape resists 300°F**

Arno Adhesive Tapes, Inc., Michigan City, Ind.

A new white vinyl-film tape, type C-727, with a high-tack double-faced adhesive can withstand temperatures as high as 300°F. The tape can be used outdoors, even in direct sunlight, and can also withstand total water immersion. It will bond to a wide variety of substances including wood, glass, metals, paper and plastic. Because its adhesive is cross-linked, the tape can be used for mounting lightweight objects.

CIRCLE NO. 412



# Use our high-powered contacts.



And use them with confidence.

For materials to be used in high-powered, demanding contact applications, such as motor starters, circuit breakers, ignition points and heavy duty relays, you need tungsten or non-alloyable sintered metals. H. A. Wilson's engineering expertise and knowledge of special powder metallurgy processes, make these available.

Regardless of your application, whether it's to be rivet form, steelbacks, faced screws, discs, washers or any special shape, you can't go wrong by relying on Engelhard. Our engineering and manufacturing facilities will produce the proper contact assemblies in riveted, hot upset, welded or brazed form.

Let the H. A. Wilson Technical Service Department advise you as to the best form, type and size of contact . . . type of material, method of attaching and best spring to use.

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ENGELHARD MINERALS & CHEMICALS CORPORATION  
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INFORMATION RETRIEVAL NUMBER 86

## Introducing MULTIPOWER MULTI-OUTPUT MODULAR POWERSUPPLIES

3 - 4 - or 5 OUTPUTS + 5VDC + 15VDC - 15VDC + 28VDC - 6VDC



Economical - - - Reliable - - - Small Size  
Low Noise - - - Series Regulated - - - Convection  
Cooled - - - Current Limiting - Standard  
Overvoltage - Optional. Available from stock.

Astro-Space Laboratories, Inc.



Research Park, Huntsville, Alabama 35806  
(205) 837-5830

INFORMATION RETRIEVAL NUMBER 87

ELECTRONIC DESIGN 17, August 16, 1970

Another tiny parts  
**FIRST** from

**GRC<sup>®</sup>**

## Now join 2 different plastics in a single small part



### MOVABLE-ELEMENT PARTS

**SEPARABLE PARTS** — Multi-part units that combine controlled separability with variable fit.

**TWO-COLOR PARTS AND NUMBERED OR LETTERED PARTS** — Make possible dual-color parts without secondary assembly costs.

**COMBINATION OF MATERIALS** — Join different plastics — in a single part for a combination of properties.

New molding process—"Inter-mold"—is GRC's exclusive patented method of producing multi-part components automatically mold-assembled in one high-speed operation. Eliminates assembly, achieves production savings and enhances performance.

Write today for "Intermold" samples and detailed bulletin

## Gries Reproducer Co.

Division of Coats & Clark Inc.

40 Second St., New Rochelle, New York 10802 • (914) 633-8600

Plants in: New Rochelle, N. Y.; Warren, R. I.; Toccoa, Ga.  
In Canada: Gries Div., Dynacast Ltd. Lachine, Que.

INFORMATION RETRIEVAL NUMBER 88



**Gunn-effect sources work from 28 V dc**



Avantek, Inc., 2981 Copper Rd., Santa Clara, Calif. Phone: (408) 739-6170. P&A: from \$695; 60 days.

A new line of compact X-band and Ku-band Gunn-effect microwave sources require only 28-V dc primary input power for operation. X-band series AV-9750 includes 25 standard fixed-frequency and tunable models covering 8 to 12.4 GHz with power outputs of 10 to 250 mW cw. Ku-band series AV-9760 operates from 12.4 to 18 GHz with outputs of 10 to 150 mW cw.

CIRCLE NO. 413

**Gallium-arsenide diodes have 6-dB noise figure**

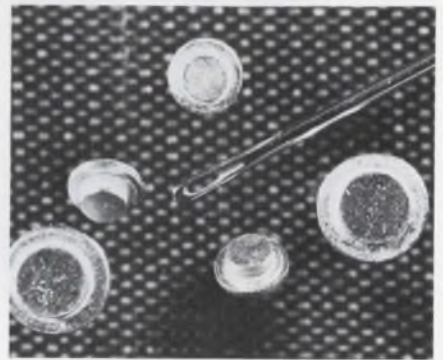


AEI Semiconductors Ltd., Carholme Rd., Lincoln, England.

The DC1300 series of gallium-arsenide Schottky-barrier diodes offers low noise figures (as low as 6 dB) at high operating frequencies (as high as 16 GHz). They come in a variety of packaged forms. These include leadless inverted devices (DC1301), plastic cases having tape leads (DC1303 and DC1305) and beam-lead chips (DC1306).

CIRCLE NO. 414

**Varactor diodes cutoff at 300 GHz**



GHz Devices, Inc., Kennedy Dr., North Chelmsford, Mass. Phone: (617) 251-4981.

Offering a typical cutoff frequency of 300 GHz, a new line of gallium-arsenide varactor diodes is designed for tuning Gunn-Effect solid-state oscillators operating in X and Ku bands. The devices can also be used as parametric amplifier diodes and for frequency multiplication as high as 60 GHz. Series GC-5400 units have a standard capacitance tolerance of  $\pm 10\%$ .

CIRCLE NO. 415

ARITECH VOLTAGE CONTROLLED FILTERS

**VCFs**  
can help you

**solve problems in radar, telemetry, voice coding, signal conditioning, data acquisition, plus many other areas.**

VCFs allow you to electronically shift cut-off frequency without affecting the shape of the response. They are compact, stable, and extremely reliable.

Our standard VCFs — now in stock — are 4-pole Butterworth, 24 dB/octave, either high-pass, low-pass, or band-pass.

Cut-off Frequency Range	0.1 Hz to 20 kHz
Tuning Ratio	50:1
Tuning Voltage	0 to 5 VDC
Module Size	0.75" x 2.15" x 2.15"
Quantity prices for some versions —	under \$80.

See us also for custom active filters.

**ARITECH CORP** 130 Lincoln St., Brighton, Mass. 02135  
Telephone: (617) 254-2990

**NEW BUCKEYE 19" CIRCUIT BOARD RACK**  
and GUIDES with 1/2" spacing



**CUTS TIME AND ASSEMBLY COST**

Flexibility of the unique design of these new Board-Pak components brings maximum simplicity to the 19" Circuit Board Rack. Fewer parts, less assembly time and lower cost. Racks completely assembled in lots of 1 to 24. Partially assembled in larger quantities. 1/4, 1/2 and 3/4 racks also available. Write for details.



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INFORMATION RETRIEVAL NUMBER 90

ELECTRONIC DESIGN 17, August 16, 1970

INFORMATION RETRIEVAL NUMBER 89



## Fiber-optic scopes inspect most areas

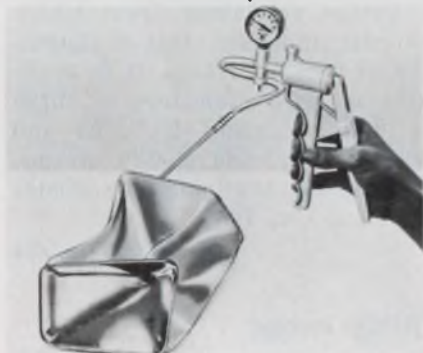


American Optical Corp., Fiber Optics Div., Southbridge, Mass. Price: \$440.

The new FS-10 3-ft fiberscope can be used to inspect inside tubing, monitors, casings, tanks and other hard-to-reach areas for various damages or imperfections. It needs only a 3/8-in. opening and can wind through the most intricate passages. It is equipped with its own light source, and a wide angle objective lens. Its 1-1/8-in.-dia fiber bundle consists of 40,000 fibers.

CIRCLE NO. 416

## Low-cost vacuum pump costs a mere \$12



Edmund Scientific Co., 380 Eds-corp Bldg., Barrington, N. J. P&A: \$12; stock.

Maintaining a constant vacuum of up to 25 in. of mercury, and lifting up to 40 lbs with a 2-1/2-in.-dia polyethylene lifter cup, a new amazingly low-cost vacuum pump costs only \$12. Vacuum pump 71,301 is used to retrieve tools or parts from hard-to-reach spots and to check vacuum-operated instruments for leaks or calibrate them.

CIRCLE NO. 417

## Inserting tool for ICs simplifies IC handling



Jonard Industries Corp., Precision Tools Div., 3047 Tibbett Ave., Bronx, N. Y. Price: \$8.90.

EI-419 is a new inserting and extracting tool specially designed for PC boards, connector assemblies, and flatpack ICs. Its unique design greatly eases handling in production lines, installation and service. It is precision-made of a special alloy that is fully nickel-chrome plated. Overall length is 6-1/2-in.

CIRCLE NO. 418

## Vacuum desolder pump is worked with one hand



Techni-Tools, Inc., 1216 Arch St., Philadelphia, Pa. Phone: (215) 568-4457.

Constructed of sturdy lightweight aluminum, the new T-2 vacuum desolder pump can be loaded and discharged with only one hand. It measures 7-in. long and consists of three parts. Tips are made of Teflon and are easily replaceable. The pump's design eliminates wasted motion and the danger of a rapidly ascending plunger.

CIRCLE NO. 419

# 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 op amps or for unbalanced loads. Other features include:

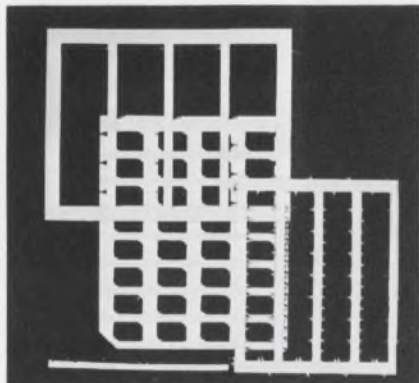
- Choice of 58 different single output modules ranging from 1 to 28 volts, 40 ma to 500 ma
- 406 combinations of dual output modules with electrically independent, like or different outputs in each section
- 0.02 to 0.1% load and line regulation, depending on model
- 0.5 mv RMS ripple
- Prices as low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





# Evaluation Samples



## Multi-layer busses

Providing an alternate choice to multi-layer printed circuit boards, Mini/Bus planar busses are now available as free evaluation samples. Typically, a Mini/Bus structure consists of planar conductors separated by a dielectric medium. In most cases, there are two planar conductors—one for power and the other for ground return.

Actually, the conductors and dielectric create a large capacitive power distribution system. This structure is then laminated on both sides with layers of insulation.

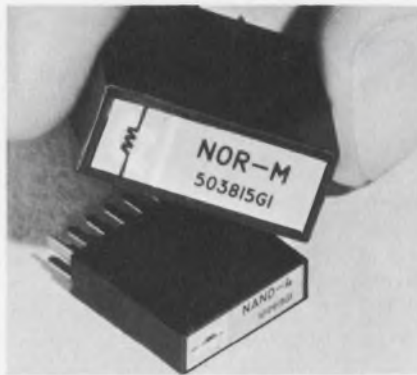
Each conductor layer has the required number of tabs for interconnection of PC-board components. The tabs are simply inserted into holes in the PC board.

The Mini/Bus approach realizes several advantages. For example, it removes all power and ground return connections from the PC board, allowing a high density of components.

Depending on the type and thickness of the dielectric medium used, Mini/Bus distributed capacitance can be as high as 850 pF per square inch. This distributed capacitance at each component power and ground terminal is said to be more effective than discrete decoupling capacitors.

In addition, noise pick-up from adjacent conductors is minimized, and some shielding from radiated ambient noise can be realized. The large surface area and thermal mass of Mini/Bus structures also protect circuitry by acting as heat sinks. Rogers Corp.

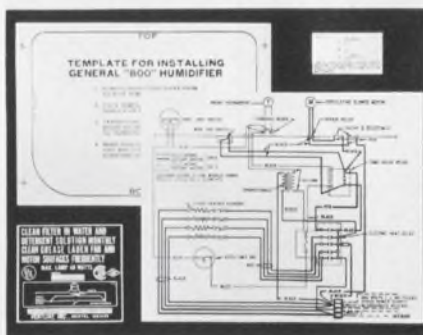
CIRCLE NO. 420



## Markers

A fast neat and permanent method of identifying electronic modules used in computers, electronic switch gear, circuitry and equipment is possible with the use of self-sticking Poly-Plates. All data, including trademarks, wording, codes and colors, is sub-surface printed on a polyester label. The self-sticking markers bond to a module by simply pressing in place. Samples are available. W. H. Brady Co.

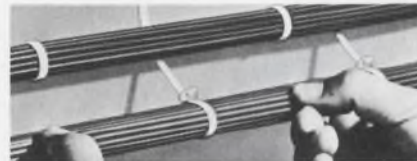
CIRCLE NO. 421



## Emblems

Schematic and wiring diagram emblems are available in a wide range of sizes, either individually cut or on rolls, in strips, perforated and consecutively numbered. In addition to pressure-sensitive stock materials, schematic or wiring diagrams on other materials, including gummed paper that can be remoistened, ungummed paper and tag stocks are available. Details and samples are available. Impact Label Corp.

CIRCLE NO. 422



## Cable tie

The SSB2S Bow-Ty is a unique cable tie that accommodates any two bundles up to an approximate total diameter of 1-1/4 in. It has a standard cross-section and is 6-3/4-in. long. Time and money can be saved, with its use, where harnesses are moved from a sub-assembly point to final assembly. Samples are available. Panduit Corp.

CIRCLE NO. 423

## Rosin-core solder

AE16 is a new rosin-core solder formulated to meet the needs of high-speed electronic production requirements. It is non-corrosive, non-hygroscopic, non-conductive and fungus resistant in accordance with military specifications. The flux core is a combination of pure-water white-gum rosin and a unique activating agent which permits unusually fast conditioning of metal surfaces. It is available in wire diameters of 0.125 to 0.006 in., and 1, 5, 25 and 50-lb spools and 350-lb drums. Samples are available. Bow Solder Products Co., Inc.

CIRCLE NO. 424

## Utility knobs

A new family of fluted utility knobs ranges in popular sizes from 2 to 3 in. in diameter. Number 3015 knobs are designed for clamping, tightening and adjusting applications, and contain fluted sides to provide a sure grip. They are compression molded in thermosetting high-lustre plastic material for lasting endurance. Threaded female inserts and male studs are included. Samples are available. Harry Davies Molding Co.

CIRCLE NO. 425



# Design Aids

ELECTRONIC, MAGNETIC, ELECTRICAL ALLOYS											
GLASS SEALING ALLOYS											
ALLOY	TEMP. RANGE	COEFF. OF EXPAN.	MOD. OF ELASTICITY	TENSILE STRENGTH	YIELD STRENGTH	ELONGATION	RESISTIVITY	TEMP. COEFF. OF RESISTIVITY	TEMP. COEFF. OF THERMAL EXPAN.	TEMP. COEFF. OF MAGNETIC PERMEABILITY	TEMP. COEFF. OF DIELECTRIC CONSTANT
...	...	...	...	...	...	...	...	...	...	...	...
LOW EXPANSION ALLOYS											
HIGH EXPANSION ALLOYS											
MAGNETIC ALLOYS											
ELECTRICAL ALLOYS											
CONSTANT-MODULUS ALLOY											

## Low-loss dielectrics

Twenty-one low-loss dielectric materials are described in a four-page folder. The folder contains a property table as well as application notes and illustrations. Properties listed include viscosities, colors, service temperatures, specific gravities, thermal expansions, thermal conductivities, dielectric strengths, volume resistivities, dielectric constants and loss tangents. Emerson & Cuming, Inc.

CIRCLE NO. 426

## Alloys

Users of electrical, magnetic and electronic metals may avail themselves of a handy pocket reference card describing most-widely used metal alloys. Chemical and physical properties such as typical coefficients of thermal expansions are shown for glass sealing, low and high-expansion, magnetic and electrical and constant-modulus alloys. Cyclops Corp.

CIRCLE NO. 427

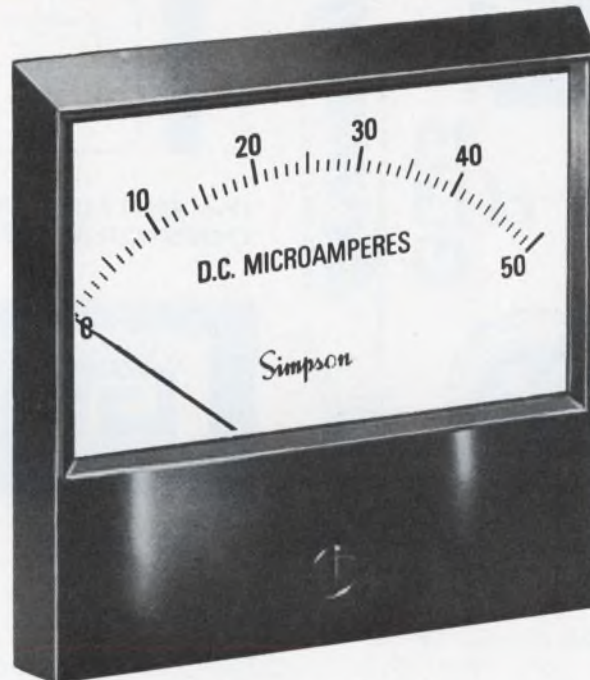
## Heat-shrink chart

A 15-by-22-in. reference chart for heat-shrinkable insulation materials extensively cross-references electrical, physical, chemical and other important properties of currently available materials. Materials are listed by both chemical and trade names. The relative cost for each material is given, in addition to military, NASA, SAE, UL and ASTM specifications. Electronized Chemicals Corp.

CIRCLE NO. 428

# Now you can specify:

- Clean-cut, modern design
- Time-Tested, tough phenolic case
- Environment-Free Viewing Area



all in the new Simpson

## CENTURY SERIES

### PANEL INSTRUMENTS

- 1½", 2½", 3½" and 4½" sizes. Ranges, scales and other characteristics to meet your exact requirements.
- Variety of movements. Matching Relays, Wattmeters and Elapsed Time Meters also available.

Standards now in stock at electronic distributors everywhere. For custom specials, see your Simpson Representative... he's listed in the Yellow Pages. For more details, write for Bulletin 2081.



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 IN CANADA: Bach-Simpson, Ltd., London, Ontario  
 IN INDIA: Ruttonsha-Simpson Private, Ltd., International House,  
 Bombay-Agra Road, Vikhroli, Bombay



# Annual Reports



**Agard Electronics Corp.**, 40 Nassau Terminal Rd., New Hyde Park, N. Y.

PC art generation for the electronic and aircraft industries.

1968: net sales, \$1,406,546; net income, \$135,483.

1969: net sales, \$1,494,667; net income, \$100,165.

CIRCLE NO. 429

**The Birtcher Corp.**, 4371 Valley Blvd., Los Angeles, Calif.

Medical instruments, integrated-circuit testers, strain-gage transducers, PC racks and guides.

1968: net sales, \$5,128,993; net income, \$162,884.

1969: net sales, \$5,164,141; net income, \$114,000.

CIRCLE NO. 430

**Computer Property Corp.**, 7 Dey St., New York, N. Y.

Computer systems sales, support, financial services and management, data processing services.

1968: total revenue, \$1,683,555; net income, \$213,670.

1969: total revenue, \$3,659,552; net income, \$513,681.

CIRCLE NO. 431

**General Instrument Corp.**, 655 Madison Ave., New York, N. Y.

MOS ICs, CATV, defense electronics, disc memories, printers, keyboards, lamps and capacitors.

1969: sales and services, \$248,006,683; net income, \$10,313,391.

1970: sales and services, \$258,132,701; net income, \$4,517,130.

CIRCLE NO. 432

**Hazeltine Corp.**, Little Neck, N. Y.

Electronics for ASW, ECM and air traffic control, film analyzers, video and keyboard displays, radar systems.

1968: revenue, \$58,648,155; net income, \$2,558,241.

1969: revenue, \$76,229,045; net income, \$2,877,088.

CIRCLE NO. 433

**National Beryllia Corp.**, Greenwood Ave., Haskell, N. J.

Technical ceramics for the electrical, electronic, mechanical and chemical industries.

1968: net sales, \$3,007,681; net earnings, \$254,385.

1969: net sales, \$4,108,931; net earnings, \$258,269.

CIRCLE NO. 434

**Raytheon Co.**, Lexington, Mass.

Computers, radar, missiles, air traffic control, lasers, communications, chemicals.

1968: net sales, \$1,192,366,000; net income, \$30,444,000.

1969: net sales, \$1,285,134,000; net income, \$35,232,000.

CIRCLE NO. 435

**Riker-Maxson Corp.**, 280 Park Ave., New York, N. Y.

Resistors, antenna systems, switches, interactive terminals.

1968: net sales, \$96,525,060; net income, \$2,322,522.

1969: net sales, \$111,827,236; net income, \$4,481,900.

CIRCLE NO. 436

**Signal Analysis Industries Corp.**, 595 Old Willets Path, Hauppauge, N. Y.

Spectrum, correlation and probability analyzers.

1968: net sales, \$384,113; net income, \$14,640.

1969: net sales, \$607,624; net income (loss), (\$46,576).

CIRCLE NO. 437

**Tenney Engineering, Inc.**, 1090 Springfield Rd., Union, N. J.

Environmental ovens, space simulators, bio-medical, power conversion and control instruments.

1968: net sales, \$7,666,717; net earnings, \$222,612.

1969: net sales, \$7,031,198; net earning, \$42,555.

CIRCLE NO. 438

**Unitrode Corp.**, 580 Pleasant St., Watertown, Mass.

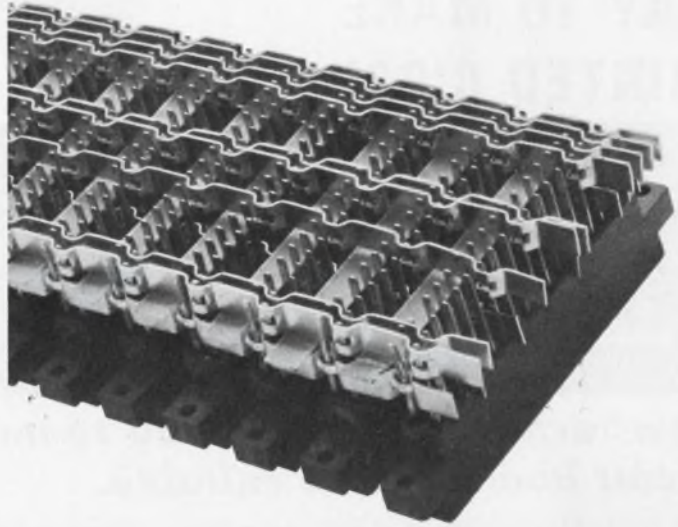
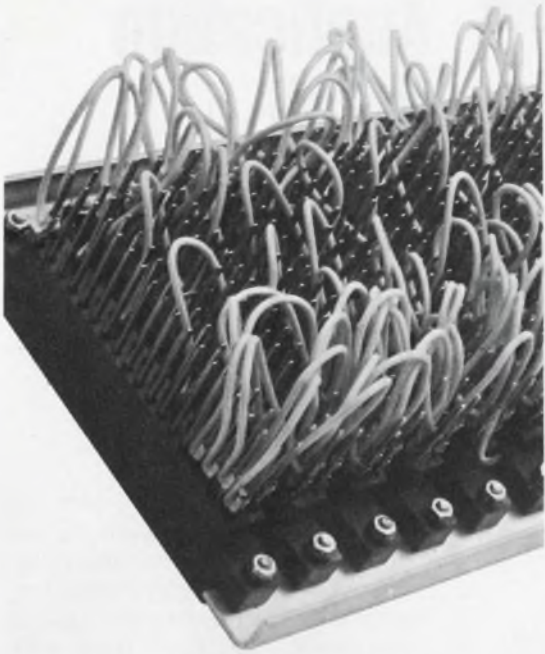
Zener, rectifier, signal and power diodes, transistors, power-supply packages.

1969: net sales, \$13,748,146; net income, \$1,317,519.

1970: net sales, \$14,822,735; net income, \$1,445,756.

CIRCLE NO. 439





# "daisy chain" or pin bars

The choice is easy if you need fast installation, low unit cost, simplicity, neatness, maximum terminal contact with minimum electrical noise and serial IR loss.

With Lear Siegler's Pin Bars, you can make hundreds of terminal connections per hour for less than 4¢ per terminal. Simply line up the Pin Bars on the terminals, tap lightly, and all terminals are connected. No soldering is necessary.

Need a quote or ready to place an order? Pin Bars are made to your specifications. Just tell us the distance between terminals, terminal size, finish and length. We'll send you prices immediately and prototype quantities in 30 days.

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Lear Siegler, Inc. Electronic Instrumentation Division, 714 North Brookhurst Street, Anaheim, California 92803. Phone: (714) 774-1010.



## LEAR SIEGLER, INC. PIN BAR

## INQUIRY FORM

Please send more information and sample.

NAME \_\_\_\_\_ TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_ PHONE \_\_\_\_\_ EXT \_\_\_\_\_

ADDRESS \_\_\_\_\_ CITY/STATE \_\_\_\_\_ ZIP \_\_\_\_\_

Please send a quotation on the following:

Center line distance between terminals \_\_\_\_\_ ±.010 Terminal size 0.025 x 0.025

or 0.031 x 0.062  Other \_\_\_\_\_ x \_\_\_\_\_

Number of terminals per Pin-Bar length \_\_\_\_\_ Overall length of Pin-Bar \_\_\_\_\_

Finish: Gold  Tin  Other \_\_\_\_\_

Total number of Pin-Bars needed \_\_\_\_\_

Application: \_\_\_\_\_

Type of connectors presently using \_\_\_\_\_

Note: Standard Pin-Bars are manufactured copper alloy.

# WE'VE GOT A BETTER WAY TO MAKE PRINTED CIRCUITS!



## New techniques developed to make circuit boards more reliable.

The Printed Circuits Operation of CDC used a unique etch-back technique for producing reliable multi-layer circuitry for the Mercury project. Its success is indicated by the fact that the same techniques were used in the Gemini and Apollo projects without design change . . . millions of inter-facial connections with no known failures.

Designs ranged from double-sided circuitry to complex 15-layer circuit boards . . . using sequential laminating, extra fine line width and spacing, and plated slots and edges . . . and were used for systems control telemetry, hi and low level multiplexer, command module telemetry, LEM flight control system, and the seismograph experiment.

The Mercury-Gemini-Apollo program demonstrates our capability for the design and production of high quality circuit boards. Hundreds of other projects use our circuit boards in many phases of civilian and military equipment. We've got a better way to make printed circuitry.



F-104

Developed new technique to produce circuit boards with more reliable plated-thru holes.



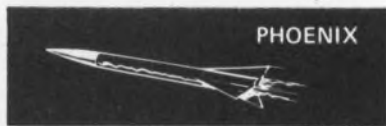
C5

We introduced circuit boards that had the highest density circuitry ever used before on a production basis.



F-111

New industry technique was used to produce multilayer circuit boards with an internal heat sink.



PHOENIX

Required new techniques for manufacturing heat sinks and insulation by chemical milling.



707

Reliable circuit boards in high volume at low cost were produced for this project.



POSEIDON

Developed new technology for sequential laminating multi-layer circuit boards with aluminum backbone.



**This design and production experience can work for you . . . CALL US NOW.**

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CORPORATION

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PHONE: (612) 927-5681

## Application Notes



### Coaxial cable

A brief descriptive folder on ultraminiature coaxial cable carries with it a sample of a minute cable. In concise form, it gives the specifications of ultraminiature coaxial cable which has been used with exceptional effectiveness in cryogenic applications where heat transfer must be kept at an absolute minimum. Berk-Tek, Inc.

CIRCLE NO. 440

### Cooling-systems design

A six-week engineering course on cooling-systems design for electronic equipment is presented in six 112-page detailed brochures. Each brochure presents a different phase of cooling-system design—for example, determining airflow and pressure requirements, as well as satisfying mechanical, structural and noise-level requirements. The brochures also cover: selecting for minimum magnetic-field interaction, evaluating the performance of the complete cooling system, and ensuring optimum reliability in the complete cooling system. Pamotor Div., William J. Purdy Co.

CIRCLE NO. 441

### Spot welding

A 34-page evaluation study contains a discussion on real time non-destructive testing of resistance spot welds. It is crammed full with correlation graphs, data tables and weld nugget illustrations. This publication is a must for all manufacturing and quality-control welding executives and engineers desiring the best economical means of monitoring resistance spot welds. Digimetrics Inc.

CIRCLE NO. 442



## Gate-oxide protection

A protection circuit for gate oxides when testing and handling MOS devices is described in a new application note. It discusses problems encountered when working with MOS devices and how this new protection circuit eliminates these problems. A schematic drawing of the protection circuit and other typical protection circuits are shown. RCA

CIRCLE NO. 443

## UL-approved materials

How to choose materials for Underwriters' Laboratories applications is shown in a 12-page booklet. It describes what Underwriters' Laboratories' materials temperature ratings mean, and outlines why Underwriters' Laboratories' approval of materials is important. It also shows how temperature ratings are determined and illustrates flammability testing procedures. Fiberfill Div., Dart Industries Inc.

CIRCLE NO. 444

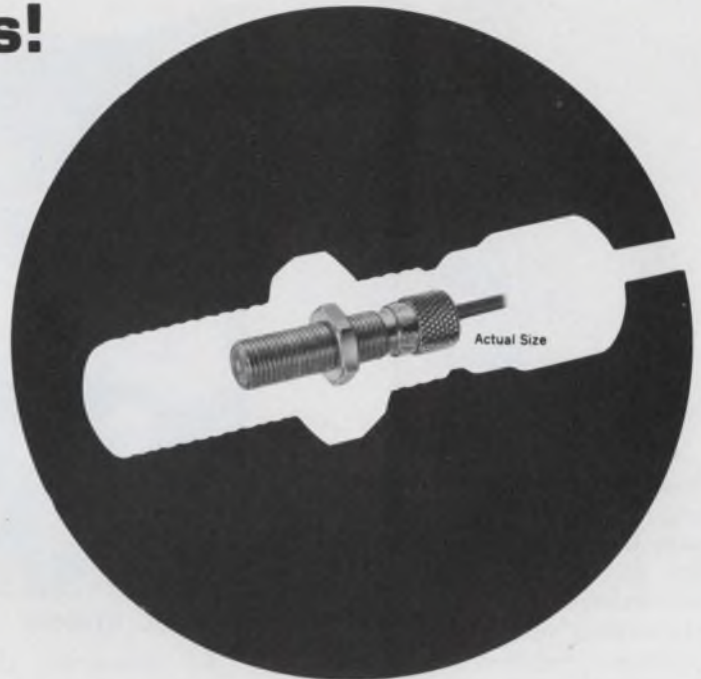


## Programming languages

Entitled "Programming Languages," a 442-page softcover book contains descriptions of the major programming languages available for the PDP-8 family of small computers. Languages such as FOCAL, BASIC, and 8K FORTRAN are described. Digital Equipment Corp.

CIRCLE NO. 445

# revolutionary digital magnetic transducer cuts costs!



Model 58388 +4 to +15 Volts Supply  
Model 58389 -4 to -15 Volts Supply

## eliminates interface circuitry... produces full output at slower speeds —wider gaps!

Take a close look. This is Di-Mag\*. A digital magnetic transducer you'll find well worth looking into. And immediately, because it outperforms any sensor now available to save you money. With a choice of two models, either positive or negative, that will produce full output equal to the supply voltage at surface speeds as low as 15 inches per second, at a gap of 0.010 inches. Even lower speeds and/or wider gaps are obtainable with this unique approach. Look again. Di-Mag's built-in circuitry has the additional ability to process its own signal for direct use in digital equipment. A revolutionary feature that eliminates interface circuitry and ups reliability. Don't overlook the lower noise factor Di-Mag offers, either. It's just another of the many reasons why Di-Mag is not only setting new standards of performance, but making countless new non-contact sensing applications possible for detecting, tachometry, computer peripheral, and industrial control operations.

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INFORMATION RETRIEVAL NUMBER 97

# New Literature



## Ceramic capacitors

A 76-page handbook on ceramic capacitors features standard capacitor product information, a guide to the use of ceramic capacitors, and capacitor manufacturing and quality-assurance information. It discusses in detail the various operations required to produce a capacitor. Gulton Industries, Inc.

CIRCLE NO. 446

## Book catalog

Describing over 125 current and forthcoming books, a new illustrated 16-page catalog covers the following subject areas: schematic/servicing manuals, broadcasting, basic technology, CATV, electric motors, electronic engineering, reference, television, radio and electronics servicing, audio and high-fidelity, hobby and experiments, test instruments and transistors. Tab Books.

CIRCLE NO. 447

## Capacitors

Three technical papers describe three new capacitors; one in production and two under development. The papers were presented at the 1970 Electronics Components Conference in Washington. Sprague Electric Co.

CIRCLE NO. 448

## MOS multiplexers

A MOSFET five-channel multiplex switch and an MOS eight-channel multiplex switch are described in two new data sheets. Amelco Semiconductor.

CIRCLE NO. 449



## Graphic system

An interactive graphic system consisting of a graphic terminal, a graphic tablet and joystick input devices are described in a four-page brochure. Computek Inc.

CIRCLE NO. 450

## Test equipment

Professional test equipment (B & K line) for electronic servicing, school, laboratory and industrial applications is shown in a new catalog. Solid-state design is dominant in such instruments as voltohmmeters, rf signal generators, sine/square-wave generators and tube testers. Other instruments include sweep/marker generators, oscilloscopes/vectorscopes, capacitor and transistor analyzers, color generators, CRT rejuvenators checkers and vacuum-tube voltmeters. Dynascan Corp.

CIRCLE NO. 451

## Publications guide

Catalog RS-70 features full-color displays of the most prominent technical books, time tools, slide rules, templates, working forms and hard-to-find valuable texts for architects, engineers, contractors, managers, technicians, and journeymen. Technical Guide Publications.

CIRCLE NO. 452



## Panel meters

Design literature and engineering specifications for a low-cost line of panel meters is available. Complete specifications for each of four standard panel-meter sizes are given plus physical design information and standard performance specifications. Phaostron Instrument and Electronic Co.

CIRCLE NO. 453

## Electrical isolation

A new newsletter that discusses the intricacies of isolated power supplies and isolation transformers compared with conventional power supplies and transformers is available. Known as Isodata, it delves into today's increasing electrical-pollution problem, and tells how power-line isolation will play a leading role in the electronic/electrical clean-up of the 1970s. Elcor, Products by Welex Electronic, a Halliburton Co.

CIRCLE NO. 454

## IC handling

An eight-page catalog lists a broad assortment of digital accessories for IC handling. It provides information for in-line IC sockets, flatpack holders, high-density wire-wrap PC cards and extenders. Cambridge Thermionic Corp.

CIRCLE NO. 455

## Solderless terminals

A colorful easy-to-use 36-page catalog details solderless terminals and connectors. Six classes of terminals are illustrated with dimensions. Vaco Products Co.

CIRCLE NO. 456





### Encapsulation shells

Nearly 1300 encapsulation shells for electronic packaging are listed in a 20-page catalog. It features precision module, oblong, round and square shells with part numbers and essential dimensions. Robison Electronics Inc.

CIRCLE NO. 457

### Teletype equipment

Answers to questions about Teletype equipment are available in a six-page foldout booklet. It lists numerous case-history brochures that describe how manufacturers, government agencies, and health and safety groups have improved their operations with Teletype equipment. Two prepaid reply cards are attached for reader use in requesting any of the listed publications. Teletype Corporation.

CIRCLE NO. 458

### High-purity metals

A 32-page catalog lists 15 high-purity metals for electronics. Technical data, including vapor pressure and analytical data are given. Alfa Inorganics, Inc.

CIRCLE NO. 475

### Pushbutton switches

Sixty-six styles of momentary-contact pushbutton switches are listed and described in a new brochure. Switches covered include military and standard types available in a variety of housing and mounting styles, contact arrangements and colors. Cinch Manufacturing Co.

CIRCLE NO. 476



## When the chips are down

REDCOR has delivered, or has on order, more computer-controlled MOS test systems than all other manufacturers combined. In fact, nearly 80% of all MOS LSI/MSI devices produced in the upcoming years will be REDCOR-tested. Surprising, perhaps, but true. Why this vote of confidence from so many industrial giants? One reason is that we design and build, using state-of-the-art techniques, all the system components, including the computers. And we provide the systems engineering, the software, and the field service . . . a "one source, one responsibility" commitment. MOS testing may not be your application, but whatever your systems requirement, let a REDCOR Systems Pro solve it for you.

**R REDCOR CORPORATION**  
**C Telephone: (213) 348-5892**

INFORMATION RETRIEVAL NUMBER 98



### Switches

Information on enclosed push-button and rotary switches and high-quality termination hardware is available in a new 88-page catalog. It contains many new products and an engineering data section that provides information on switch parameters. Grayhill, Inc.

CIRCLE NO. 477

### Electronics marketing

"Marketing Publications for the Electronics Industry" is a new catalog for design engineers and engineering managers whose engineering efforts involve them in some aspects of marketing their products. It lists publications dealing with market research for the electronics industry. Schoonmaker Associates.

CIRCLE NO. 478

### Phase measurements

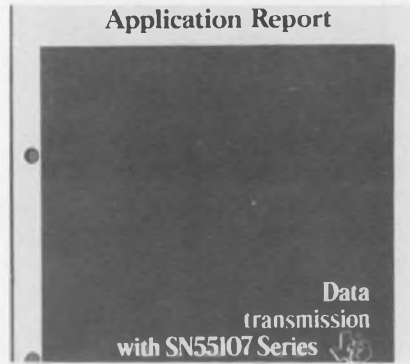
A four-page application note describes an unusual and versatile approach to high-accuracy phase measurements at frequencies up to 15 MHz. Phase measurements, which were formerly cumbersome and expensive and sometimes required a computer, are made by a computing counter and its programmable keyboard. Hewlett-Packard.

CIRCLE NO. 479

### MOS reliability report

A total of 1,479,000 life-test device hours with zero failures are reported in a new MOS reliability report. The total represents 115-million-bit test hours with a failure rate of 0.0008% per thousand hours at 125°C. The report describes MOS device fabrication, production processing, quality-control and failure screening. National Semiconductor Corporation.

CIRCLE NO. 480



### Data transmission

Describing the characteristics of series 55/75 line drivers and line receivers, an eight-page booklet shows how designers can benefit by using these integrated circuits in party-line data transmission systems. Discussed are two signal generating and detecting systems, which are coupled by a single bifilar line to make use of the party-line facility of the IC drivers and receivers. Also described is a method of transmitting a digital signal and its synchronizing pulses down a single-wire line. Texas Instruments Inc.

CIRCLE NO. 481

### Software

How engineers can profitably use APL (A Programming Language) is explained in a new folder. Specifically, the publication describes ACTION/APL, a modified version of APL computer language and illustrates its use in engineering problem solving. Available library programs are listed, and an example of program construction is given. The Computer Company.

CIRCLE NO. 482

### Instrument rental

A 22-page bulletin describes a recently announced instrument rental program. Ranging from short-term rentals (under 6 months) to annual rental contracts (for billings over \$20,000 per year), the program encompasses a wide selection of rental opportunities. Also described are a lease program and a purchase option plan. Beckman Instruments, Inc.

CIRCLE NO. 483



### Breadboarding system

A new universal circuit system for test and breadboarding is fully detailed in a six-page catalog. Accessories and components for the system are included. They include vertical socket boards, input/output connectors, stacking gangplugs, and TO-5 and flatpack ICs. Robinson-Nugent Inc.

CIRCLE NO. 484

### Optoelectronic news

A new single-page monthly optoelectronic newsletter titled "Eye On" features news of the latest optoelectronic products, specifications and applications. It includes a check-off coupon system for requesting additional product literature. A glossary of optoelectronic terms is also available. Schweber Electronics.

CIRCLE NO. 485

### Wire-wrap assemblies

A comprehensive 44-page catalog provides complete details about wire-wrap plate assemblies, male headers, and edge-card connector wire-wrap plate assemblies. In addition to cross-section drawings, product dimensions and specifications, it contains extensive guidance for the design engineer. Masterite Industries.

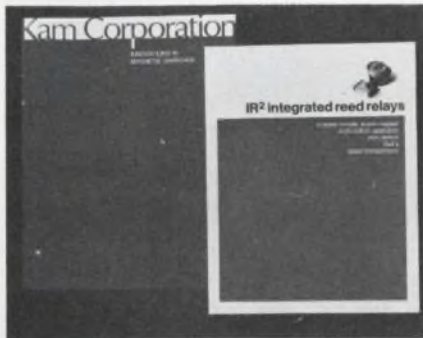
CIRCLE NO. 486

### Printed wiring boards

"Computer-Aided Production Techniques for Prototype Development" is the title of a technical paper concerned with the application of computer-aided techniques for manufacturing initial prototypes and short production runs of printed wiring boards. The paper was delivered at a seminar at the NEPCON 1970 show in New York City. Computer Art Services Co.

CIRCLE NO. 487

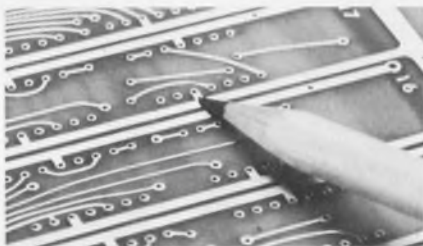




## Integrated reed relays

Two pieces of literature describe a development and manufacturing firm and its activities in magnetic switching and switching devices, and a product line of integrated reed relays. The relays have integral provisions for the inclusion of electromagnetic coils, coil terminations, and magnetic shields. Kam Corporation.

CIRCLE NO. 488



## PC-board plating

Cu-Tronix, a new economical acid-copper electroplating process, is described in a ten-page technical bulletin. The process features favorable metal distribution along with the deposition of smooth fine-grained copper plate. Harshaw Chemical Co.

CIRCLE NO. 489

## Amplifiers

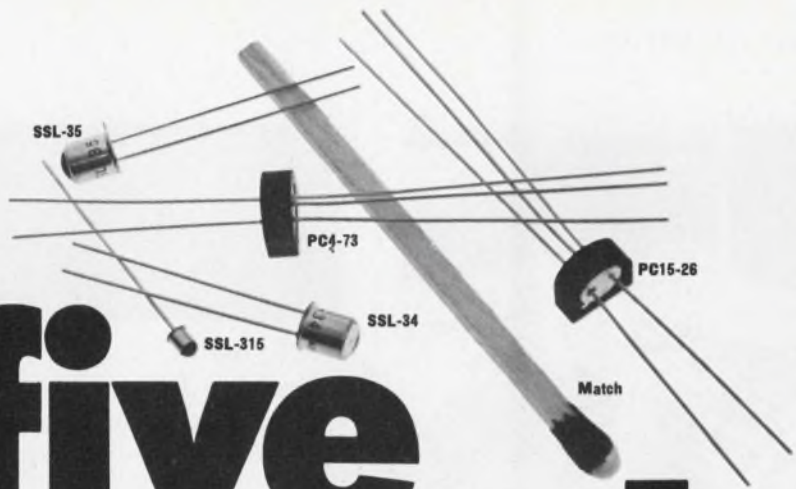
Pulse, wideband, video, and power amplifiers are described in a new short form catalog. Characteristics and specifications are given. C-Cor Electronics, Inc.

CIRCLE NO. 490

## Hybrid components

A series of hybrid multipliers, dividers, and compatible power supplies is described in a four-page brochure. GPS Instrument Co.

CIRCLE NO. 491



# five more!

## from General Electric, five new bursts in the SSL explosion.

At GE, solid state lamp technology is booming. And no wonder. For reliability, long life and fast switching speeds, no other SSL's outperform General Electric SSL's (previously known as light emitting diodes). Or withstands shock and vibration better. They practically eliminate maintenance costs. And these five new GE SSL's offer you other outstanding benefits:

- SSL-35** A gallium arsenide infrared SSL with more milliwatt output per dollar (5.5mW at 100mA) than any other SSL on the market. So you can locate it farther from the detector, or use less expensive detectors. Typical applications: intrusion alarms, safety devices and computer-related uses like BOT and EOT sensing. Price \$3.90 each in 1,000 quantity.
- SSL-315** A gallium arsenide infrared SSL, hermetically sealed, with twice the power (1mW at 20mA) of our SSL-15. High (4%) external efficiency. Less than 1/10th inch diameter. For printed circuit board applications, tape readers and other photoelectric systems. Price \$3.27 each in 1,000 quantity.
- SSL-34** Another high output gallium arsenide infrared SSL, giving up to ½ Watt peak power output. Permits increasing distance between lamp and detector. Applications similar to SSL-35. Price \$2.50 each in 1,000 quantity.
- PC15-26** A photon coupler consisting of a gallium arsenide SSL and an NPN planar silicon phototransistor. Has the inherent reliability of a transistor, and can withstand severe shock and vibration. Recommended for electrical isolation and high speed switching. Isolates up to 2,500 volts. Price \$7.20 each in 1,000 quantity.
- PC4-73** First of its kind. Combines a gallium arsenide SSL and an NPN planar silicon photodarlington amplifier. Has the highest transfer ratio (125%) of any coupler on the market today. Isolates up to 2,500 volts. Price \$6.50 each in 1,000 quantity.

Ask us for complete mechanical and electrical data on all five of these new GE SSL products. Or send for free detailed information on the entire General Electric SSL line — or order either of these new SSL Manuals: Theory, Characteristics and Applications, \$2.00. Applications only, \$1.00. Write: General Electric Company, Miniature Lamp Department, M-ED, Nela Park Cleveland, Ohio 44112.

GENERAL  ELECTRIC

INFORMATION RETRIEVAL NUMBER 99



**Computer books**

Two reference books for the PDP-10 computer, a basic course in time-sharing and a programming guide, are available. The time-sharing handbook is a 501-page publication. The reference handbook contains 657 pages of information. Digital Equipment Corp.

CIRCLE NO. 492

**Modular connectors**

A comprehensive line of modular connectors is described in a 16-page catalog. Known as Snap-Wrap and Mini-Wrap, they permit the design of a solderless wrap, crimp or solder contact configuration. Amphenol Industrial Division, Bunker-Ramo Corp.

CIRCLE NO. 493

**Connectors**

A revised and expanded guide describes a wide range of low-cost rack-and-panel connectors. Rectangular, miniature, modular, and appliance connectors ranging in complexity from 2 to 140 contacts with current ratings of 5 to 20 A are illustrated. Elco.

CIRCLE NO. 494

**Minicomputer hardware**

A process input-output system, a card punch, and a line printer for the Prodac minicomputer system are described in three illustrated publications. Westinghouse Electric Corp.

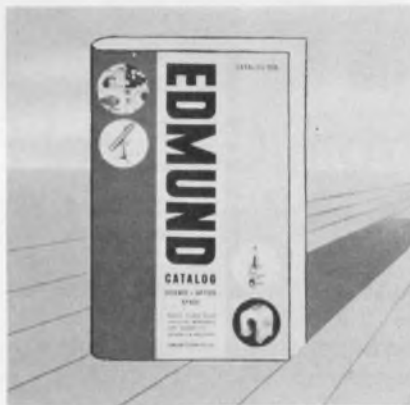
CIRCLE NO. 495



**Components**

A 20-page distributor stock catalog provides technical and price information on a line of relays and optoelectronic components. All products are illustrated and described. Sigma Instruments.

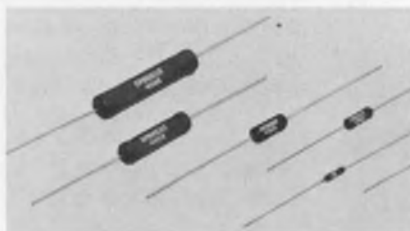
CIRCLE NO. 496



**Edmund catalog**

The new Edmund 148-page catalog has over 50 separate categories packed with more than 4000 unusual and hard-to-find items. These include fiber-optic glass pipes, light guides and face plates, encapsulated liquid crystal slurries, simulated moon dust, quartz-Halogen projection lamps, trick and special-effects photography kits, and laser optics kits. Edmund Scientific Co.

CIRCLE NO. 497



**Wirewound resistors**

Power wirewound resistors are featured in an eight-page brochure. Complete and detailed performance characteristics, as well as standard resistance ranges are given. Sprague Electric Company.

CIRCLE NO. 498



**Linear IC handbook**

An 88-page pocket-size catalog describes a complete line of linear integrated circuits. It provides key information and pin diagrams for 31 products, and previews a number of special linear products that are scheduled for introduction later in 1970. Fairchild Semiconductor.

CIRCLE NO. 499

**Thermocouples**

A comprehensive 20-page catalog describes a wide variety of miniature thermocouples. Photographs, ISA (Instrument Society of America) calibration charts, specifications and dimensional drawings are included. Thermo Electric.

CIRCLE NO. 600

**Transistor packages**

A standard line of packages for uhf and microwave power transistors is described in a new brochure. The brochure gives engineering outline drawings of power transistor headers for application in the 150 MHz to 3-GHz frequency range. National Beryllia Corp.

CIRCLE NO. 601

**Analytical services**

"Analytical Services" is the title of a new book that describes extensive facilities for the analysis of materials from a wide variety of industries. Johnson Matthey Chemical Limited.

CIRCLE NO. 602





### Solid-state modules

A new means of building and expanding flexible intercommunication systems by the use of a family of solid-state modules is described in a detailed bulletin. Daven McGraw Edison.

CIRCLE NO. 603

### Microwave products

A 56-page microwave product guide lists microwave products with their key operating characteristics. Sylvania Electric Products, Inc.

CIRCLE NO. 604

### Time-delay relays

Four new bulletins illustrate and describe a complete line of ac and dc subminiature and standard-size hermetically sealed time-delay relays. Styles covered include adjustable, preset and proportional reset. Listed also are specifications, dimensional details, performance ratings and specifying information. A. W. Haydon Company.

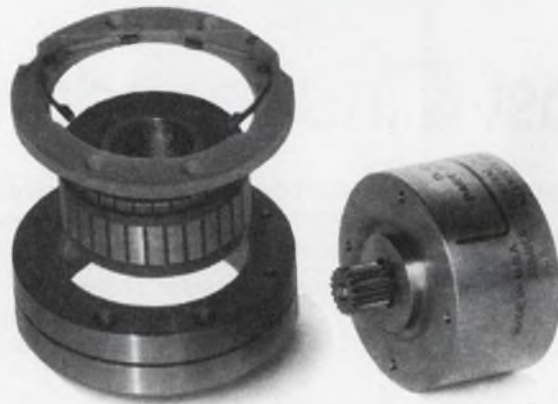
CIRCLE NO. 605

### Control modules

"The Complete Modular Solution To Control System Design" is a new publication that describes a broad range of information, decision and action solid-state control modules, mechanical and electrical construction aids and devices. These products include vane-switched reeds, cadmium-sulphide photoelectric detectors, counter modules, thumbwheel switches and decision-making NOR gates. Mullard, Inc.

CIRCLE NO. 606

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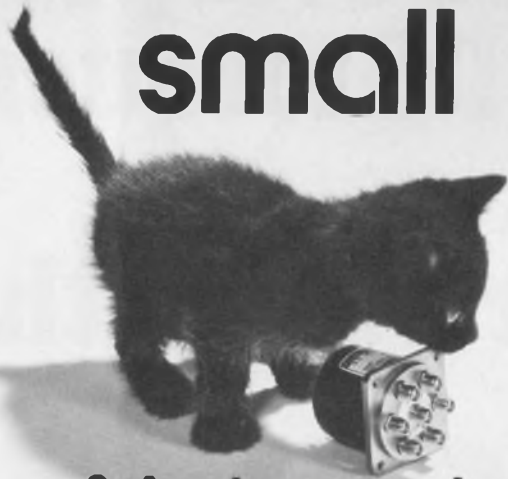
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INFORMATION RETRIEVAL NUMBER 100

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INFORMATION RETRIEVAL NUMBER 107

## Bulletin board

of product news and developments



A subminiature CCTV camera, the Falcon VE12G, is now for sale in the United States. Designed for monitoring instrumentation in difficult locations, the camera has a total length of 5.5 in. and a maximum diameter of 1.5 in. Made by Seer T. V. Surveys Ltd., Surrey, England, the unit will be available from stock in November for under \$4000. U. S. distributor is M.T.I., div. of K.M.S. Industries Inc., North Haven, Conn.

CIRCLE NO. 607



Conventional Super-8 movies can now be transmitted to any number of black-and-white television screens by a new system that resembles an ordinary tape recorder. The equipment consists of a projector and a small video camera which picks up the image for transmission to the TV screen. Either spools or cassettes of film can be used, and sound can be recorded on pre-stripped film through the equipment. The manufacturer is Vidicord Holdings Ltd., Condon, England.

CIRCLE NO. 608



**TRANSCAP**, a new interactive computer-aided circuit design package, is now available from Binary Systems, Inc., Plainview, N. Y. The package, **TRANSient Circuit Analysis Program**, provides transfer-function, ac, dc and transient computation for large circuits. All popular transistor models are accommodated. Proprietary algorithms reduce running time of transfer-function calculations by an order of magnitude over comparable older methods. The package, which is claimed to have solved problems that caused other methods to fail, is fully documented and available on time-sharing networks. A batch version in **FORTRAN IV** for lease has a 30-day delivery.

CIRCLE NO. 609

**AMCAP** is a computer program that can be used to cut costs and save time in many phases of microwave engineering. The engineer can simulate the effect of faults and obtain a set of diagnostics that can be used for rapid troubleshooting. **AMCAP** can also generate test specifications for subassemblies. It is a product of Environmental Computing Inc., Lowell, Mass.

CIRCLE NO. 610

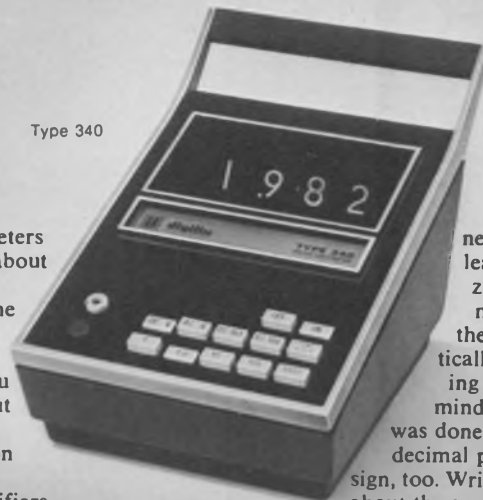
**Premium-grade op amps** from Precision Monolithics Inc., Santa Clara, Calif. have been reduced in price. Models **SSS101A**, **SSS107**, **SSS741** and **SSS747** now reflect single-unit costs as low as \$36.

CIRCLE NO. 611

An electronic sensing device, known as an indium-arsenide-phosphide photocathode, can substantially increase the performance of optical communications systems that employ space lasers and telescopes. The unit reportedly can detect infrared light with 30 times the efficiency of present photocathodes. It is available from the Electro-Optics Div., Sylvania Electric Products Inc., Mountain View, Calif.

CIRCLE NO. 612

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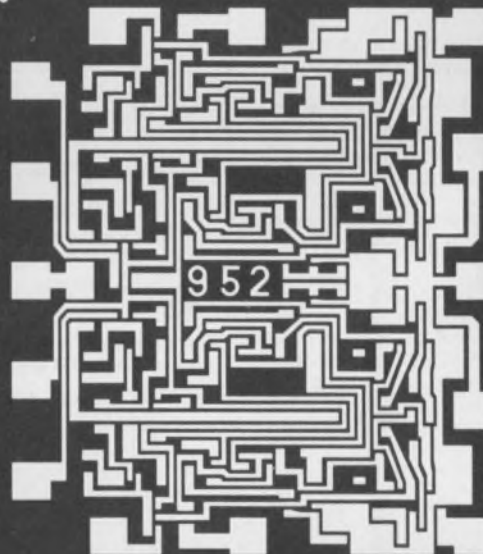
WESCON BOOTH 228

**digilin**  
DIGITAL INSTRUMENTS



Type 330  
3½-digit panel meter

INFORMATION RETRIEVAL NUMBER 102



At WESCON '70. 8/25-8/28. L.A. Sports Arena Booth No. 2512-13. MITSUBISHI Digital ICs (TTL, DTL, MOS, MSI) and Linear ICs, Light Emitting Diodes, FM 2-way Radios, and Circulators. These are impact products. Come looking for big profits.

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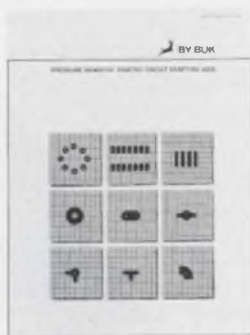
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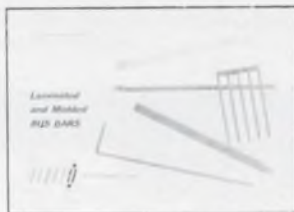


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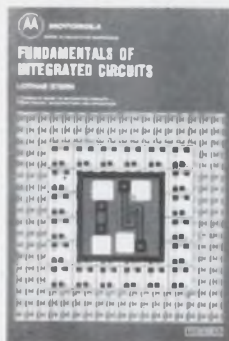


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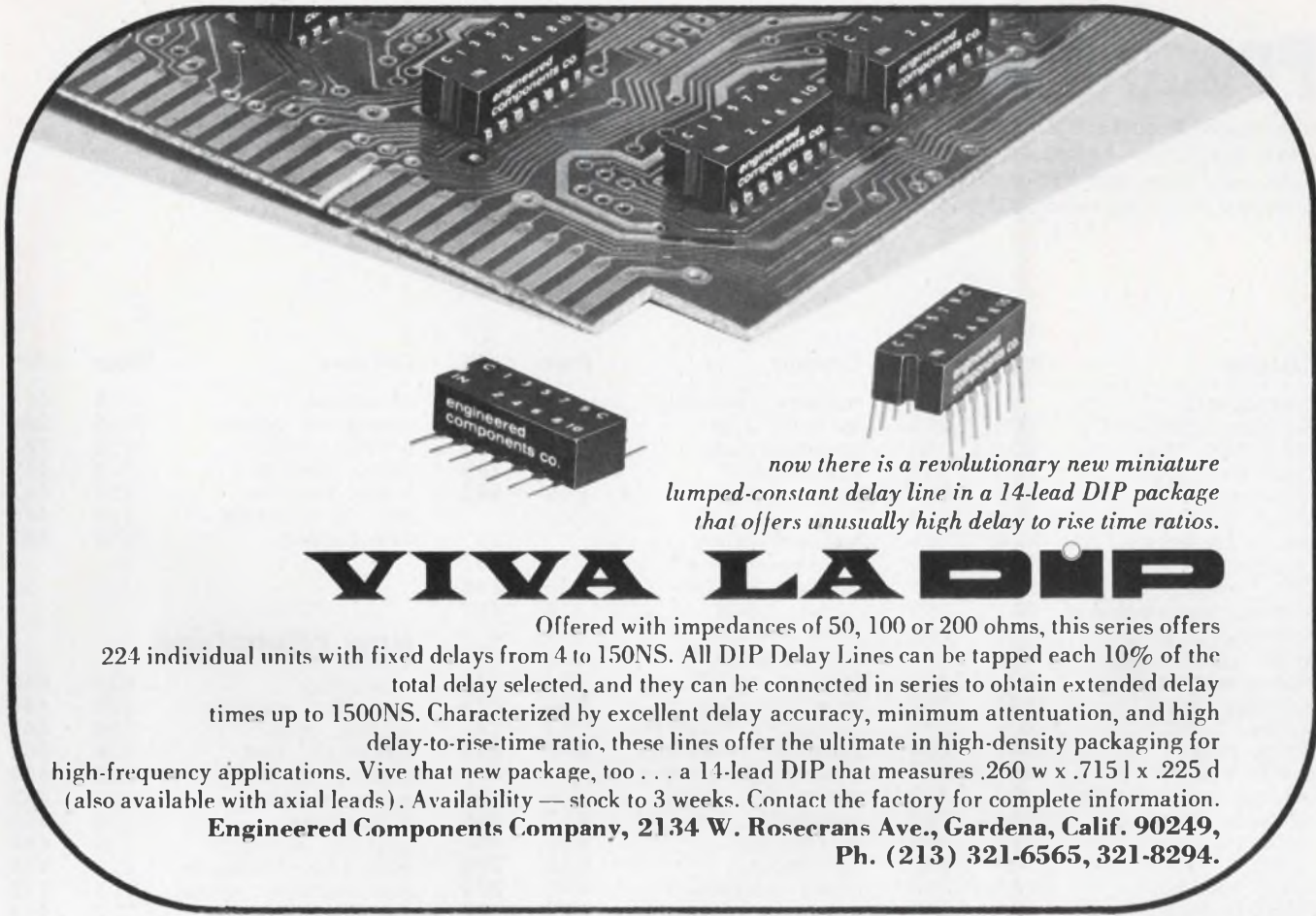
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# Advertisers' Index

Advertiser	Page	Advertiser	Page	Advertiser	Page
AMF Incorporated, Potter & Brumfield Division	W19	General Electric Company, Electronic Capacitor & Battery Dept.	W33	Piezo Technology, Inc.	200
Abbott Transistor Laboratories Incorporated	13	General Electric Co., Tube Dept.	W30	Plastic Capacitors, Inc.	204
Acopian Corporation	219	General Electric Company, Miniature Lamp Dept.	229	Pomona Electronics Co., Inc.	198
Adams & Westlake Company, The	W49	General Reed, Division of Sigma Instruments, Inc.	16	Potter & Brumfield Division of AMF Incorporated	W19
Aladdin Electronics	W35	Gould, Inc., Graphics Division	84, 85		
Alco Electronic Products, Inc.	194, 207	Grayhill, Inc.	213	Qualidyne Corporation	W50
Allen Avionics, Inc.	W42	Gries Reproducer Corp.	217		
Allen-Bradley Co.	6, 7, 35	Guardian Electric Manufacturing Company	W15		
American Lava Corporation	193				
American Monarch	W43				
Amerex Electronic Corporation	W39				
Amphenol, The Buker-Ramo Corporation	213				
Analogic Company	210				
Aritech Corp.	218				
Arnold Engineering Company, The	W14				
Associated Testing Laboratories, Inc.	W42				
Astro Communication Laboratory, Inc.	212				
Astro Space Laboratories, Inc.	217				
Augat, Inc.	215				
Automatic Electric Company	36, 37				
Beckman Instruments, Inc., Helipot Division	183				
Bishop Graphics, Inc.	235				
Bodine Electric Company	41				
Buckbee Mears Company	W25				
Bud Radio, Inc.	201				
Buckeye Stamping Co., The	218				
By-Buk Company	234				
Cambridge Thermionic Corporation	232				
Centralab Semiconductor Division, Globe-Union, Inc.	177				
Cinch-Nuline, A Division of TRW, Inc.	Cover II				
Circuit-Stik, Inc.	W58				
Clare & Co., C. P.	W37, W47				
Columbia Components Corp.	W59				
Consolidated Reactive Metals, Inc.	214				
Control Data Corporation	224				
Cunningham Corporation	43				
Dale Electronics, Inc.	99 thru 174				
Datascan, Inc.	W52				
Dearborn Electronics, Inc.	190				
Digilint, Inc.	223				
Du Mont Oscilloscope	W34				
ENM Company	W60				
FRA Transpac Corporation	48				
Eastman Kodak Company	175				
Elco Corporation	12				
Eldre Components, Inc.	234				
Eldorado Electrodata Corporation	206				
Electro Products Laboratories, Inc.	225				
Electronic Design	237				
Engineered Components Co. Ltd.	237				
English Electric Valve Co., Ltd.	206A				
Engelhard Industries Division, Engelhard Minerals & Chemicals Corporation	217				
Erie Technological Products, Inc.	39				
Fairchild Microwave and Optoelectronics	2				
Fairchild Semiconductor, A Division Fairchild Camera and Instrument Corporation	10, 11, 49, 50, 51				
Federal Scientific Corp.	235				
Fluke Mfg. Co., Inc., John	W55				
G-V Controls, Inc.	W62 A-B				
General Automation, Inc.	65				
General Electric Company, Variable Transformers	17				
Hamlin, Inc.	W53				
Hayden Book Company, Inc.	52, 234				
Hewlett-Packard	1, 4, 5, 60, W1, 197				
Howard Industries, A Division MSL Industries, Inc.	W22				
IMC Magnetics Corporation	59				
Indiana General, Electronic Products	68				
Inland Controls, A Division of Kollmorgen	63				
International Electronic Research Corporation	90, 91				
ISE Electronics Corporation	W62				
JFD Electronics Corp./Components Division	42				
Janco Corporation	W54				
Jewell Electrical Instruments, Inc.	58				
Johanson Manufacturing Corp.	W23				
Jonathan Manufacturing Company	44				
Keithley Instruments, Inc.	195				
Krohn-Hite Corporation	181				
Lear Siegler Inc.	223				
Ledex, Inc., Microelectronics Division	W48				
3M Company, Chemical Division	W61				
Magnecraft Electric Company	W57				
Malco Manufacturing Company, Inc.	W24				
Mallory Capacitor Company	53				
Marconi Instruments Division of English Electric Corporation	W21				
Matsuo Electric Co., Ltd.	216				
Microdot, Inc.	56, 57				
Mitsubishi Electric	233				
Molex Incorporated	23				
Monsanto Company	62, Cover III				
Motorola Semiconductor Products, Inc.	8, 9				
North Atlantic Industries, Inc.	66				
Panduit Corp.	237				
Penn Engineering and Manufacturing Corp.	235				
Philco-Ford Corporation Microelectronics Division	76, 77				
Philips Electronic Components and Materials Division	64, 213				
RCA Electronic Components and Devices	W46, 81, Cover IV				
RFL Industries, Inc.	W51				
Redcor Corporation	227				
Remex Electronics Division of Ex-Cello Corporation	203				
Rohde & Schwarz	206B				
Rotron, Incorporated	W41				
S & EI Corp.	210				
SRC Division, Moxon, Inc.	208				
Sangamo Electric Company	54				
Signalite, A Division of General Instruments	61				
Signetics Corporation	27				
Singer-General Precision, Inc., Kearfott Division	231				
Singer Electronic Products	W45				
Simpson Electric Company	221				
Spectronics Incorporated	196				
Sprague Electric Company	18				
Standard Condenser Corporation	W40				
Switchcraft, Inc.	W29				
Sylvania Electric Products, Inc., Electronic Components Group	179				
Systrom-Donner Corporation	W27				
TRW Semiconductor Division of TRW, Inc.	75				
Tektronix, Inc.	47				
Teletype Corporation	14, 15				
Teradyne	20				
Texas Instruments Incorporated, Components Group	33				
Texscan Corporation	W56				
Toyo Communication Equipment Co. Ltd.	237				
Transco Products, Inc.	232				
Trio Laboratories, Inc.	199				
Triplet Corporation	209				
Trygon Power Supplies	202				
Tung Sol Division, Wagner Electric Corporation	184				
Ulano	211				
United Systems Corporation	W31				
United Telecontrol Electronics, Inc.	205				
Victoreen Instrument Division	W54, W60				
Weston Instruments, Inc.	55, 67				
Zenith Radio Corporation	W58				





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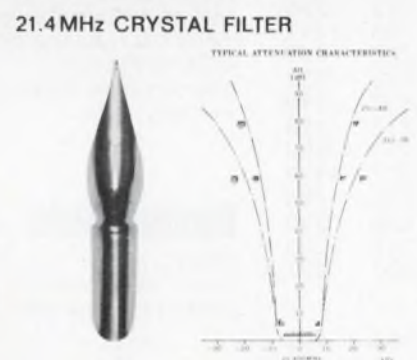
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# Product Index

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Category	Page	IRN
<b>Components</b>		
capacitor, trimmer	206	383
capacitors, chip	205	380
capacitors, DIP	206	384
capacitors, HV	206	382
capacitors, MOS chip	205	379
circuit breakers	W44	261
coulometer, dual	W44	299
DIPs, transformer	207	386
displays, alphanumeric	202	369
displays, plug-in	W46	266
drive, cassette-tape	203	372
filter, ceramic FM	202	368
indicator lights	W44	262
ladder, 12-bit	207	385
lights, panel	W44	264
matrix boards	W48	258
readout, incandescent	202	370
readouts, fiber-optic	W44	268
readouts, projection	W44	260
readouts, segmented	207	388
relay, latching	W48	265
relays, solid-state	204	378
resistor, NC-style	203	373
resistors, TC	204	375
stabilizer, temperature	207	387
switch, latching reed	203	374
switch, thumbwheel	202	371
switches, pushbutton	W46	263
thermistor	205	381
time capsule, ac	204	377
two-color storage	204	376
<b>Data Processing</b>		
amplifier, agc	195	351
calculator	194	348
calculators	W50	255
calculators	195	352
computer, desktop	194	349
computer, operational	W52	253
controller, data	196	354
data storage system	191	340
data transfer system	W50	291
display control	196	356
display terminal	194	346
image processor	196	355
keyboards	191	342
keyboards, low-cost	191	341
memories, glass	195	350
memories, thick-film	192	343
memory, disk	196	353
memory, random-access	W52	250
recorder, cassette	W50	254
recorder, tape	192	345
transport, cassette	192	344
transport, tape	194	347
typewriter, transduced	W50	152
<b>ICs &amp; Semiconductors</b>		
counter/divider	199	363
dice, tested	200	366
diode, varactor	200	365
generator, character	200	367
FETs, low-noise	199	361
LEDs, low-cost	200	364

Category	Page	IRN
memory, read-only	198	357
op amp, dual	198	360
op amps, dual	198	358
shift register	198	359
shift registers	199	362
<b>Instrumentation</b>		
amplifier, scope	215	407
counter, 20-MHz	W36	298
decade boxes	214	400
DMM, low-cost	214	275
DVM, low-cost	W38	272
DVM, three-digit	214	273
generator, data	W40	274
generator, waveform	W40	270
generator, waveform	W40	293
generators, function	W38	269
multimeter, digital	214	401
multimeter, five-digit	W32	286
oscilloscope	W36	288
oscilloscope	W36	292
power supplies	W40	271
resolver/converter	W38	287
transistor tester	215	402
<b>Microwaves &amp; Lasers</b>		
counter	W60	276
diodes, GaAs	218	414
diodes, varactor	218	415
oscillators	W60	278
power divider	W60	277
sources, Gunn-effect	218	413
<b>Modules &amp; Subassemblies</b>		
amplifier, data	W28	267
amplifiers, audio	212	397
converter, d/a	208	389
converters, d/a & a/d	W26	294
converters, dc-dc	W30	256
interface circuit	210	393
mixers, balanced	212	396
op amp	208	391
op amp, differential	208	257
op amp, FET	W30	259
op amp, FET	W30	290
op amp, FET	212	398
op amp, transducer	210	392
op amp, wideband	212	399
phase shifter	211	394
power supplies	208	390
readout	211	395
sampling module	W30	297
<b>Packaging &amp; Materials</b>		
cabinets, instrument	W54	282
circuit, stripline	216	410
connector kit	216	408
contact cleaner	W54	281
etching fluid	W54	280
fiber optics	216	411
Mylar, substrate	216	409
tape, vinyl	216	412
<b>Tools &amp; Engineering Aids</b>		
desolderer, DIP	W56	251

Category	Page	IRN
fiberscope	219	416
measuring system	W58	284
prober, wafer	W56	285
pump, desolder	219	419
pump, vacuum	219	417
tool, IC inserting	219	418
wire bonder	W58	283

## New Literature

capacitors	226	448
capacitors, ceramic	226	446
catalog, book	226	447
equipment, test	226	451
graphic system	226	450
guide, publications	226	452
IC handling	226	455
isolation, electrical	226	454
marketing, electronic	228	478
measurements, phase	228	479
metals, high-purity	227	475
meters, panel	226	453
MOS devices	226	449
reliability, MOS	228	480
rental, instrument	228	483
shells, encapsulation	227	457
software	228	482
switches	228	477
switches, pushbutton	227	476
Teletype equipment	227	458
terminals, solderless	226	456
transmission, data	228	481

## Application Notes

cable, coaxial	224	440
cooling-system design	224	441
materials, UL-approved	225	444
MOS protection	225	443
programming languages	225	445
welding, spot	224	442

## Design Aids

alloys	221	427
chart, heat-shrink	221	428
dielectrics, low-loss	221	426

## Evaluation Samples

busses, multi-layer	220	420
emblems	220	422
markers, identifying	220	421
knobs, utility	220	425
solder, rosin-core	220	424
ties, cable	220	423





## Reflect, please, on the new generation in signal generation.

The Model 310B Frequency Synthesizer is the most efficient instrument yet devised for generating sine waves. Any sine wave from 0.01 Hz to 1.3 MHz. With resolution and resettability of 0.01 Hz. Calibrated output level over a 90 dB range. AM and/or FM capability and built-in sweeps plus provision for external sweeping. That's a lot, but not all.

The Model 310B Frequency Synthesizer is BCD programmable, and switching time is less than 30  $\mu$ sec. Stability is 1 part in  $10^9$  per day. Finally, Monsanto's "fourth generation" design for compactness and reliability makes the 310B truly a new generation instrument.

For the dollars you put in (\$4950—

other models from \$3950) you take out far more performance than you can via the signal generator route. Reflect on that, please, as you watch your local Monsanto Field Engineer demonstrate the Model 310B in your plant.

Monsanto Electronic Instruments,  
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# Introducing RCA's new superswitch: light sensor and power amplifier on one IC chip!

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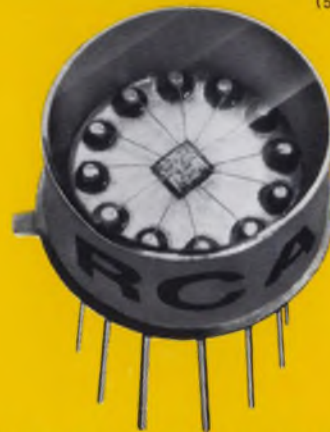
For further details, see your local RCA Representative or your RCA Distributor. For technical bulletin, File No. 421, write: RCA, Commercial Engineering, Section 57H-16/CA41, Harrison, New Jersey 07029. International: RCA, 2-4 rue du Lièvre, 1227 Geneva, Switzerland, or P. O. Box 112, Hong Kong.

## CA3062 Photo Detector and Power Amplifier

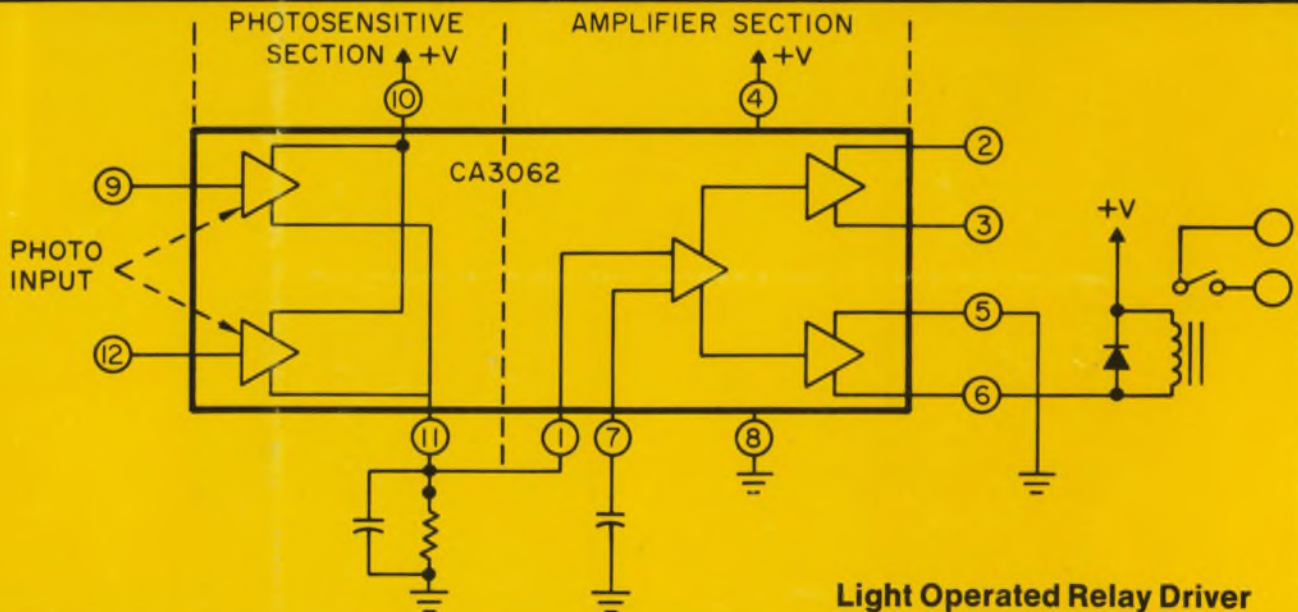
- FOR:
- counters
  - sorters
  - level controls
  - intrusion alarms
  - edge monitoring
  - position sensor
  - isolators
  - inspection

- FEATURES:
- Darlington-connected photosensitive pairs
  - 100 mA output current capability (drives a relay or thyristor directly)
  - 5 to 15 Vdc supply voltage range
  - compatible with RCA= 40736R IR emitter

(5x actual size)



CA3062 \$2.95 (1000-unit level)



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