VOL. 18 NO.

Electronic Design 17

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.

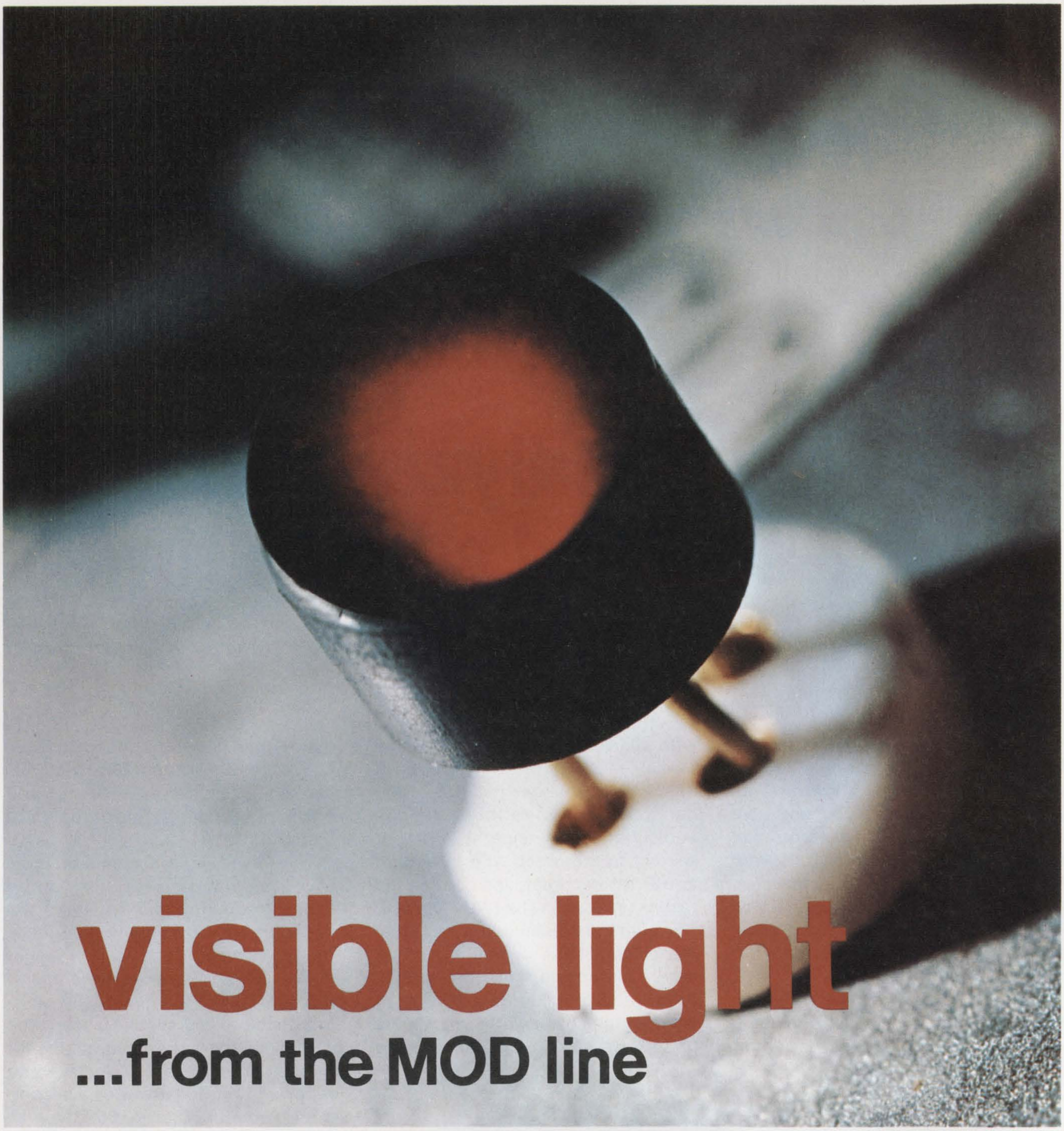
For delivery information contact any Cinch Sales Office or write to Cinch-Nuline, a division of TRW Inc., 1015 S. Sixth Street, Minneapolis, Minnesota, 55415.

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

CINCH DIVISIONS OF TRW INC., CINCH MANUFACTURING, CINCH-GRAPHIK, CINCH-MONADNOCK AND CINCH-NULINE

INFORMATION RETRIEVAL NUMBER 202



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

Electronic Design 17

VOL. 18 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

AUG. 16, 1970

NEWS

TECHNOLOGY

PRODUCTS

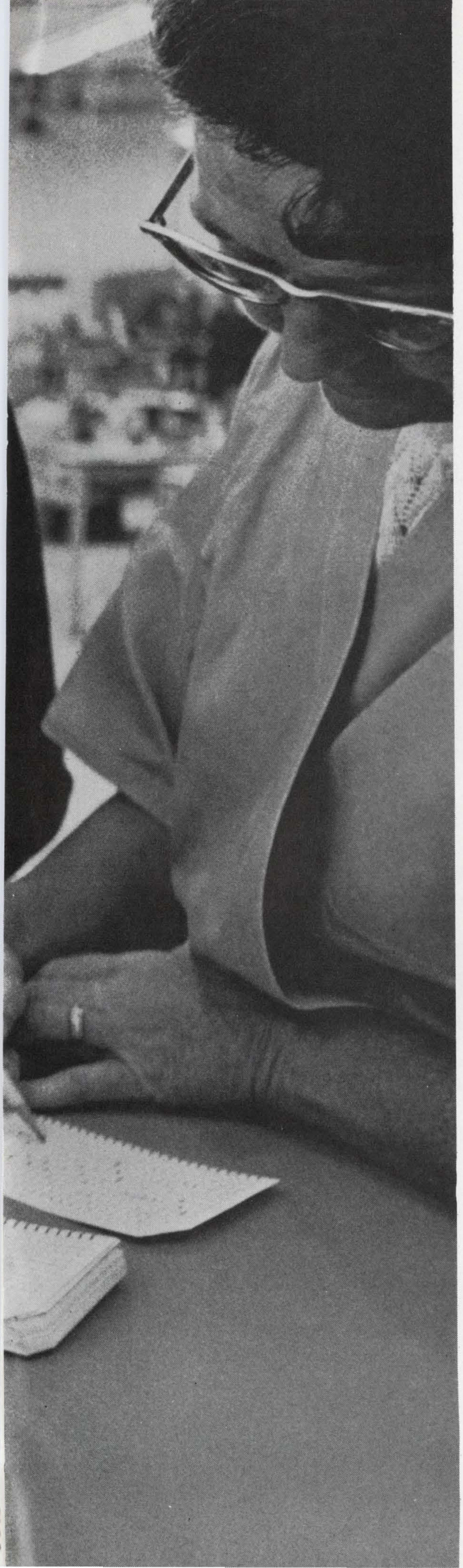
Departments

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

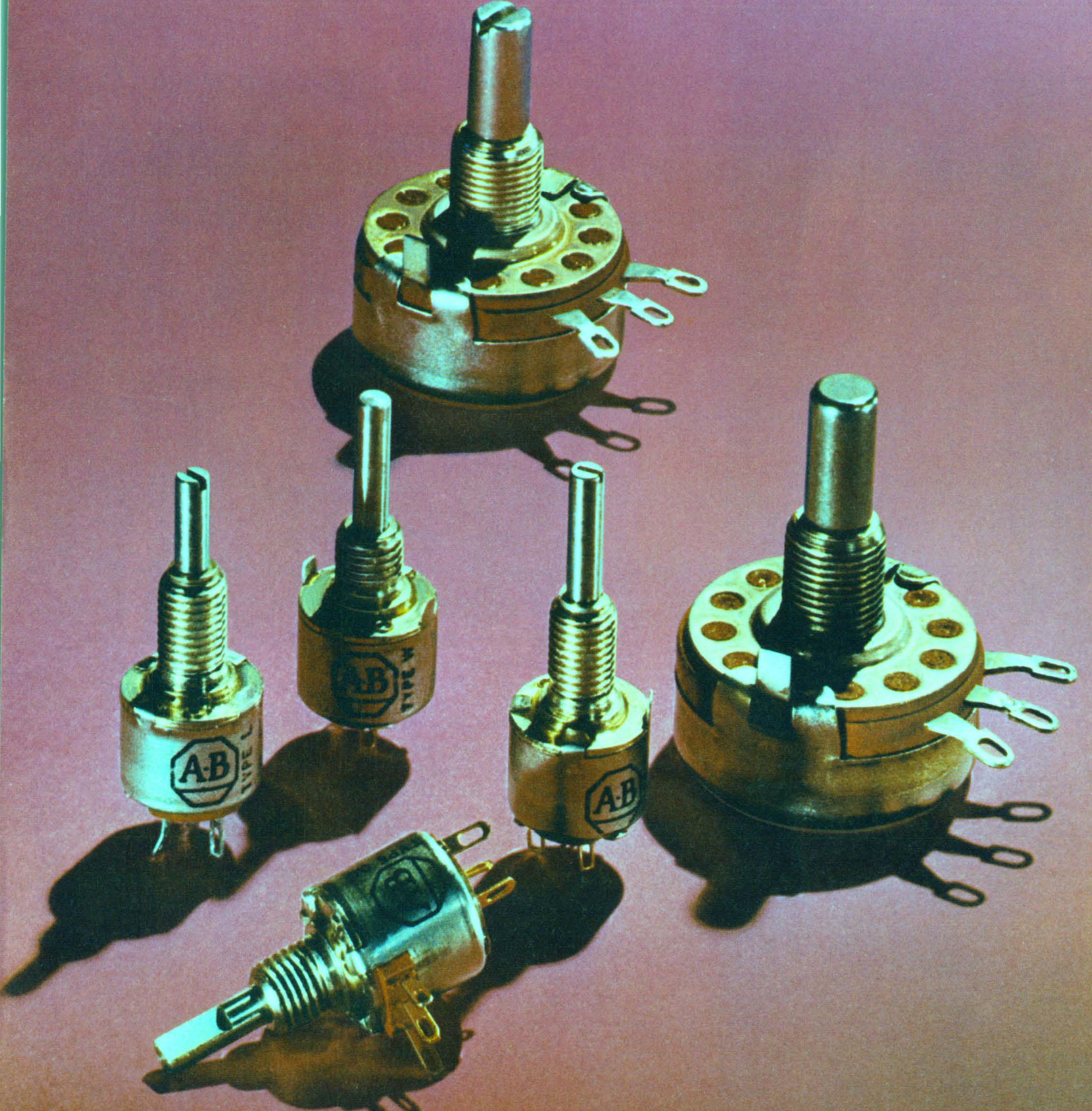
ELECTRONIC DESIGN is published biweekly by Hayden Publishing Company, Inc., 850 Third Avenue, New York, N.Y. 10022. James S. Mulholland, Jr., President. Printed at Brown Printing Co., Inc., Waseca, Minn. Controlled circulation postage paid at Waseca, Minn., and New York, N.Y.

82,501 copies this issue.


2701A OPTICAL MARK READER
HEWLETT · PACKARD



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.

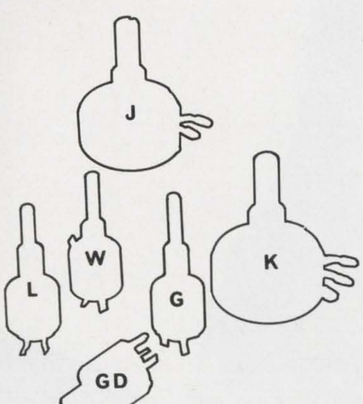
This important Allen-Bradley difference means better short-time overload capacity and a long operating life. Control is smooth, resolution almost infinite. These variable resistors are ideal for high frequency circuits. Why should you trust the performance of your designs or your reputation to anything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

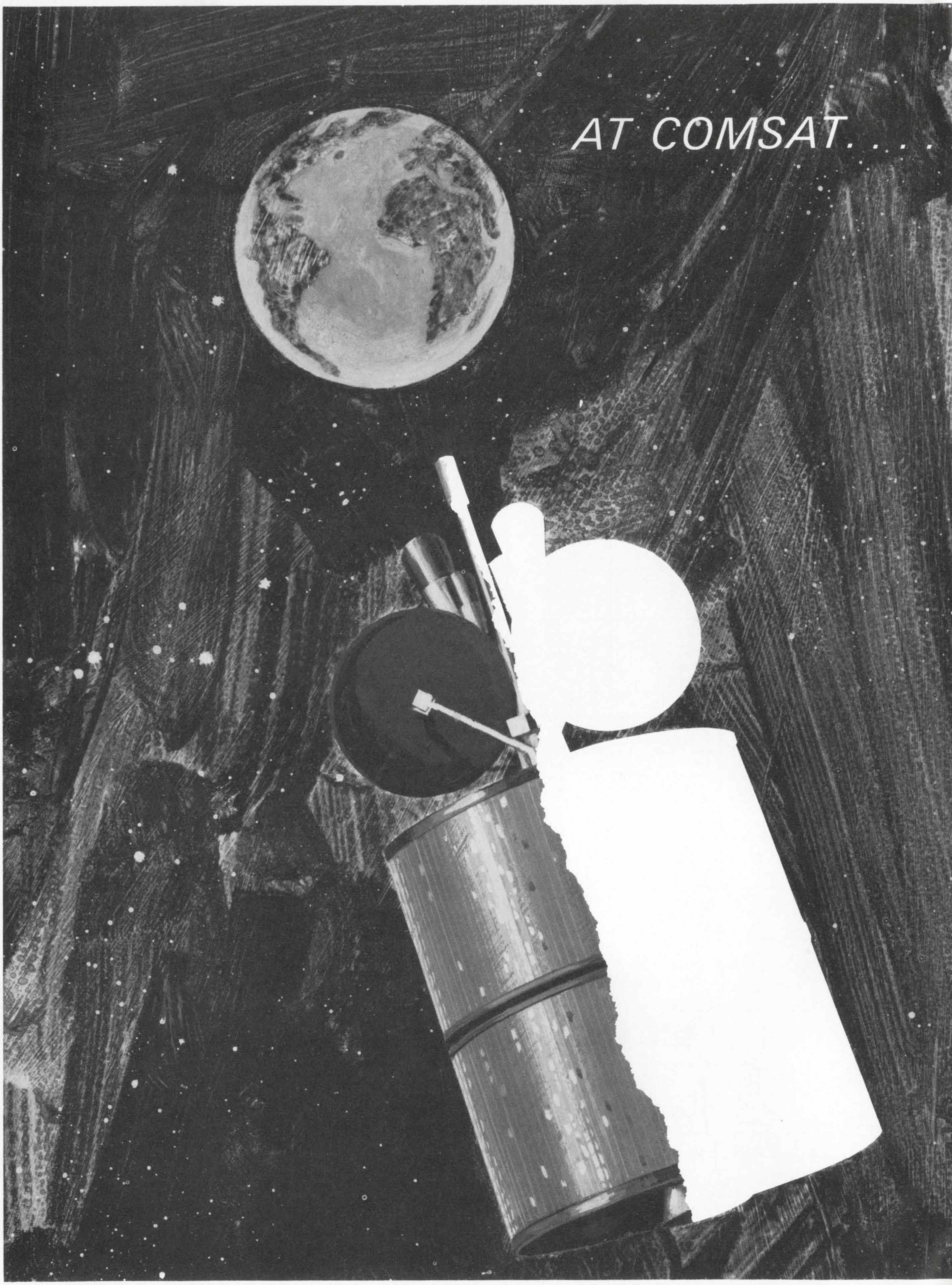
ALLEN-BRADLEY



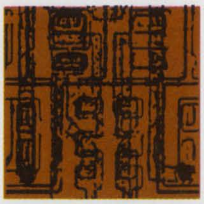
NEW DIMENSION ELECTRONICS

INFORMATION RETRIEVAL NUMBER 4

EC70-6


AT COMSAT.....

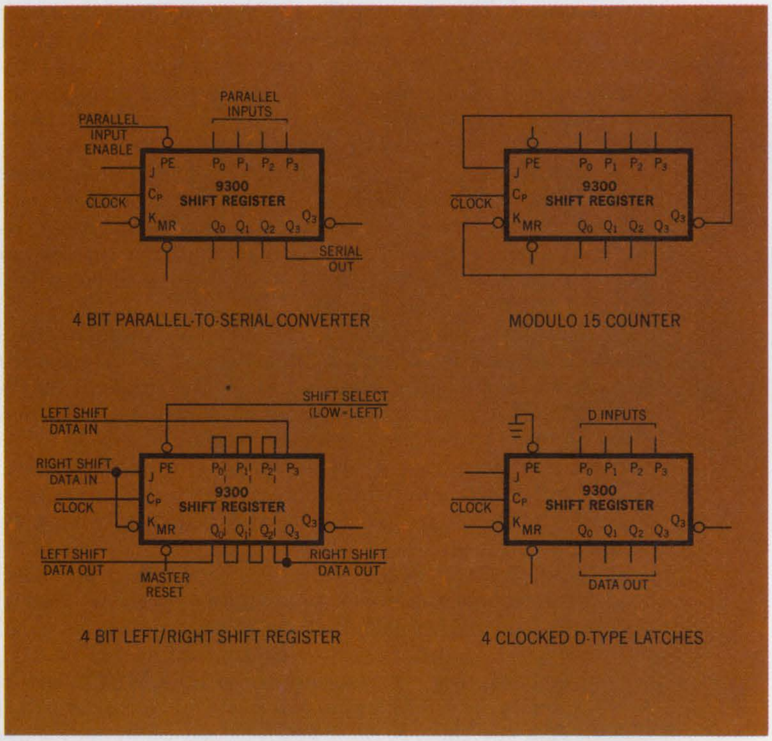
To make a Register that does a lot more than shift,



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 $\overline{K}$ inputs (which, tied together, provide D-type input), gated synchronous parallel inputs, Q and $\overline{Q}$ 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.

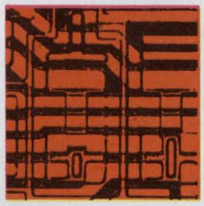
We put together a family plan by taking systems apart. All kinds of digital systems. Thousands of them.

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.

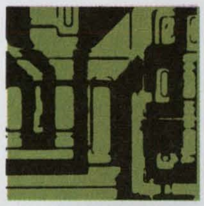
Inside each of the seven categories, we sifted by application. We wanted to design the minimum number of devices that could do the maximum number of things. That's why, for example, Fairchild MSI registers can be used in storage, in shifting, in counting and in conversion applications. And you'll find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

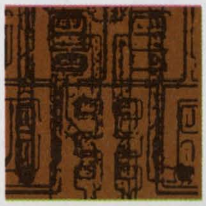
The Fairchild MSI family plan. A new approach to MSI that's as old as the industrial revolution. It started with functional simplicity, extended through multi-use component parts, and concluded with a sharp reduction in add-ons. Simplicity. Versatility. Compatibility. Available now. In military or industrial temperature ranges. In hermetic DIPs and Flatpaks. From any Fairchild Distributor.



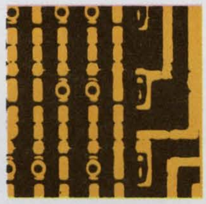
OPERATORS
9304 – Dual Full Adder/Parity Generator



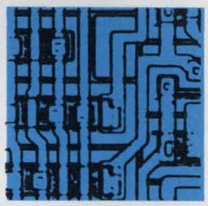
LATCHES
9308 – Dual 4-Bit Latch
9314 – Quad Latch



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

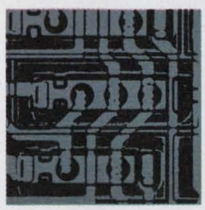


MULTIPLEXERS
9309 – Dual 4-Input Digital Multiplexer
9312 – 8-Input Digital Multiplexer



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 – Hexidecimal Counter



ENCODERS
9318 – Priority 8-Input Encoder

FAIRCHILD
SEMICONDUCTOR

FAIRCHILD SEMICONDUCTOR A Division of Fairchild Camera and Instrument Corporation Mountain View, California 94040, (415) 962-5011 TWX: 910-379-6435

INFORMATION RETRIEVAL NUMBER 6

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

...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.

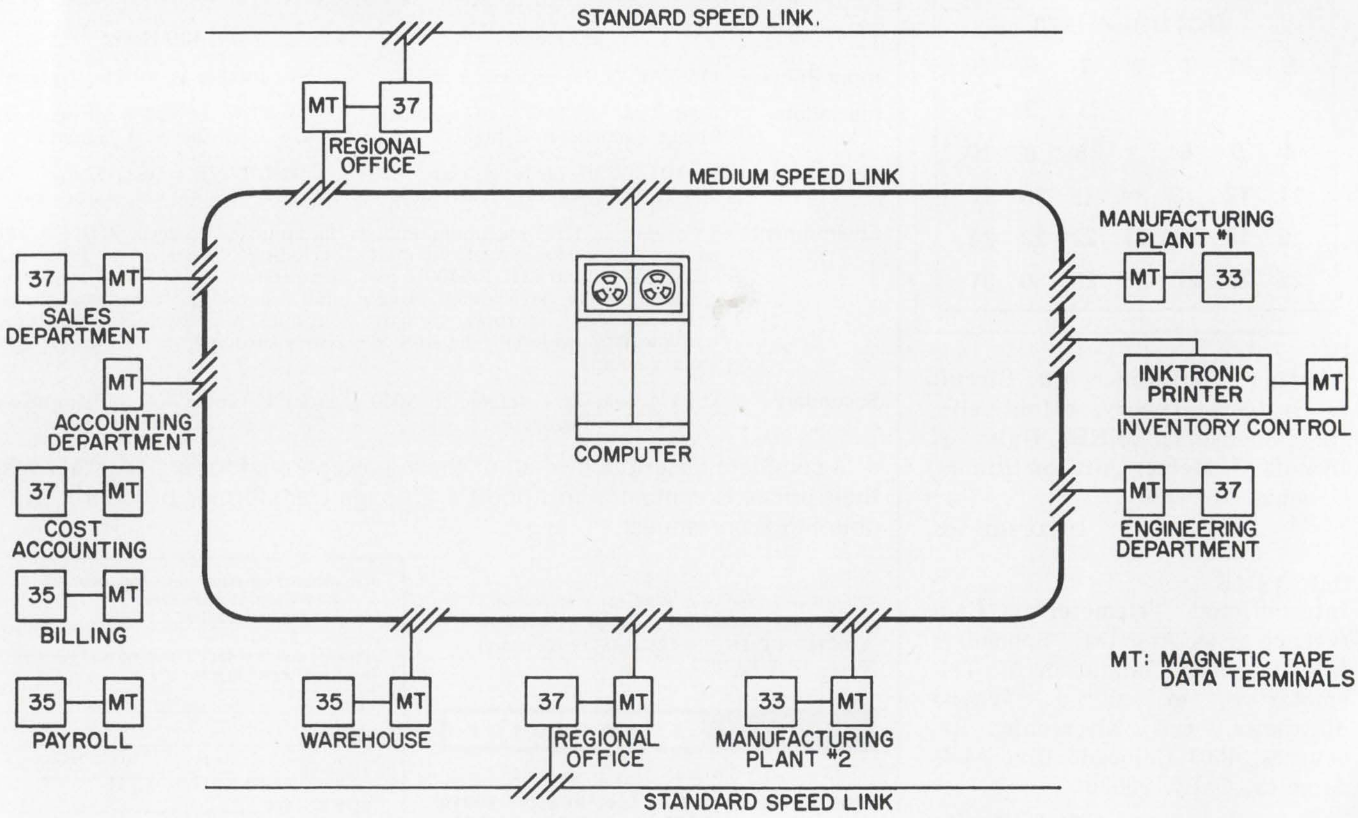
Some of the things, we at Teletype look at, that make the job a little easier are these:

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 various units as building blocks to meet the most demanding system needs. Teletype also has the station and error control accessories necessary for more efficient and economical data communications operations. Since cost is a very important part of the mix, Teletype offers greater terminal capabilities on a price/performance basis than any other manufacturer.

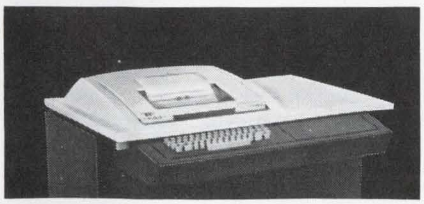
If you're involved in designing a teleprocessing, time-sharing, remote batch or computer switched system; looking into a multi-point private line, point-to-point private line or switched data communications network; talk to Teletype about terminals. For ideas, equipment and understanding, you'll find no better source. Anywhere.

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.

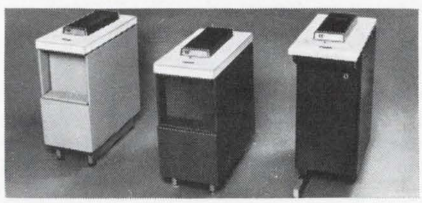
model 33 series: *An extremely low-cost 100 wpm terminal line. Uses ASCII. The most widely used terminal in time-sharing systems today.*

model 35 series: *A rugged, heavy-duty line of 100 wpm terminals. Uses ASCII.*

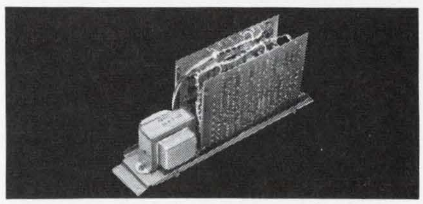
model 37 series: *One of the most versatile heavy-duty terminal lines going. Generates all 128 characters of ASCII. Operates at 150 wpm. Prints in upper and lower case.*



Inktronic® data terminals: *A unique electronic, solid state terminal. Prints up to 1200 wpm. Forms characters through electrostatic deflection (no typebox). ASCII compatible.*



magnetic tape data terminals: *Use compact reusable tape cartridges. Operate on-line at up to 2400 wpm, and connect "locally" to lower speed Teletype terminals using ASCII.*



StuntronicTM accessories: *Electronic solid state terminal logic devices offering many control options. Such as, automatic station control, error detection and correction capabilities.*

TELETYPE

machines that make data move

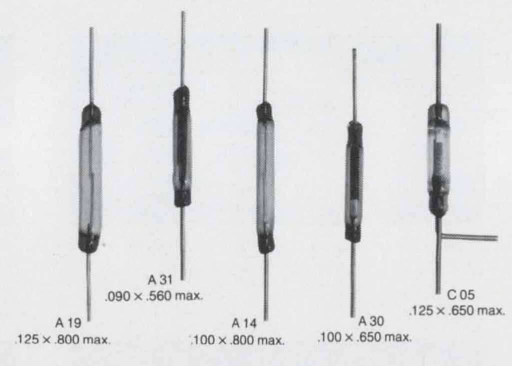
INFORMATION RETRIEVAL NUMBER 9

If you're reed-switching 5-10V, 5-10 ma loads

(as in keyboards and IC packages),

there's a good, small but growing company making good, small reed switches you should know about:

GENERAL REED



In the last seven years, General Reed has designed and produced many millions of high-quality, miniature magnetic reed switches of Form A and Form C types. Expansion of our manufacturing, including the installation of over 1000 sq. ft. of Class 3-4 clean room facility, has now increased our capacity to deliver *highly reliable* snap-action reed switches *in quantity*, at competitive prices, to meet your requirements. Many standards can be shipped immediately from stock, specials in as little as three days depending on the characteristics you need. General Reed quality assurance techniques include on-line testing of electrical characteristics . . . production in controlled clean room areas . . . heat-treating in controlled atmospheres for precise control of magnetic and mechanical properties . . . mechanical run-in of at least 100,000 operations for all switches . . . microscopic inspection for all Form C switches.

To achieve low and *stable* contact resistance throughout the operating life, General Reed selects from over 50 different combinations of noble contact plating materials specially developed to match a wide variety of specific load requirements. This capability alone offers significant advantages in difficult minimum-current switching applications, such as keyboards and other solid-state circuit interfaces, where erratic contact resistance has been a frequent problem.

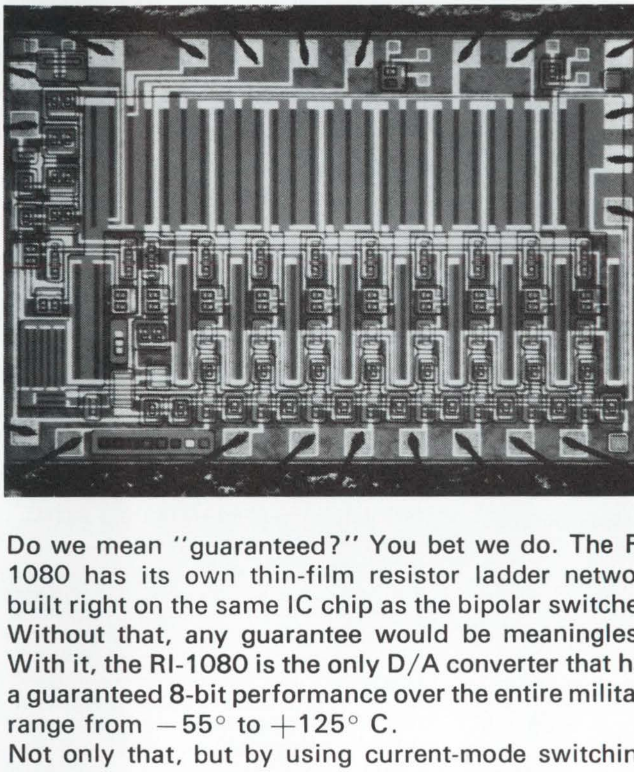
Low bounce, long life and relatively high immunity to vibration, shock and temperature extremes are characteristic trademarks of General Reed switches. Call or write the Sigma stocking distributor near you for full details – or contact General Reed Division, Sigma Instruments, Inc., 19 Walnut Avenue, Clark, N.J. 07066. Tel. (201) 382-7373.

GENERAL REED

DIVISION OF SIGMA INSTRUMENTS INC.

INFORMATION RETRIEVAL NUMBER 10

THE ONLY 8-BIT GUARANTEED MONOLITHIC D/A



- Guaranteed performance from $-55°$ to $+125°$ C.
- Incorporates an internal resistor ladder network on the same chip.
- Operates in bipolar, unipolar positive or unipolar negative modes.
- 1 μs typical settling time to $\pm\frac{1}{2}$ L.S.B.
- $82.50 in quantities of 100 to 999.
- Available off-the-shelf in 24 lead dual in-line or flat-pack packaging.

Do we mean "guaranteed?" You bet we do. The RI-1080 has its own thin-film resistor ladder network built right on the same IC chip as the bipolar switches. Without that, any guarantee would be meaningless. With it, the RI-1080 is the only D/A converter that has a guaranteed 8-bit performance over the entire military range from $-55°$ to $+125°$ C.

Not only that, but by using current-mode switching, the converter ladder bus can be returned to voltages off-ground for high versatility. Current switching reduces ringing in output and reduces power-supply transients. The converter is capable of conversion rates in excess of 10^6 words/sec. Just check our specs with any other D/A — monolithic or hybrid — and we think you'll agree that the Radiation RI-1080 offers the *best price/performance on the market.*

Lexington, Massachusetts (617) 862-1055
Norwalk, Connecticut (203) 853-3646
Frederick, Maryland (301) 662-5400
Oaklawn, Illinois (312) 423-6010
Dallas, Texas (214) 231-9031
Albuquerque, New Mexico (505) 268-3549
Palo Alto, California (415) 321-2280
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P. O. Box 37, Melbourne, Florida 32901 (305) 727-5430

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RADIATION
INCORPORATED
SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION
MICROELECTRONICS DIVISION

INFORMATION RETRIEVAL NUMBER 248

did you know?

General Electric volt-pac® variable transformers help you vary voltage dependably...year after year,* after year, after year, after year, after year, after year, after year, after year...

Send in this coupon for free bulletin giving complete details on Volt-Pac transformer features, ratings and application data; or see your GE sales representative today.

* Laboratory tested for over one million failure-free operations.

Section 413-34
General Electric Company
Schenectady, New York 12305

Please send me free bulletin GEA-8110 on Volt-Pac Variable Transformers.

NAME ______________________

COMPANY ______________________

TITLE ______________________

ADDRESS ______________________

CITY ____________ STATE ____________ ZIP ______

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 11

SOLID TANTALUM CAPACITORS

BOARDABLE & AFFORDABLE

RIGHT ON THE MONEY FOR PRINTED WIRING BOARDS IN INDUSTRIAL, COMMERCIAL, AND ENTERTAINMENT ELECTRONICS

Sprague Type 196D Dipped Solid-Electrolyte Tantalex® Capacitors cool the performance/budget argument. Newly broadened line—now available in all popular 10% decade values between 0.1 μF and 330 μF. Voltage range: 4 to 50 vdc. Hard insulating resin coating is highly resistant to moisture and mechanical damage. Straight or crimped, long or short leads. Operate to 125 C with only ⅓ voltage derating. Write for Engineering Bulletin 3545A.

Technical Literature Service
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347 Marshall Street
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SPRAGUE®
THE MARK OF RELIABILITY

THE BROAD-LINE PRODUCER OF ELECTRONIC PARTS

4SM-0139

INFORMATION RETRIEVAL NUMBER 12

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.

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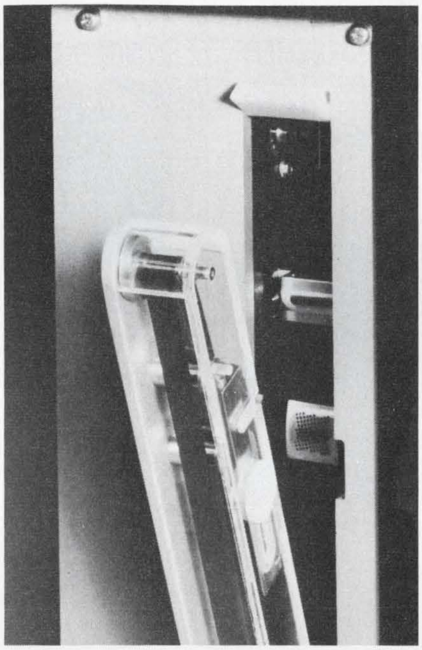


A new data storage system called Comfile provides the data access and organization styles of discs and drums at the low costs associated with magnetic-tape cartridge systems. At the heart of the new system is a 30-inch-long magnetic-tape loop capable of storing up to 72,000 characters of data. This stored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

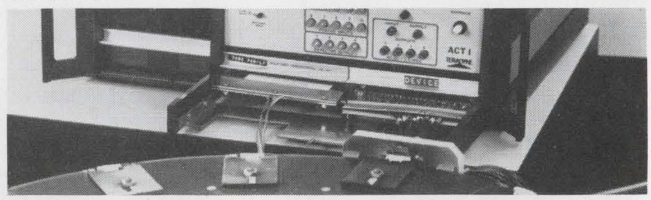
First, because it is so easy to use and program. Plug-in PC cards do the job, and DEC doesn't have to worry about getting stuck for a program: Teradyne offers cards for over 1000 different ICs.

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 it 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 Services 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 Aution 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 customer 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 nondestructive 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.

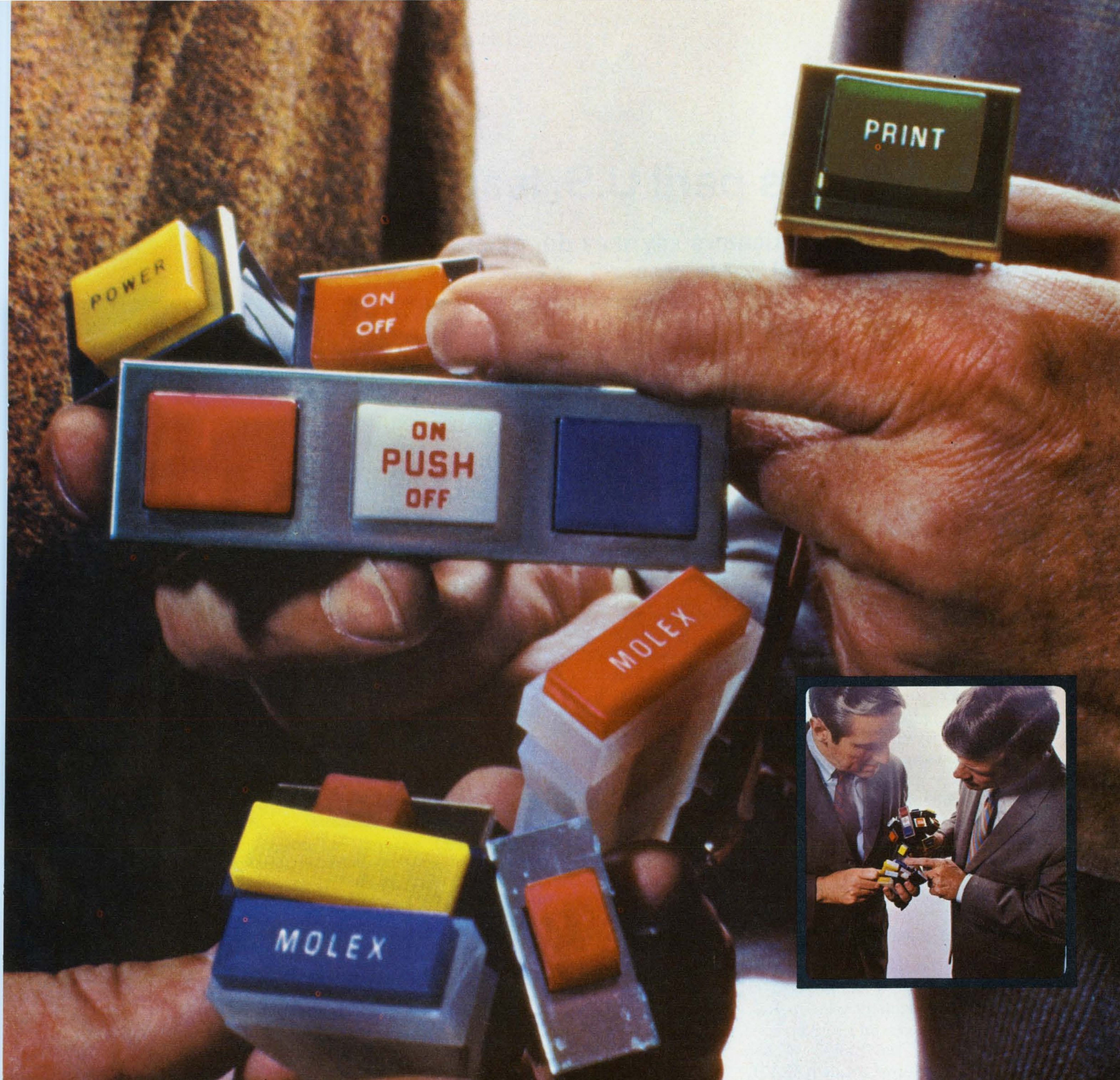
Custom LSI at low cost promised by Motorola

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."



HERE ARE TWO EASY WAYS TO SOLVE LIGHTED PUSH BUTTON SWITCH PROBLEMS. Economically. Reliably. Fast. The Molex 1175 snap mounts. Offers spade or wire terminals for fast, easy assembly. A choice of nine colors, 500 variations. And look at the Molex 1820. You can use one, or a gang of them, for an infinite variety of applications. Lighted push button can be wired to light independently of the switch. And it's available in colors galore. Best of all . . . both switches are priced considerably under one dollar in quantity. ▪ These components are good examples of the Molex creative approach to design problems. And we have the ability to design reliability and ease of assembly into a product without letting costs run wild due to over-engineering. ▪ If this makes sense, and you would like a *free sample* of either the 1175 or 1820 switch, write: Molex Incorporated, Downers Grove, Illinois 60515. Or phone (312) 969-4550.

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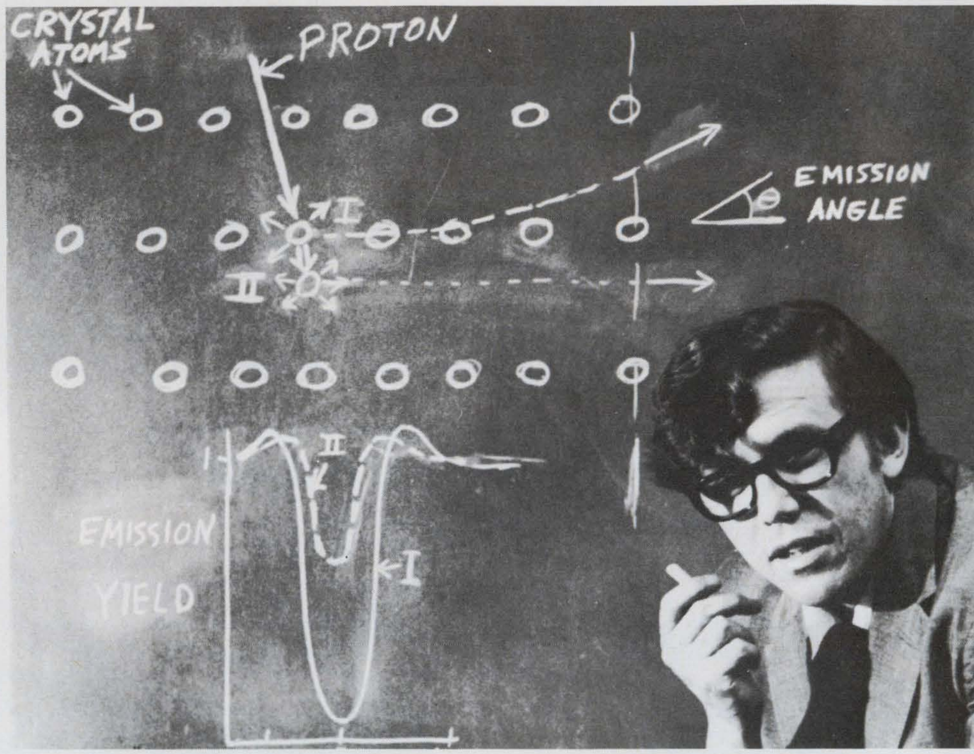
M159

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



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.

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 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 technological 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."

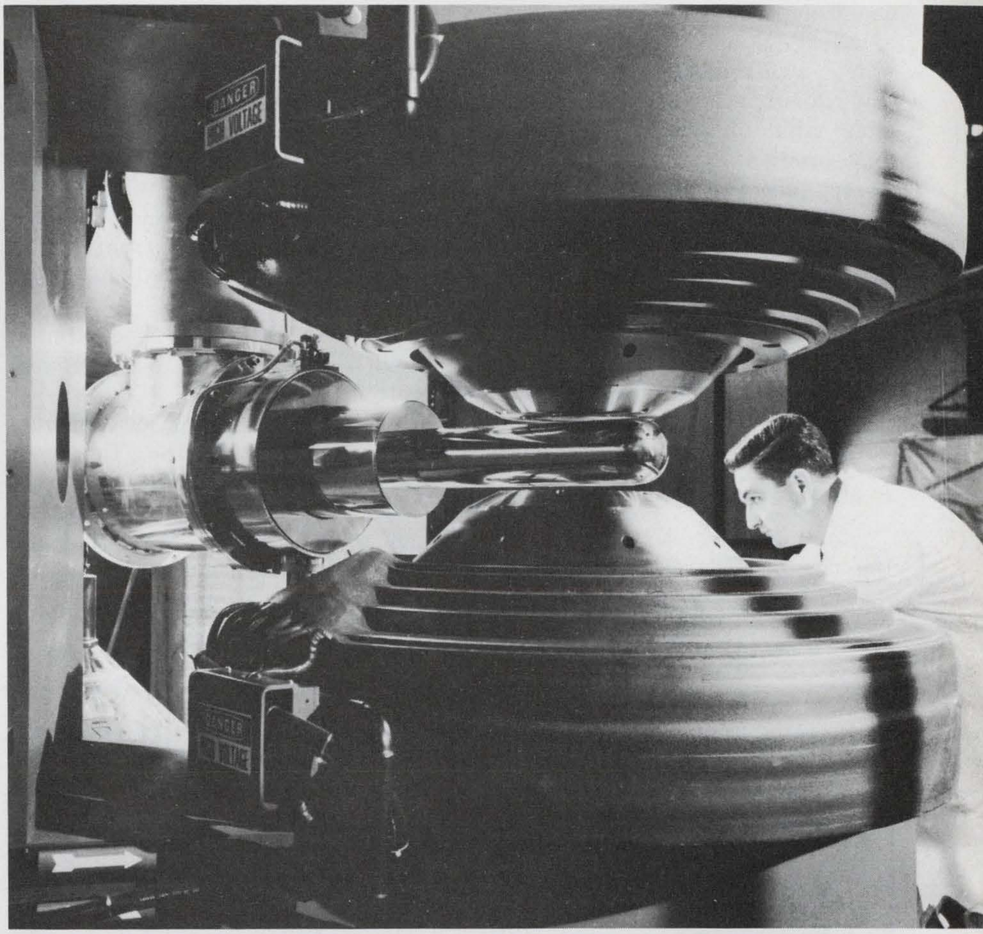
Government agencies, such as the Dept. of Defense, the Atomic Energy Commission and the National Aeronautics and Space Administration, have been forced to cut their academic support as budgetary economy measures. As a result, Eirich says, "we are going to lose [over an 18-month period] almost 30% of 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 spokesman 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 Commission'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

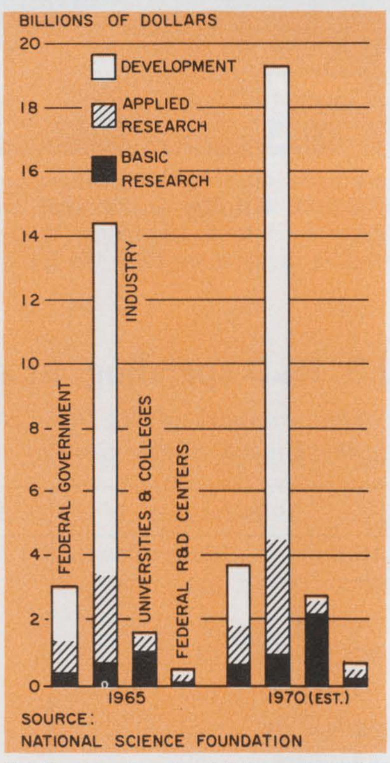
How is industry reacting to federal cuts in R&D spending?

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.

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 missilemen 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 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.

Protesting the Navy in San Juan

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 Ladron 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."

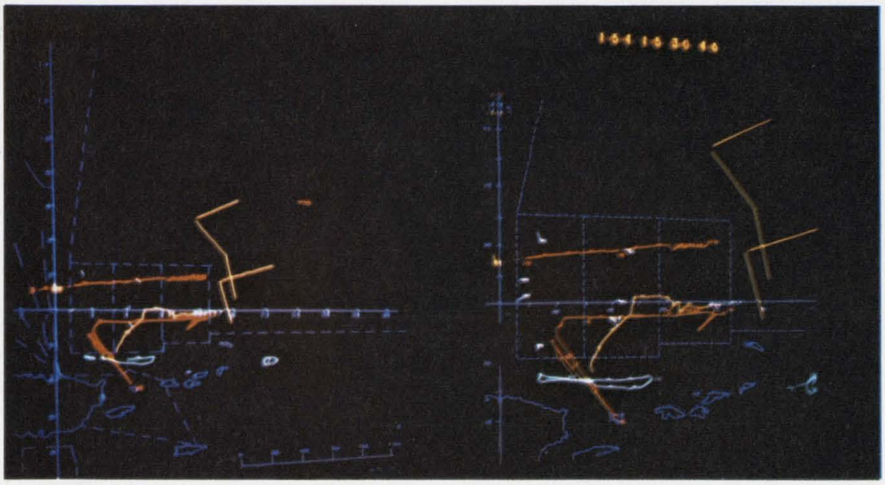
Several methods are being studied. One calls for the drone to be equipped with a navigation system, such as loran, and to telemeter its position to the control room. "This would be very expensive," he says, "and is going the wrong way. We want cheaper drones, not more expensive ones."

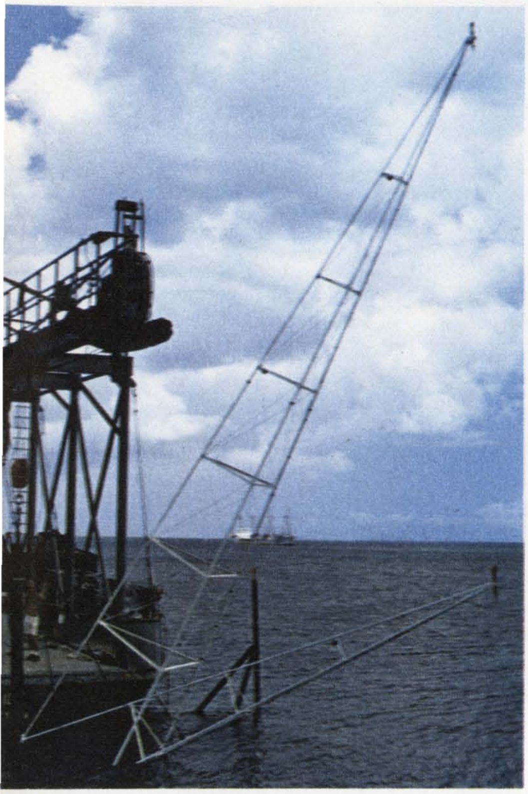
Another approach is for the drone to send continuous telemetry data that tells its speed, heading, turns, and other maneuvers, while a computer in headquarters calculates its position. This amounts roughly to having the data-processing portion of an inertial guidance system on the ground.

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).

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 greatly 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 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, 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 hydophones 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.

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 cviilian aircraft by vhf and to ships by hf.

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 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, quantative 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.

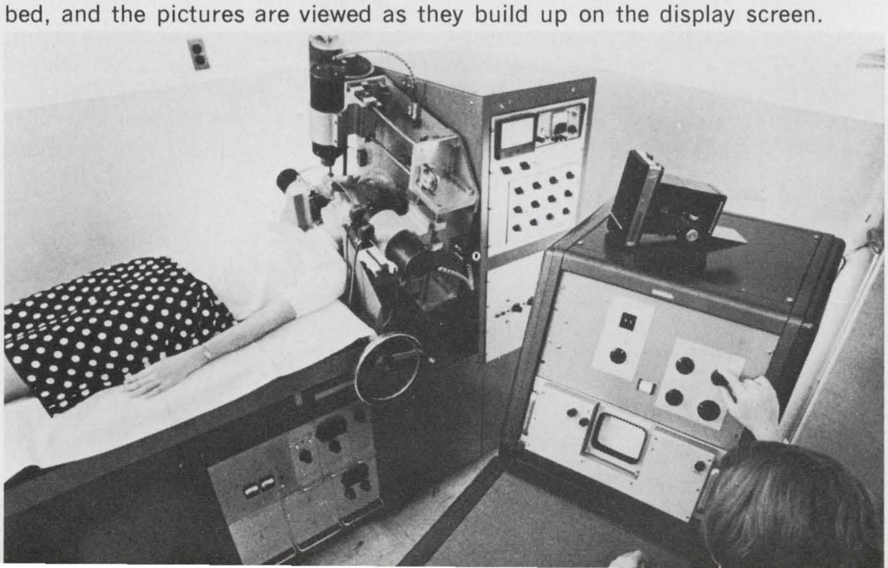
Basically the brain-scan instrument consists of scintillation counters that detect the presence of radioactive substances, which have been administered orally or intravenously to a patient. The radioactivity tends to accumulate around diseased areas of the body. By scanning at a specific rate, the doctor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

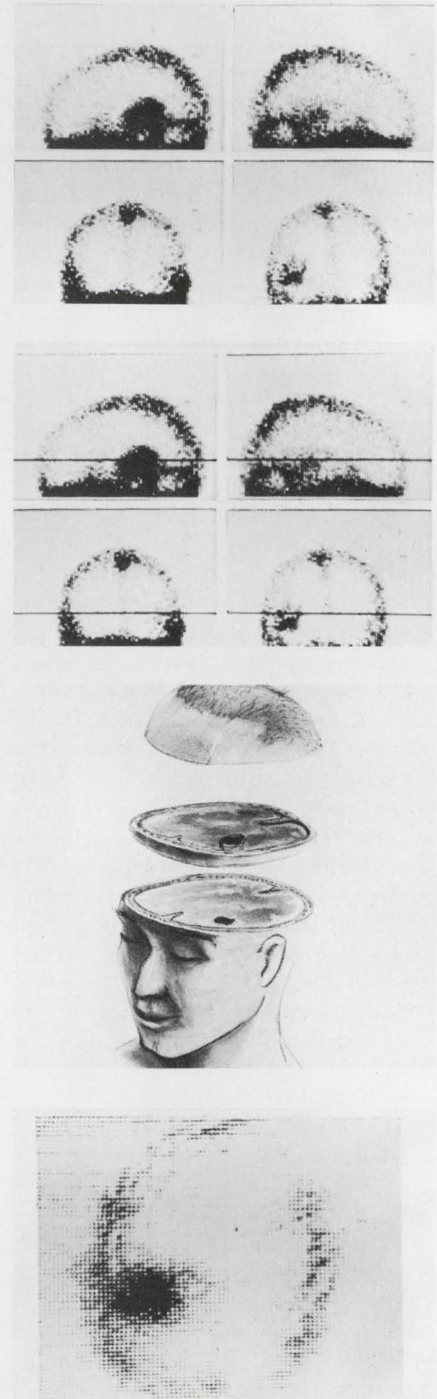
In early work by Dr. Kuhl and Edwards, this information was recorded on paper tape. The new instrument records image data directly on a magnetic drum; it is then run through a small computer processor for smoothing and boundary definition—techniques similar to those used by NASA in increasing the resolution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

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.





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.

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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

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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:

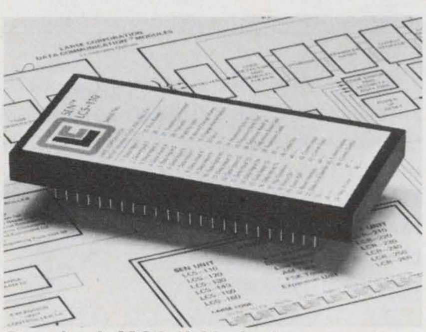
- Flexibility—the system permits radio-nuclide scanning of the brain and the rest of the body.
- Simplicity — the instrument does not require the use of complex programs.
- Immediacy—pictures can be processed so rapidly that the physician can remain with the patient and redirect the scan to focus on 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.



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.

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 is 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.

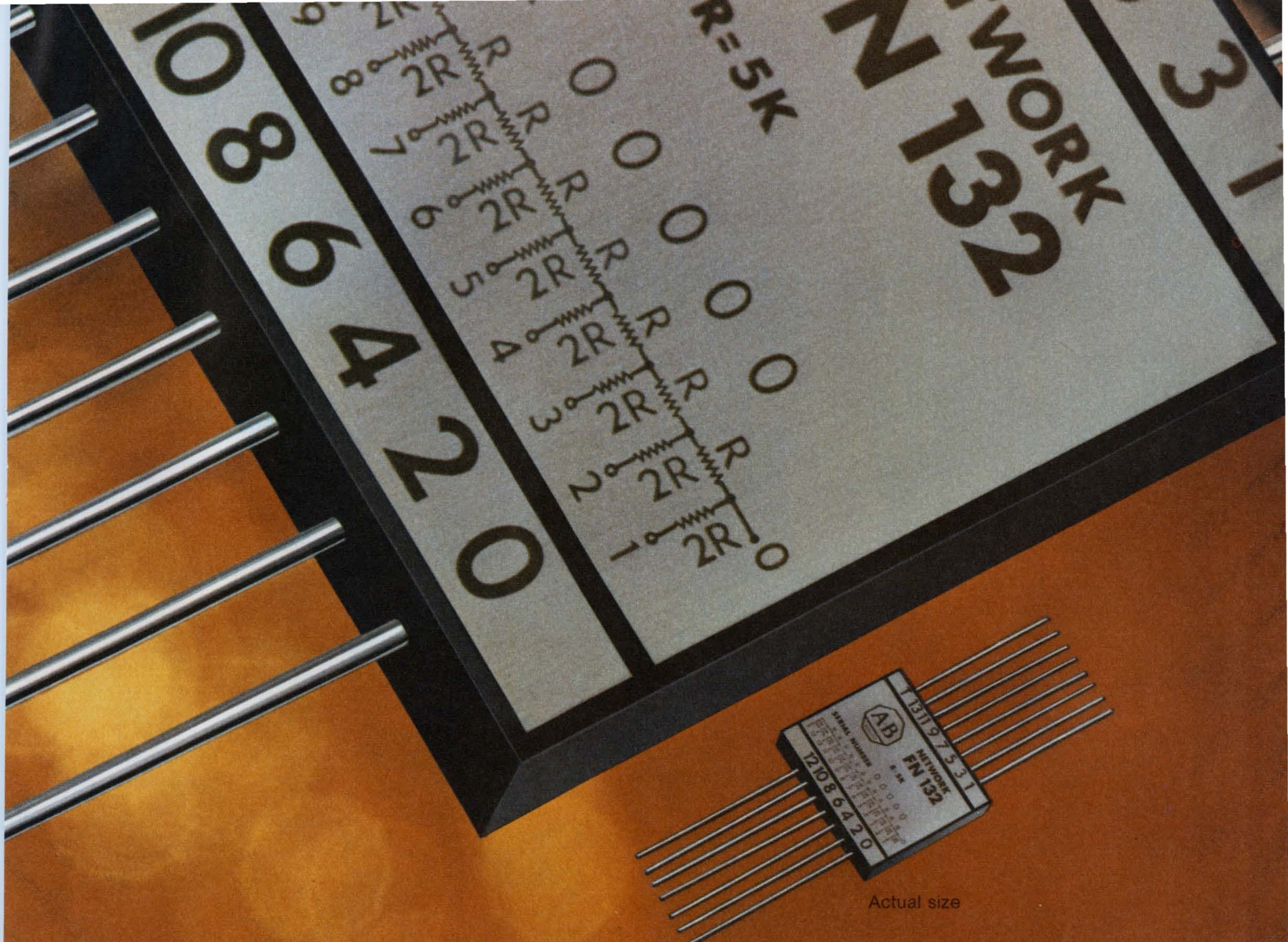
For example, the Larse telemetry units can work with almost any kind of communication link (telephone line, dc wire, microwave link, radio link, etc.) and can transmit or receive in eight different modes, including single-word, continuous, tone interrogation and coded interrogation. Every receiving unit 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."

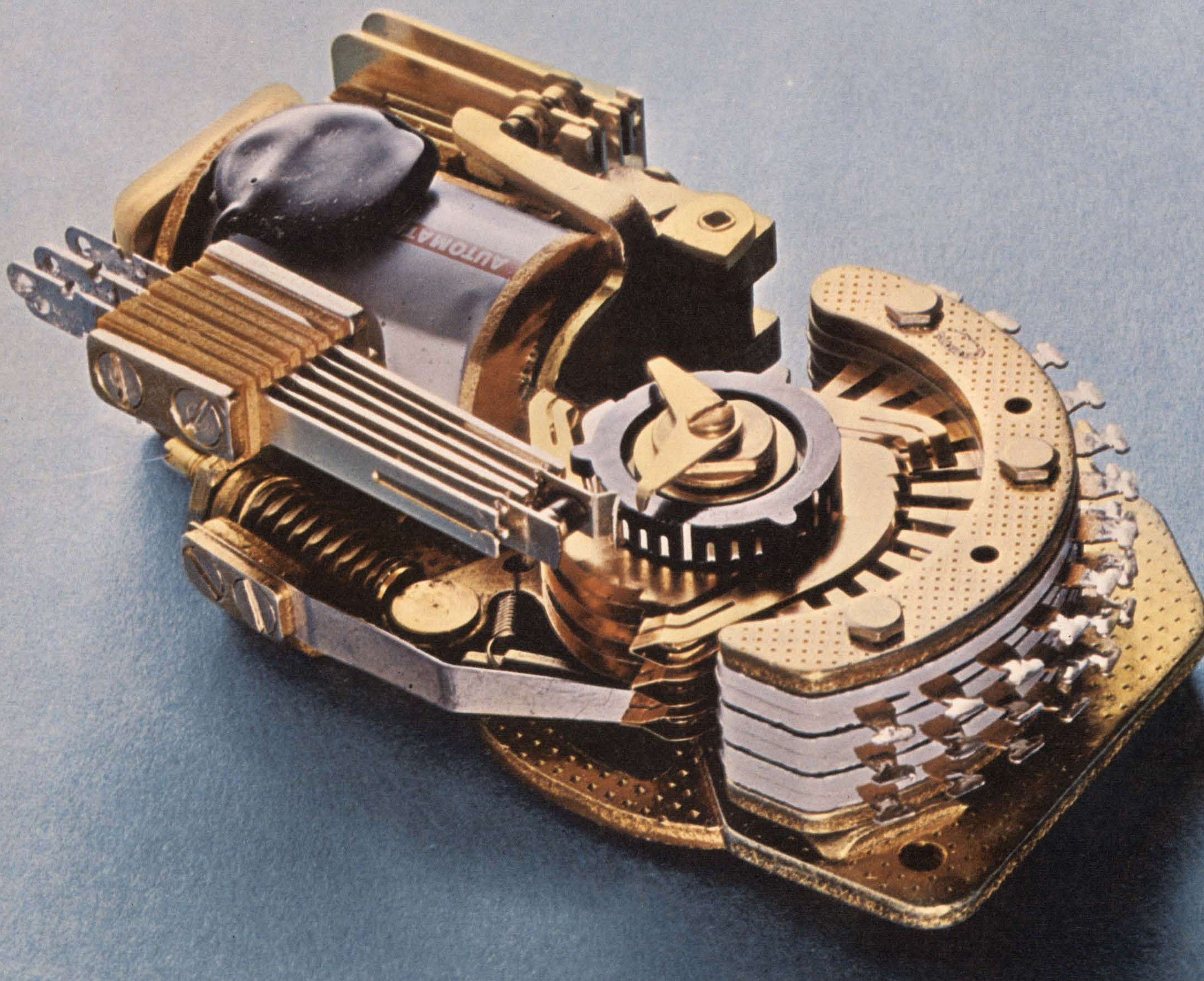
Larse Corp. designs its own MOS/LSI chips, sends them out for mask and wafer making, then tests, scribes, dices and packages the chips inhouse. Wafer yields have been running around 30%, Larse says—which is considered phenomenally high for LSI. ■■

INFORMATION RETRIEVAL NUMBER 18 ►



Actual size

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.

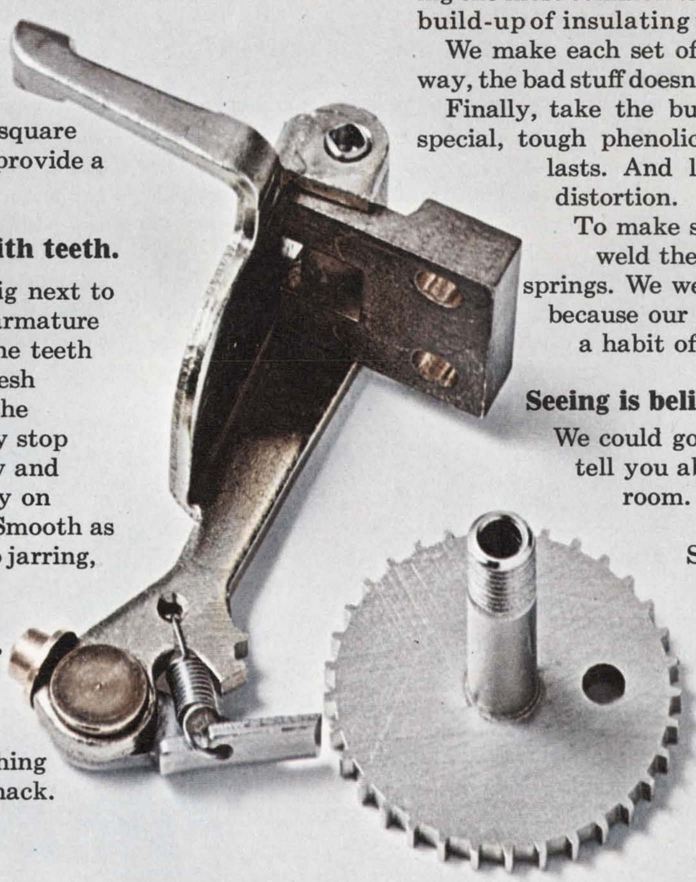
At one end of the drive spring is an adjusting screw. We turn it a little this way or a little that way and the tension is always perfect.

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.

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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.

Don't bother looking for this special set-up anywhere else. It's patented.

The other thingamajig.

It's called a contact spring. We've got some strong feelings as to what makes a contact spring strong.

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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 industrial 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.

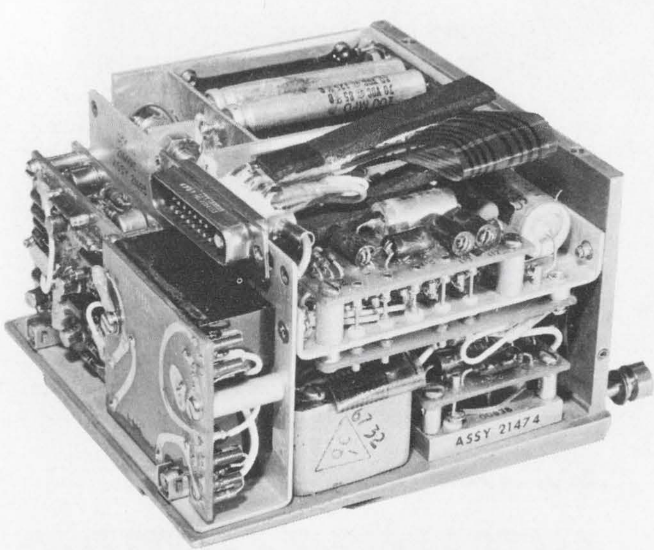
The overriding problem in redesigning from a military to civilian version is reducing the product cost. Although many techniques are uniquely related to a particular military design, there are cost-shaving design principles that can be universally applied.

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):

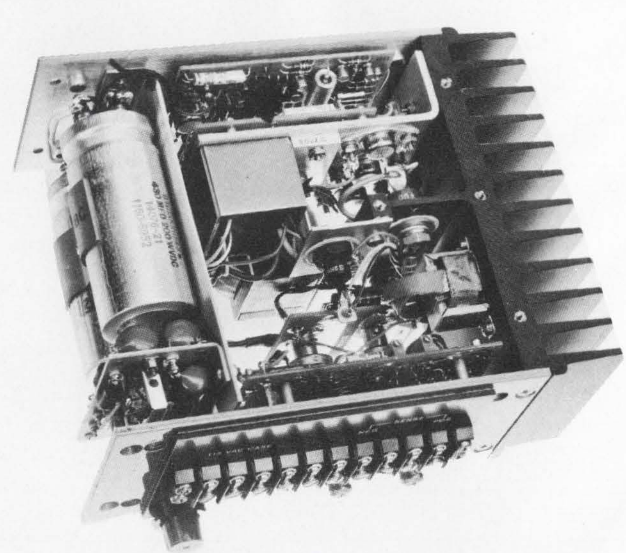
"The compact military designs are expensive to fabricate, and because of limited heat dissipation, they require costly, high-temperature components. So the first step in lowering the price is to repackage the equipment—providing more room between the individual components.

"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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(**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 lighter 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.

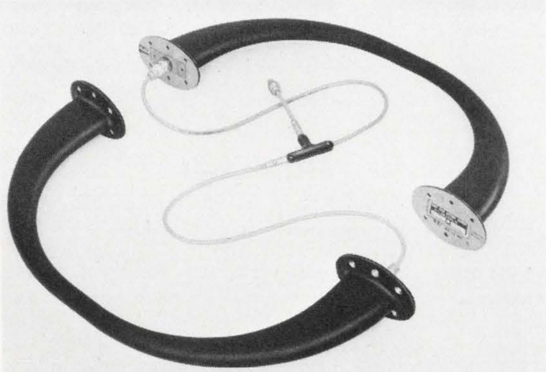
"Another area where we made considerable savings was in the display itself. The original requirements were for high-brightness display, because it was under a bubble canopy, which is subject to high ambient light. This required an expensive, high-brightness tube, plus a costly 15-kV power supply.

"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."

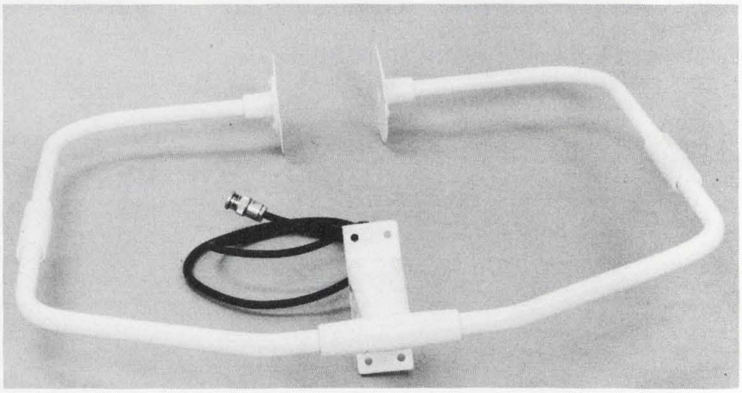
As far as packaging is concerned, Sabel and Crawbuck of Trio Labs are in agreement.

"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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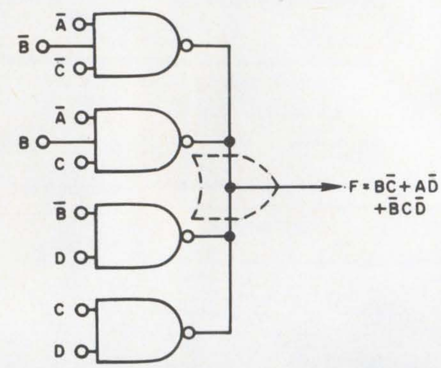
Letters

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.)

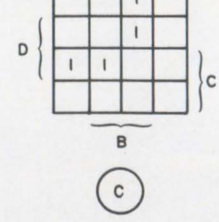
Now suppose that due to some failure—incorrect wiring, etc.—F remains at logical 0. The DTL gate outputs must be removed from the wired-OR one at a time until the one causing the problem is found. If the wired-OR happens to be on a PC board or wire-wrapped panel, this can be a tedious task.

Rudolph Pappa

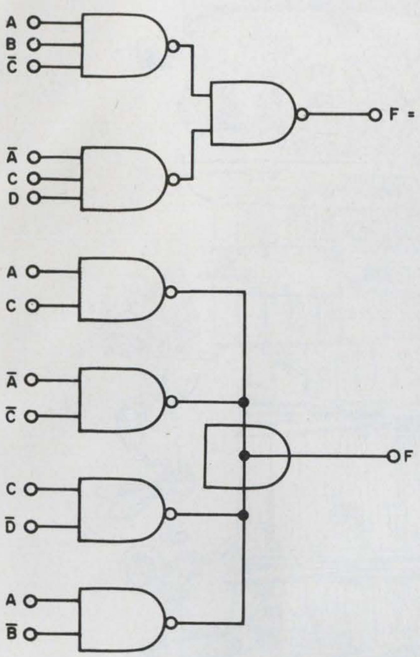
Link Division
Singer-General Precision, Inc.
Sunnyvale, Calif.

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:



c



(d)

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 whole-heartedly 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

Great Milestones in Packaging

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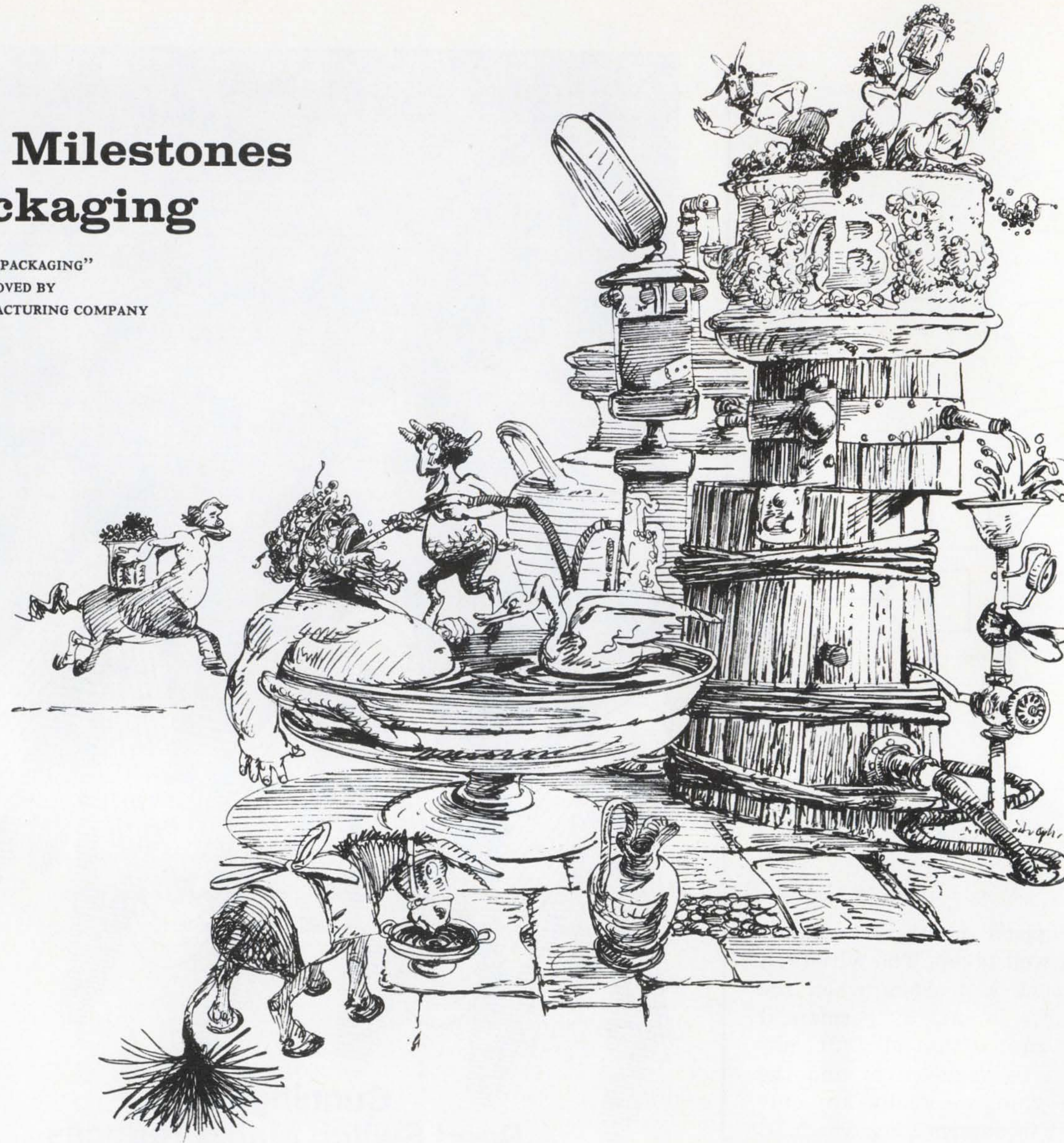

Long, long ago, in the early awakenings amongst the Isles, a happy accident happened. A grape, then a series of grapes were squashed in such a peculiar way that, fermentation being what it is, someone sensed putting the results in a container would prove of high interest. Thus does history begin.

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

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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- **60-MHz Bandwidth**
- **Dual-Trace, 5 mV/div**
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- **8 x 10 cm Display**
- **Solid State**

$2325 **COMPLETE WITH PLUG-INS**

The TEKTRONIX 7503 THREE-PLUG-IN OSCILLOSCOPE offers *more* measurement capability per dollar than any other quality oscilloscope.

Easier to use. An exclusive peak-to-peak auto-triggering mode provides a triggered sweep throughout the 360° range of the level/slope control. The front panel is uncluttered, lighted push-button switches are extensively used to conserve space. Controls are conveniently related to function through the use of a color-keyed front panel.

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.

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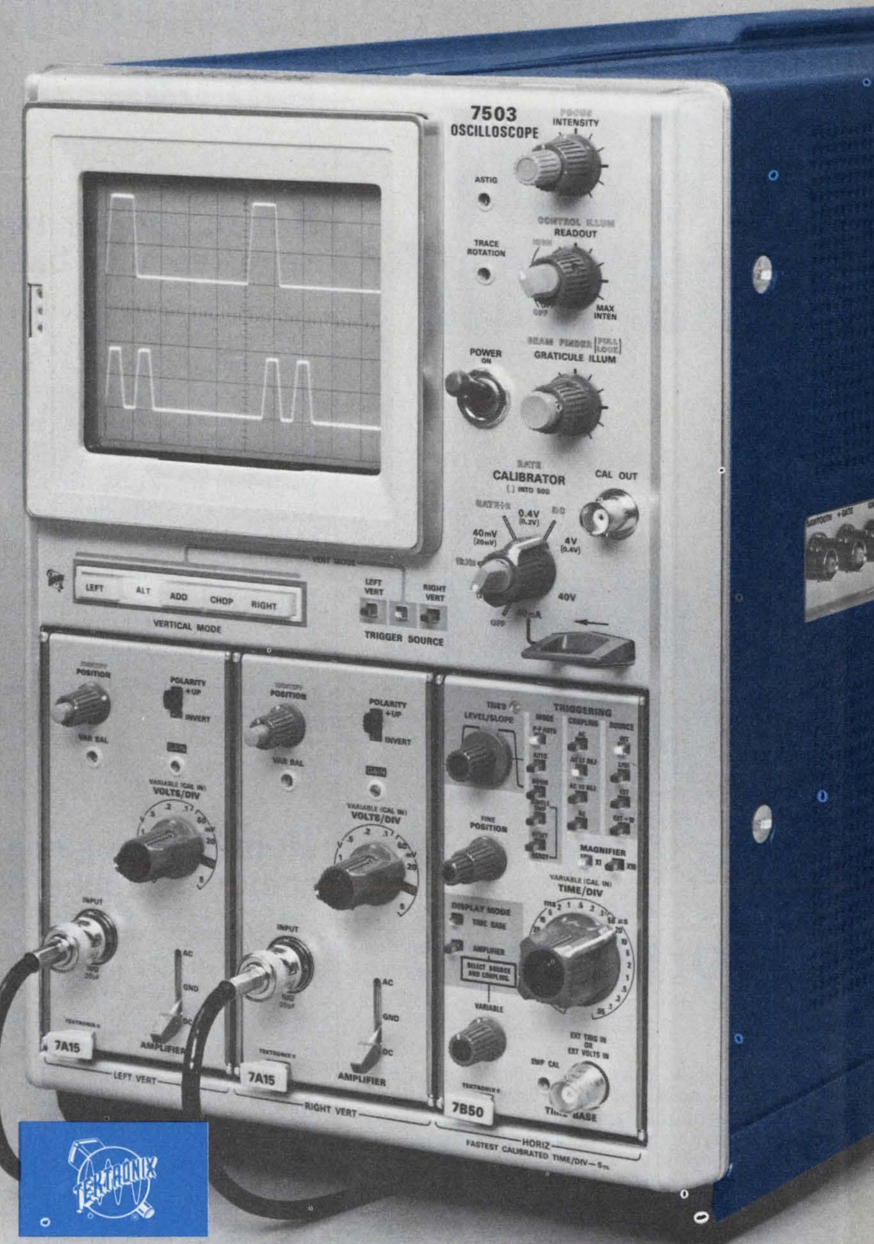
An **I**ntegrated **T**est **S**ystem! With the introduction of the 7D13 and 7D14 digital plug-ins, the 7000-Series becomes an Integrated Test System. **ITS** much more than an ordinary oscilloscope. SEVENTEEN plug-ins covering a wide performance spectrum are available to solve virtually all of your measurement problems. Some of the features offered are: dual-trace, differential comparator, 10-μV 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.



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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-μs 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 μA709 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.

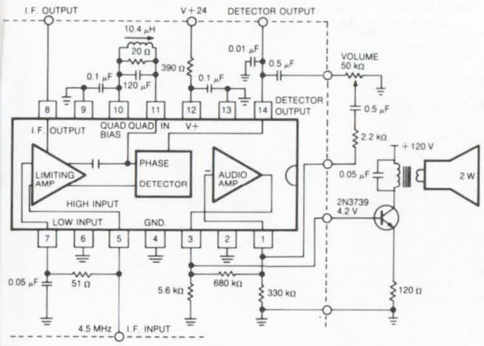
logical crown
inment devices

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

We make promises into realities like the μA754C 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 μA754C: 80 μV sensitivity. 50dB AM rejection. 3V RMS output. All at low harmonic distortion plus a low impedance IF output compatible with ceramic filters.



- f_o 4.5 MHz
- Deviation for 100% FM ±25 kHz
- AM rejection at 1mV 50dB
- Limiting sensitivity 80μV
- Recovered audio at detector output 380mV
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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

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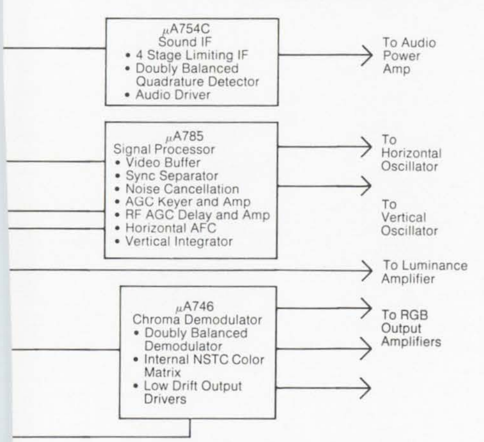


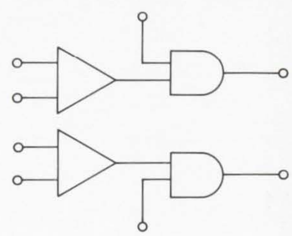
As No. 1 in 2nd sources, we give you not only pin-for-pin duplicates, but even better performers, if we can find a way of making 'em better without adding to the cost.

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

MHITHDLIC μA761 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 μA761 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^2L compatible outputs and inputs, but they share common threshold and power supplies.

The μA761 is an exact pin-for-pin replacement for the SN7524/25, but if you need the same specifications as the SN7524/25, specify the μA7524 and μA7525 Two Channel Core Memory Sense Amplifier.



Electrical Performance
- Threshold uncertainty ±2mV
- Differential input bias current 30μA
- Input to output delay 20nS
- Propagation delay 15nS
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Guaranteed AC min ONE and max ZERO tests

The μA761 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!

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And two more MHITHDLIC products from Fairchild μA729/μA732 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 μA732 is a pin-for-pin replacement for the MC1304 and the μA729 is a pin-for-pin replacement for the MC1305. Both are available now. Off the shelf.

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

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You save $2.00. Available now.
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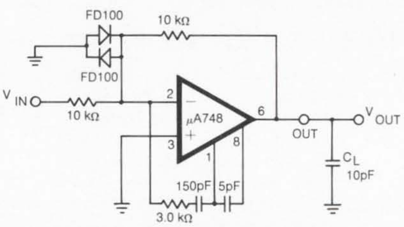

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General purpose dual monolithic op amp. Each amplifier useful at frequencies up to 20 MHz. Output stage uses external load resistor, which makes circuit ideal for matching special output loads, allows tailoring of open loop gain.

- 20 MHz bandwidth
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DIP. 0 to +70°C. Now $1.90/100 pc. You save $1.59. Available now off the Fairchild Distributor shelf.
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Fairchild retains techno with integrated enterta

(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?*

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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.

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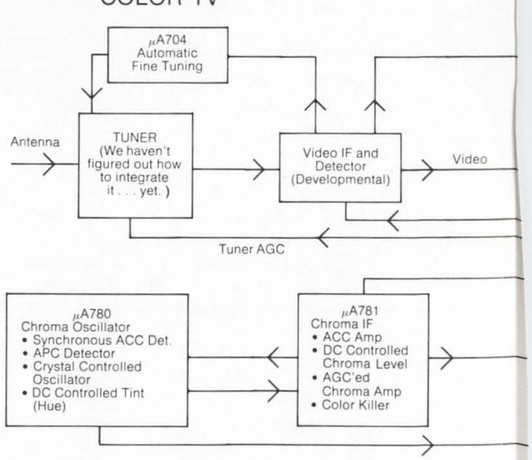
Incidentally, if you're interested in playing with the μA780 Chroma Oscillator and the μA781 Chroma IF, let us know, on your company letterhead, here at the factory.

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

COLOR TV



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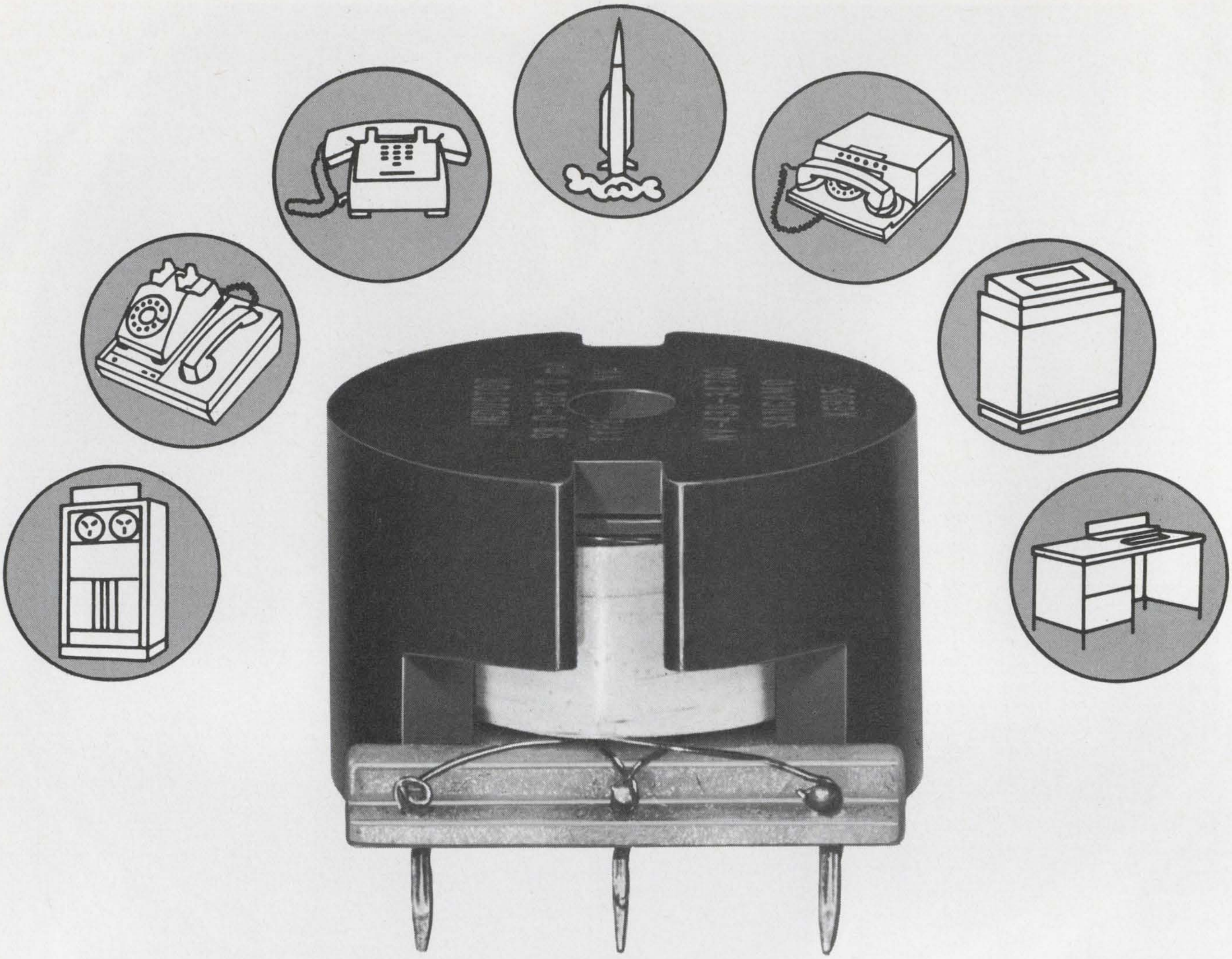

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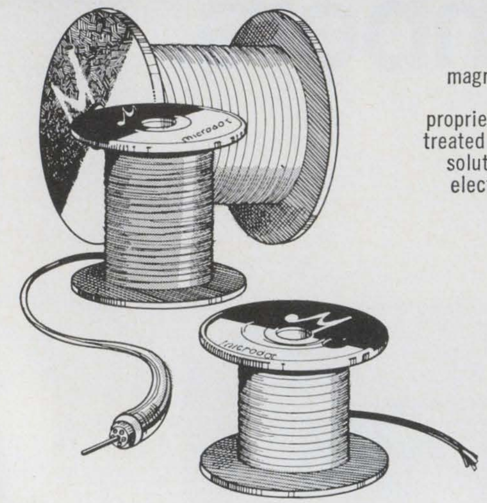
Very, Very Microdot.



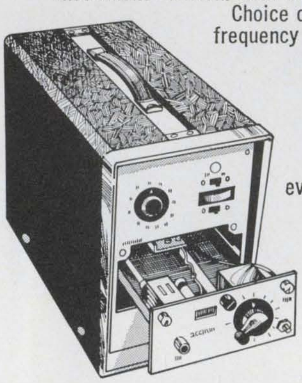
Able cable.

"Mini-Noise" coaxial reduces noise voltage magnitude by a factor of 100 to 1 compared with other cables. Reason: Our Cable Division's proprietary process of coating cable with specially treated Teflon* or polyethylene dielectrics. A great solution to audio noise problems encountered by electronic component manufacturers and users.
*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.

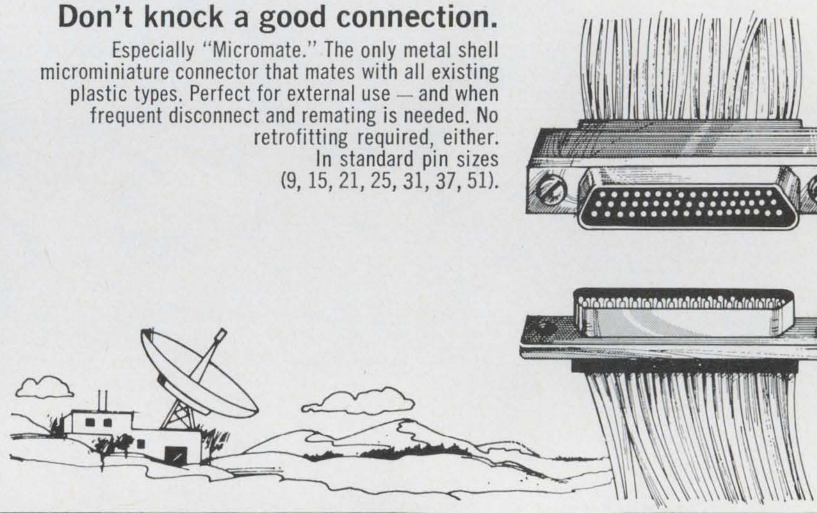
Watts the difference?

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.



Don't knock a good connection.

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).

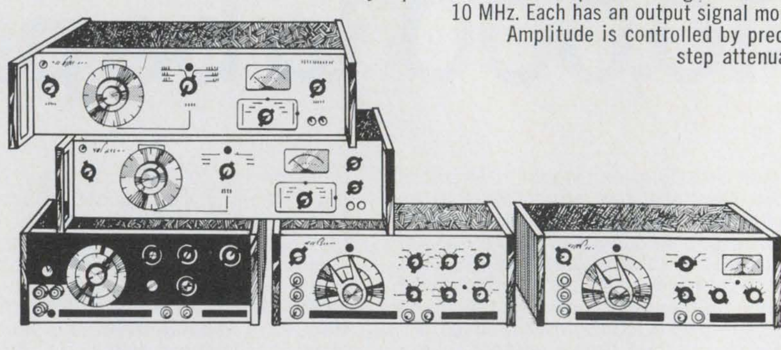


Decisions. Decisions.

You now have a choice in helically coiled threading inserts. Plus good reasons for deciding on 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.

Testing: 1-2-3-4-5.

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.
220 Pasadena Ave., South Pasadena, Calif. 91030

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:

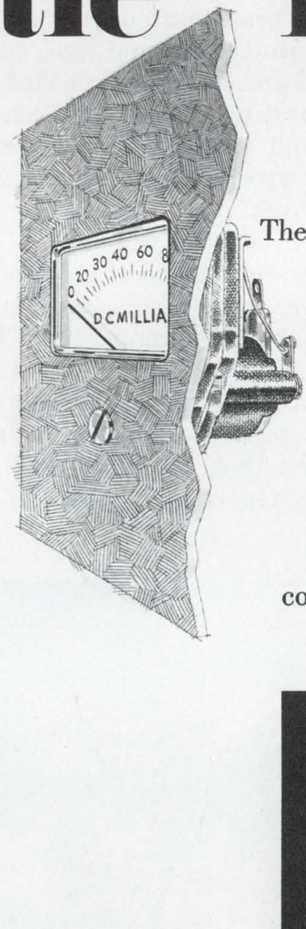
- He hadn't counted on having to enter San Juan Naval Station through the back gate to avoid the demonstrators out front shouting: "Yankee go home!" and "Get out of Culebra!" Culebra is the small island that's more or less the center of the complex of rocks and cays the Navy uses for strafing and for 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

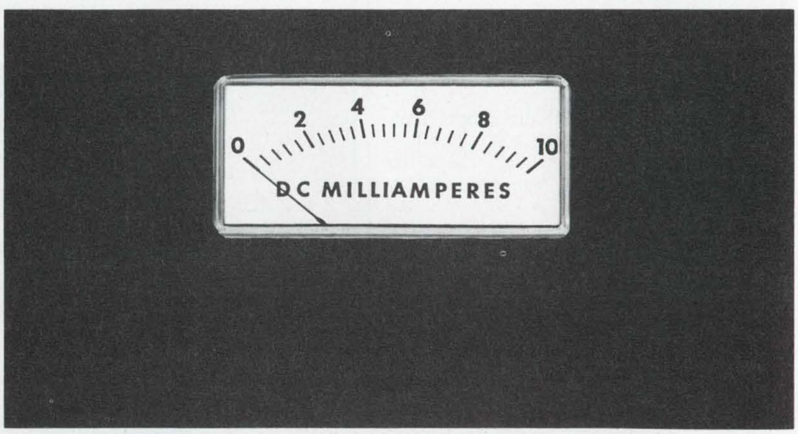
little meters



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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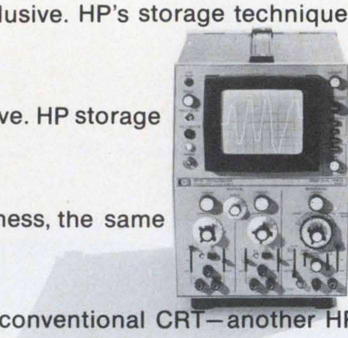
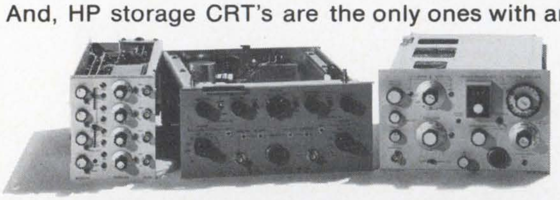
INFORMATION RETRIEVAL NUMBER 31

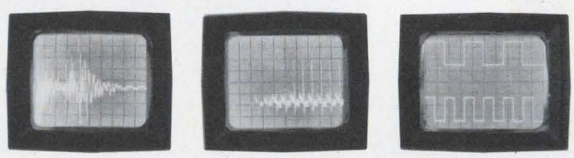
INFORMATION RETRIEVAL NUMBER 32 ►

Need A Scope That Remembers?

☐ If you make real-time measurements in the 50 MHz to 100 MHz frequency range, here's something for you to remember: Only Hewlett-Packard offers 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 remembers, HP has it, too. ☐ In all the HP scopes, at the twist of a knob, you can 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 CRT's use industry-standard, aluminized, P-31 phosphor; so you get the same brightness, the same 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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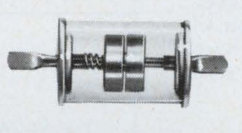
OSCILLOSCOPE SYSTEMS

INFORMATION RETRIEVAL NUMBER 33

INFORMATION RETRIEVAL NUMBER 34 ►

clip transients...



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

- Impulse Ratio .... 1:1 to 1
- Trip Voltages .... 550V to 15.OkV (constant up to 50 kV/microsec.)
- Life .... greater than 5,000 shots @ max. rating
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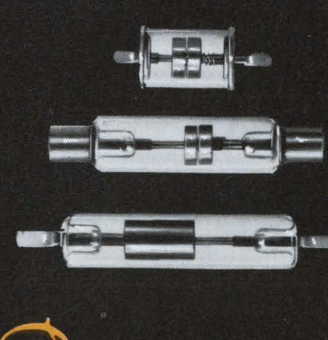
Now it is possible to protect sensitive components, even semi-conductor equipment, against voltage transients without concern for the rate of voltage rise. The "zero" reaction time of Signalite's new Uni-Imp is only one of the many unique features. Others include: bipolar, making them immune to di/dt restrictions; infinite high leakage resistance . . . plus more are described in a new data sheet.



AVAILABLE UPON REQUEST Detailed Data Sheet . . . on Signalite's Uni-Imp Zero Reaction Time Voltage Surge Protectors.

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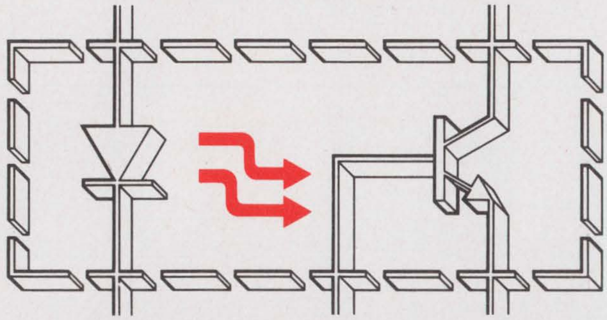
Consider the GaAsLITE opto isolator.



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%

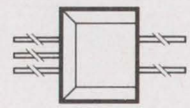
Bandwidth 8.5 MHz

Price: 1,000 quantities: $3.95.

INFORMATION RETRIEVAL NUMBER 35

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 MSC 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:

$V_{AX} \geq 200$ @ $R_{GK} = 27$K

$V_{AK} = .9$ V (typ.) @ $I_A = 200$ mA

$\left.\begin{array}{l} I_F = 4 \text{ mA} \\ I_H = .1 \text{ mA} \end{array}\right\}$ @ $V_{cc} = 50$ V, $R_{GK} = 27$K

Price: $11 ea., 1,000's.

Coupled pairs are in stock world wide

You know that all of our products are available in the U.S. through Schweber (516) 334-7474; Semiconductor Specialists (312) 279-1000; K-Tronics (213) 685-5888; or Kierulff. You can get them overseas as easily:

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INFORMATION RETRIEVAL NUMBER 36 ▶

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.

And more importantly, SPC-16 can increase your productivity and profits with a minimum initial investment . . . with fast pay back.

Ask about the reliability of SPC-16 today . . . it's backed by a full range of software packages, technical services and maintenance support.

Ask about other automation computers in the GA family. The SPC-12 for less than $5000. System 18/30 for under $20,000.

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INFORMATION RETRIEVAL NUMBER 38

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 ½ 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 industry workhorse . . . is available with its 6 minute accuracy, 25°/second slew speed, and many options. • Input of the 8525 is any 60 or 400Hz resolver/synchro data from control instrumentation. The patented servo design eliminates all inertia and improves dynamic performance many times over. Its digital outputs are especially suited to the computer-oriented requirements of today's automatic test systems. The 8525 . . . priced at $2475 . . . and the API-8025 priced at $995 actually cost less because they perform more functions per dollar. And with greater reliability.

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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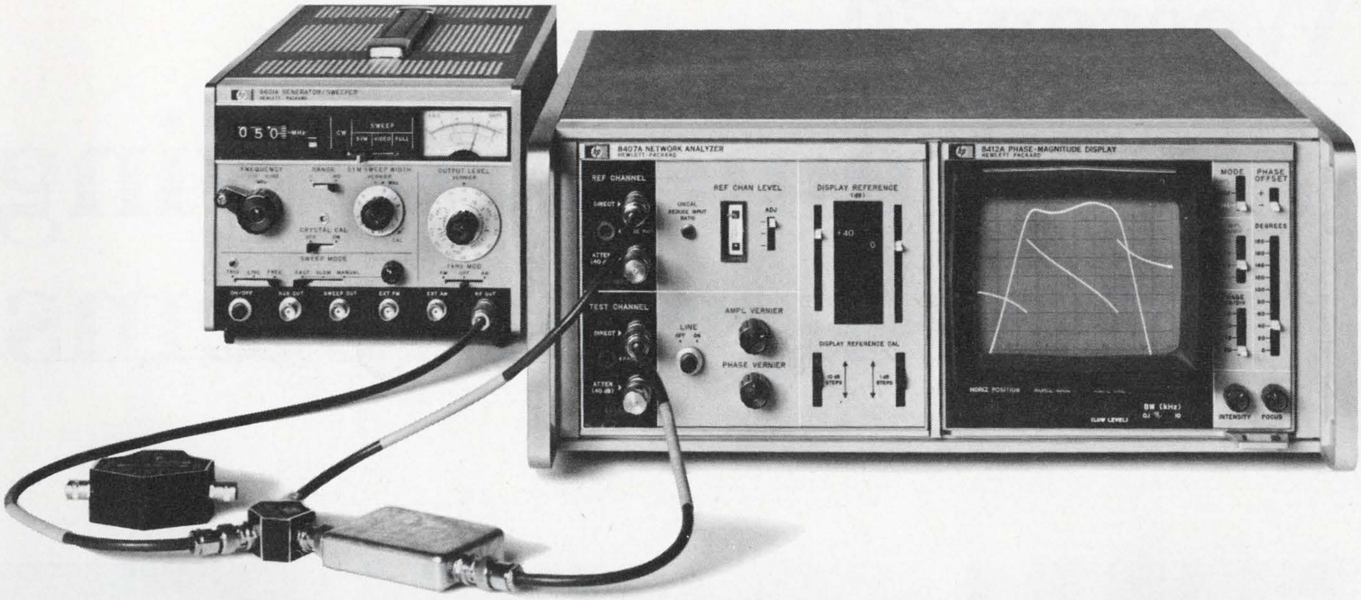
INFORMATION RETRIEVAL NUMBER 39



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 detection 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

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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.

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.

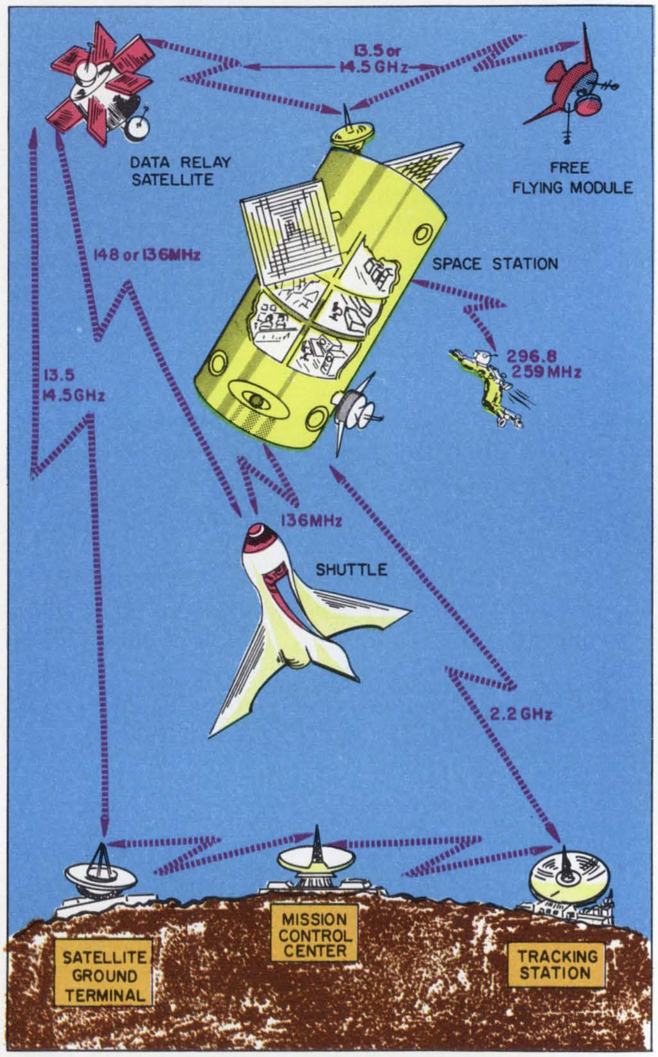
To keep the meeting within the world of reality, session organizer S. H. Durrani, Comsat Labs, Clarksburgh, Md., has included only projects that are already funded.

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



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.

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 multifunctional 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 DIMATE (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 passive. 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 Aircraft 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 narrowband 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.

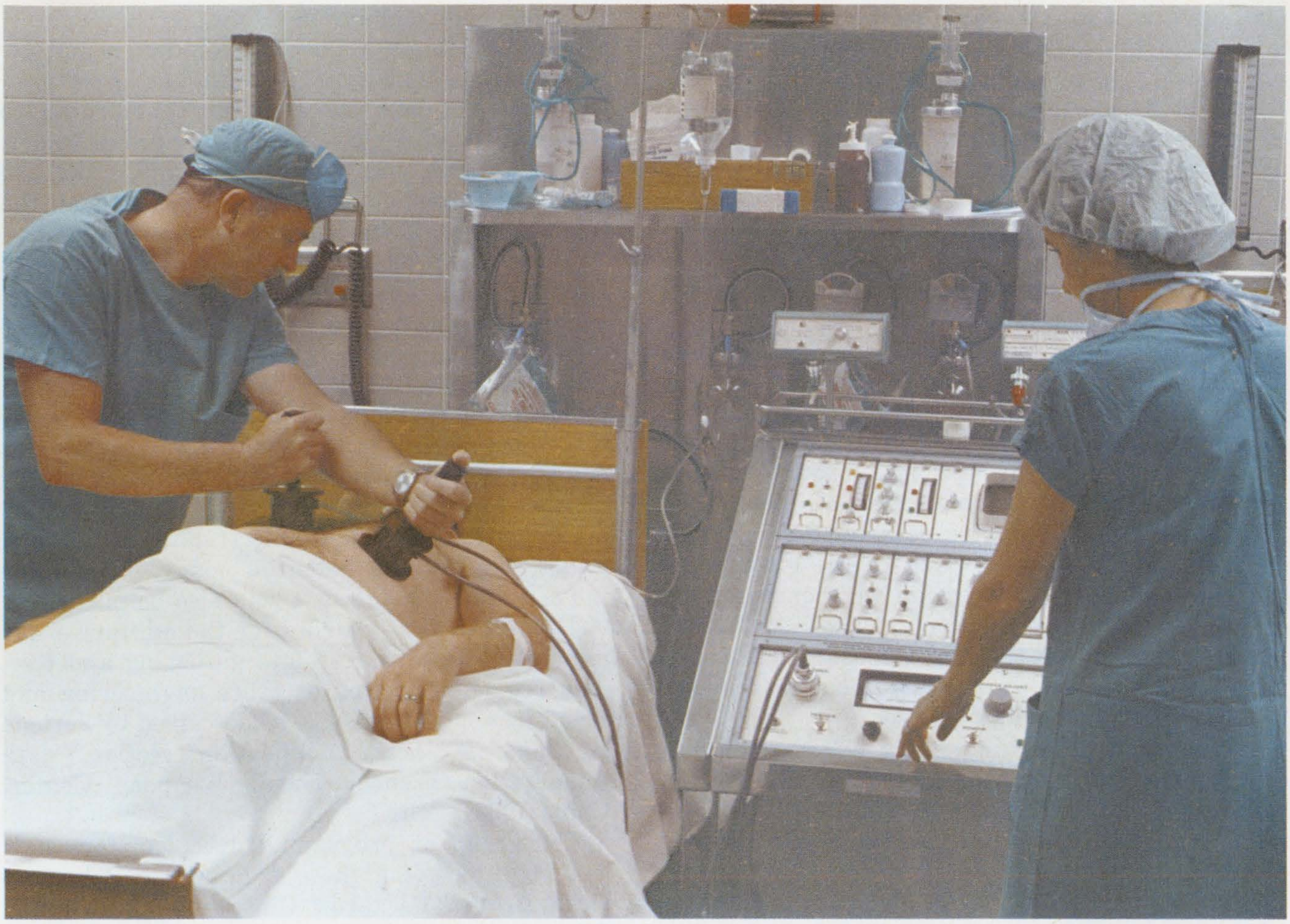
There are currently more than 60 different models of minicomputers on the market. (See "The Minicomputer: machine with an endless future," ELECTRONIC DESIGN 9, April 26, 1970, p. C6.) The number of minicomputers applied in industrial and process control applications has increased dramatically in the 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.

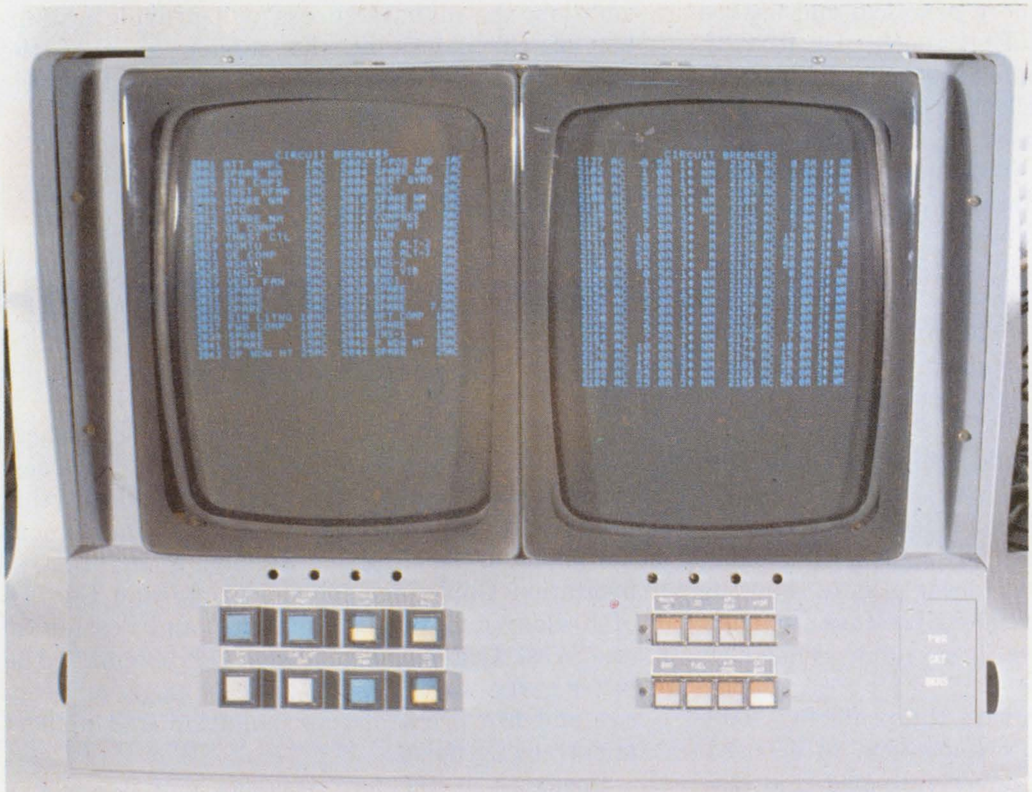
He says that the first job is to match the requirements of the system. In process control the minicomputer is used in data acquisition; direct digital control; a combination of the two; or as the lowest member of a computer hierarchy.

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 assembling 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. Russel, 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 μA 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.

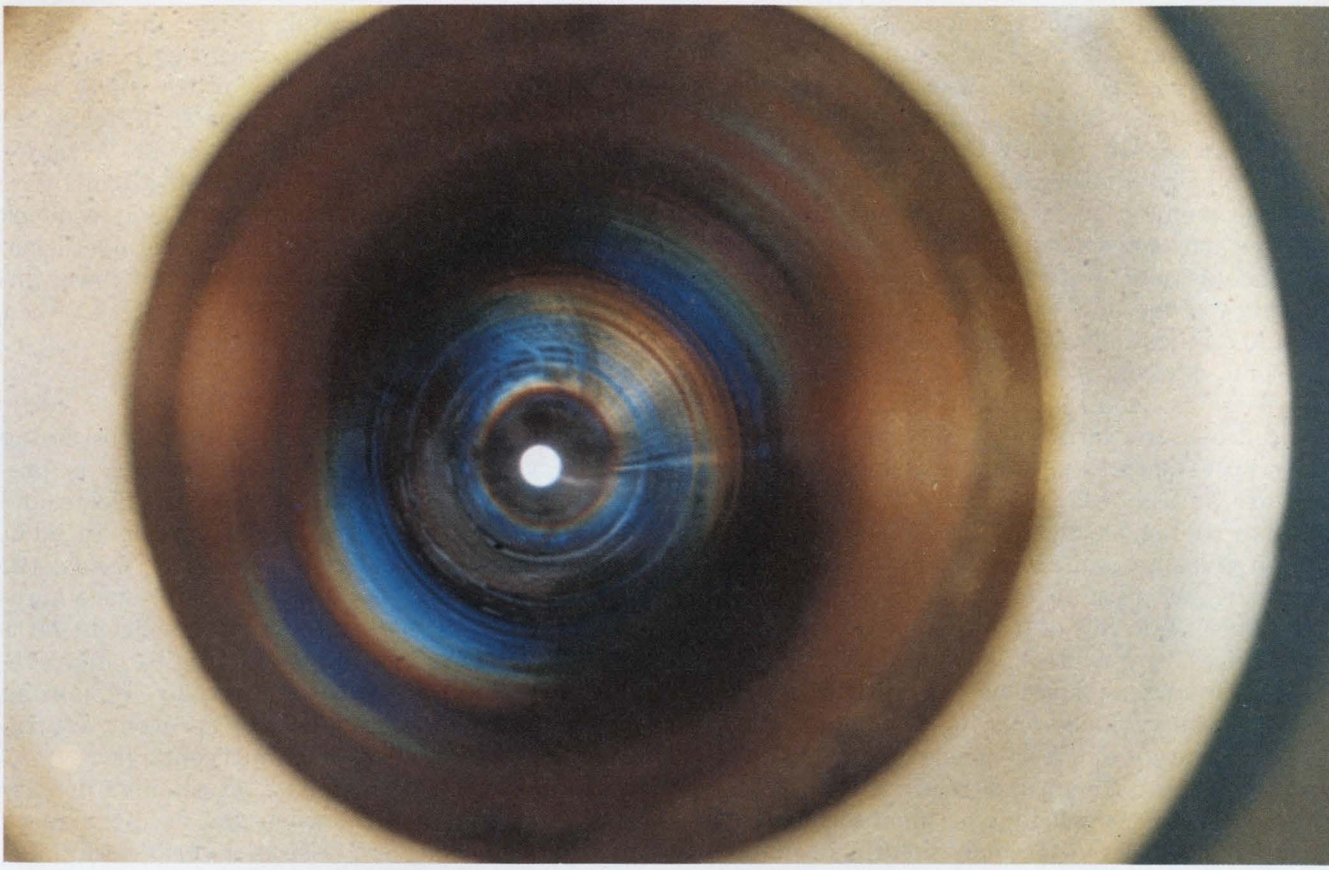
In an interview with Electronic Design, Broutman pointed out that most of the screening systems used today consist of instruments that were designed for diagnostic purposes and must be used by doctors. What is needed, he said, is instrumentation that can be used by technicians, as well as doctors, to 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 diffferent 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. ▪▪

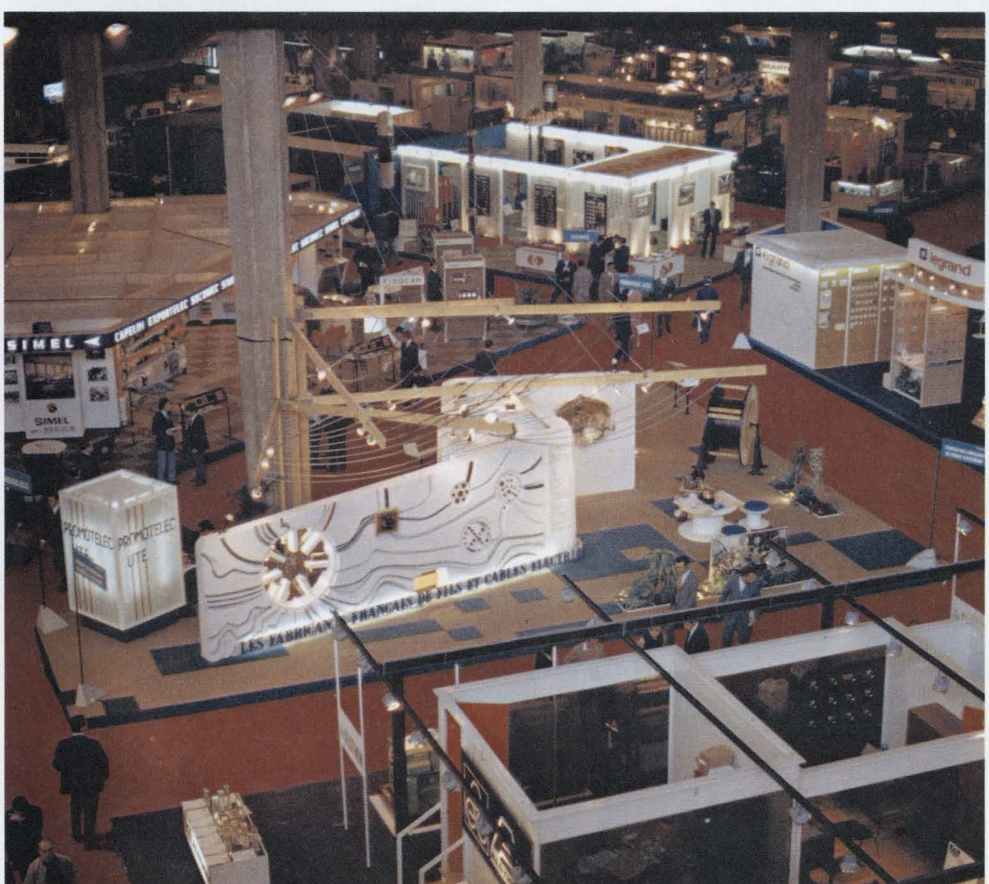
Microelectronics

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 describe 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 radiometery 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.

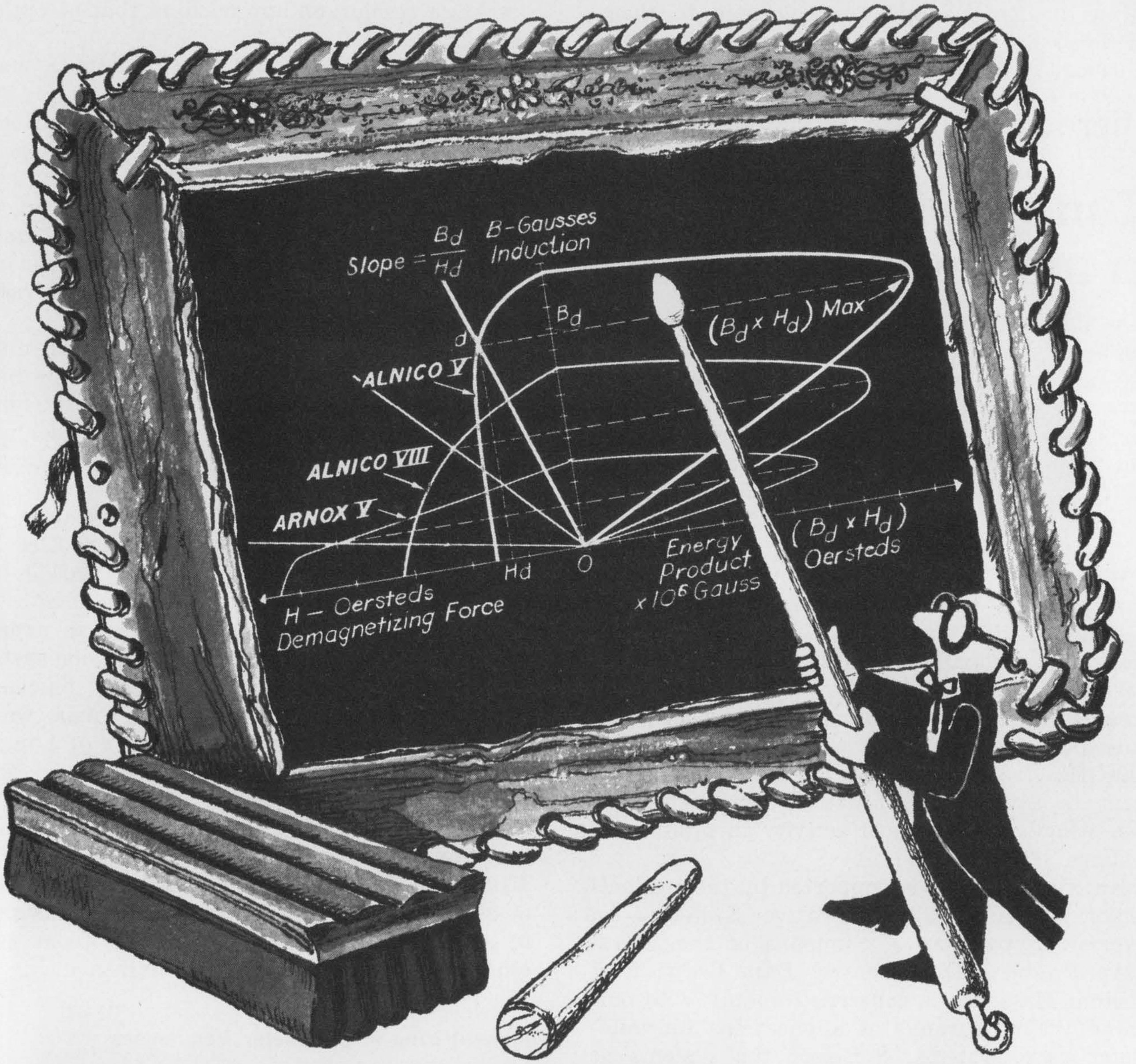
Backing up this viewpoint is the paper, "A Digital Transmission System Using Circular Electric-Mode Waveguide," by E. T. Harkless of Bell Telephone Laboratories, Holmdel, N. J. He gives a fairly detailed description of an experimental millimeter waveguide transmission system with a capacity of 230,000 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. Toulious 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. Toulios 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. 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)

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, Redono 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 Proprietory 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)

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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-

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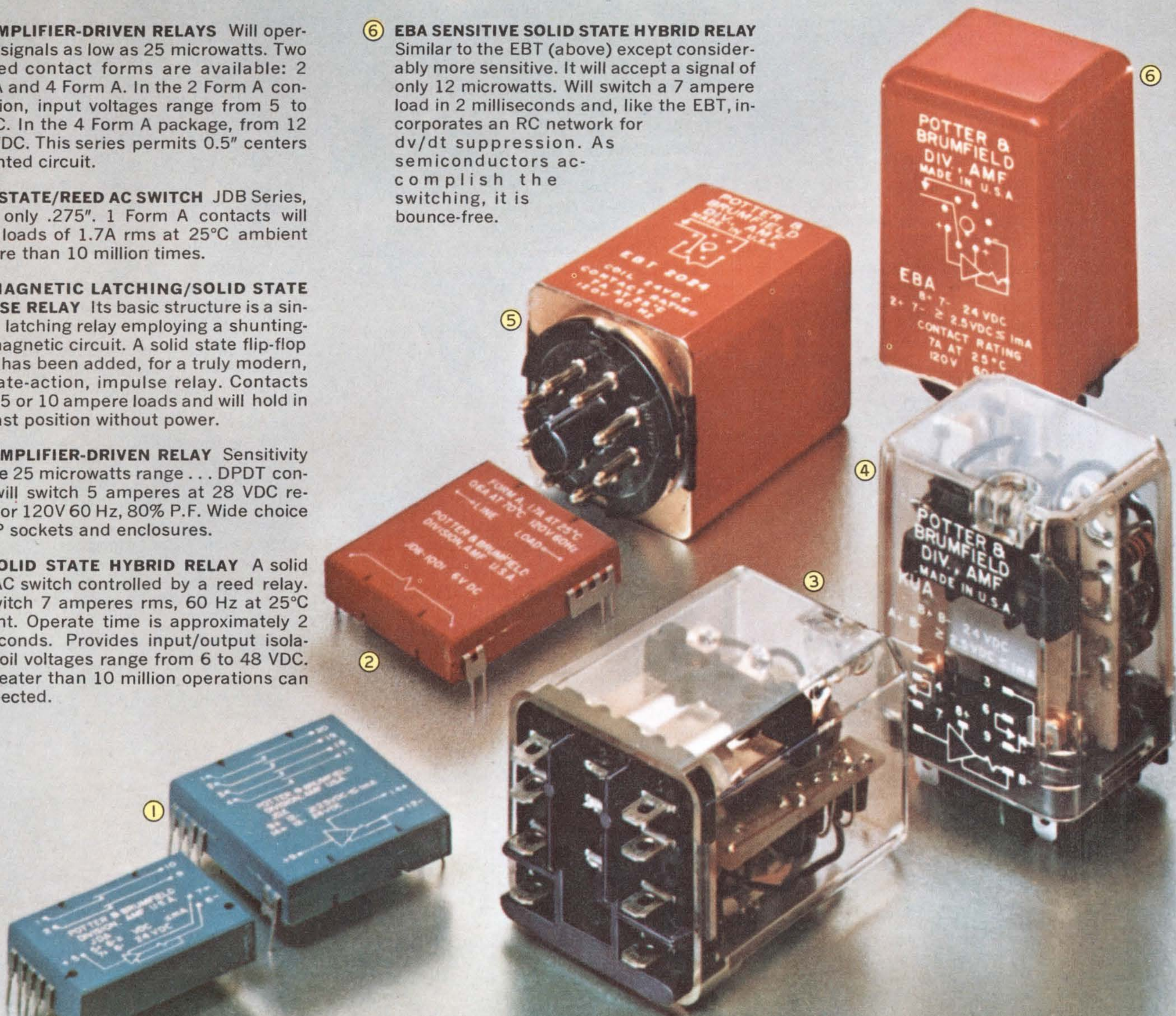
⑤ **EBT SOLID STATE HYBRID RELAY** A solid state AC switch controlled by a reed relay. Will switch 7 amperes rms, 60 Hz at 25°C ambient. Operate time is approximately 2 milliseconds. Provides input/output isolation. Coil voltages range from 6 to 48 VDC. Life greater than 10 million operations can be 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.



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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 Manner Space Craft Center, Houston, Tex. (A.2/Tues./a.m./D)

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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. Slawecki, 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)

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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)

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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)

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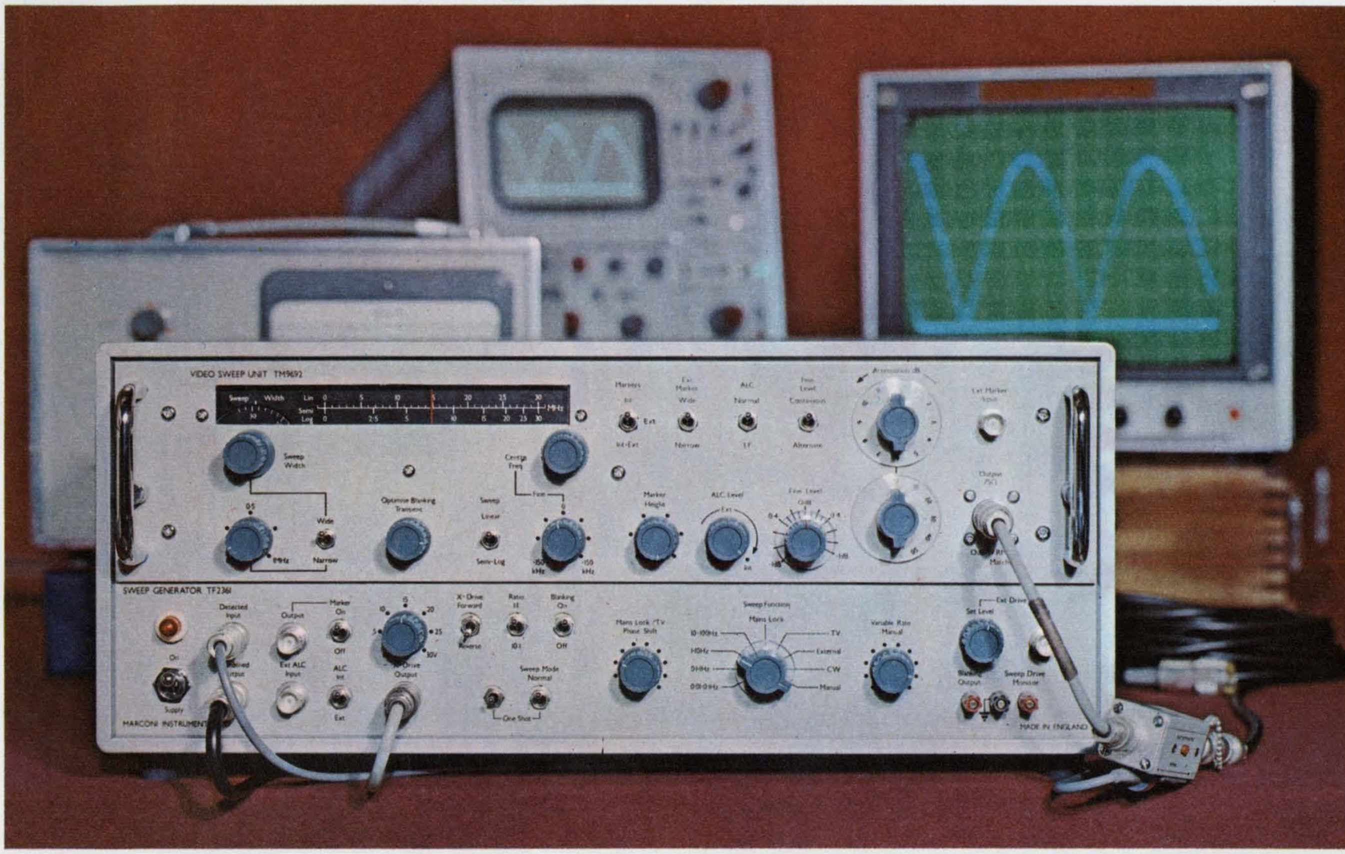
Microwaves

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. Toulios and R. M. Knox, IIT Research Institute, Chicago. (3.3/Tues./a.m./C)

The flattest sweeper news in years!



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✳ 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.

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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 (LC-SS)—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)

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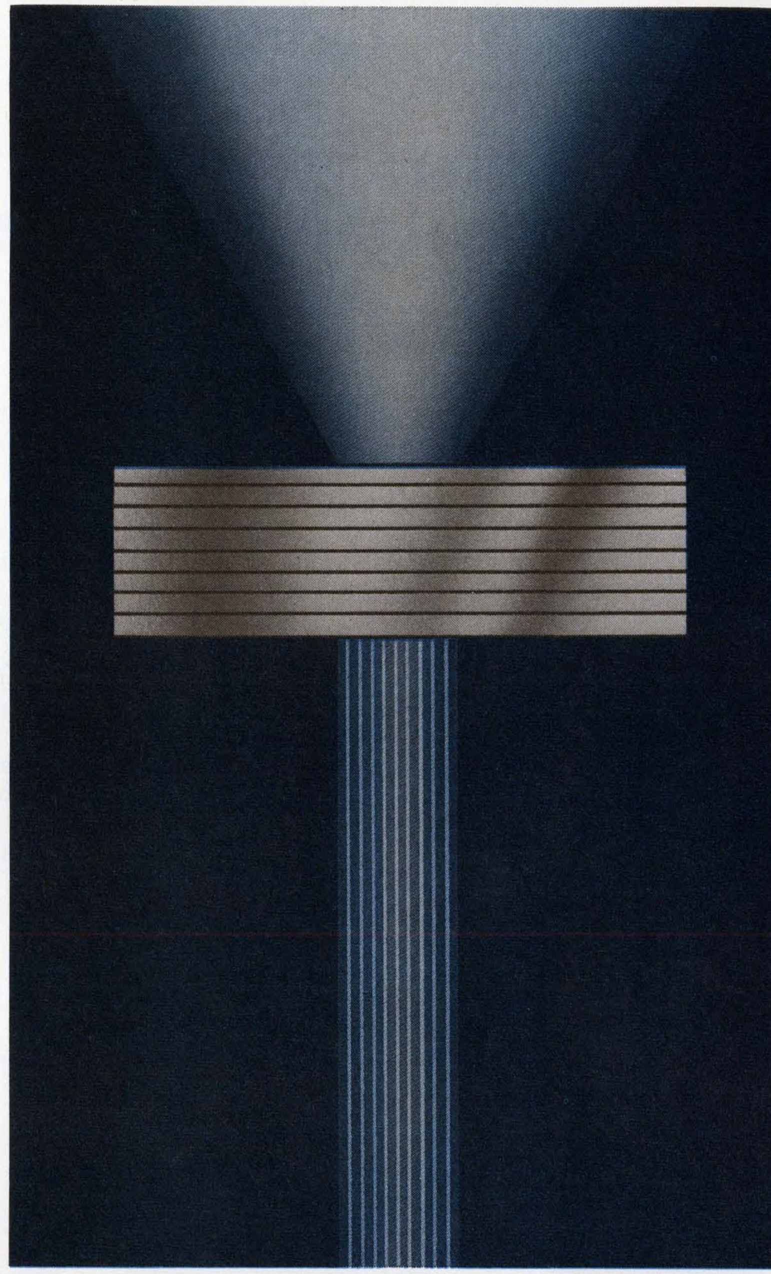

Until now, no one has been able to produce holes in thick metal at anything smaller than a one-to-one ratio. We put our world leading technology in photomechanical reproduction to work and came up with a way to laminate sheets of etched metal in perfect register. We can produce sharply cornered holes 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 ±.0005″. Tolerance on hole size is ±.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

$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 ±0.2% with a voltage resolution of 40 mV, and an output settling time of 20 μs to ±0.2%. Full-scale outputs can be either 0 to 10 V or ±5 V at 5 mA.

Overall accuracy is ±0.2% of full scale with a temperature coefficient of ±30 ppm/°C. Long-term stability is better than ±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 ±0.2%, while its temperature coefficient is ±0.005%/°C. The unit offers a long-term stability of better than ±0.05%.

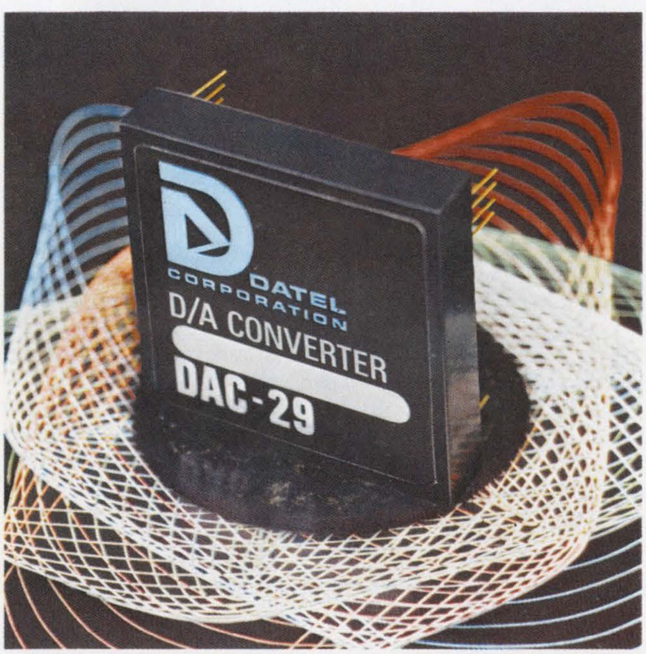
Full-scale inputs can be unipolar (0 to 10 V) or bipolar (±10 V) at an input impedance of 50 kΩ. Output coding can be straight binary for unipolar inputs or two's complement for bipolar inputs.

The unit, which can be operated in an asynchronous mode, has a digitizing speed of 5 kHz (200 μs). Input power requirements are ±15 V dc at ±35 mA and 5 V dc at 300 mA.

Both converters offer an operating temperature range of 0 to 70°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.

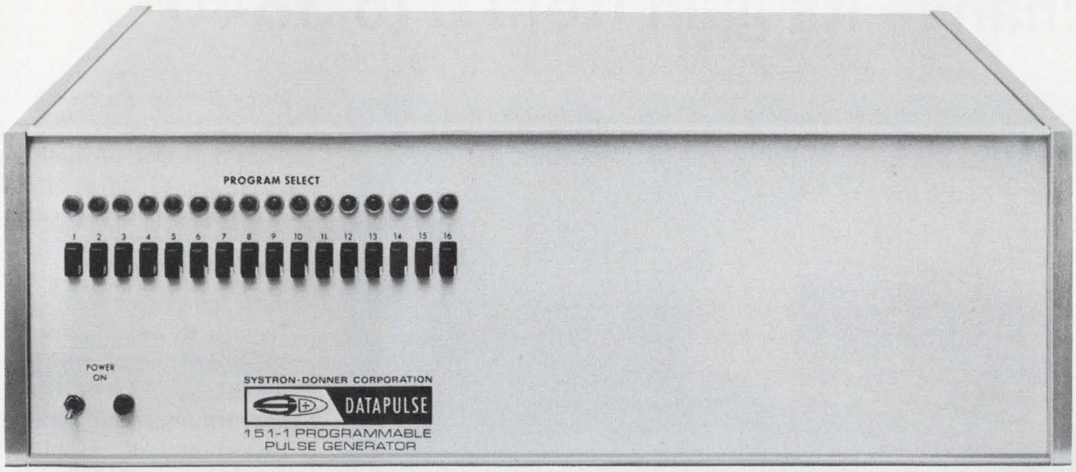
Booth No. 574 *Circle No. 294*



Modular eight-bit digital-to-analog converter gives an overall full-scale accuracy of ±0.2% for only $29. Its output settling time is 20 μs to ±0.2%.

Plug-in eight-bit analog-to-digital converter module carries $89 price tag and yet delivers an overall accuracy of ±0.2%. The unit is completely self-contained.

GUARANTEE



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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.

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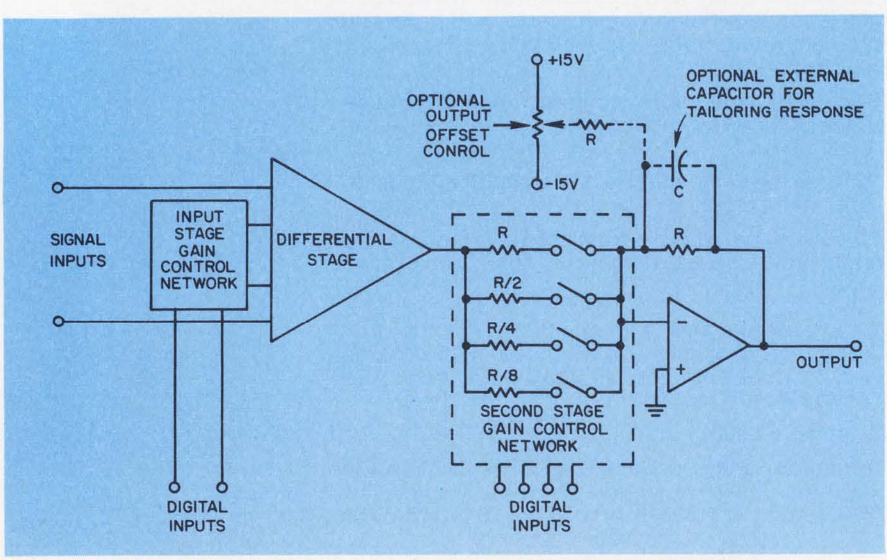
INFORMATION RETRIEVAL NUMBER 130

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 μs 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 ± 1 μV/°C and a noise of 2 μV rms.

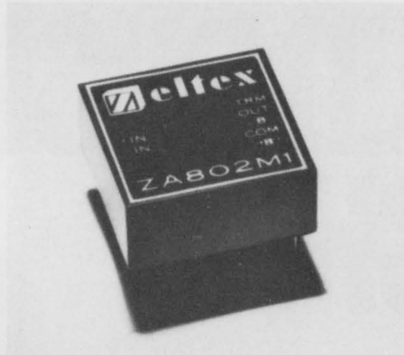
An active guard driver aids in rejecting common-mode noise by driving internal and external shields with common-mode signals. The epoxy-cased amplifier operates from standard ± 15-V supplies.

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

FET op amp for $26 holds bias to 15 pA

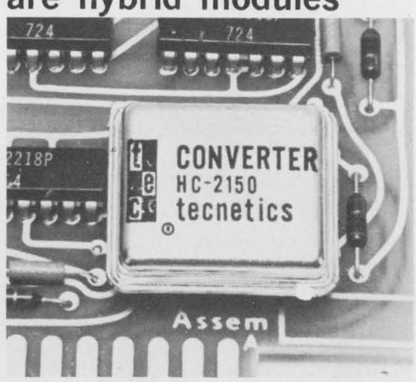


Zeltex, Inc., 1000 Chalomar Rd., Concord, Calif. Phone: (415) 686-6660. P&A: $26; stock.

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 μV/°C over the range of −25 to 85°C. Its gold-plated leads meet MIL-G-45204A.

Booth No. 1225 Circle No. 259

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 ±12, ±15, ±18 or ±25 V.

Booth No. 1917 Circle No. 256

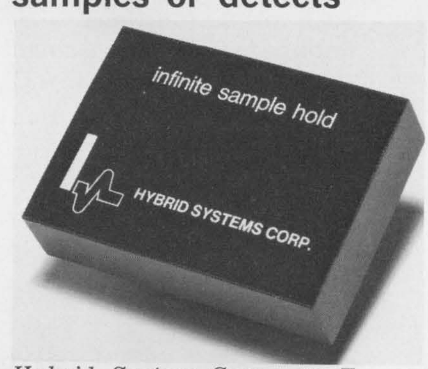
FET op amp for $29 performs out to 10 MHz

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 V/μs. The unit has a settling time of 1 μs to 0.01% and a voltage drift temperature coefficient of 50 μV/°C. Its input bias current is 20 pA, and open-loop gain is 80 dB.

Booth No. 138 Circle No. 290

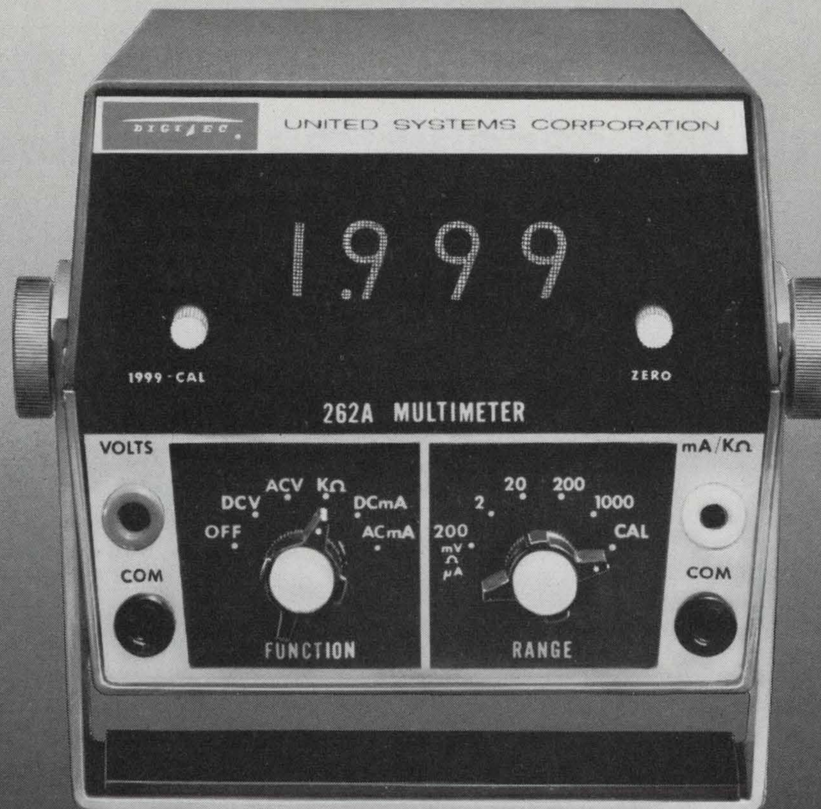
Dual-function module samples or detects



Hybrid Systms 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



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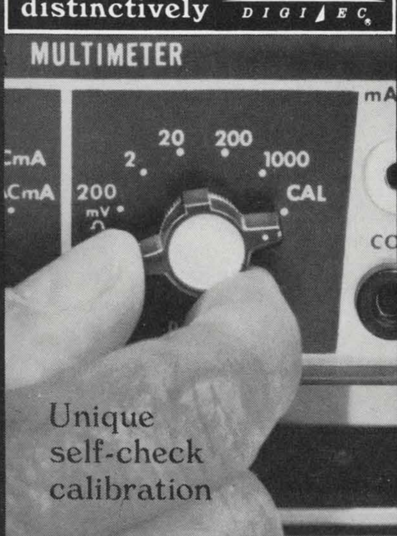

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INFORMATION RETRIEVAL NUMBER 133

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 ±0.003% of reading ±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 ±0.08% of reading ±0.02% of full scale to ±0.8% of reading ±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 ±0.06% of reading ±0.02% of full scale to ±0.8% of reading ±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 approximation to a square law is first generated, then a psuedo-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 ±0.08% of reading ±0.02% of full scale to ±1% of reading ±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, autotrack, 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 autotrack 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 ±1.09999 to ±1099.99 V in four ranges at a resolution of 10 μV. Input resistance ranges from 1 to 10 MΩ.

A chopper preamplifier board (model 05) is available to extend dc voltage measurements down to 10 mV full scale at 0.1-μV 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 Ω to 100 MΩ full scale. Resolution is 10 μΩ. 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.

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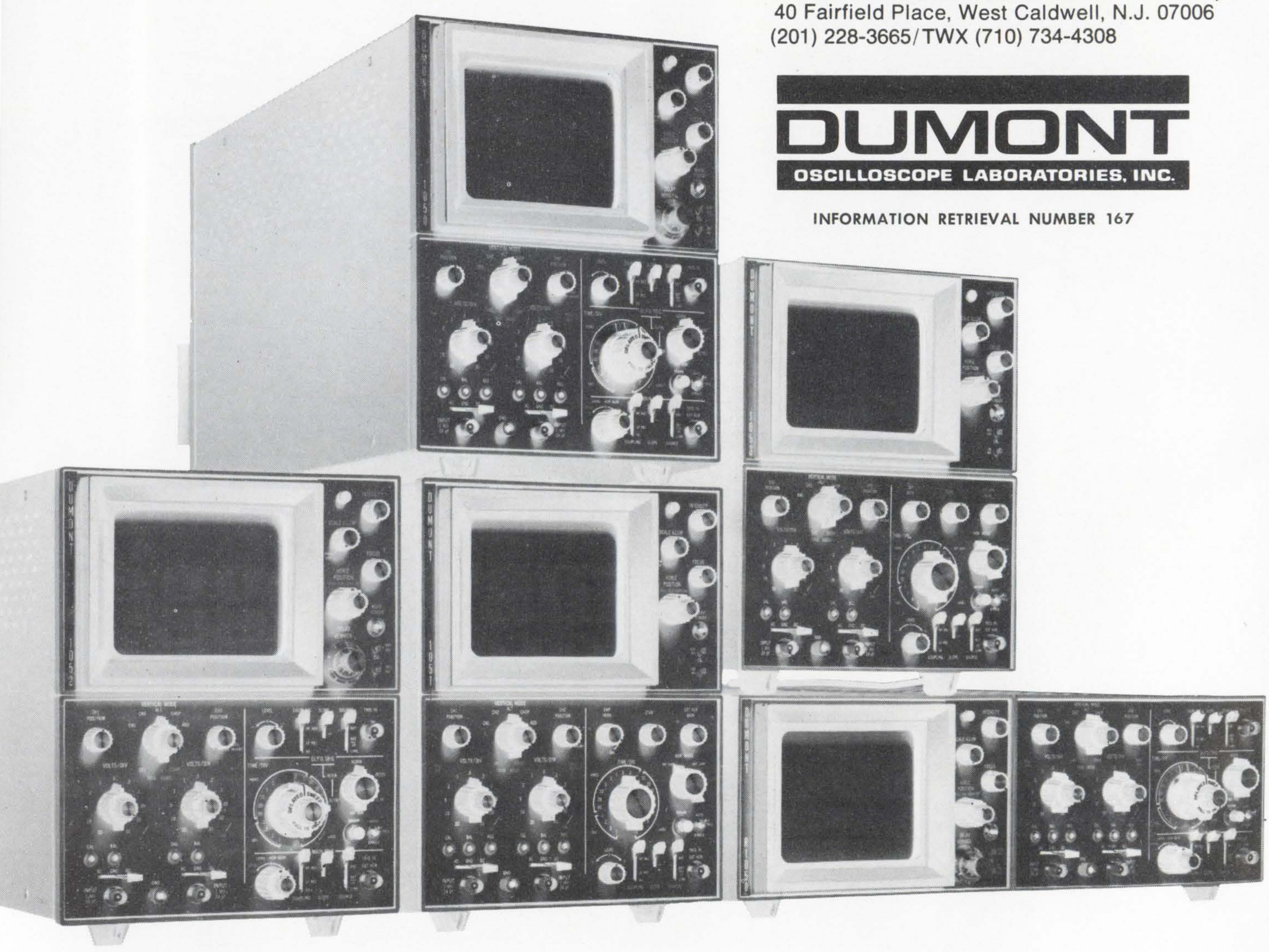


Autoranging $950 counter measures 0.1 Hz to 20 MHz

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 reliabiilty. 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 μs, 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 MΩ shunted by 20 pF. Input signal amplitudes can be as large as 35 V peak, ac plus dc.

Besides its five-digit display with auomatic decimal-point location, the 107A has an overrange indicator that illuminates when register capacity is exceeded. There is also a manual reset pushbutton.

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-Iida (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 μs/cm to 1 s/cm, and its sweep calibration accuracy is ±5%. Input impedance is 1 MΩ and 38 pF.

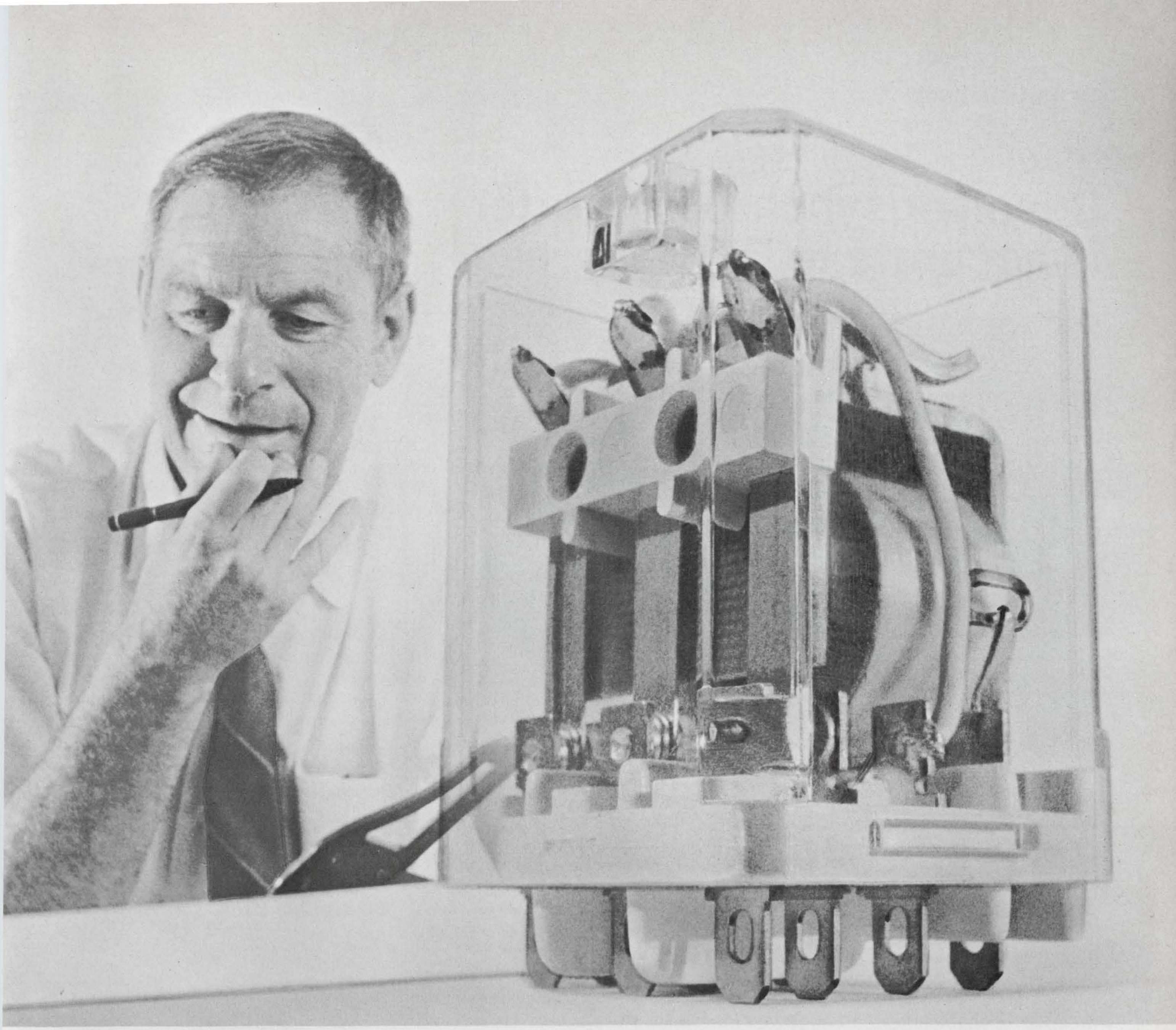
Booth No. 430 Circle No. 288

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 Synchroscope 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



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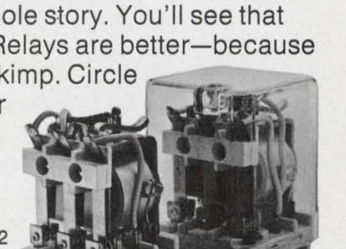

Clare GP2

Clare GP3

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INFORMATION RETRIEVAL NUMBER 136

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 ±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 Ω 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 checkout 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

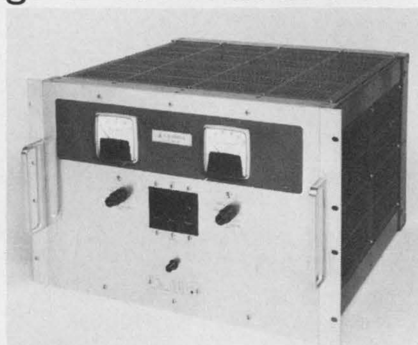
Function generators span 0.5 mHz to 10 MHz

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

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*

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*

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*

Waveform generator is programmable

Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif. Phone: (213) 682-3351.

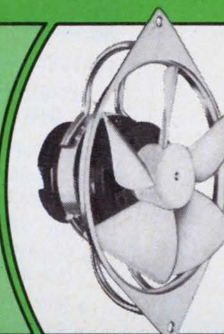
A programmable waveform generator, which supplies a sine, square, triangular, or a sine-squared-pulse output, provides three-digit resolution from 0.01 Hz to 1.1 MHz in eight decade ranges. Model F280A has a maximum voltage output of 11 V pk-pk into a 50-Ω load in the manual mode, or 16 V pk-pk when programmed. All manual controls are programmable.

Booth No. 630 *Circle No. 270*

3 cool ways to beat hot budget problems

AVAILABLE FROM STOCK

LESS THAN $5



- Delivers a full 100 CFM at free delivery
- Quiet operation
- Lightweight — only 20 ounces
- 5 year operating life at continuous duty

- Simple installation — only two mounting screws required
- Three optional mounting arrangements available
- Measures just 4$^{11}/_{16}$" by 2¾" depth
- Noise level — 43 db SIL.

Rotron Sergeant(TM) Fan

AVAILABLE FROM STOCK

LESS THAN $6

- Only 1$^{13}/_{16}$" deep by 5$^{3}/_{16}$" diameter
- Lightweight — 14 ozs.
- Delivers 100 cfm
- Quiet — just 38 db SIL

- 5 year operating life
- Reversible air flow
- May be mounted without nuts or bolts
- UL Yellow Card Recognition

Rotron Skipper® Fan

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LESS THAN $7

- 10 year operating life
- Provides 107 cfm at free delivery
- Compact — just 1½" deep by 4$^{11}/_{16}$" square
- Lightweight — only 1 pound

- Impedance protected
- Airflow instantly reversible
- UL Yellow Card Recognition
- Low noise level — 42 db SIL

Rotron Muffin® Fan

ROTRON® INCORPORATED

All prices shown are per thousand

For price, delivery or technical assistance call 914-679-2401 for immediate service, or write Rotron Incorporated, Woodstock, New York 12498

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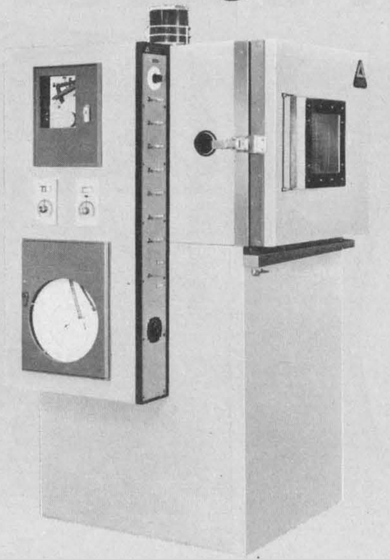
INFORMATION RETRIEVAL NUMBER 139

Tight Tolerance T-H Testing



for labs that are tight with a buck!

Now from Associated–an all-new temperature-humidity test chamber that delivers tight tolerance performance at low, low prices!

Series HH-5100 Temperature-Humidity Chambers feature a new precision instrumentation package, new refrigeration and an improved recirculating humidity system that gives weeks of operation on a gallon of water. Specs? Consider these:

- **temperature range —100 to +350°F or —65 to +350°F**
- **temperature control accuracy ±1°F or better**
- **humidity range 10 to 98% RH, ±2% or better**
- **all solid state wet and dry bulb controllers with RFI suppression; dual centigrade and Fahrenheit scales**
- **two-pen, two-cam programmer, 24-hour recording**
- **built-in demineralizer with replaceable cartridge**

Available with single- or dual-stage cascade refrigeration, in 4, 8 and 27 cubic foot capacities. Write or call for detailed data.

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West Coast Office

1304 Seventh St., Santa Monica, Calif. 90401 • (213) 451-8521

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INFORMATION RETRIEVAL NUMBER 140

INTRODUCING . . .

DUAL-IN-LINE "MINI" SPIRADEL®*

ACTUAL SIZE

THE WORLD'S SMALLEST

DELAY LINE HAVING TIME DELAY TO RISE TIME RATIO GREATER THAN 5/1

FEATURES EXCELLENT PULSE FIDELITY

Exceptionally Fine Phase Linearity Over Wide Frequency Range.

- **Operation from —55°C to +105°C.**
- Designed for dual-in-line mounting. Compatible with integrated circuits.
- Size: .780 x .460 x .250 inches.
- Standard delay tolerance 10%. (5% available).
- Minimum attenuation for all delays: 5%.
- Bandwidth from DC to frequency f = .35/rise time.

*Patented and patents applied for.

Time Delay (Nano-seconds)	Rise Time (Nano-seconds)	Impedance (ohms)
10	2.5	125
20	4	200
30	6	250
40	8	300
50	10	350
60	12	400
70	14	400
80	16	475
90	18	500
100	20	500

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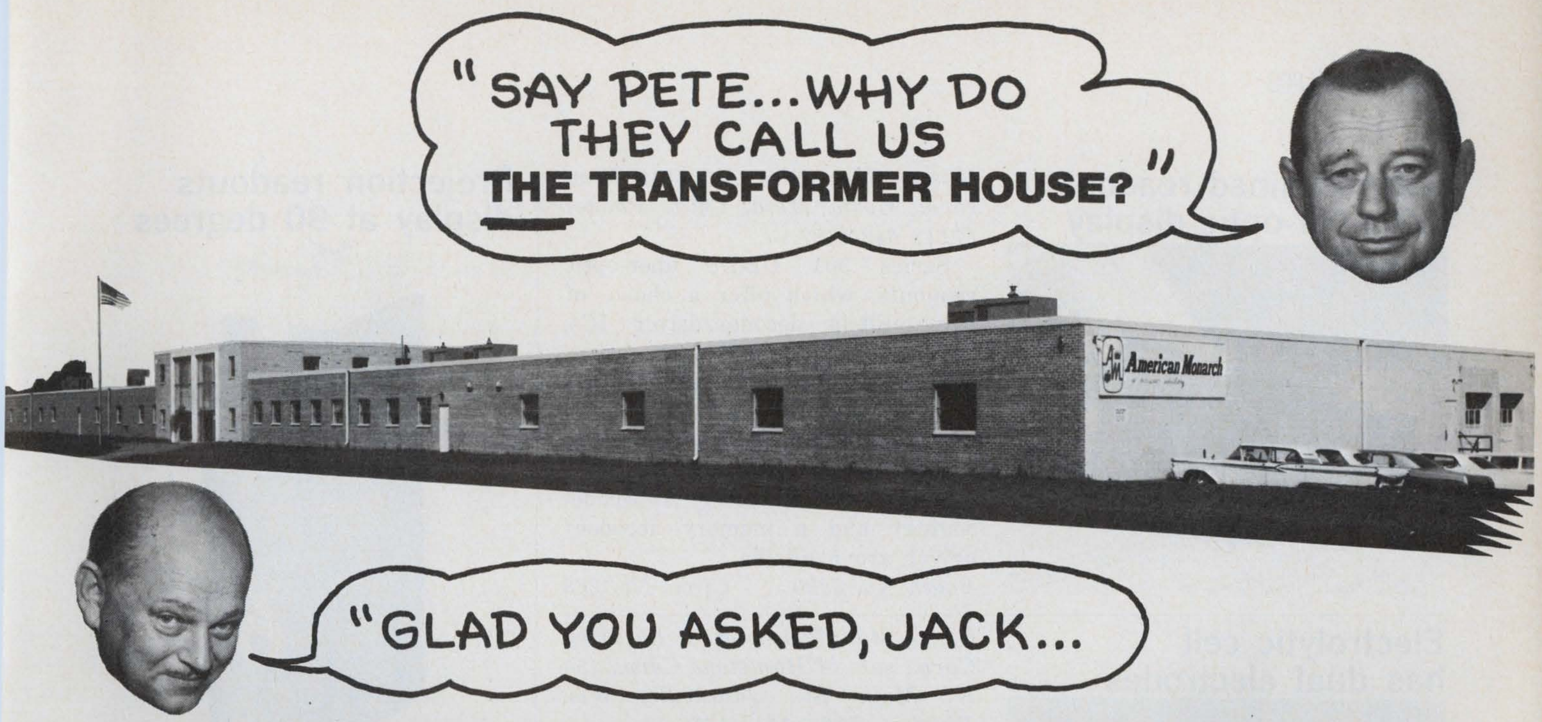
INFORMATION RETRIEVAL NUMBER 141

"IT'S GOOD BUSINESS TO HIRE THE HANDICAPPED."

ISN'T THAT A GREAT IDEA, SNOOPY?

THE PRESIDENT'S COMMITTEE ON EMPLOYMENT OF THE HANDICAPPED, WASHINGTON, D. C.

INFORMATION RETRIEVAL NUMBER 142 ►



"**AMERICAN MONARCH** is one of the very few high production, high quality custom transformer manufacturers in the country specializing in CVT (Ferro-Resonant).

Our engineering staff provides custom designs to meet any specification.

Our range in CVT's is from 6 VA up to 4000 VA and includes 3 phase combinations of Ferro transformers.

"**AUTOMATED TRANSFORMER DESIGN** permits all of our designs to be optimized for minimum cost in a matter of a few minutes of computer operation. Many different designs can be explored for cost, efficiency, performance and size, allowing us to respond quickly and accurately to requests for quotation.

"**STANDARD UN-MATCHED RESONANT CAPACITORS** can be used with our transformers. Our manufacturing is so precise that standard tolerance capacitors can be used. In many cases, we have won large customers with this capability as it is no longer necessary to match the transformer and capacitor. The customer can purchase his capacitors directly from the original manufacturer with no special sorting.

"**EPOXY ENCAPSULATED TRANSFORMERS** have been developed by American Monarch over the past 10 years offering a complete line of epoxy-embedded terminal blocks, connectors, etc. It is possible to insert the customers identification in the mold when the transformers are cast. Some thermal characteristics are improved by this system.

"**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 customers 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 1⅛ inch through 2½ 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.

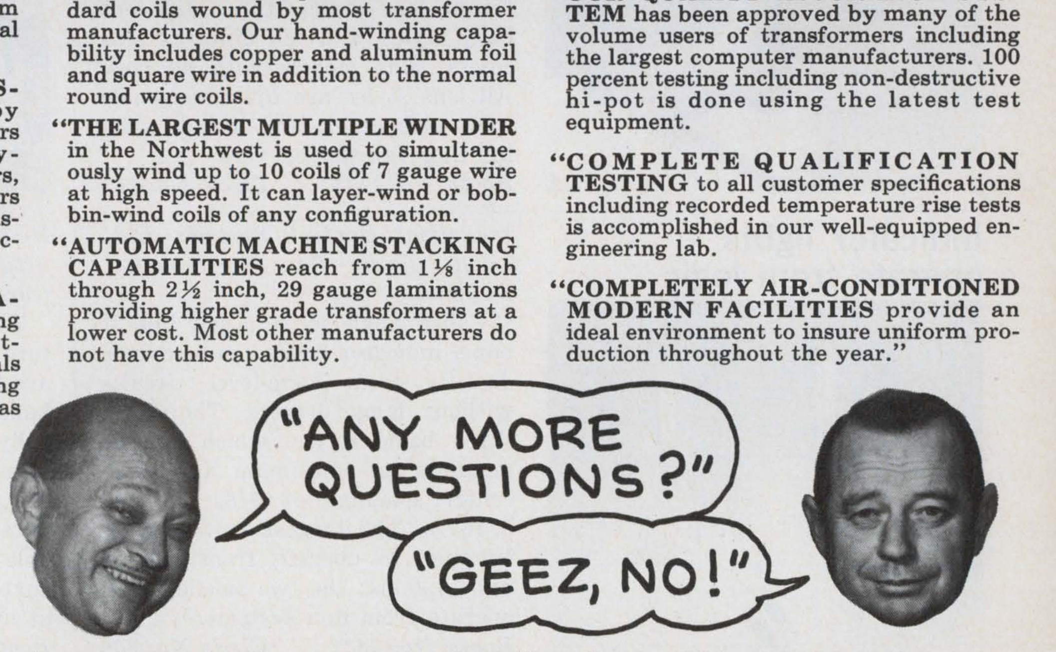
"**WELDING** of transformer laminations to accommodate stringent transformer grounding requirements is accomplished in volume production by our unique process.

"**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.

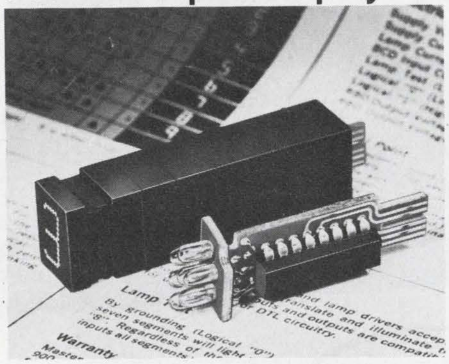
"**COMPLETELY AIR-CONDITIONED MODERN FACILITIES** provide an ideal environment to insure uniform production throughout the year."



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

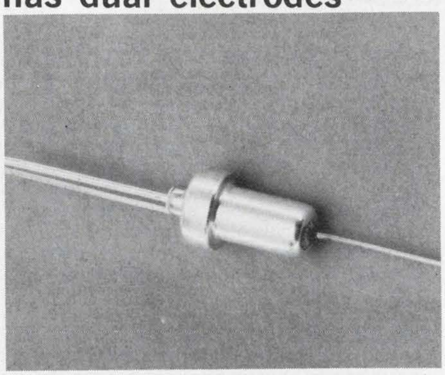


Master Specialties Co., 1640 Monrovia, Costa Mesa, Calif. Phone: (714) 642-2427.

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

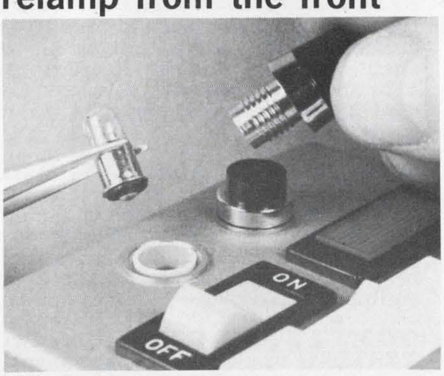


Gibbs Manufacturing & Research Corp., sub. of Hammond Corp., 450 N. Main St., Janesville, Wis. Phone: (608) 754-4467.

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

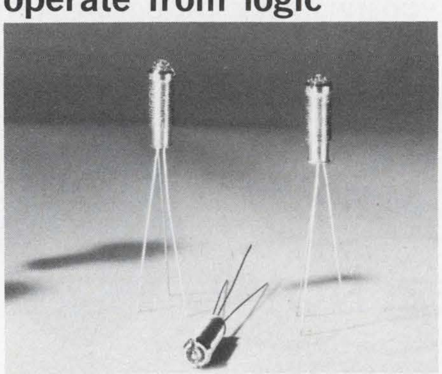


Chicago Switch, Inc., 2035 Wabansia Ave., Chicago, Ill. Phone: (312) 489-5500. Price: $1.45 typical.

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

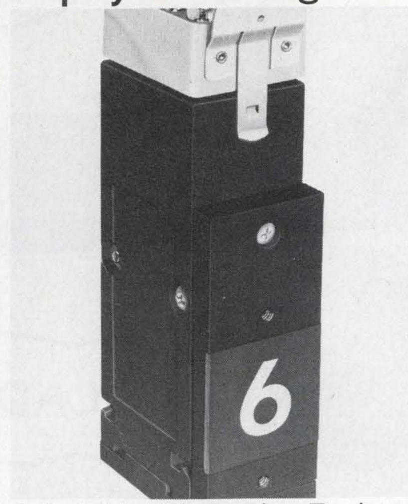


Industrial Control Systems Ltd., 78/90 Clarke Rd., Northampton, England.

Called Logiclamps, 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

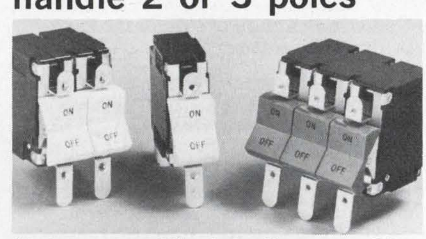


Industrial Electronic Engineers, Inc., 7720-40 Lemona Ave., Van Nuys, Calif. Phone: (213) 787-0311. P&A: $52; 6 wks.

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

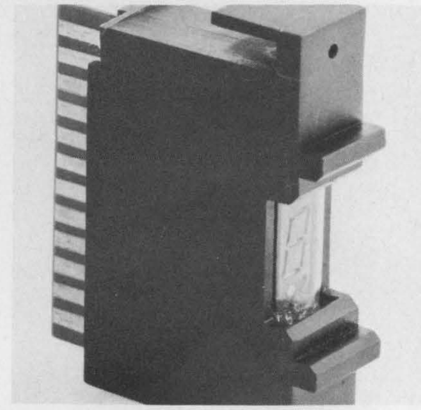


Heinemann Electric Co., 248 Magnetic Dr., Trenton, N. J. Phone: (609) 882-4800.

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

Plug-in neon displays have decoder/drivers

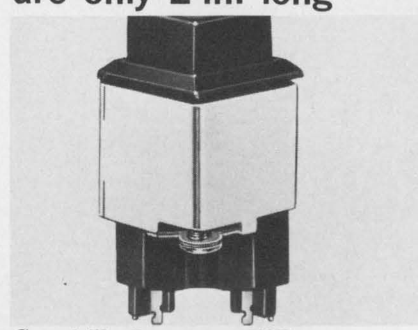


Alco Electronic Products, Inc., P.O. Box 1348, Lawrence, Mass. Phone: (617) 686-3887. P&A: $24.45 to $29.80; stock.

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

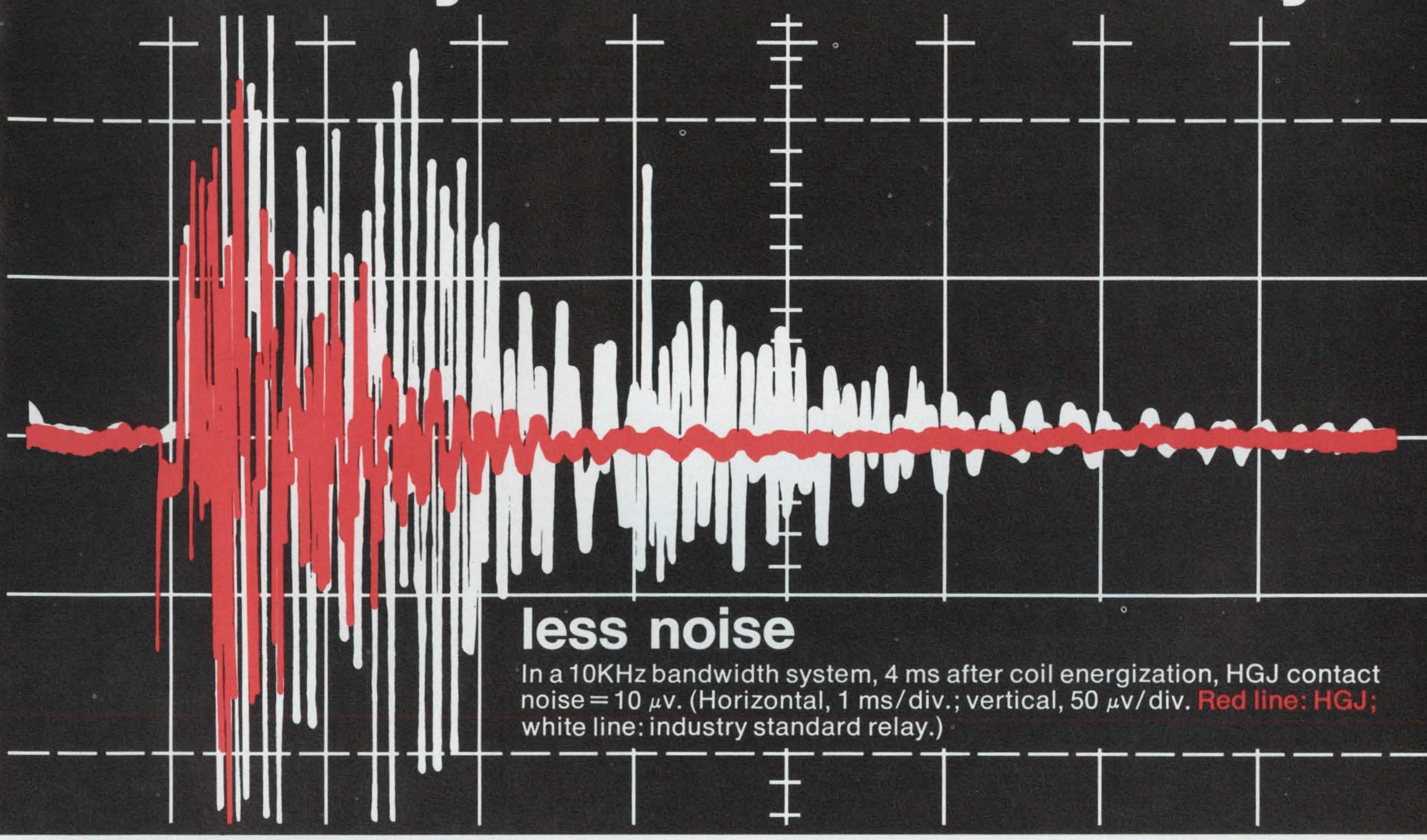


Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill. Phone: (312) 354-1040. Price: $3.40 or $4.85.

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 monentary-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*

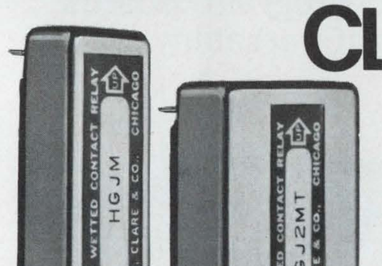
BREAKTHROUGH
in mercury wetted contact relays



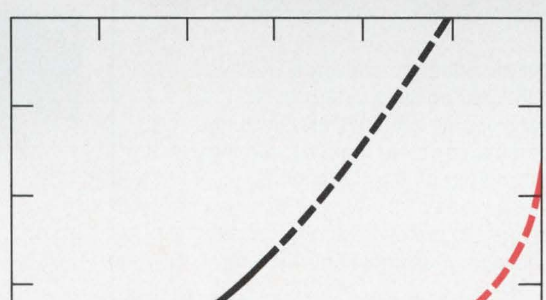
less noise

In a 10KHz bandwidth system, 4 ms after coil energization, HGJ contact noise = 10 μv. (Horizontal, 1 ms/div.; vertical, 50 μv/div. Red line: HGJ; white line: industry standard relay.)

CLARE HGJ RELAYS
shatter industry standards



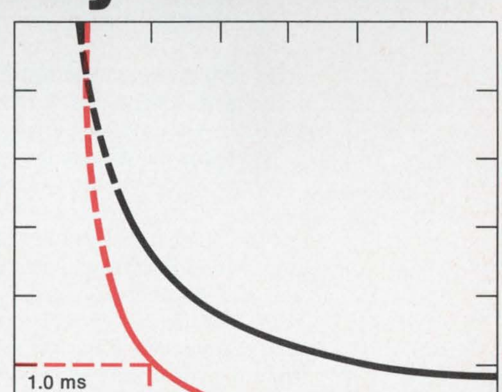
Compare the new Clare HGJ Relays with any other mercury-wetted contact relays. You'll get more speed, less noise, and less jitter—in less space than any other! Take your choice: 0.340″ profile for true half-inch pcb spacing, 0.400″ profile for higher sensitivity. Single-pole HGJM, two-pole HGJ2MT. Both 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 μs.

HGJ   Industry standard



faster response

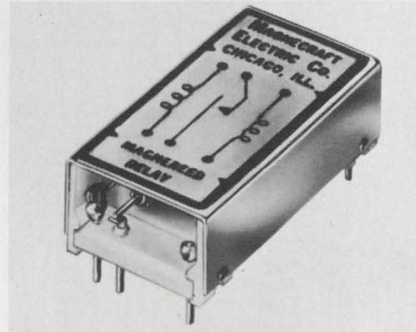
At nominal voltage, HGJ response time = 1 ms.

For full information, circle the Reader Service Number.

CLARE

C. P. CLARE & CO.
Chicago 60645 and worldwide.
A General Instrument company.

Reed relay stays latched

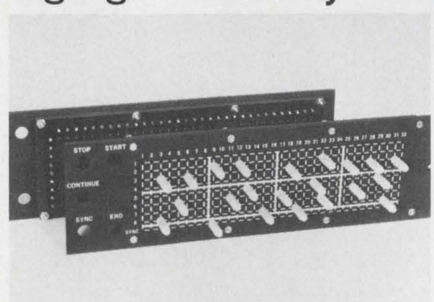


Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. Phone: (312) 282-5500. P&A: $8.93; stock.

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

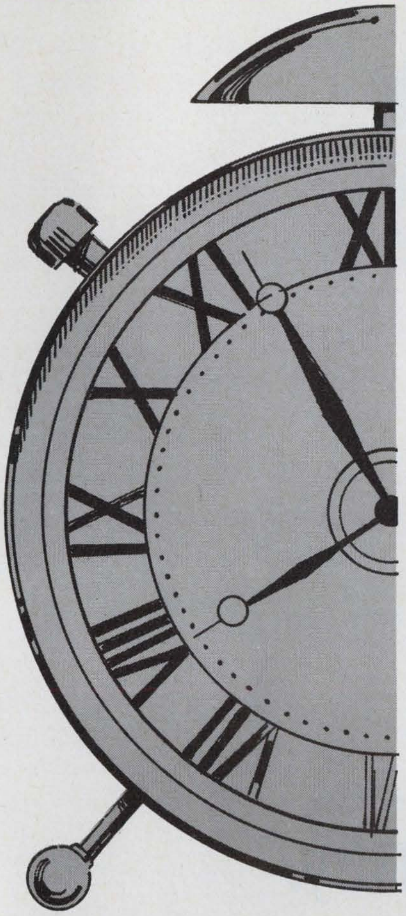


Info-Lite Corp., sub. of Systems & Components, Inc., 2337 Lemoine Ave., Fort Lee, N. J. Phone: (201) 947-6646. P&A: 20¢ per crosspoint; 4 to 6 wks.

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

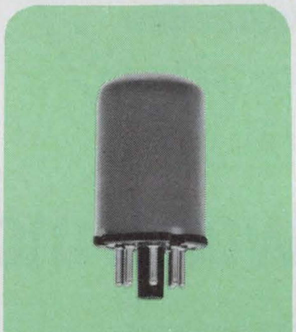
up-to-date "clocking" solves your advanced LOAD TIMING/CONTROL PROBLEMS



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

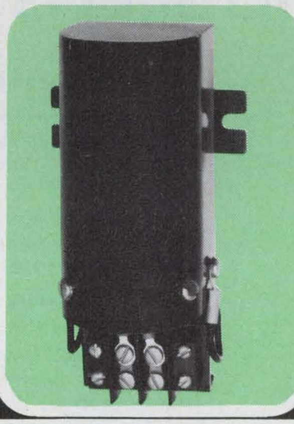
The **Unipulse Latch** is a solid-state bistable relay of advance design which controls loads in excess of 3 amps (8-200 Volts). Positive input pulses as narrow as 100 usec. to the same terminal will alternately latch the two outputs. Switching rates as high as 2 kHz are attainable, depending on output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



The **Unipulse Latch** is unaffected by shock or vibration and is internally supressed 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

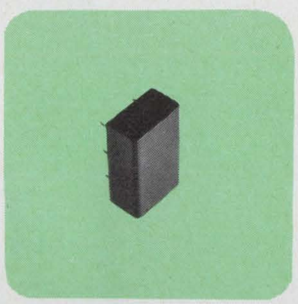
For the first time, an economical timer to handle 35 amp loads for the full timing period (no derating necessary). No need for a costly additional driven relay for high currents. Inputs up to 220 VAC and/or 200 VDC are time delayed from 50 msec. to over 2 minutes. ±5% accuracy under all load conditions in an operating temperature range from —30 to 200°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 ±2.5% at recycle times as



low as 20 msec. Operating temperature range is —30 to 170°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.

Adlake SINCE 1857 **THE ADAMS & WESTLAKE** *COMPANY*

A SUBSIDIARY OF **ALLIED** *PRODUCTS CORPORATION*

(219) 264-1141 • TWX 219-522-3102 • TELEX 25-8458 • CABLE ADLAKE 1025 North Michigan Street, Elkhart, Indiana 46514

INFORMATION RETRIEVAL NUMBER 147

TAILORED WAFER FABRICATION

TWf

OPTIMUM MINIMI

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.

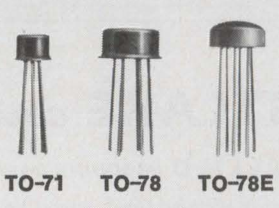
That in itself is only part of the story. Quality hasn't been sacrificed for price. The process lets us produce components of unusually high quality.

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 μA 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 μA 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

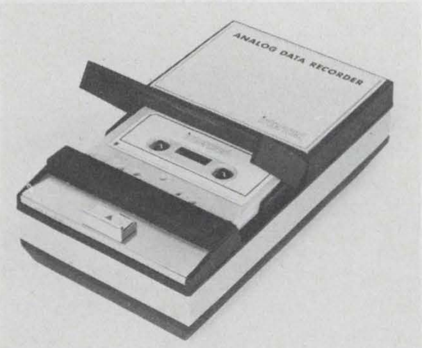


TO-71 TO-78 TO-78E

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

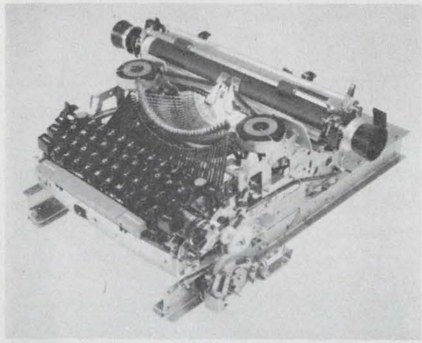


Intermed Corp., 2710 Forest Lane, Dallas, Tex. Phone: (214) 241-6831. P&A: $3700 to $5000; 30 to 45 days.

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*

Transduced typewriter boasts $300 price tag

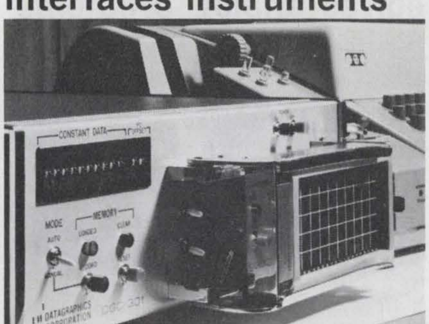


Smith-Corona Marchant, div. of SCM Corp., 3210 Porter Dr., Palo Alto, Calif. Phone: (415) 326-9500. P&A: $300; October, 1970.

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*

Data transfer system interfaces instruments

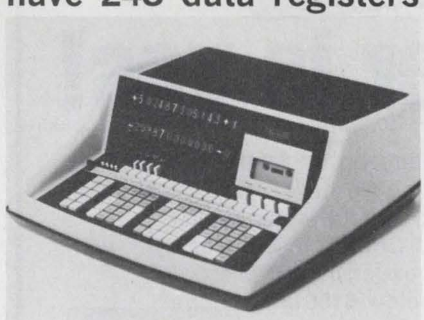


Data Graphics Corp., 8402 Speedway Dr., San Antonio, Tex. Phone: (512) 342-9486. P&A: from $2500; 60 to 90 days.

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*

Desktop calculators have 248 data registers

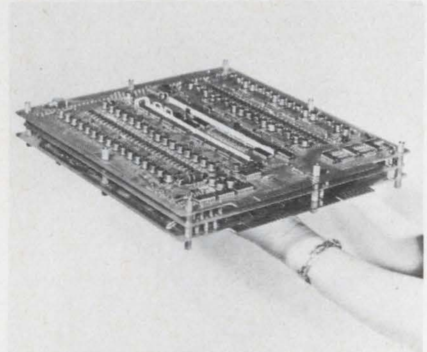


Wang Laboratories, Inc., 836 North St., Tewksbury, Mass. Phone. (617) 851-7311. P&A: $6700 (A), $6800 (B); 6 months.

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*

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 μs. 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*

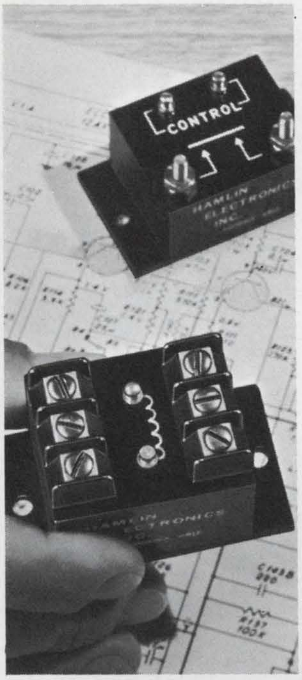
Small digital computer solves analog problems

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.™



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 ½ 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.

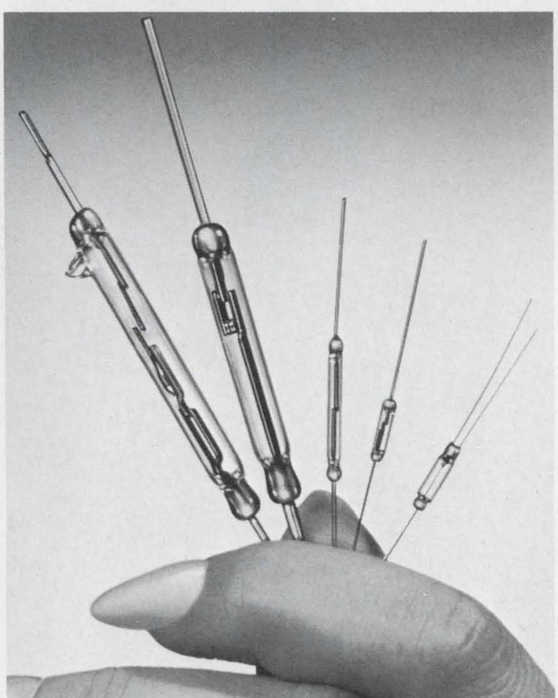
¾ actual size.

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.



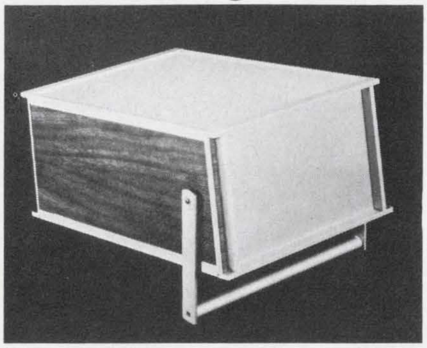
JUST ONCE.

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

INFORMATION RETRIEVAL NUMBER 153

Portable cabinets enhance designs

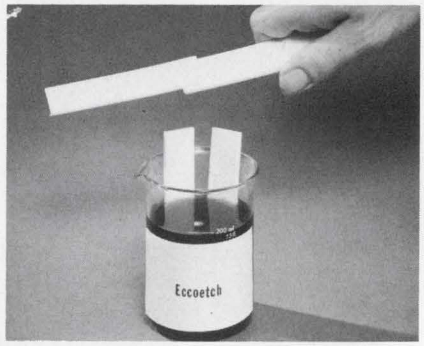


Techmar Corp., 2232 S. Cotner Ave., Los Angeles, Calif. Phone: (213) 478-0046. P&A: $81.37 to $105.97; stock.

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 Eccotech for 5 to 10 seconds, the exposed fluorocarbon surface displays a uniform light brown color. Eccoetch is dark blue-green.

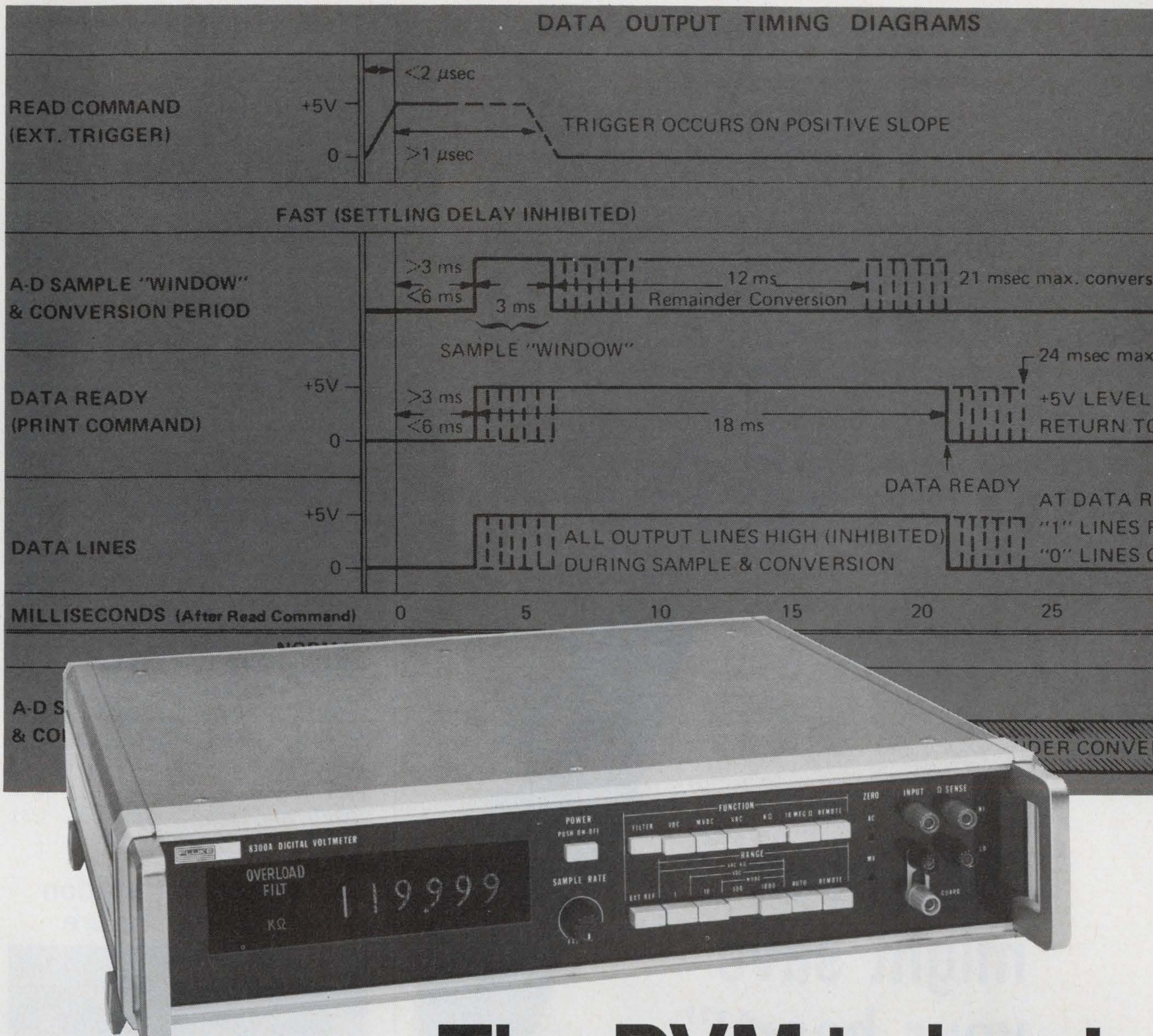
Booth No. 368 *Circle No. 280*

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*



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.

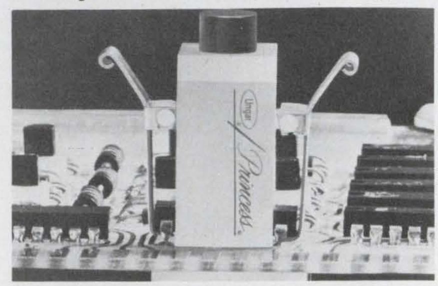
1. We blank the data output during conversion and time out to keep random signals out of the system.
2. A "device busy"/"ready" flag inhibits acquisition of readout until data is ready.
3. Programmable, on-call time-outs allow settling of analog options and auto-ranging, then call up a final conversion 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 compatability.
10. High accuracy/low price...0.005% with prices from $1395.

FLUKE®

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

Pop-up DIP extractor simplifies desoldering

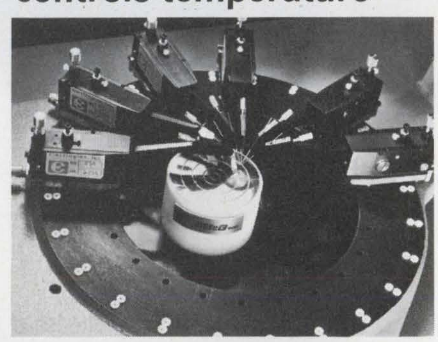


Ungar, div. of Eldon Industries, Inc., 233 E. Manville, Compton, Calif., Phone: (213) 774-5950. Availability: stock.

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

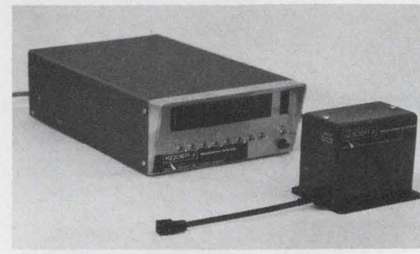


EG&G, Inc., 160 Brookline Ave., Boston, Mass. Phone: (617) 267-9700.

Thermochuck series TP3000 wafer probers feature temperature-controlled vacuum chucks, which can be preset anywhere within the range of −30 to +180°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*

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 ±0.0005 in. for any 20 in. of travel or ±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*

eering, 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*

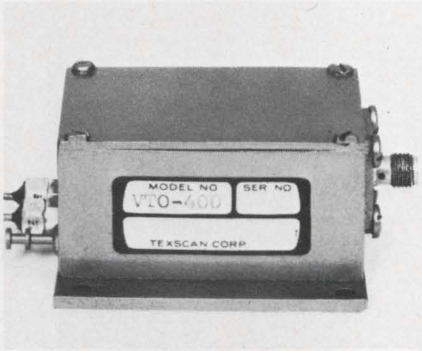
Two-input counter spans dc to 3 GHz

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*

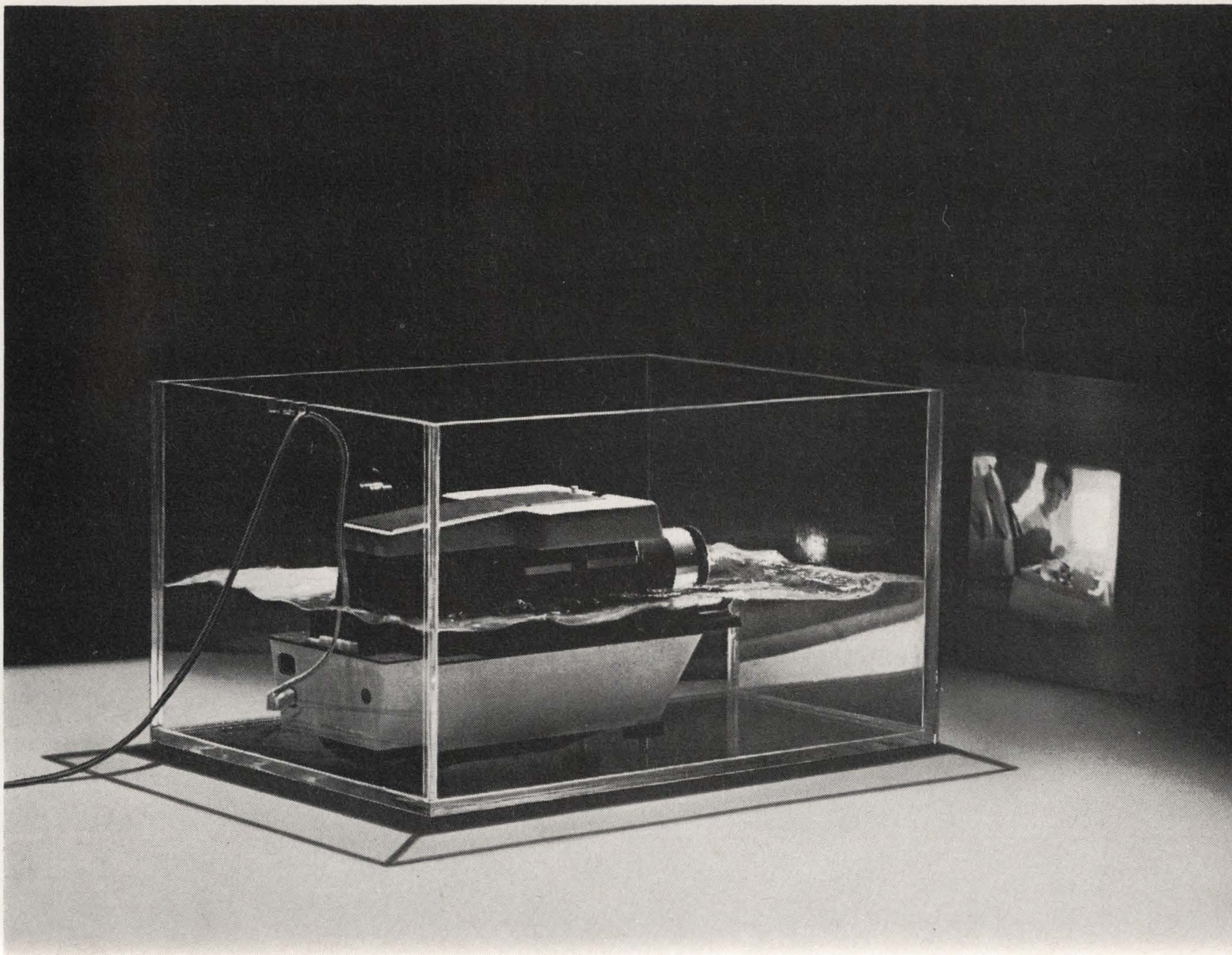
Solid-state VCOs put out 150 mW



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*



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 the most sensitive of component materials. They are inert . . . in the most inclusive sense of the word.

Send the coupon for the whole story. 3M Company, Chemical Division, 3M Center, St. Paul, Minnesota 55101.

What we send you may be dry, but it'll be illuminating.

Fluorinert® BRAND Electronic Liquids 3M COMPANY

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Send me all the details about Fluorinert Brand Electronic Liquids.

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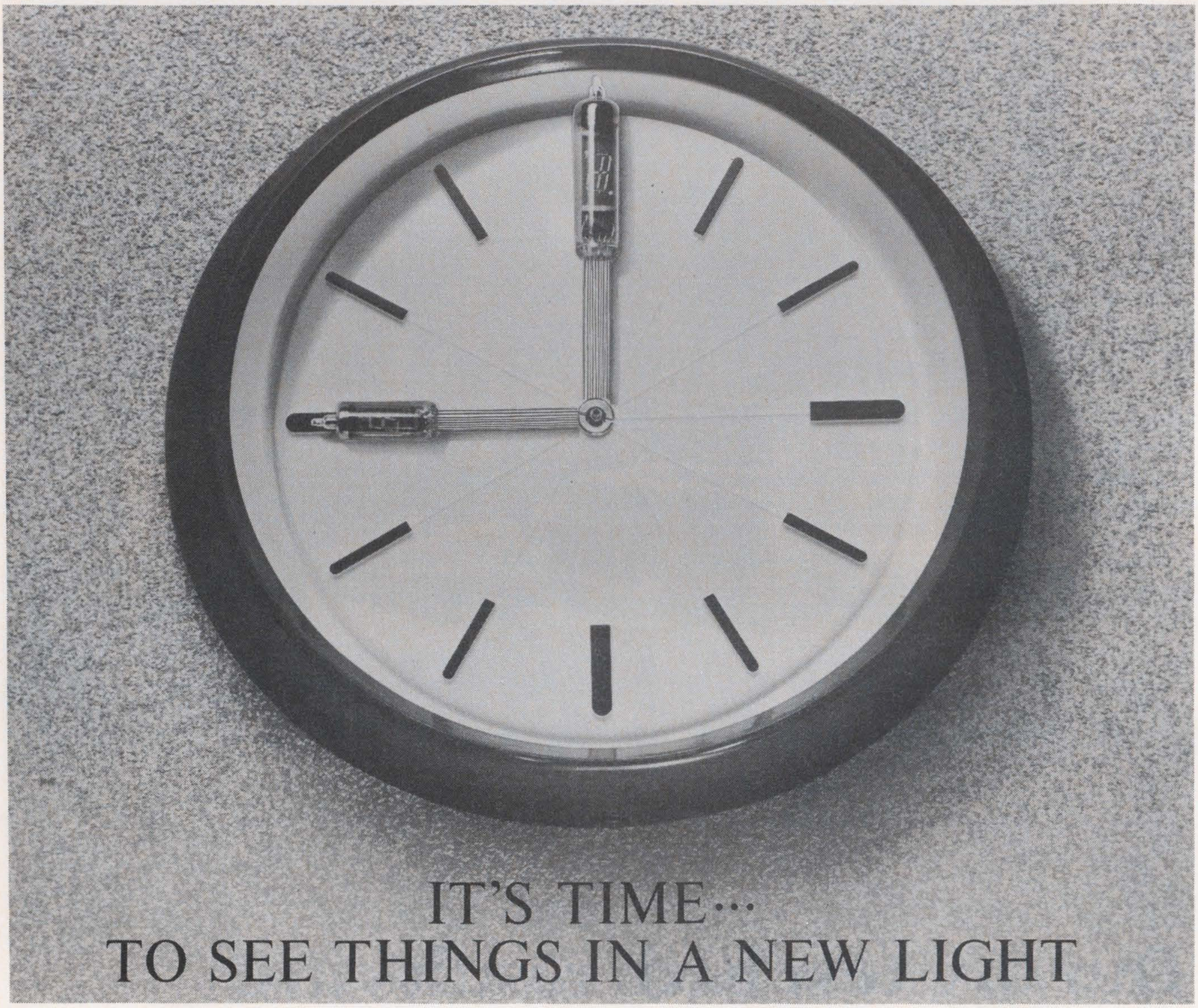
Company____________ Title____________

Address________________________

City____________ State______ Zip______

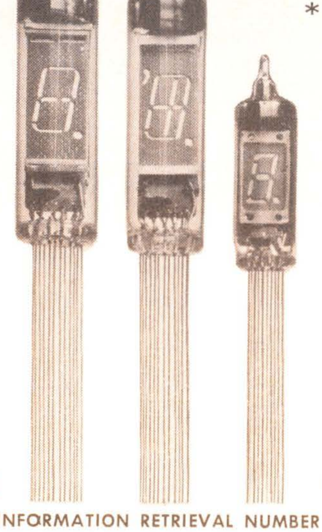
INFORMATION RETRIEVAL NUMBER 164



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:



DG 12H DG 10A

LEGI DG 12C

Filament voltage at 95 mA .... 0.85 volts ±10%
Phosphor segments & control grid .... 20 Vdc
Brightness ....80 foot-lamberts
Operating temperature ...... −10° to +70° C
∗ Dynamic life expectancy ..... 200,000 hrs.

U.S. PATENT 3508101

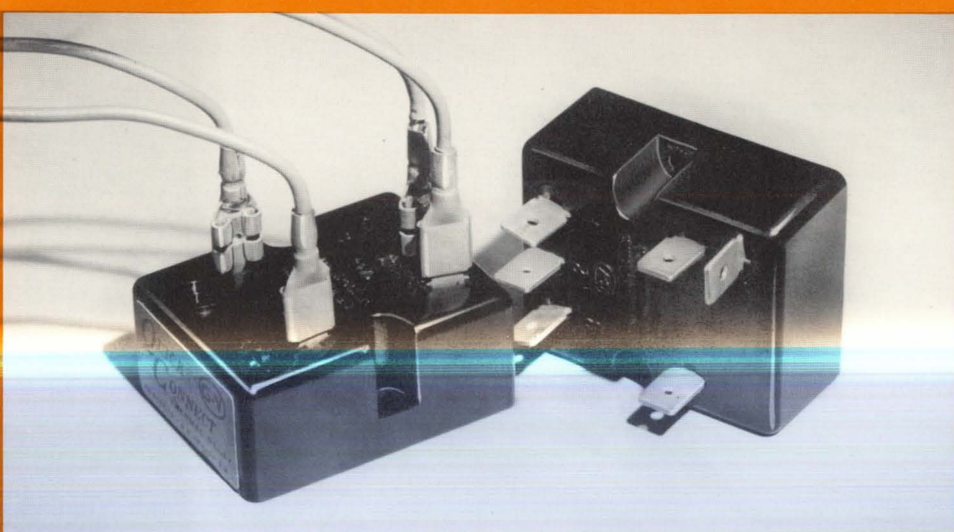
Legi *Sole U.S. Distributor:*
Legi Electronics Corporation
3118 West Jefferson Blvd. Los Angeles, California 90018 U.S.A.
Phone: RE 3-4508, 733-9105

ISE *Manufacturer:*
Ise Electronics Corporation
P.O. Box 46, Ise City Mie Pref., Japan Phone: Mie (059627)-26

INFORMATION RETRIEVAL NUMBER 165

FOR G-V CONTROLS INC. REGIONAL INSERT, CIRCLE 246 ►

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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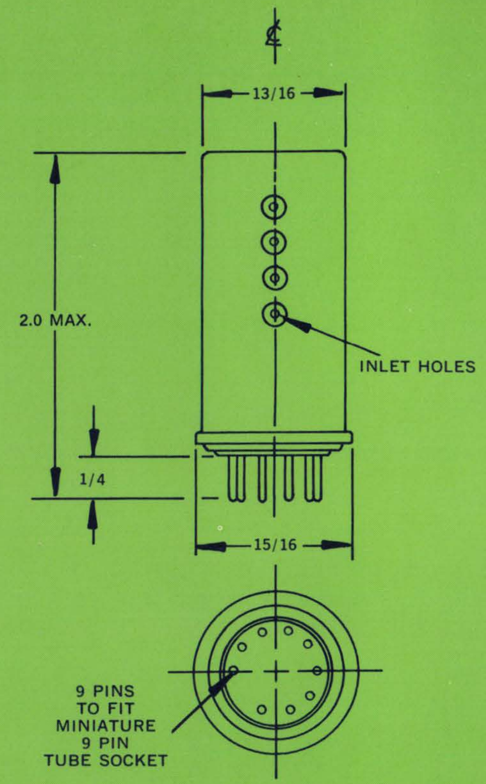
G-V CONTROLS INC.
OKNER PARKWAY
LIVINGSTON, NEW JERSEY 07039

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

Voltage:	115 AC or DC
Power:	2.5 Watts
Contact Rating:	2 amps resistive @ 115 VAC 1 amp resistive @ 28 VDC
Contact Configuration:	N.C.
Useable Voltage Variation:	± 10% of nominal
Standard Air Velocity Setting:	300 ft. per min. (4 mph)
Response Time:	1 to 40 seconds
Temperature Range:	0 to 80°C
Mounting:	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.)

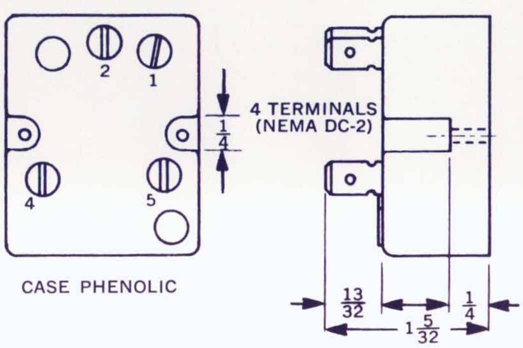
NOTE: Other voltages and contact configurations available. For Specs. covering the complete line of G-V Air Flow Sensing Switches, request Publication #70-1.

QUICK CONNECT INDUSTRIAL THERMAL TIMING RELAYS

Series ET
STANDARD TIME DELAY

Contact Rating:	2 amps resistive @ 115 V A.C. 1 amp resistive @ 28 V D.C.
Heater Voltage:	6.3, 26 or 115 A.C. or D.C.
Heater Power:	2.5 watts nominal
Time Delays:	2 to 180 seconds in 14 individual ranges
Ambient Temperature:	0°C to 80°C
Electrical Connections:	4 Push-On ¼" tinned brass terminals (NEMA DC-2)
Time Delay Tolerance:	± 20%

(115 V, 60 second version supplied as free sample. For a Quick Connect Relay with other ratings, see your G-V representative.)



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.

☐ Air Flow Sensing Switches ☐ Quick Connect Industrial Thermal Timing Relays

☐ I would like a full line G-V Catalog

☐ Put me on your mailing list to receive information on G-V products

Name ____________ Title ____________

Company ____________________

Address ____________________

City ____________ State ________ Zip ________

Telephone ____________ Extension ____________

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.

G-V

G-V CONTROLS INC.

LIVINGSTON, NEW JERSEY 07039

(201) 992-6200

Offer expires Dec. 31, 1970

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.

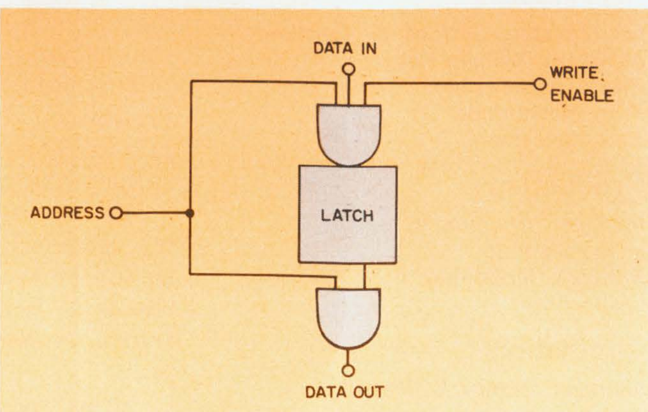
The monolithic RAM is produced in many different configurations by a number of manufacturers. Two of the configurations (16 by 4 and 16 by 1) will be examined to illustrate their basic operation and differences.

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.

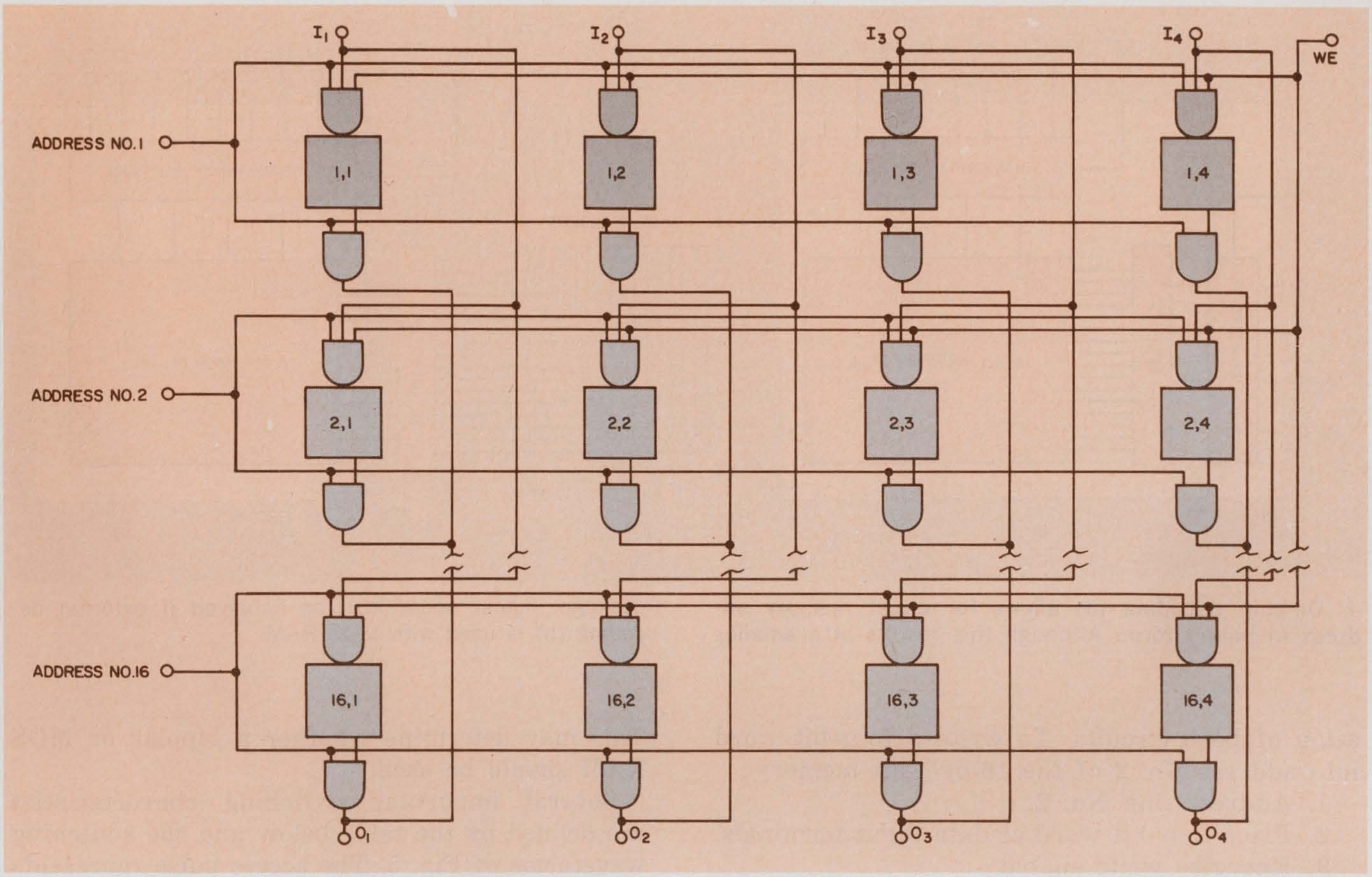
The 16-bit memory shown in Fig. 3 is a 16-by-1 RAM. 16 one-bit words may be written in or read out in serial at random. Each word (bit) for this configuration is addressed by four X and four Y address lines (coincident selection).

To demonstrate the difference between the two configurations, examine the read and write oper-

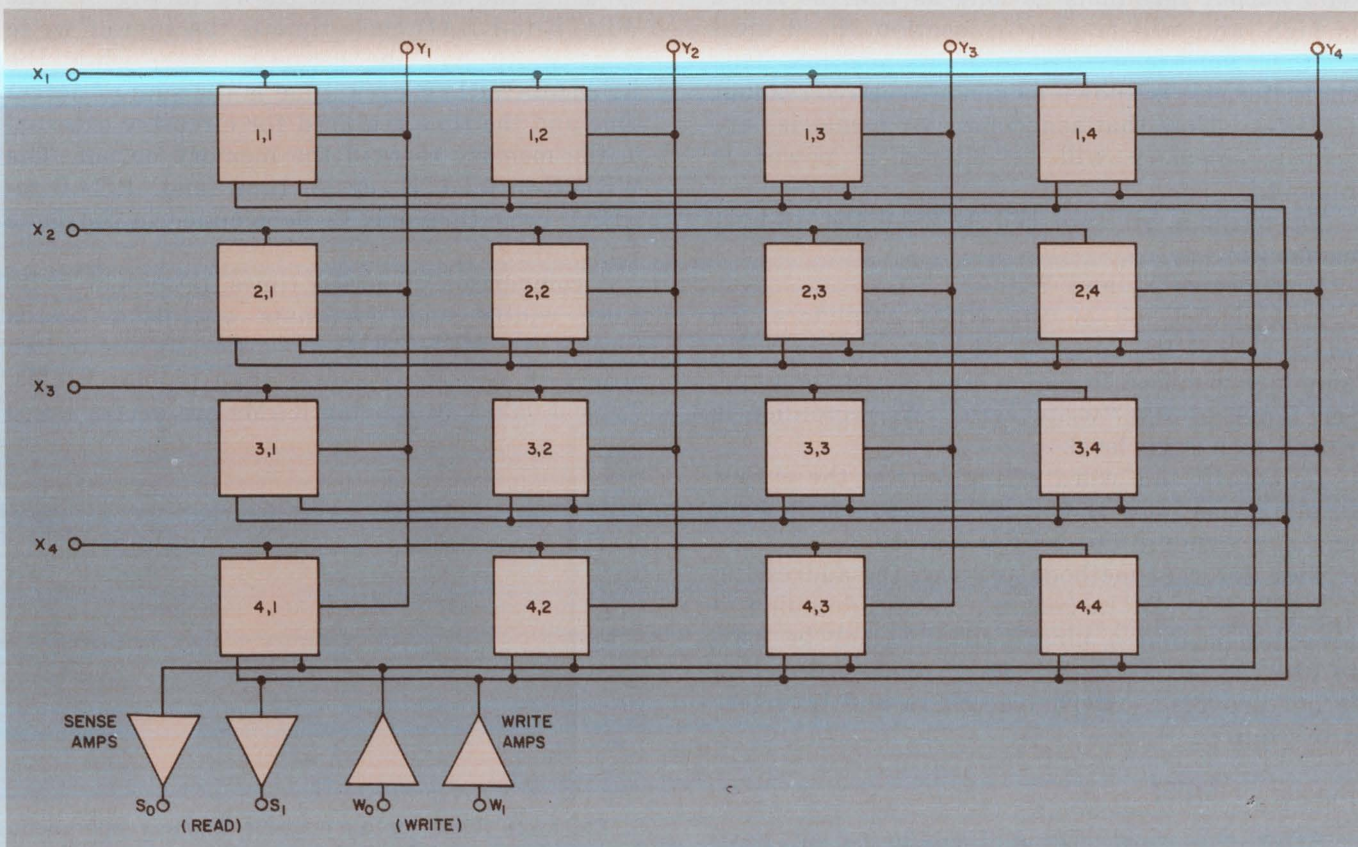
C. D. (Mike) Talbert, Engineer, Avionics Division, Bendix Corp., Fort Lauderdale, Fla.



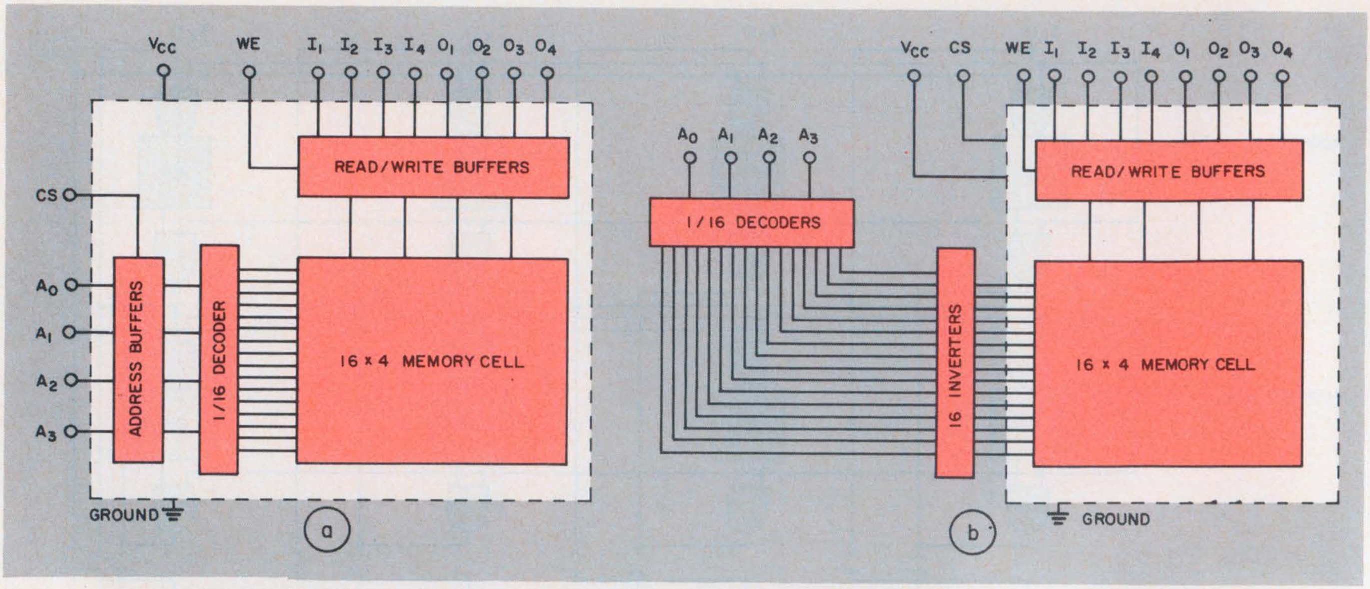
1. **A basic one-bit read/write memory is simply a latch** with input and output control lines.



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.

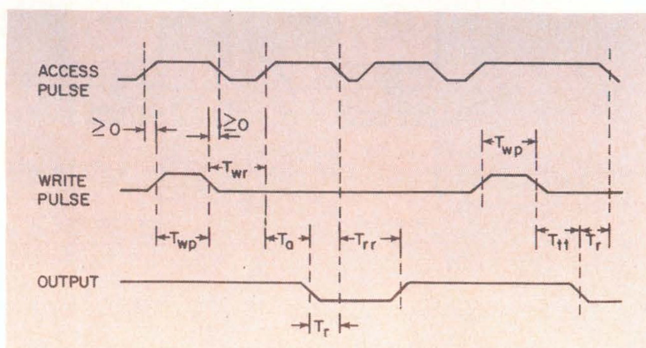
Bipolar or MOS?

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.

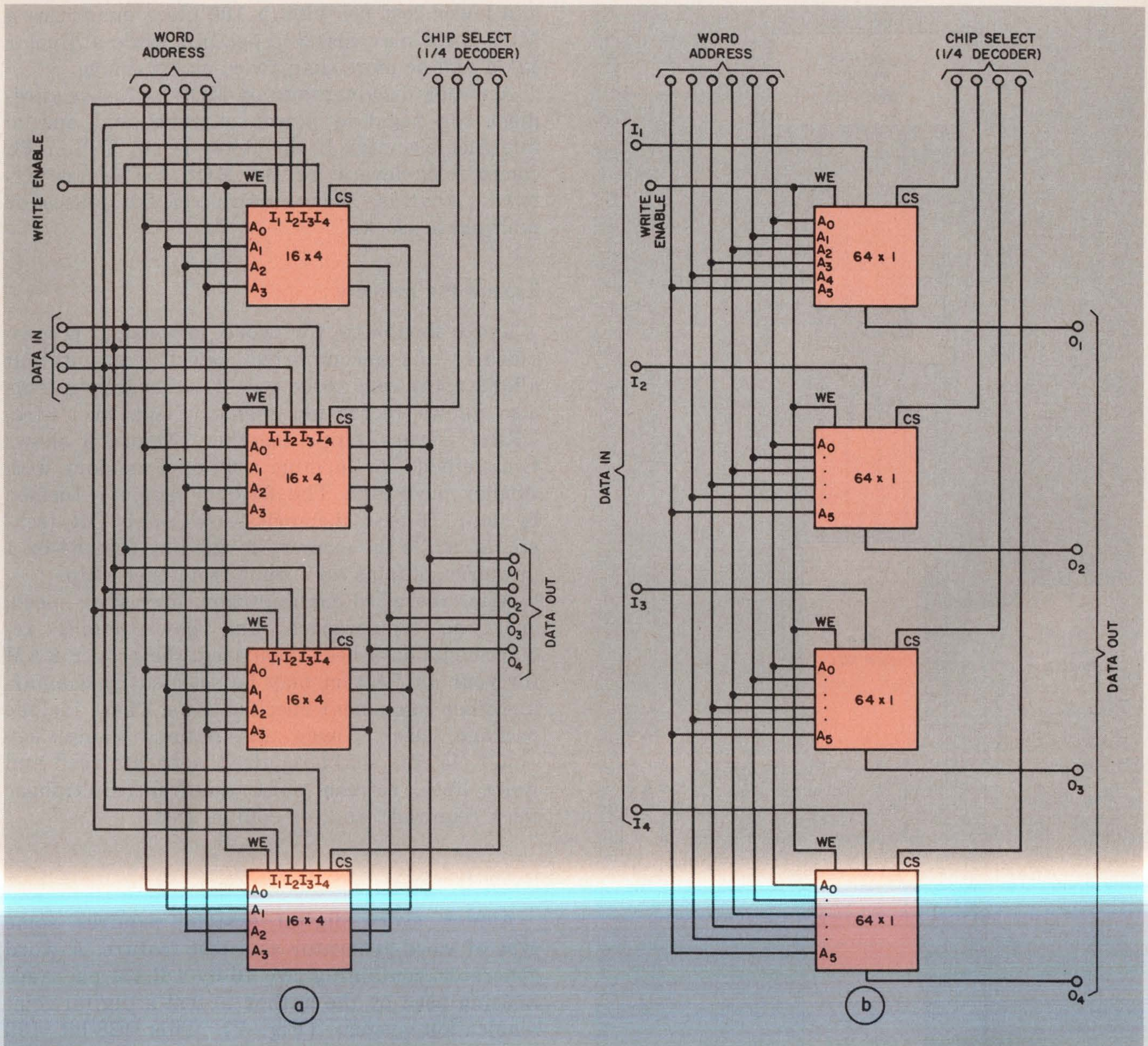
Several important switching characteristics are defined by the table below and the switching waveforms of Fig. 5. The access pulse represents the switching of the address lines.

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



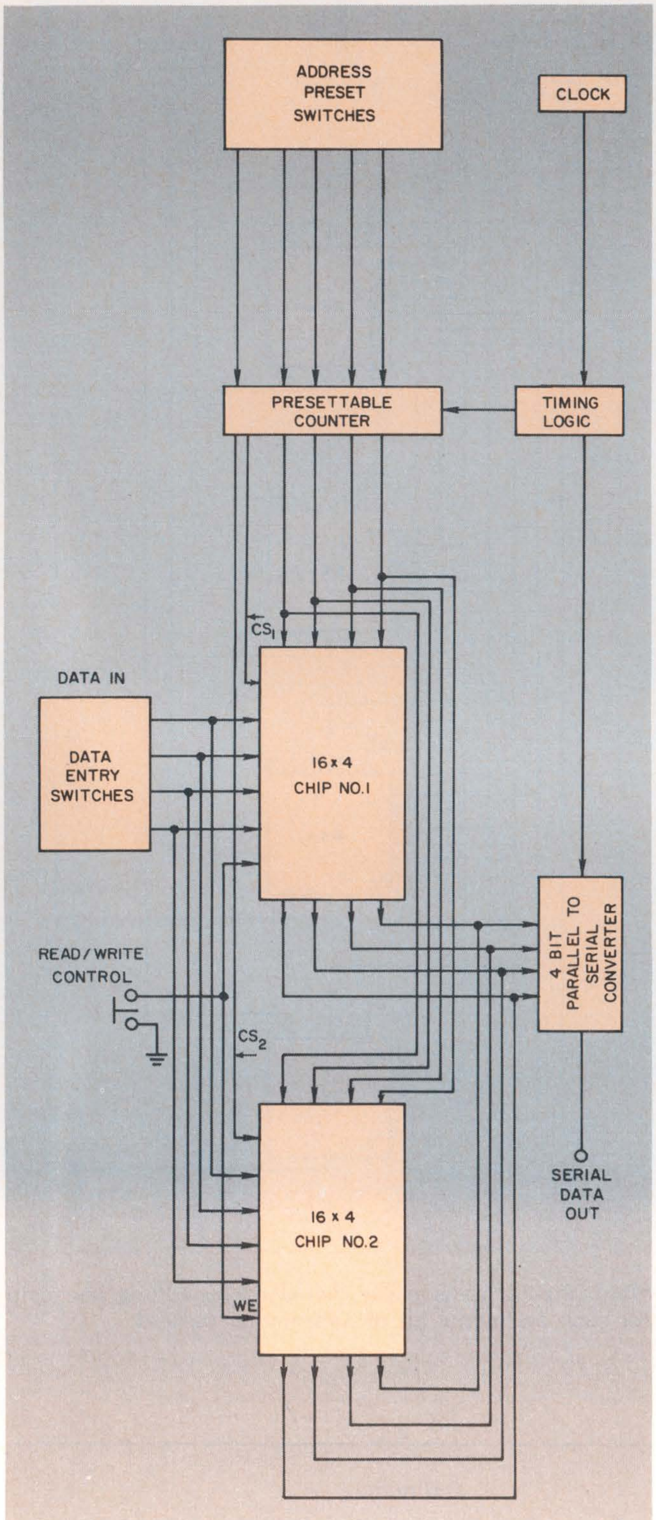
5. **The cycle times for all possible memory** operations can be determined from the switching characteristics. For example, the WRITE to READ cycle time is the sum of WRITE pulse width (T_{wp}) and the recovery time (T_{wr}).



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 (Ta)	The time delay between a valid address at the input and the indicated point on the output waveform.
Read recovery time (Trr)	Time for output to turn off after access pulse goes low.
Write pulse (Twp)	Minimum pulse guaranteed to write.
Write throughput time (Ttt)	Time from write pulse to read data out from bit just written into.
Write recovery time (Twr)	Time before another location can be addressed after write pulse.
Read time (Tr)	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. ■■

8-66

Vceo = 100 V, I = 10 A, f_t = 80 MHz, β = 1000

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microtopics

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There are linear arrays, circular arrays, staggered arrays . . . arrays with more than 100 elements . . . elements as small as .002″ x .002″ and with less than .001″ spacing.

And as for performance, detectivity approaches theoretical limits. Electrical crosstalk can be held to less than –40 db between elements, while optical and mechanical dimensions can be held to ±.001″ and ±.0005″ respectively.

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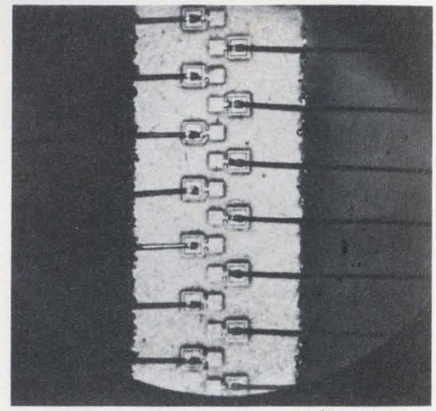

A Typical Array with .0033″ x .0033″ InSb Elements Spaced .0033″ Apart.

Custom 2048-Bit ROMs.

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Delivery for custom patterns is 6 weeks . . . with standard ASCII patterns available off-the-shelf for evaluation.

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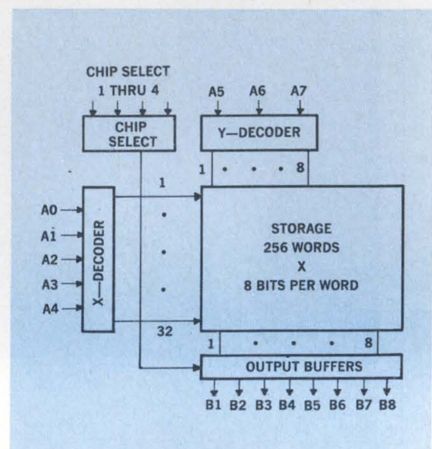

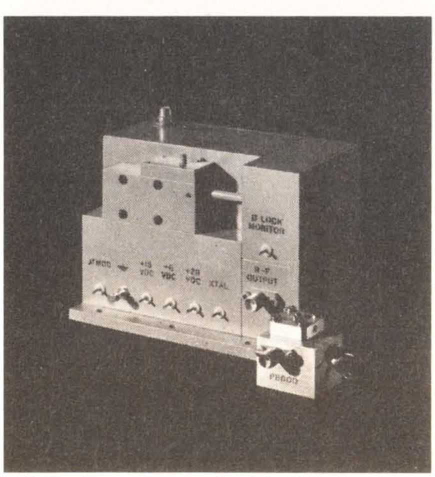

New phase-locked Gunn source.

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INFORMATION RETRIEVAL NUMBER 193

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%.

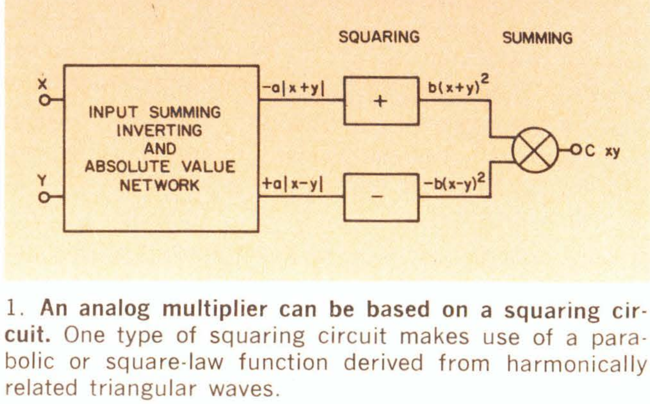
Adding up triangular waves

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 adefor 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.

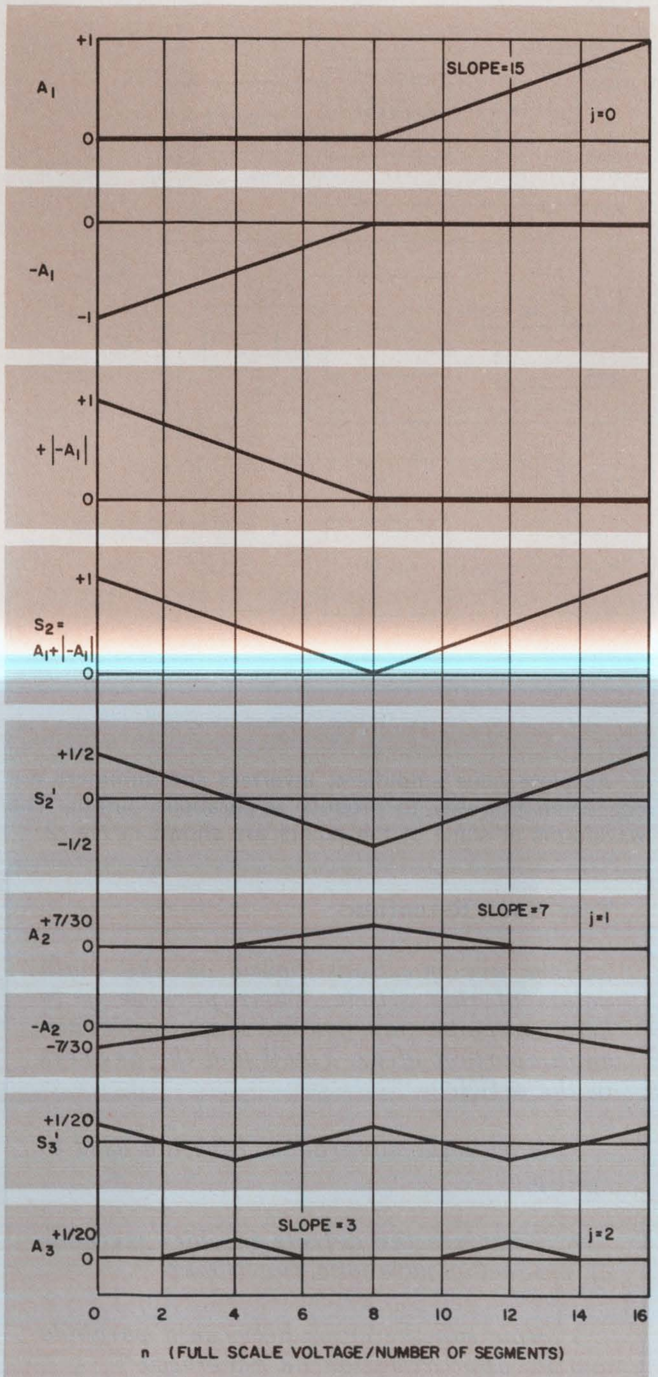
The squaring network is the critical element. If the inputs are zero, the output should be zero. Thus, the output curve of the squaring network is a parabola that passes through the origin. If a sequence of harmonically related triangular waves with a frequency progression of 2^j where $j=1,2\ldots$, 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_4, 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.

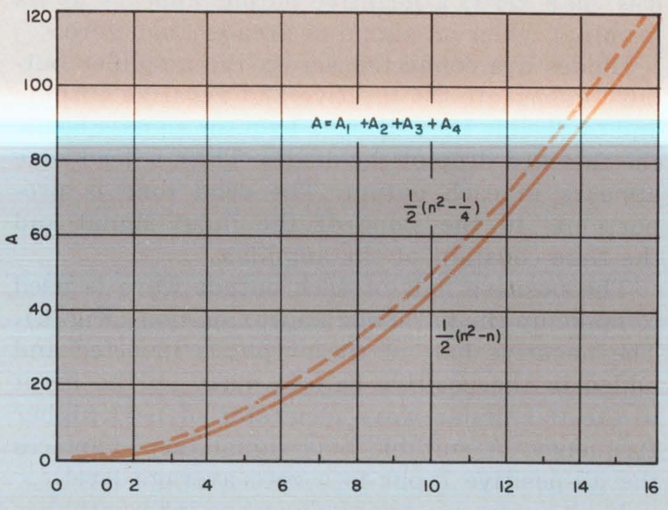


2. **The outputs of the triangular-wave generators** are A_1, A_2 and A_3. Their slopes decrease in the ratio 15:7:3. A_4 is not shown, but its slope is one. The curves S'_2 and S'_3 are input signals in the circuit shown in Fig. 6.

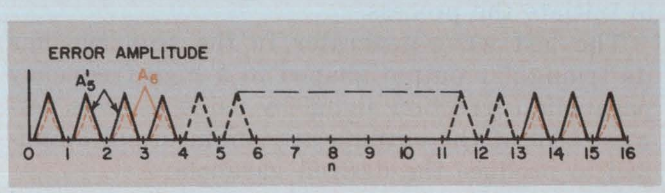
eliminated. One way of accomplishing this is by shifting the base breakpoints of the triangular waves A_1, A_2, A_3 and A_4 n/2 to the left of their positions in Fig. 2.

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_6.

ber of segments and hence the accuracy can be easily increased. Precisely 2^p 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_6 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.

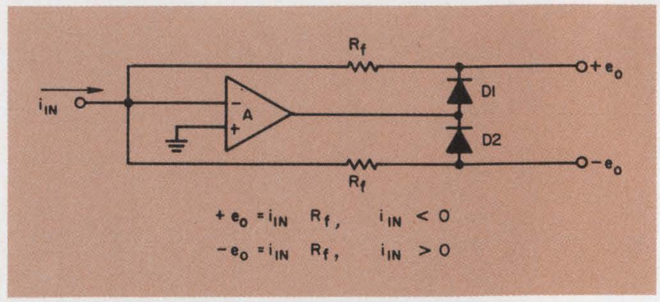
Diodes are connected across the amplifier output to separate the positive and negative outputs and to disable the feedback loop for signals below the forward drop of the diodes. Thus, a dead zone appears in each output. The dead zone is proportional to the slope of the input signal and the time constant 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.

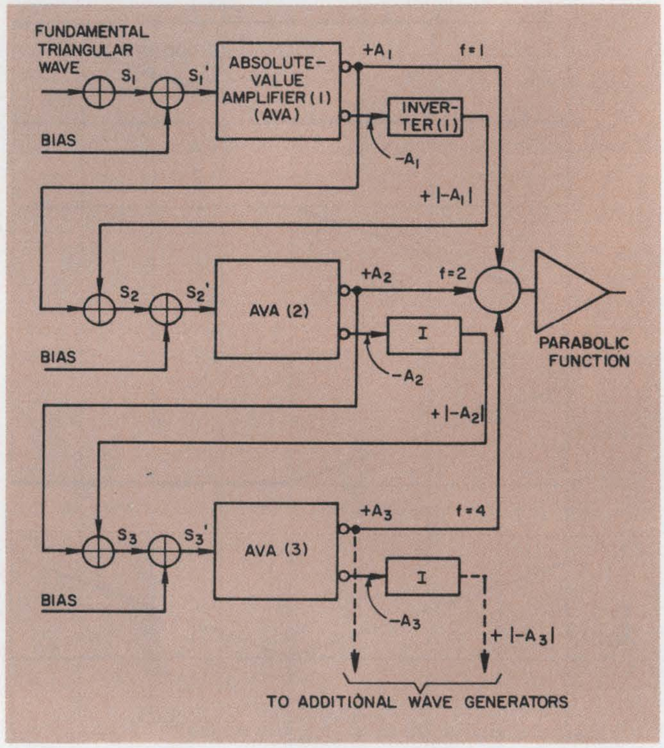
Each successive triangular wave inherently has a frequency precisely twice that of the previous one (Fig. 2). The relative amplitude of each triangular wave is adjusted by setting the gain of its amplifier and the magnitude of the input bias signal. Note that a ramp function is used to initiate the process.

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?

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 nonlinear 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.

Kenneth A. Peterson, AIL Div., Cutler-Hammer, Deer Park, N. Y.

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 polynominal of infinite order.

$$C_x = \sum_{j=0}^{\infty} \sum_{k=0}^{\infty} B_{jk} X^j Y^k, \tag{1}$$

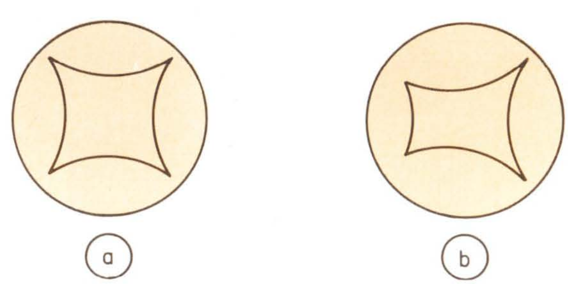
where B_{jk} are the coefficients in the polynomial.

In order to fit the data to the polynomial, the sum of the errors squared must be minimized. This is expressed by

$$S = \sum_{L=1}^{N} (E_x - C_x)^2, \tag{2}$$

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 pincushion of "a." An off-axis gun, as found in a multigun tube, causes additional keystone distortion (b).

To minimize this sum, the partial derivatives with respect to the various coefficients are taken. The partial derivatives of Eq. 2 are:

$$\frac{\partial S}{\partial B_{st}} = 2\sum_{L=1}^{N}(E_x - C_x)\frac{\partial CX}{\partial B_{st}},$$

where $s = 0, 1, 2, \ldots ; t = 0, 1, 2, \ldots$

Set the partials equal to zero and substitute for C_x to get:

$$\sum_{L=1}^{N} E_x \frac{\partial C_x}{\partial B_{st}} = \sum_{L=1}^{N}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty} B_{jk}X^jY^k \frac{\partial C_x}{\partial B_{st}} \quad (3)$$

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:

$$C_x = \sum_{j=0}^{2}\sum_{k=0}^{2} B_{jk}X^jY^k.$$

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:

$$\sum_{L=1}^{30}(E_x)\ Y = \sum_{L=1}^{30}(B_{01}Y^2 + B_{10}XY + B_{12}XY^3)$$

$$\sum_{L=1}^{30}(E_x)\ X = \sum_{L=1}^{30}(B_{01}XY + B_{10}X^2 + B_{12}X^2Y^2)$$

$$\sum_{L=1}^{30}(E_x)\ XY^2 = \sum_{L=1}^{30}(B_{01}XY^3 + B_{10}X^2Y^2 + B_{12}X^2Y^4).$$

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 obtained 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

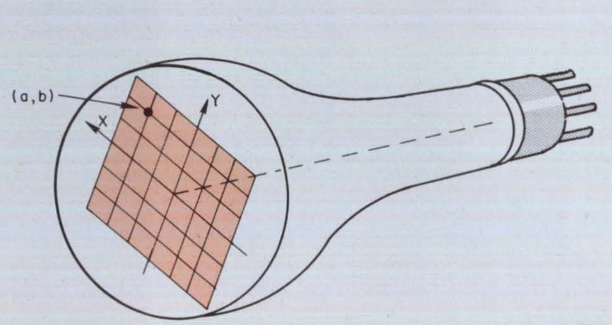
$$C_x = B_{10}X + X\,(B_{20}X + B_{30}X^2 + B_{21}XY).$$

The hardware representing this equation is shown in a block diagram in Fig. 3.

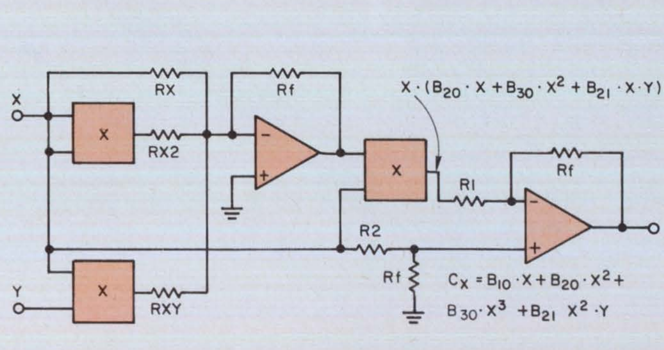
The resistor values are:

$$R_x = \frac{R_f}{B_{20}};\ R_{x2} = \frac{R_f}{B_{30}};\ R_{xy} = \frac{R_f}{B_{21}};\ R_1 = R_f$$

$$\text{and } R_2 = \frac{2R_f}{B_{10}} - R_f.$$ ■■



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.



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

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.

Thomas H. Baker, development engineer, Hewlett-Packard, Loveland, Colo.

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 aquaintance 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 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. Depending 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 graduation from Grimbley, a fairly well respected engineering school.

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
		TOTAL	286

1. **Job qualifications and weights** will vary by company needs. This interview rating sheet might be used for an instrument design laboratory.

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 technician 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 average. 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.

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	3.0/4.0 = 7.5	38
SELF-MOTIVATION	5	9	45
PERSONALITY	4	5	20
		TOTAL	377

2. **Rating sheet for Frank**

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 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.

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 = 8.75	44
SELF-MOTIVATION	5	6	30
PERSONALITY	4	8	32
		TOTAL	297

3. **Rating sheet for George**

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 interest 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. ■■

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 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 ⅓rd the weight and ⅔rd the volume of the extrusion.

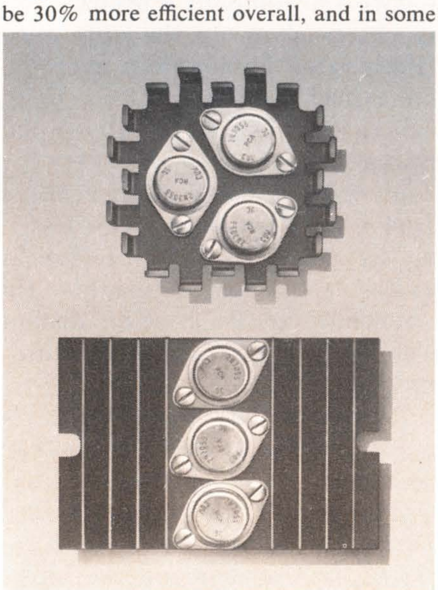


FIGURE 1

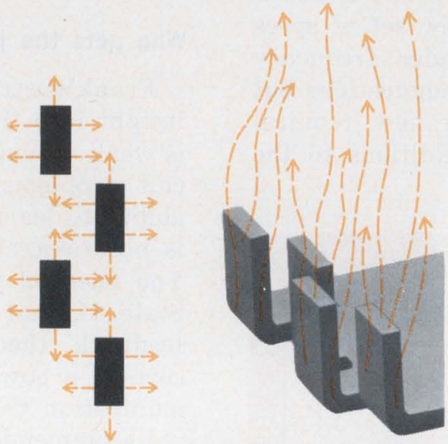


FIGURE 2

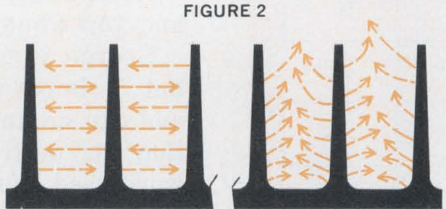


FIGURE 3

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.

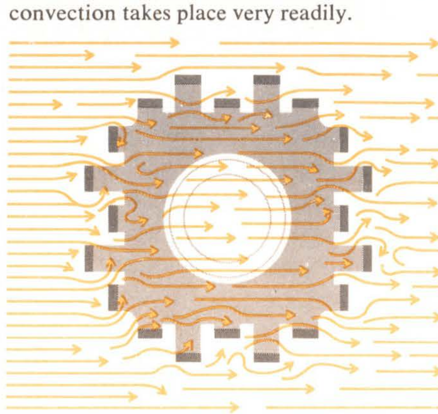


FIGURE 4

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 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.

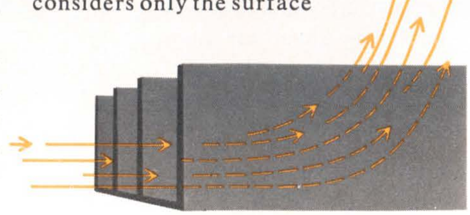


FIGURE 5

Broad line accommodates all lead and case mounted semiconductors.

During the past several years, IERC has developed numerous heat dissipating devices

"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

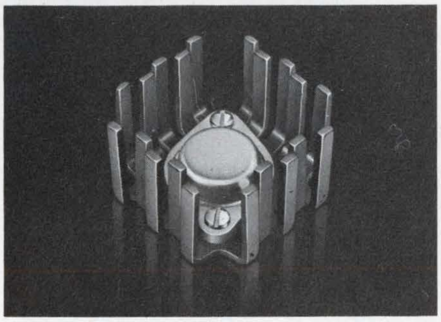


FIGURE 6

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

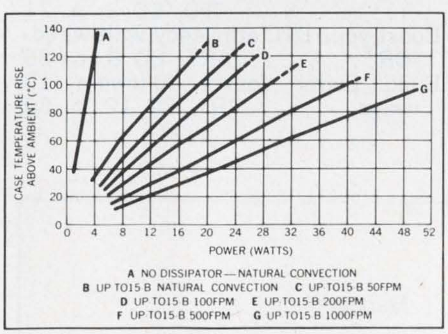


FIGURE 7

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?

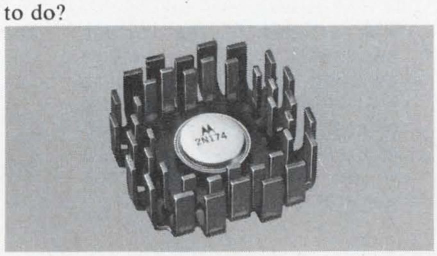


FIGURE 8

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 3⅛ 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

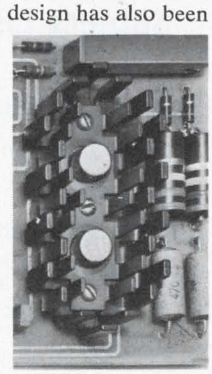


FIGURE 9

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 phencmenally 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.

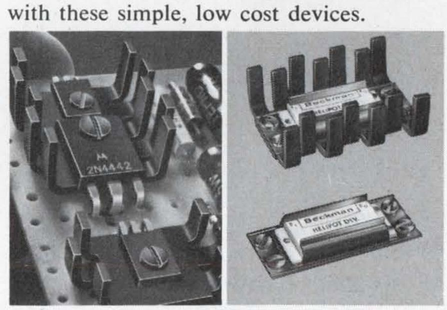


FIGURE 10

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.

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HEAT SINKS/DISSIPATORS

INFORMATION RETRIEVAL NUMBER 47

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.

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
Circuits & Circuit Theory
Communications
Components
Computer-Aided Design
Computers & Data Processing
Consumer Electronics
Displays
General Industry
Industrial Electronics
Management
Materials & Packaging
Medical Electronics
Microelectronics
Microwaves & Lasers
Military & Aerospace
Product Source Directories
Semiconductors
Systems
Test & Measuring

Communications

Components

Computer-Aided Design

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Consumer Electronics

Displays

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Medical Electronics

Microelectronics

Microwaves & Lasers

Military & Aerospace

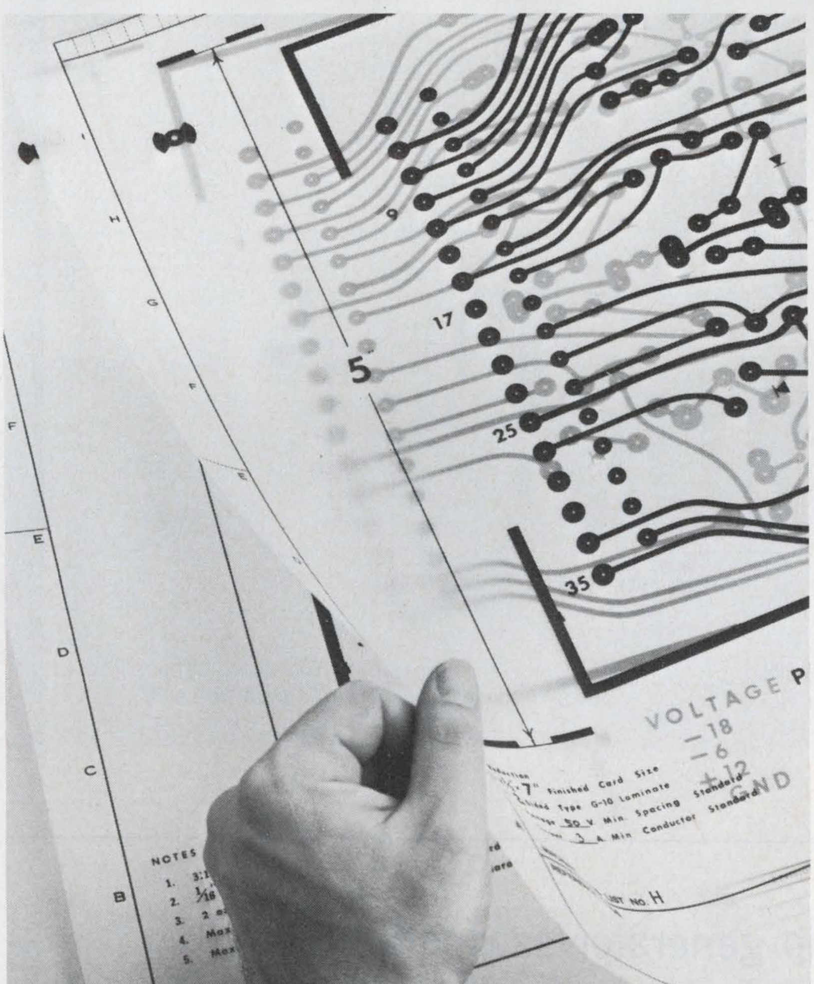
Product Source Directories

Semiconductors

Systems

Test & Measuring

Short circuits.



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INFORMATION RETRIEVAL NUMBER 50

Transformerless modulator operates from dc to 1 MHz

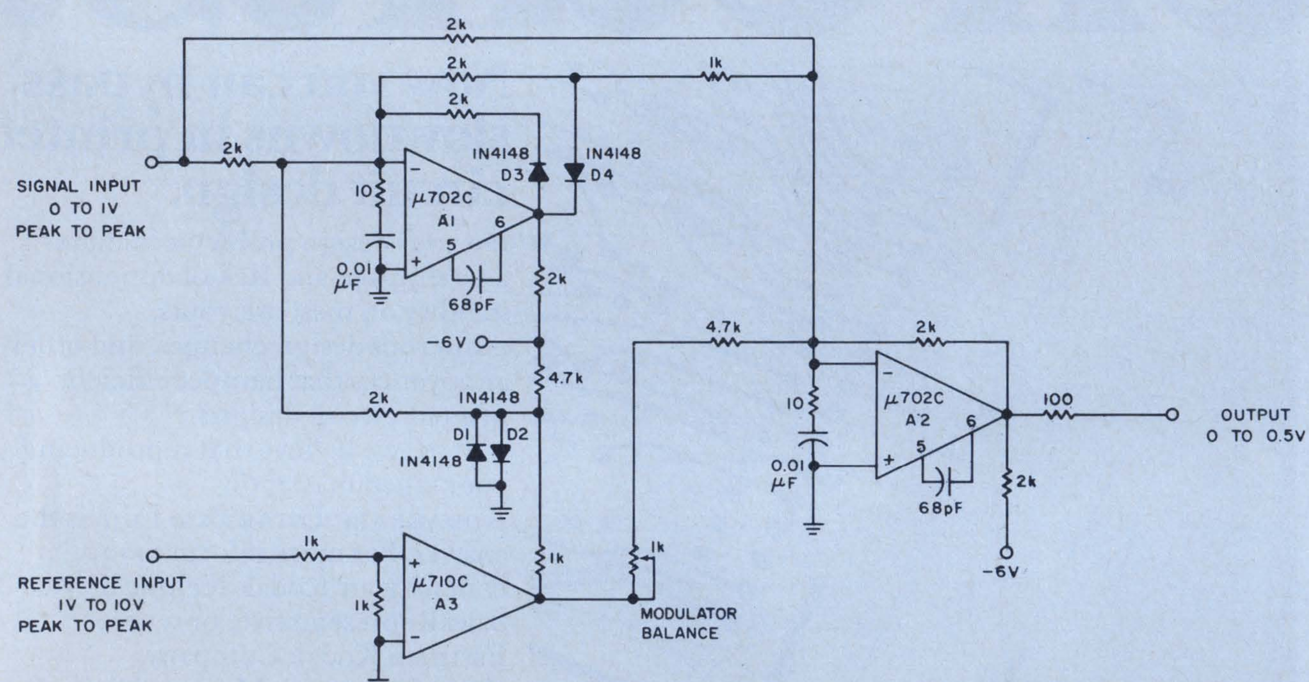
This circuit uses inexpensive monolithic operational amplifiers and operates as a full-wave modulator or phase detector from dc to 1 MHz with no component changes. By comparison, most modulator designs use transformers that limit the useful frequency range.

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



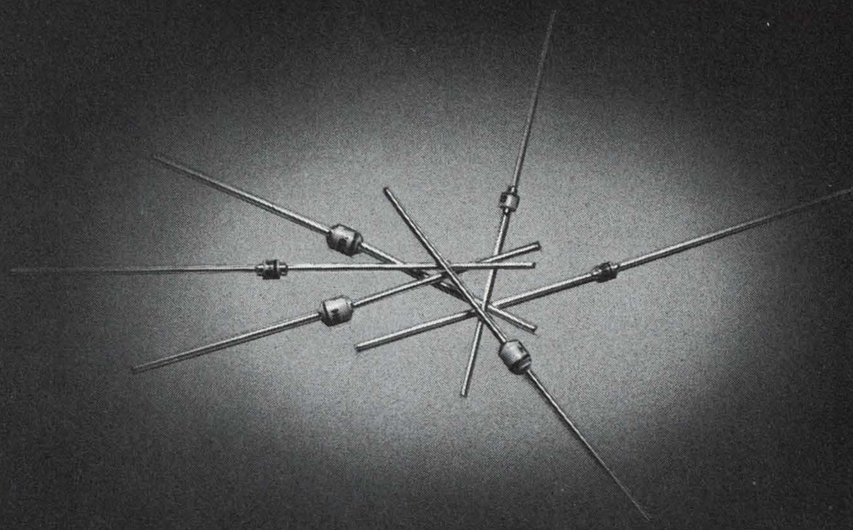
Modulator's reference input may be a sine function or complex wave shape. A_3 produces a square wave just from zero-crossing information. The signal input should not exceed 1.2 V peak-to-peak.

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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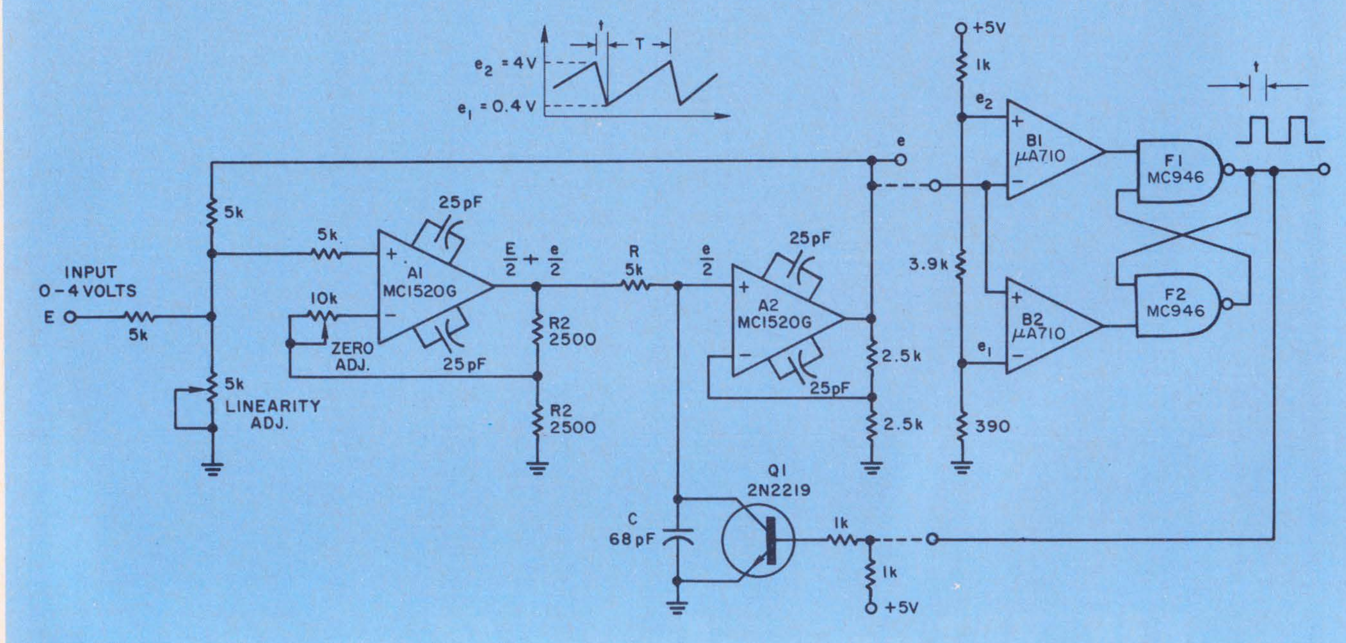
INFORMATION RETRIEVAL NUMBER 51



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 $(RC)(e_1 - e_2)/(E/2)$. 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/μs 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, F_1, F_2 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.

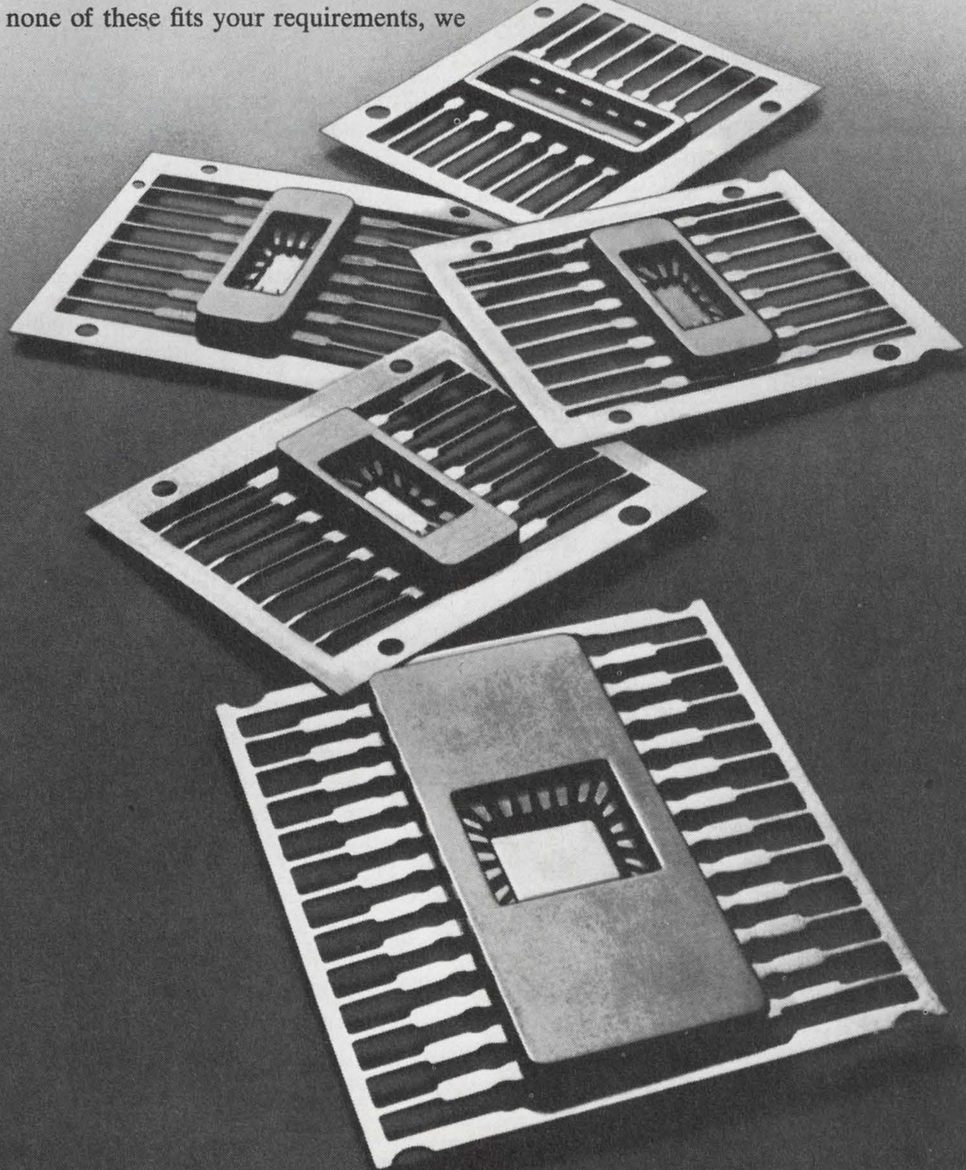
The empirical equation relating cable diameter, D, wire size, d; and the number of wires, N, is

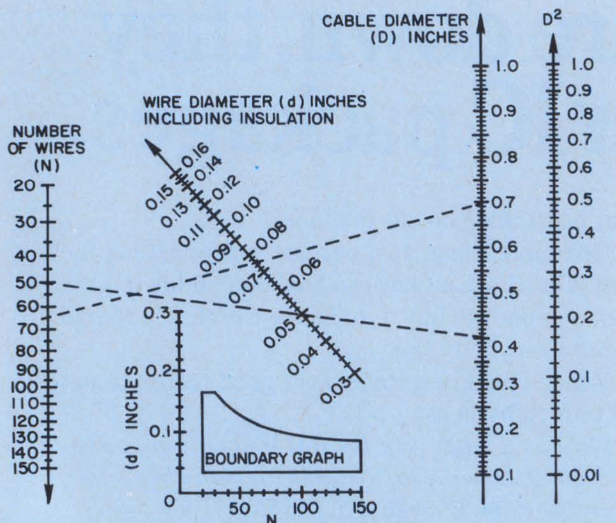
$$D = d\,[0.94 + \sqrt{(N - 3.7)/0.907}]\ .$$

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

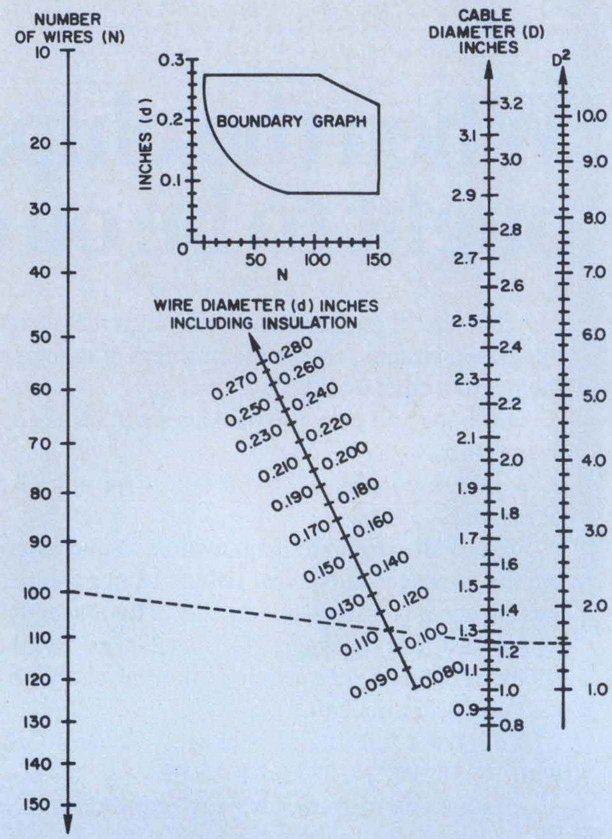
$$D_{total} = \sqrt{\Sigma\,(D_1^2 + D_2^2 + D_3^2 \cdots D_n^2)}$$

where D_1, D_2, $D_3 \cdots D_n$ are the individual cable diameters for each wire size.





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^2 scale. Locate the first two groups of wires in Fig. 1 and the third group in Fig. 2.

$D_{total} = \sqrt{0.49 + 0.16 + 1.50} \simeq 1.5$ inches, which is the desired minimum cable diameter.

Bibliography:

Caso, L. F., "Estimating Cable Diameters," *Design News*, Jan. 5, 1970, p. 70.

Mager, A. H. and Hayden, R. D., "Cable Assembly Standardization Do's and Don'ts" *Wire and Wire Products*, March, 1965, p. 367.

Taylor, F. G. and Hinchliffe, V. D. S., "Cables for Aircraft; Design and Development," *IEEE Proceedings*, Sept., 1967, p. 1298.

"Cable, Cord and Electric Wire, Electric, Packaging and Packing of," MIL-C-12000.

"Cable, Electric, Aerospace Vehicle, General Specifications for," MIL-C-7078.

"Wire and Cable, Hookup, Electrical Insulated," MIL-W-76.

"Wiring, Guided Missile, Installation of, General Specifications for," MIL-W-8160.

Louis F. Caso, Jericho Plant, PRD Electronics, Inc., Jericho, L. I., N. Y.

VOTE FOR 313

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.

Advantages of this arrangement include simplicity, low cost, input/output isolation, fast response time, no power-supply requirement and

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Check these specs. **Frequency Range:** 0.02 Hz to 20 KHz, **Attenuation Slopes:** 24, 18, 12, 6 db/octave, **Band Pass Gain:** 0 db or 20 db, **Frequency Response:** Butterworth or Low Q, **Frequency Accuracy:** 5%, **Hum and Noise (RMS):** 0.3 mv, **Optional Feature:** Battery Operation.

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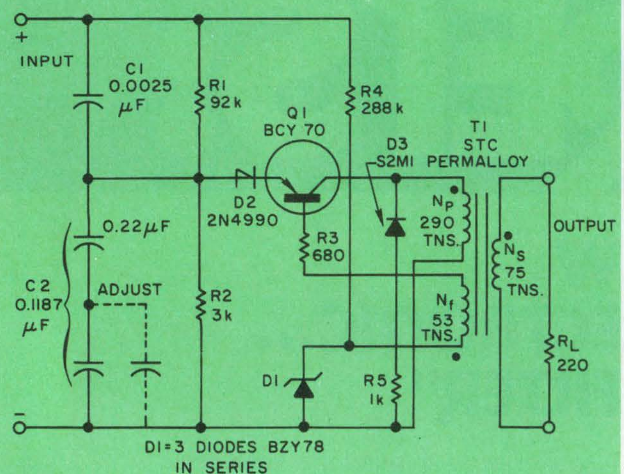

A pulse train appears at the output as long as the input voltage remains above a preset value. Series zeners (D_1) provide a stable dc reference voltage.

good temperature stability.

R_1, C_1; R_2, C_2 form a frequency-compensated voltage divider network, while D_1 provides a stable dc reference voltage. Whenever the input level is such that the voltage across R_2, C_2 is greater than the sum of breakover voltage V_{D2}, V_{be} of Q_1 and the zener voltage V_{D1}, the four-layer diode D_2 breaks over and Q_1 conducts, thereby discharging C_2. This produces an output pulse at the transformer secondary.

The feedback winding N_f, with the polarity shown, will increase the base drive to Q_1. This allows C_2 to discharge through Q_1 to a lower voltage than that across D_1. As the feedback voltage across N_f decreases, a point is reached when Q_1 turns off. The current through D_2 will then decrease below the holding level, turning D_2 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

$$T = \left[\frac{R_2R_1(C_2+C_1)}{R_2+R_1}\right] \ln\left[\frac{E_1R_2}{E_1R_2-(V_{D1}+V_{D2}+V_{be})(R_1+R_2)}\right]$$

where E_1 = input voltage.

The trip level, E_2, can be set by varying R_2 and/or C_2 so that the product $(R_2)(C_2)$ remains constant. E_2 can be expressed as

$$E_2 = (V_{D1} + V_{D2} + V_{be})(R_1 + R_2)/R_2$$

When trip level E_2 = 840 V, input voltage E_1 = 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_2 = 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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IFD Winner for April 26, 1970
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.
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New Helipot DAC & ADC Hybrids are MOS system compatible

Model 847 DAC & Model 871 ADC offer:

- Integration of the best DAC/ADC functional elements from MOS/LSI, Bipolar and cermet thick-film technologies into *complete* hybrid converters.
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	MODEL 847 DAC			MODEL 871 ADC		
■ Resolution	10 bit			12 bit		
■ Accuracy: (Code)	D1	D2	D3	D1	D2	D3
at 25°C	±0.025%	±0.05%	±0.1%	±0.025%	±0.05%	±0.1%
−20 to 85°C	±0.05%	±0.1%	±0.2%	±0.05%	±0.1%	±0.2%
■ Price (50-99 Quantity)	$165.00	$148.75	$136.00	$252.25	$191.25	$165.00
■ Power Consumption	350mW max.			950mW max.		

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INFORMATION RETRIEVAL NUMBER 54

A significant advance in silicon rectifier power handling capacity

3 new series of silicon rectifiers from Tung-Sol permit designers to meet extremely high power requirements.

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- **Average forward current to 500 Amperes**
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Controlled avalanche characteristics provide transient handling capability that results in increased reliability.

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Surge overload rating, 1 cycle—8500 Amperes
Controlled Avalanche Voltage—1100-2300 Volts

1611 SERIES
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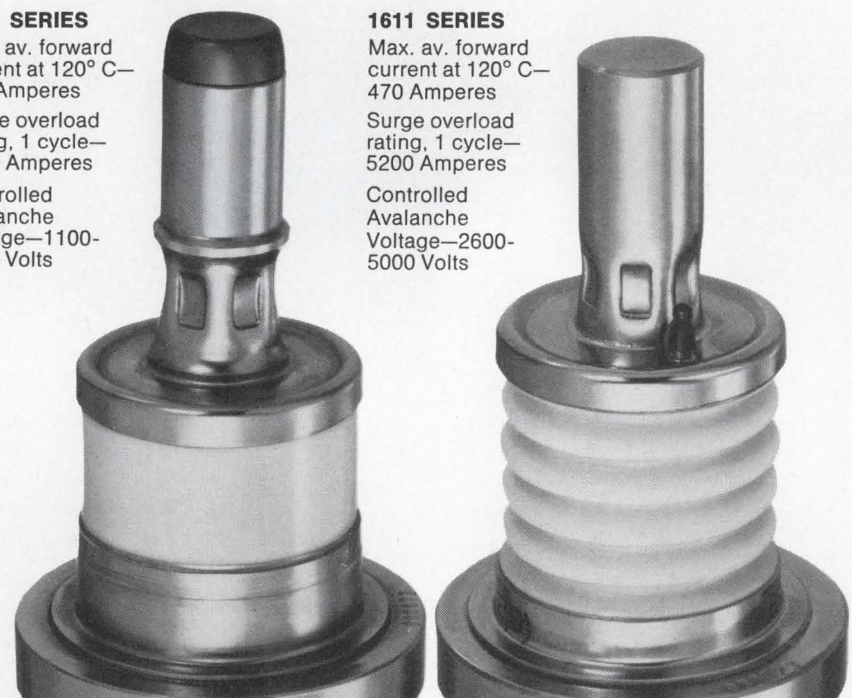
Surge overload rating, 1 cycle—5200 Amperes
Controlled Avalanche Voltage—2600-5000 Volts



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TUNG-SOL
High Power Silicon Rectifiers

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

Word Generators

Manufacturer	Model	Clock Rate Min Hz	Clock Rate Max MHz	Word Length (Bits)	Number of Channels	Bit Width (ns)	Bit Rise & Fall Time (ns)	Output Voltage (V)	Output Impedance (Ω)	Notes	Price $
Datapulse	215C	1	1	1-32	1	m	20	6	50	m	4750
GR	1395	2.5	1.2	16	n	n	n	10	150	n	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	pq	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	EC-22	1	8	32	8	a	6.5	5	ina	c	2500
H-P	8006A	0	10	2-16 4-32	NRZ/RZ	ina	15	5	50	s	825
Datapulse	201	0	10	16	1	NRZ	15	10	50	g	680
Datapulse	208A	1	10	1-16	10	j	10	7.5	50	j	6680
Adar	SQ260	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	SQ280	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	SQ320	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 R 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) +	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 ±14/10k	10	1M	3	±10-12	80	22	22	-55 to +125	(6)	req
FS	μA740C	(11)(21)	1,000,000M	75	±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^{11}	n/a	±10/2k	(13)	100k	4	±10	66	15	15	-25 to +85	(2)	20
Intech	A-101	(11)(20)	10^{11}	n/a	±10/2k	(13)	100k	4	±10	66	15	15	-25 to +85	(2)	25
Intech	A-102	(11)(20)	10^{11}	n/a	±10/2k	(13)	100k	4	±10	100	15	15	-25 to +85	(2)	33
Intech	A-103	(11)(20)	10^{11}	n/a	±10/2k	(13)	100k	4	±10	100	15	15	-25 to +85	(2)	40
Intech	A-122	(11)(20)	10^{12}	n/a	±10/2k	1.5 (13)	100k	10	±10	94	15	15	-25 to +85	(2)	60
Intech	A-123	(11)(20)	10^{12}	n/a	±10/2k	1.5 (13)	100k	10	±10	94	15	15	-25 to +85	(2)	70
Intech	A-124	(11)(20)	10^{12}	n/a	±10/2k	2 (13)	100k	4	±10	98	15	15	-25 to +85	(2)	95
Intech	A-125	(11)(20)	10^{12}	n/a	±10/2k	2 (13)	100k	4	±10	98	15	15	-25 to +85	(2)	84
Intech	A-126	(11)(20)	10^{13}	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^{13}	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^{12}	n/a	±10/500	(13)	50k	20	±10	80	15	15	-25 to +85	(2)	68
Intech	A-131	(11)(20)	10^{12}	n/a	±10/500	(13)	50k	20	±10	80	15	15	-25 to +85	(2)	68
Intech	A-136	(11)(20)	10^{12}	n/a	±10/500	1(13)	100k	20	±10	94	15	15	-25 to +85	(2)	75
Intech	A-137	(11)(20)	10^{12}	n/a	±10/500	1(13)	100k	20	±10	94	15	15	-25 to +85	(2)	85
Intech	A-148A	(11)(20)	10^{11}	n/a	±10/500	(13)	50k	15*	±10	72	15	15	-25 to +85	(2)	40
Intech	A-148B	(11)(20)	10^{11}	n/a	±10/500	(13)	50k	15	±10	72	15	15	-25 to +85	(2)	45
Intech	A-148C	(11)(20)	10^{11}	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

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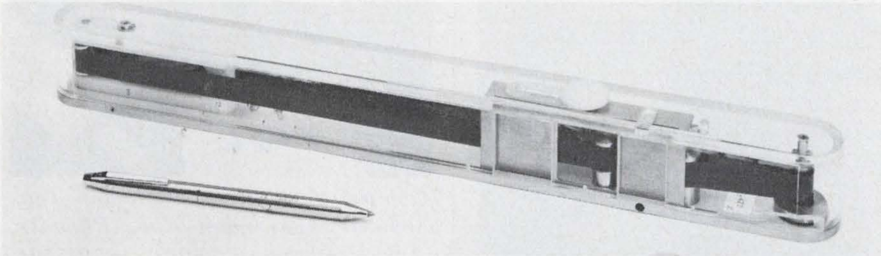
Mfr.	Device Number	Notes	Differential Input Impedance Typical (ohms)	Differential Output Impedance Typical (ohms)	Output Voltage Swing/Load Resistance Maximum (Volts/ohms)	Input Offset Voltage (mV)	Dc Voltage Gain	Unity Gain Bandwidth (MHz)	Common Mode Input Voltage Maximum (Volts)	Common Mode Rejection Ratio (Decibels)	Supply Voltages (Volts) +	Supply Voltages (Volts) -	Operating Temperature Range (°C)	Package Type	Price per Unit
Intech	A-160	(11)(20)	10^{11}	n/a	±50/10k	1 (13)	200k	6	±50	90	60	60	-25 to +85	(2)	85
Intech	A-180A	(14)(20)	5M	n/a	±10/4k	1	300k	1	±10	100	15	15	-25 to +85	(2)	75
Intech	A-180B	(14)(20)	5M	n/a	±10/4k	0.1	300k	1	±10	100	15	15	-25 to +85	(2)	98
Intech	A-180J	(14)(20)	5M	n/a	±10/4k	0.25	300k	1	±10	100	15	15	-25 to +85	(2)	72
Intech	A-180K	(14)(20)	5M	n/a	±10/4k	0.1	300k	1	±10	100	15	15	-25 to +85	(2)	90
Intech	A-183J	(14)(20)	2M	n/a	±10/2k	3	200k	0.5	±10	100	15	15	-25 to +85	(2)	33
Intech	A-183K	(14)(20)	2M	n/a	±10/2k	0.5	200k	0.5	±10	100	15	15	-25 to +85	(2)	44
Intech	A-183L	(14)(20)	2M	n/a	±10/2k	0.5	200k	0.5	±10	100	15	15	-25 to +85	(2)	62
Intech	A-190	(11)(20)	10^{11}	n/a	±10/2k	5	1	0.8	±10	80	15	15	-25 to +85	(2)	18
Intech	A-191	(11)(20)	10^{11}	n/a	±10/2k	3	1	0.8	±10	86	15	15	-25 to +85	(2)	23
Intech	A-300	(11)(20)	10^{11}	n/a	±140/28k	3 (13)	100k	1	±125	100	150	150	-25 to +85	(2)	80
Intech	A-301	(11)(20)	10^{11}	n/a	±140/28k	3 (13)	100k	1	±125	100	150	150	-25 to +85	(2)	90
Intech	A-401	(16)(20)	10k	n/a	±10/100	200	1	1	±10	n/a	15	15	-25 to +85	(2)	30
Intech	A-440	(11)(20)	10^{12}	n/a	±10/100	(13)	50k	20	±10	80	15	15	-25 to +85	(2)	82
Intech	A-1005	(17)(20)	2M	n/a	±10/500	6	25k	1	±10	86	15	15	-25 to +85	(2)	18.50
Intech	A-1026	(11)(20)	10^{11}	n/a	±10/2k	1 (13)	250k	1.5	±10	94	15	15	-25 to +85	(2)	85
Intech	A-1027	(11)(20)	10^{11}	n/a	±10/2k	1 (13)	250k	1.5	±10	94	15	15	-25 to +85	(2)	65
Intech	A-240	(18)(20)	400k	n/a	±10/1k	0.010	10^7	1	n/a	n/a	15	15	-25 to +85	(2)	91
Intech	A-241	(18)(20)	400k	n/a	±10/1k	0.010	10^7	1	n/a	n/a	15	15	-25 to +85	(2)	97
Intech	A-230J	(18)(20)	400k	n/a	±10/2.5k	0.015	10^7	1	n/a	n/a	15	15	-25 to +85	(2)	64
Intech	A-230K	(18)(20)	400k	n/a	±10/2.5k	0.015	10^7	1	n/a	n/a	15	15	-25 to +85	(2)	80
Intech	A-230L	(18)(20)	400k	n/a	±10/2.5k	0.010	10^7	1	n/a	n/a	15	15	-25 to +85	(2)	85
Intech	A-225	(18)(20)	400k	n/a	±10/500	0.050	10^7	16	n/a	n/a	15	15	-25 to +85	(2)	85
Intech	A-226	(18)(20)	400k	n/a	±10/500	0.050	10^7	16	n/a	n/a	15	15	-25 to +85	(2)	95
Intech	A-200	(11)(19) (20)	10^{12}	n/a	±10/2k	(13)	1-1000	1.5	±10	96	15	15	-25 to +85	(2)	49
Philco	PLR709	(5)(21)	400k	100	±14/2, 10k	±1.5	45k	1	±10	90	18	18	-55 to +125	(1)	53
Philco	PA7709	(4)(21)	400k	150	±15/2, 10k	1	45k	1	±10	90	18	18	-55 to +125	(1)(3)(7)	4.60- 7.50
Philco	7709A	(4)(21)	750k	150	±13/2k ±14/10k	0.5	45k	1	±8	115	36	36	-55 to +125	(1)(3)(7)	11- 16.20
Philco	PA7709C	(4)(21)	250k	150	±13/2k ±14/10k	2	45k	1	±10	90	18	18	0 to 70	(7)	req
Philco	PA7712	(4)(21)	60k	200	±4/10k ±5.3/100k	0.5	3600	60	ina	95	21	21	-55 to +125	(1)(3)(7)	6.60
Philco	PA7712C	(4)(21)	32k	200	±4/10k ±5.3/100k	1.5	3400	60	ina	86	21	21	0 to 70	(1)(3)(7)	2.25
Philco	7741C	(4)(21)	2M	75	±13/2k ±14/10k	2	200k	1	±13	90	18	18	0 to 70	(1)(3)(7)	req
PM	SSS747	(4)(10) (21)	2M	n/a	±15/10k	2	100V/mV	ina	ina	80	22	22	-55 to +125	(1)(3)	60-75
PM	SSS101A	(4)(21)	2M	n/a	±15/10k	1.8	100V/mV	ina	ina	80	22	22	-55 to +125	(1)(2)(6)	45-60
PM	SS201A	(4)(21)	1.5M	n/a	±15/10k	2	50V/mV	ina	ina	80	22	22	-25 to +85	(1)(2)(6)	18-20
PM	SS107	(4)(21)	2M	n/a	±15/10k	1.8	100V/mV	ina	ina	80	22	22	-55 to +125	(1)(2)(6)	50-60
PM	SSS207	(4)(21)	1.5M	n/a	±15/10k	2	50V/mV	ina	ina	80	22	22	-25 to +85	(1)(2)(6)	20-22
PM	SSS741	(4)(21)	2M	n/a	±15/10k	2	100V/mV	ina	ina	80	22	22	-55 to +125	(1)(2)(6)	40-54
PM	SSS741B	(4)(21)	2M	n/a	±15/10k	3	50V/mV	ina	ina	80	22	22	-25 to +85	(1)(2)(6)	16-18
PM	SSS747B	(4)(10) (21)	2M	n/a	±15/10k	3	50V/mV	ina	ina	80	22	22	-25 to +85	(1)(3)	32-42
PM	SSS725	(4)(21)	0.7M	n/a	±12.5/10k	0.5	1M	ina	ina	120	22	22	-55 to +125	(6)	56-70
Solit	UC4741C	(4)(21)	1M	n/a	±14/10k	1	200k	ina	±13	90	22	22	-55 to +125	(6)	req
Solit	UC4741	(4) (21)	2M	75	±14/10k	2	200k	ina	±13	90	18	18	0 to 70	(6)	req
Solit	UC4000	(4)(21)	2.5M	n/a	±10/10k	5	20k	1	±10	90	±5	±18	-55 to +125 0 to 70	(3)(7)	req
Solit	UC4101	(21)	800k	n/a	±14/10k	1	25k	1	±12	90	22	22	-55 to +125	(1)(7)	req
Solit	UC4201	(21)	400k	n/a	±14/10k	1	25k	1	±12	90	22	22	0 to 70	(1)(7)	req
Solit	UC4101A	(21)	4M	n/a	±14/10k	0.7	25k	1	±15	96	22	22	-55 to +125	(1)(3)(7)	req
Solit	UC4201A	(21)	4M	n/a	±14/10k	0.7	25k	1	±15	96	22	22	-25 to +85	(1)(3)(7)	req
Solit	UC4301A	(21)	2M	n/a	±14/10k	2	15k	1	±12	90	18	18	0 to 70	(7)	req
Solit	UC4250C	(21)	3M	n/a	±10/10k	6	75k	0.3	±12	70	±1	±18	0 to 70	(1)(3)(7)	req
Solit	UC4250	(21)	3M	n/a	±10/10k	3	100k	0.3	±12	70	±1	±18	-55 to +125	(1)(3)(7)	req
TI	SN72741	(4)(21)	1M	n/a	±2/13k	2	100k	ina	ina	90	18	18	0 to 70	(1)	req
TI	RSN52709	(4)(5) (21)	100k	150	15/10k	1	40k	ina	ina	90	18	18	-55 to +125	(1)	req
TI	SN72709 DN	(4)(10) (21)	250k	150	±10/2k	2	45k	ina	ina	90	18	18	0 to 70	(1)(3)(7)	req
TI	SN72709 AN	(4)(21)	400k	150	±15/10k	1	50k	ina	ina	90	18	18	0 to 70	(1)(3)(7)	req
TI	SN72709	(4)(21)	250k	150	±14/10k	10	45k	ina	ina	90	18	18	0 to 70	(1)(3)(7)	req
TI	SN52709A	(4)(21)	185k	150	15/10k	0.6	25-70k	ina	ina	110	18	18	-55 to +125	(1)(3)(7)	req
TI	SN52709	(4)(21)	100k	150	15/10k	1	45k	ina	ina	90	18	18	-55 to +125	(1)(3)(7)	req
TI	SN72702	(4)(21)	6k	200	±5/100k	1.5	1000	ina	ina	92	21	21	0 to 70	(1)(3)(7)	req
TI	SN52702A	(4)(21)	6k	200	±5/100k	0.5-2	1000	ina	ina	65	21	21	-55 to +125	(1)(3)(7)	req
TI	SN52702	(4)(21)	3k	200	±5/100k	6.5	800	ina	ina	65	21	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) +	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

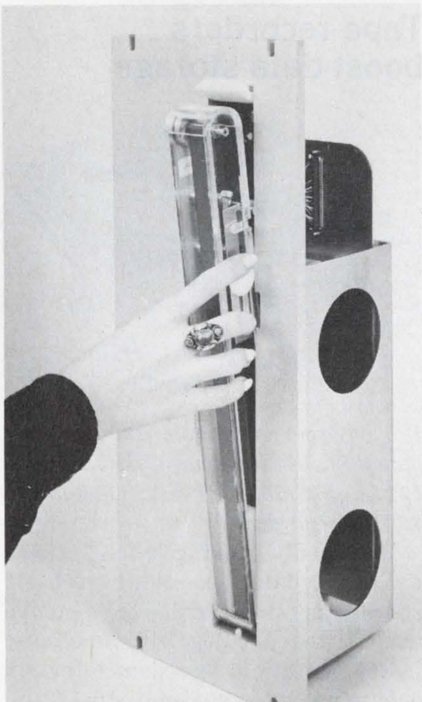
(1) FL − Flat pack
(2) Epoxy
(3) DIL − Dual-in-line package
(4) General purpose
(5) Radiation hardened operational amplifier
(6) TO-99 can
(7) Metal can
(8) TO-100 can
(9) Differential
(10) Dual op amp
(11) FET input op amp
(12) Inverting op amp
(13) Input offset voltage adjustable to zero
(14) Low drift 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

$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 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.



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.

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.

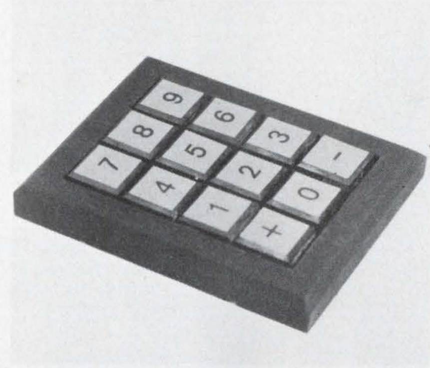
The entire Comfile magazine and drive combination has only three moving parts for high reliability. The tape head and tape cleaners are the only parts that touch the oxide side of the tape.

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

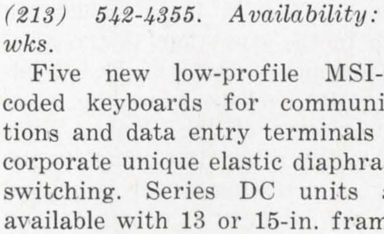


Chomerics, Inc., 77 Dragon Court, Woburn, Mass. Phone: (617) 935-4850. Price: $9.50 for 12 keys.

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

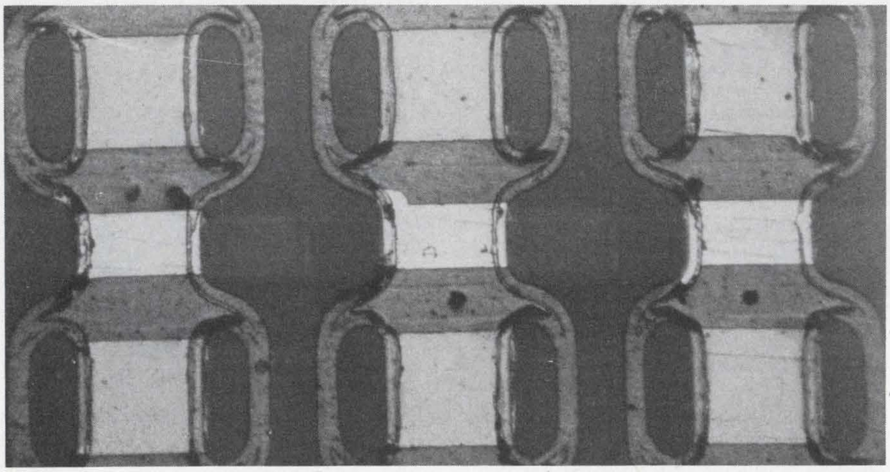


Datanetics Corp., 2828 Spreckels Lane, Redondo Beach, Calif. Phone: (213) 542-4355. Availability: 2 wks.

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-readout 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.

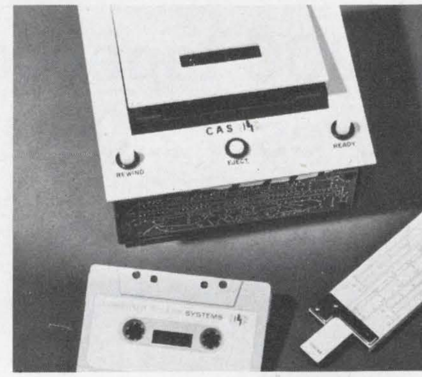
There are two adjacent memory elements per bit in the flux-ring memory resulting in 100% redundancy. Although the failure of one of the two elements will cause a degraded output of that element, the remaining element will still function as a storage unit.

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

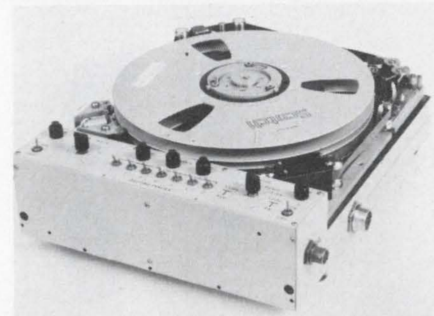


Computer Access Systems, Inc., 3050 W. Clarendon Ave., Phoenix, Ariz. Phone: (603) 279-5591. P&A: $720; 10 days.

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. Halladay 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

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

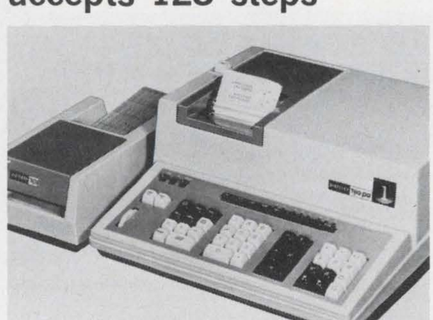
Desktop calculator simplifies operation

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 μs. 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 ±3 dB. Frequency range is 100 Hz to 20 kHz.

CIRCLE NO. 351

Printing calculators offer 14 registers

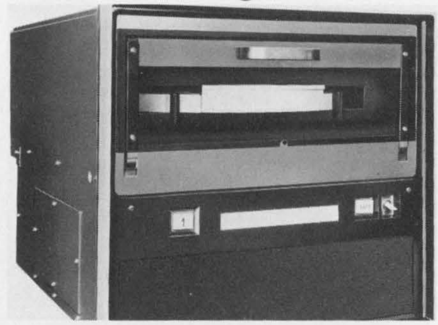
Wang Laboratories Inc., 836 North St. Tewksbury, Mass. Phone: (617) 851-7311. Price: $1495 to $2295.

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

DATA PROCESSING

Universal disk memory stores 12 megabits

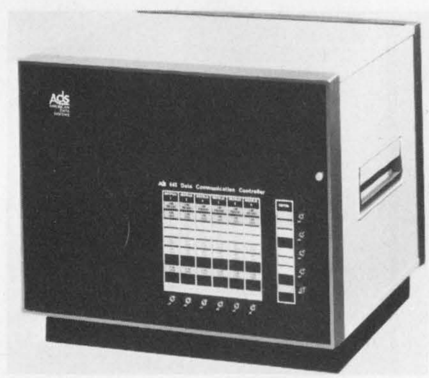


Dynacoustics, Inc., 1980 National Ave., Hayward, Calif. Phone: (415) 783-5614. P&A: $9950; 60 to 90 days.

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

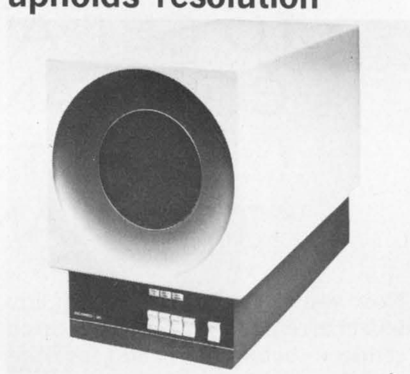


American Data Systems, 8851 Mason St., Canoga Park, Calif. Phone: (213) 882-0020.

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

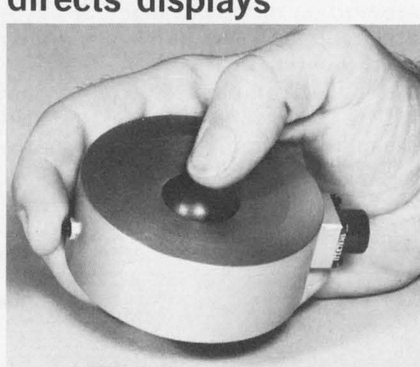


Dicomed Corp., 7600 Parklawn Ave., Minneapolis, Minn. Phone: (612) 920-8980. Price: from $15,000 (display), $29,500 (digitizer).

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

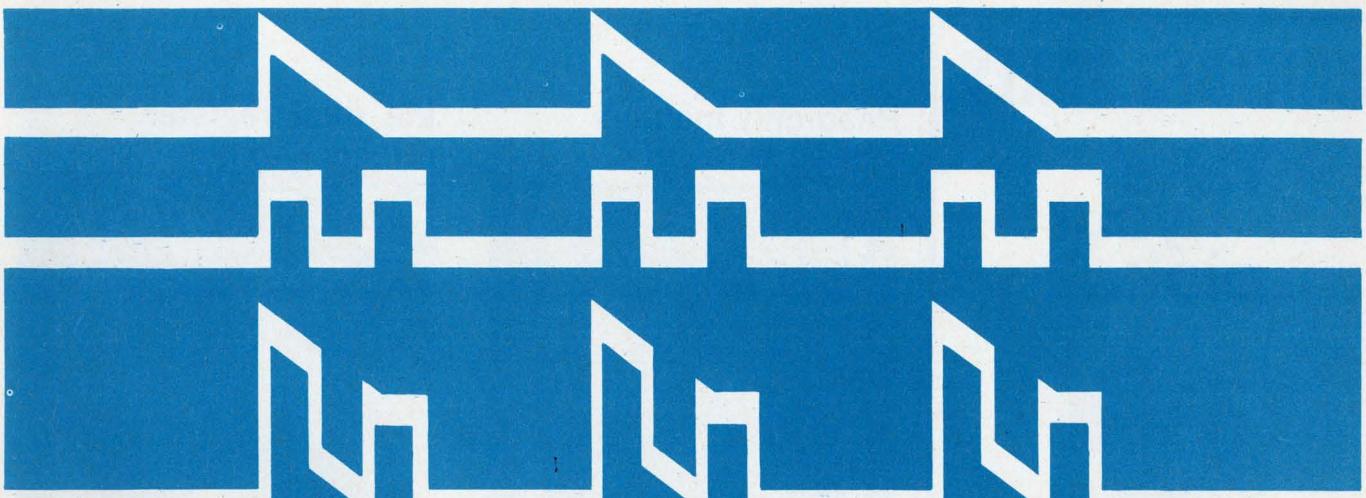
Track ball control directs displays

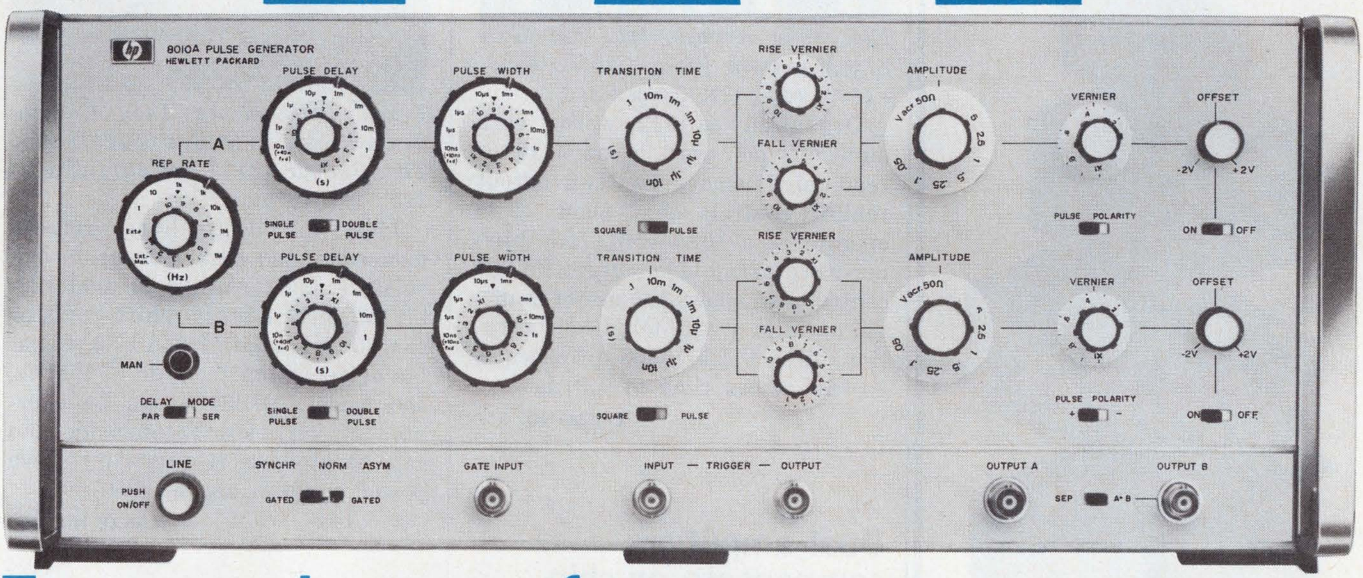


Singer-Librascope, 1100 Francis Court, Glendale, Calif. Phone: (213) 245-8591.

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.

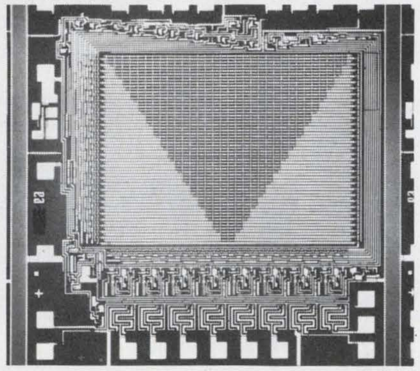
080/18

HEWLETT hp PACKARD

SIGNAL SOURCES

INFORMATION RETRIEVAL NUMBER 62

Read-only memory can be wire-OR'd

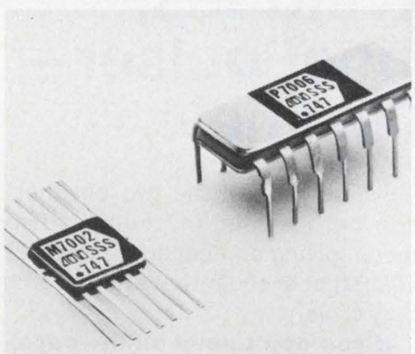


Electronic Arrays, Inc., 501 Ellis St., Mountain View, Calif. Phone: (415) 964-4321. Price: $60.

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 μs.

CIRCLE NO. 357

Dual amplifiers compensate on-chip

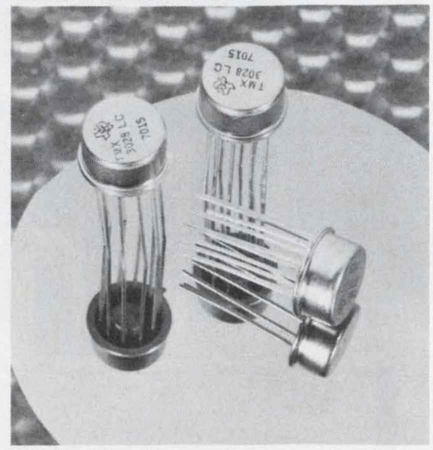


Precision Monolithics Inc., 1500 Space Park Dr., Santa Clara, Calif. Phone: (408) 246-9222. P&A: $24 or $60; stock.

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°C for the SSS747, and −25 to +85°C for the SSS747B. Input resistance is 2 MΩ.

CIRCLE NO. 358

LSI dual register retains 256 bits

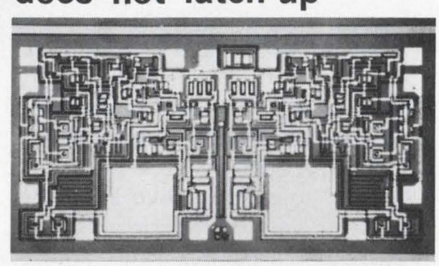


Texas Instruments Inc., Components Group, P. O. Box 5012, Dallas, Tex. Phone: (214) 238-2011. P&A: $20; 2 to 4 wks.

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 μmho and typical forward transconductance is 4500 μmho.

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

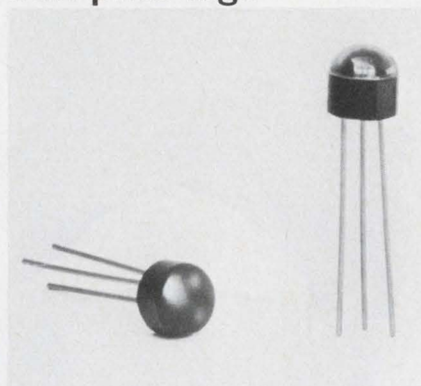
Counter/divider dissipates 5μW

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 μW 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

Visible LEDs trim price tags

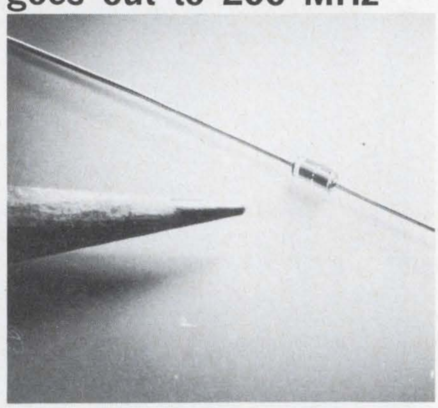


Fairchild Camera and Instrument Corp., Microwave and Optoelectronics Div., 2513 Charleston Rd., Mountain View, Calif. Phone: (415) 961-9644. P&A: 99¢ to $3; stock.

Two new visible light-emitting diodes, the FLV100 and the FLV-101, 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

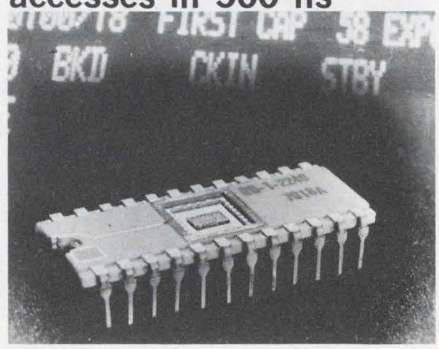
Unpackaged chips are fully tested

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 ASC11-coded inputs for 5 by 7 character selection. It provides asynchronous/synchronous operation.

CIRCLE NO. 367

You don't have to baby this beauty.

CLASSIC II Cabinets combine a designer's genius with painstaking engineering and expert fabrication. The result is enclosures that more than meet the desire for sheer beauty and flawless construction using aluminum as the medium.

- **CLASSIC II** is a standard product having the appearance of being custom designed.
- Compared to similar products, it is less costly.
- Has close tolerances and is unusually rugged.
- Strikingly attractive with distinctive colors.
- Production quantities are available immediately.

Send for **CLASSIC II** literature and name of closest Bud Distributor handling **CLASSIC II** cabinets.

BUD

BUD RADIO, INC.
Willoughby, Ohio 44094

INFORMATION RETRIEVAL NUMBER 66

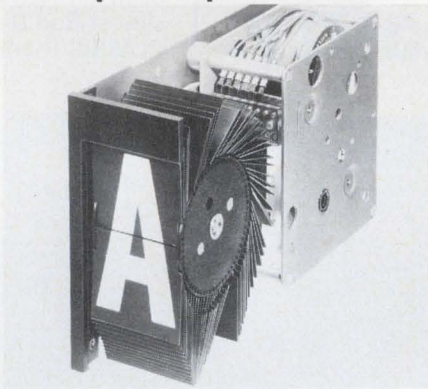
Ceramic FM i-f filter retails as low as $1.20

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 ±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 Ω. Operating range is −30 to +80°C.

CIRCLE NO. 368

Alphanumeric displays use split flaps

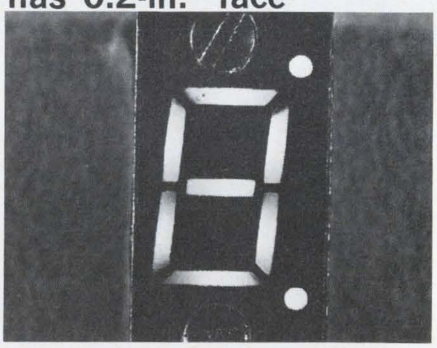


Conrac Corp., 330 Madison Ave., New York, N. Y. Phone: (212) 687-3330.

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.^{2} 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 subminiature 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 Ω to 100 kΩ 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

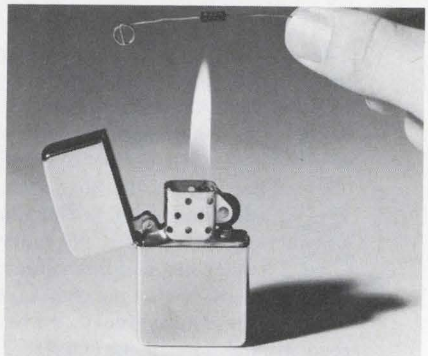
Latching reed switch uses magnetic contacts

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 μs causes the switch to respond in 1 ms. Rating is 200 V dc at 0.5 A dc and contact resistance is 0.1 Ω at 1 V dc and 10 mA dc.

CIRCLE NO. 374

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/°C, Temp-Istor temperature sensing or compensating precision wire-element resistors retail from 75¢ in quantities of 100. Resistance value at 25°C is 100 Ω ±0.25% and operating temperature range is −55 to +125°C. Special-order elements can be made.

CIRCLE NO. 375

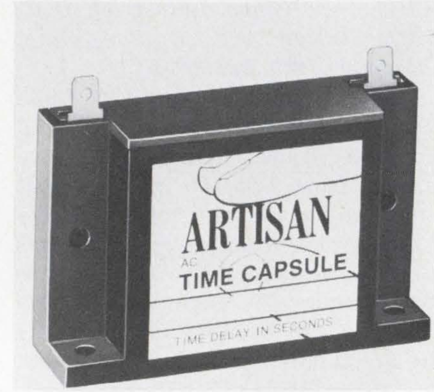
Dual-gun storage tube displays in 2 colors

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 halftone 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-μs durations will not cause premature operation.

CIRCLE NO. 377

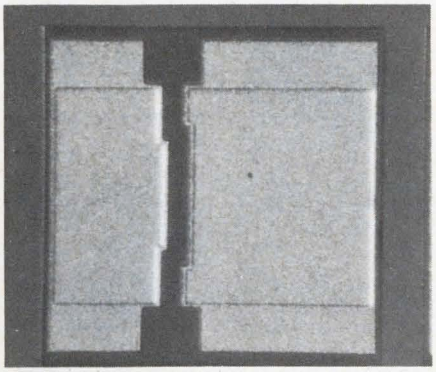
Solid-state relays isolate input/output

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 (fieldplate) which does not require a separate reference voltage.

CIRCLE NO. 378

MOS chip capacitors span 0.5 to 220 pF

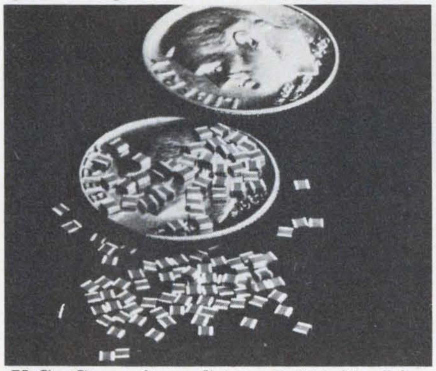


Dionics Inc., 65 Rushmore St., Westbury, N.Y. Phone: (516) 997-7474.

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

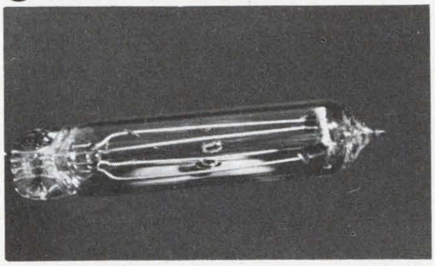


U.S. Capacitor Corp., 2151 N. Lincoln St., Burbank, Calif. Phone: (213) 843-4222.

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



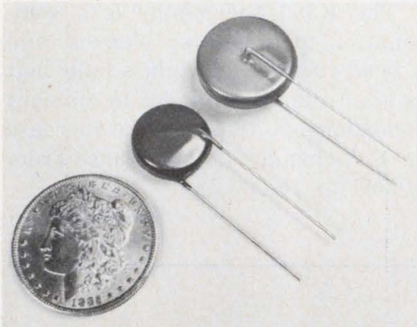
Fenwal Electronics Inc., 63 Fountain St., Framingham, Mass. Phone: (617) 872-8841.

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

INFORMATION RETRIEVAL NUMBER 70

Disc capacitors accept 10 kV dc

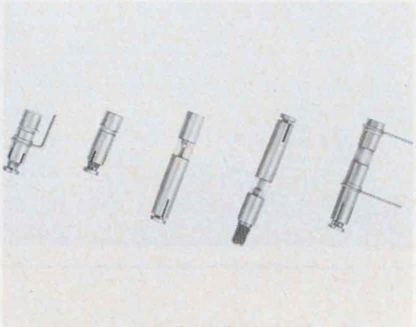


Centralab, 5757 N. Green Bay Ave., Milwaukee, Wis. Phone: (414) 228-2769. P&A: from 21¢; 5 to 7 wks.

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

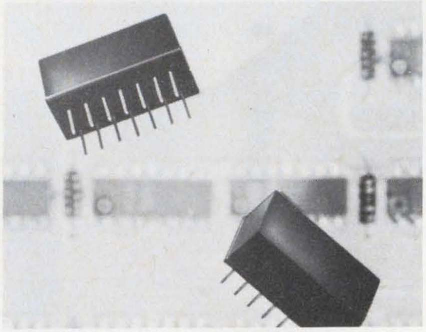


Johanson Mfg. Corp., 400 Rockaway Valley Rd., Boonton, N. J. Phone: (201) 334-2676.

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 μF

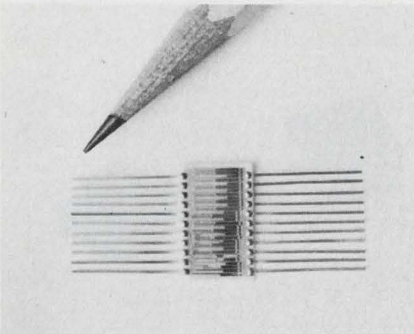


S&EI Mfg., 18800 Parthenia St., Northridge, Calif. Phone. (213) 349-4111.

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 μF and with a tolerance to ±1%. Operating temperatures are −55 to +105°C. Special designs are also available. Applications include integrated circuits where stringent space requirements exist.

CIRCLE NO. 384

Flatpack 12-bit ladder is accurate to ±125 ppm

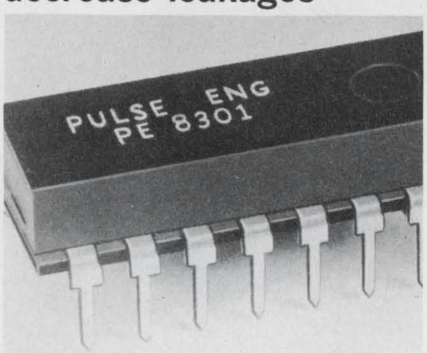


Halex, Inc., 3500 W. Torrance Blvd., Torrance, Calif. Phone: (213) 370-6175. Price: $58.50.

The HX510 12-bit flatpack ladder network has total output accuracy of ±125 ppm ±1/2 the least significant bit over the temperature range of −55 to +125°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

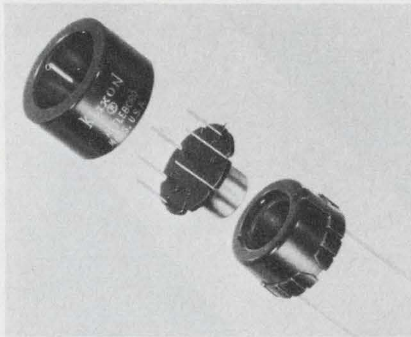


Pulse Engineering, Inc., Box 12235, San Diego, Calif. Phone: (714) 453-6010. P&A: $18.50; stock.

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 μH and of 6 pF, respectively. Inductance values from 20 to 500 μH and turns ratios of 1:1 and 2:1 are available. Peak pulse voltage rating is 50 V and insulation resistance is 10,000 MΩ.

CIRCLE NO. 386

Temperature stabilizer regulates in 1 minute

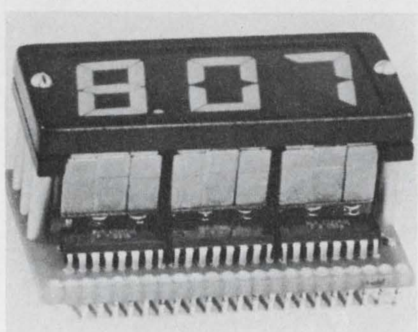


Texas Instruments, Inc., Control Products Div., Attleboro, Mass. Phone: (617) 222-2800.

A new solid-state self-regulating TO-5-cased device operates without thermostatic controls to self-stabilize both itself and contained components at 65°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°C below its control temperature. Operating voltage is 24 V ac or dc.

CIRCLE NO. 387

Segmented readouts vary brightness equally

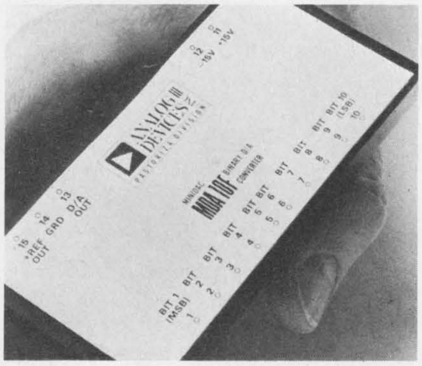


Readouts, Inc., 215 15 St., Del Mar, Calif. Phone: (714) 755-2641. P&A: $7 per decade; stock.

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

10-bit d/a converter settles within 40 ns

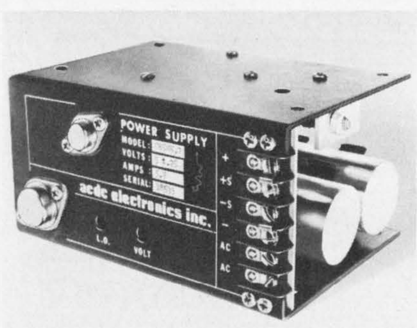


Analog Devices, Inc., Pastoriza Div., 221 Fifth Ave., Cambridge, Mass. Phone: (617) 492-6000. P&A: $370; 3 wks.

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 ±15 V.

CIRCLE NO. 389

Economy supplies deliver 150 W

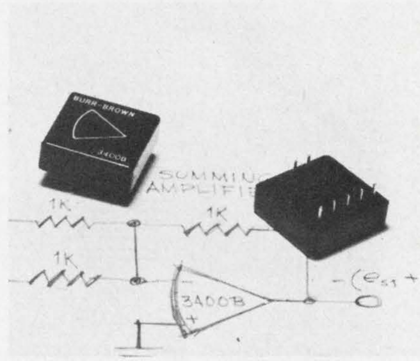


ACDC Electronics Inc., Oceanside Industrial Center, Oceanside, Calif. Phone: (714) 757-1880. P&A: $51 to $110; stock.

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/μs

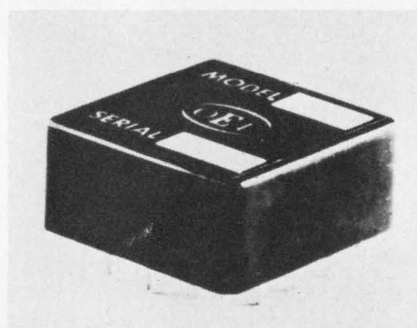


Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. Phone: (602) 294-1431. P&A: $55; stock.

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/μs. 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 ±10 V at 0.5 A, the model 9695 operational amplifier offers a slewing rate of 100 V/μs 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 μV/°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

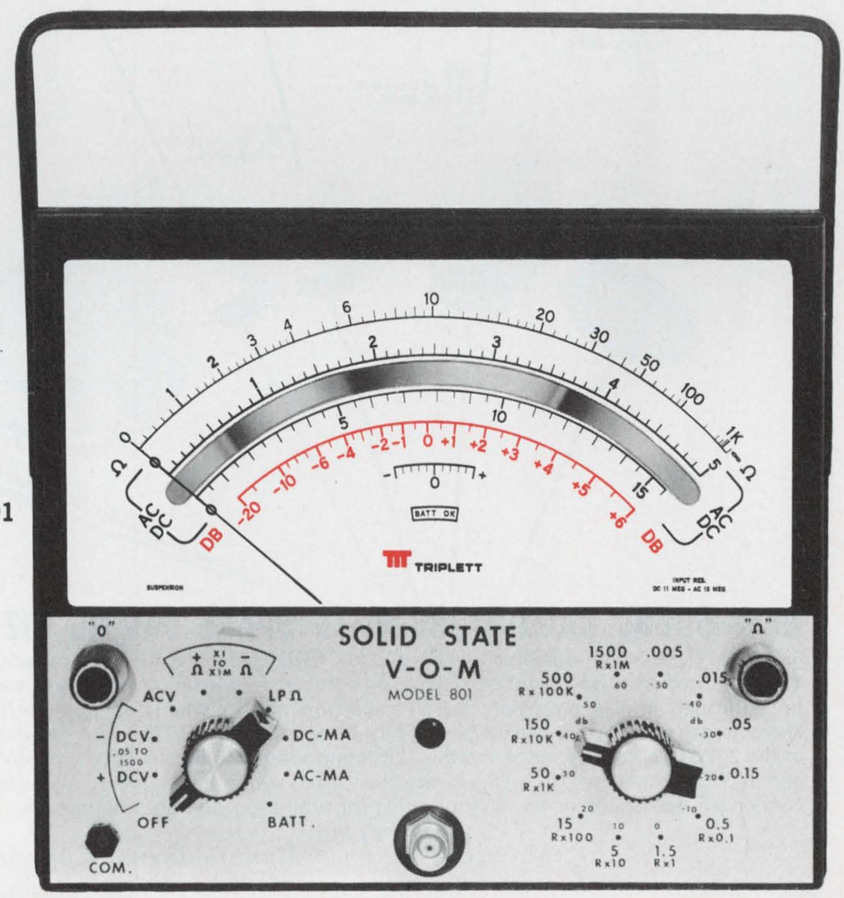
Triplett's new Model 801 V-O-M offers 73 measurement ranges including 8 low-power resistance ranges that apply only 35 mV to the device under test. There are 22 voltage ranges—10 DC and 12 AC; 24 current ranges divided equally between DC and AC; 15 resistance ranges—including the 8 low-power ranges; 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 uA suspension-type meter with a nearly 7½" long scale. There's no doubt that the new Triplett 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 Triplett distributor. For more information—or for a free, no-obligation demonstration—call him or your Triplett sales representative right away. Triplett Corporation, Bluffton, Ohio 45817.

TRIPLETT

The World's most complete line of V-O-M's . . . choose the one that's just right for you

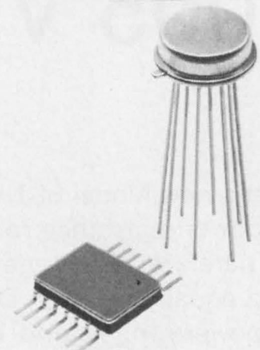


Model 801

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

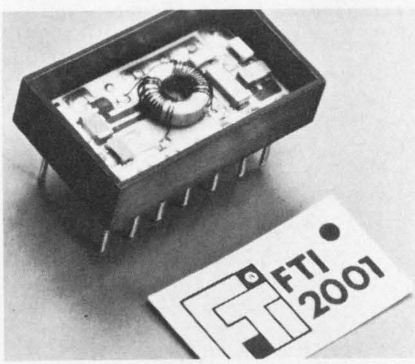


Kulite Semiconductor Products, Inc., 1039 Hoyt Ave., Ridgefield, N. J. Phone: (201) 945-3000.

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 $\mu V/°C$. 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

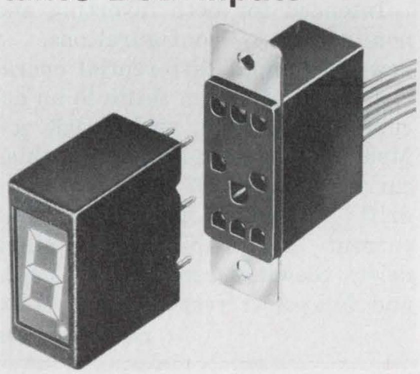
Modular phase shifter puts out square wave

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

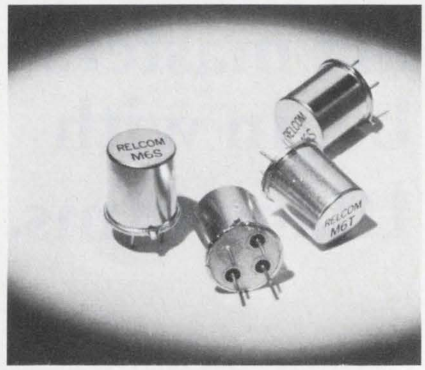


Alco Electronic Products, Inc., Alco-Display Div., Lawrence, Mass. Phone: (617) 686-3880. P&A: $29.45; stock.

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

Uhf/vhf mixers hold down noise

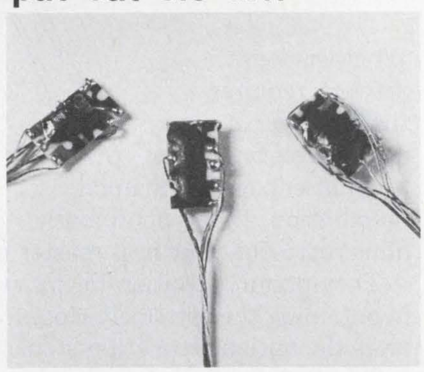


Relcom, 2329 Charleston Rd., Mountain View, Calif. Phone: (415) 961-6265. P&A: $52 or $55; stock.

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

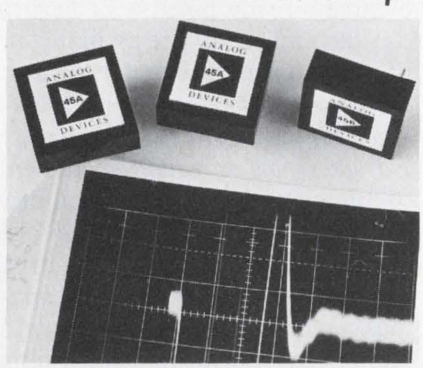


ASC Microelectronics, div. of Acousticon Systems Corp., Shelter Rock Lane, Danbury, Conn. Price: $7.99 to $10.49.

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 μs



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 μs. Model 45J provides 50-pA bias current and ±50-μV/°C voltage drift; model 45K offers 25-pA bias current and ±15-μV/°C voltage drift. Slewing rate is 75 V/μs, and full-power response is 1 MHz.

CIRCLE NO. 398

Wideband op amp slews 1000 V/μs

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/μs. The unit also offers a settling time of 250 ns to 0.1%, and an output of ±10 V at 50 mA. Its voltage stability is 10 μV/°C, and current stabiilty is 0.3 nA/°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.

PHILIPS

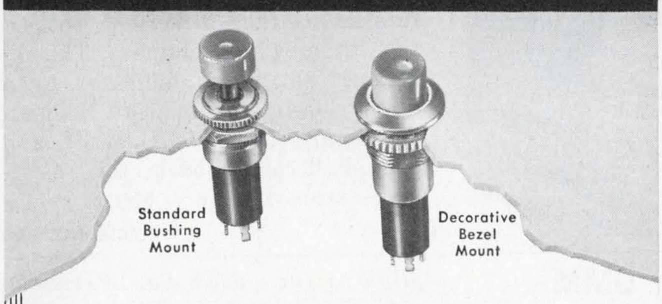
** Registered trade-mark of N. V. Philips' Gloeilampenfabrieken, Eindhoven.the Netherlands.*

INFORMATION RETRIEVAL NUMBER 79

NEW ALTERNATE ACTION PUSH BUTTON SWITCHES

(Push-On, Push-Off)

...the Reliable Ones by Grayhill



250,000 operations – WITHOUT A MISS.

- SPDT, SPST
- ¼ Amp., 115 VAC resistive
- Totally enclosed
- Space saving - .937" behind panel
- Momentary action counterpart available

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Grayhill INC

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

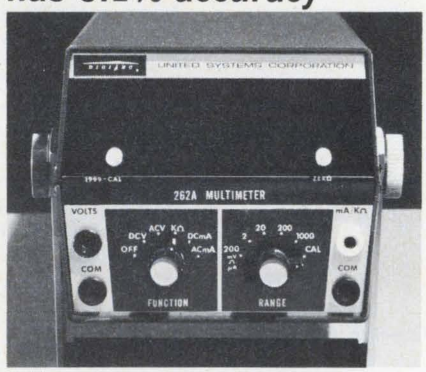
DVM costing $350 is 0.1% accurate

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 ±0.1% of the measured reading and ±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

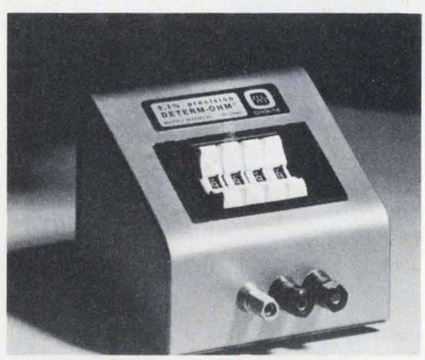


United Systems Corp., 918 Woodley Rd., Dayton, Ohio. Phone: (513) 254-6251. P&A: $375; 4 wks.

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 ±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 Ω to 1 MΩ.

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 iself by generating a zero-correction signal.

CIRCLE NO. 401

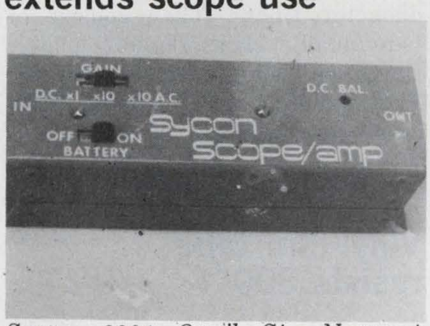
Transistor analyzer tests gain and leakage

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 readout 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 μA 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 ±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/μs when driving a 100-pF load. Input impedance is 1 MΩ shunted by 15 pF.

CIRCLE NO. 407

INFORMATION RETRIEVAL NUMBER 83

INFORMATION RETRIEVAL NUMBER 84

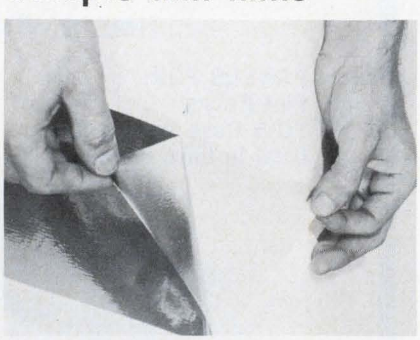
Plastic-connector kit makes low-cost mates

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

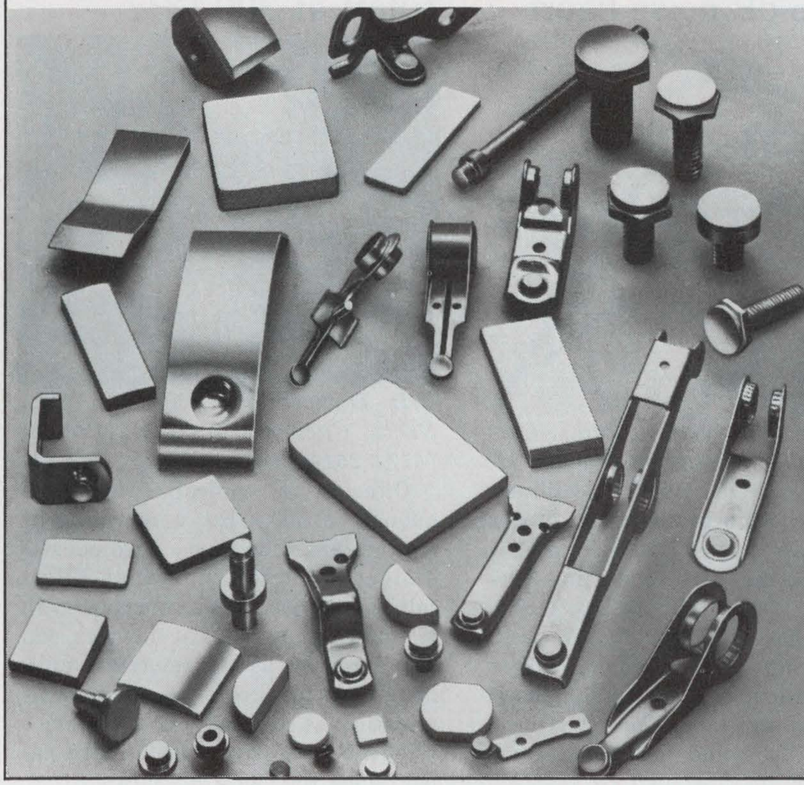
Vinyl-film tape resists 300°F

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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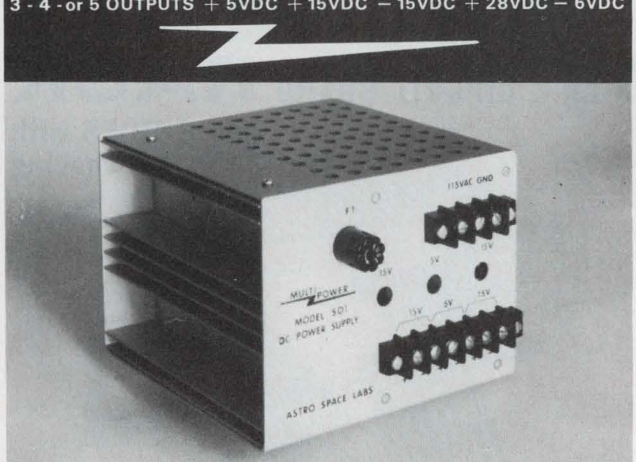
INFORMATION RETRIEVAL NUMBER 86

Introducing MULTIPOWER

MULTI-OUTPUT MODULAR POWER SUPPLIES

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

Another tiny parts FIRST from GRC®

Now join 2 different plastics in a single small part

WITH Intermold®

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—"Intermold" — 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

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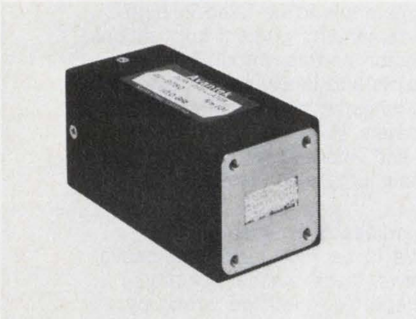
In Canada: Gries Div., Dynacast Ltd. Lachine, Que.

INFORMATION RETRIEVAL NUMBER 88

Gunn-effect sources work from 28 V dc

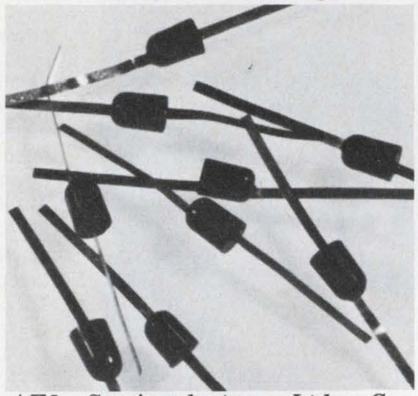


Avantek, Inc., 2981 Copper Rd., Santa Clara, Calif. Phone: (408) 739-6170. P&A: from $695; 60 days.

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

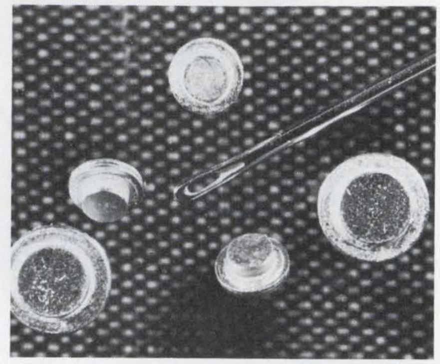


AEI Semiconductors Ltd., Carholme Rd., Lincoln, England.

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

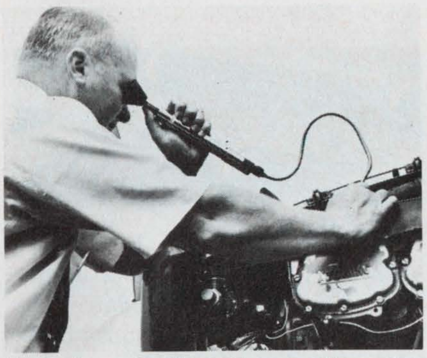


GHz Devices, Inc., Kennedy Dr., North Chelmsford, Mass. Phone: (617) 251-4981.

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 ±10%.

CIRCLE NO. 415

Fiber-optic scopes inspect most areas

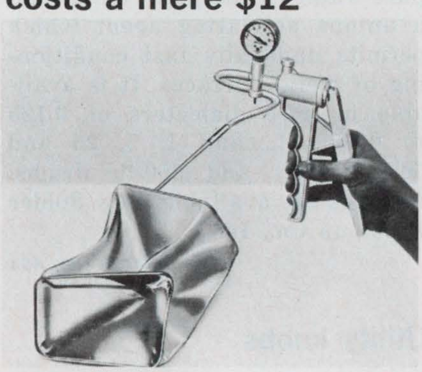


American Optical Corp., Fiber Optics Div., Southbridge, Mass. Price: $440.

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

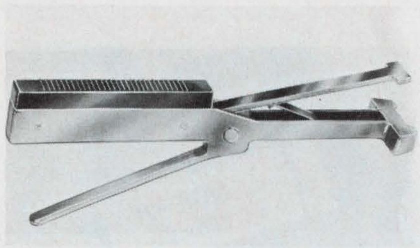


Edmund Scientific Co., 380 Edscorp Bldg., Barrington, N. J. P&A: $12; stock.

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

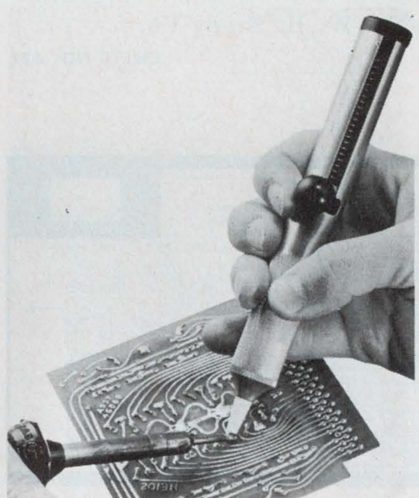


Jonard Industries Corp., Precision Tools Div., 3047 Tibbett Ave., Bronx, N. Y. Price: $8.90.

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

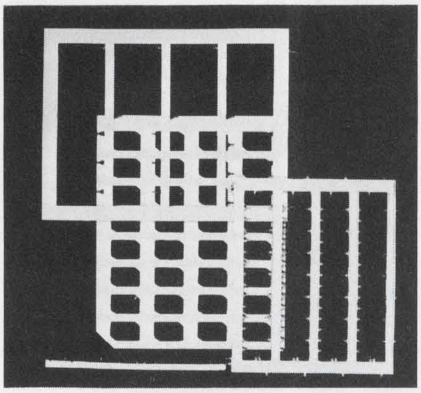


Techni-Tools, Inc., 1216 Arch St., Philadelphia, Pa. Phone: (215) 568-4457.

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

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.

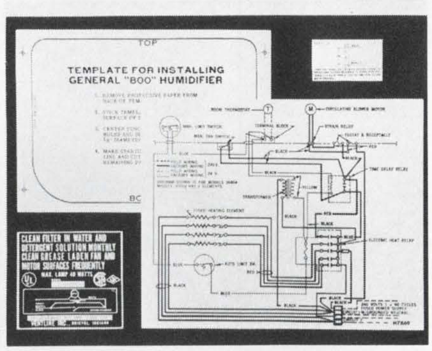
In addition, noise pick-up from adjacent conductors is minimized, and some shielding from radiated ambient noise can be realized. The large surface area and thermal mass of Mini/Bus structures also protect circuitry by acting as heat sinks. Rogers Corp.

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 subsurface 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.

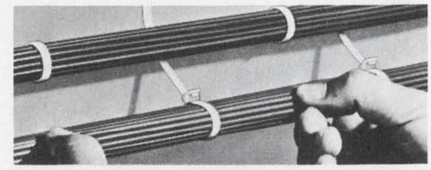
CIRCLE NO. 421



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 subassembly 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.

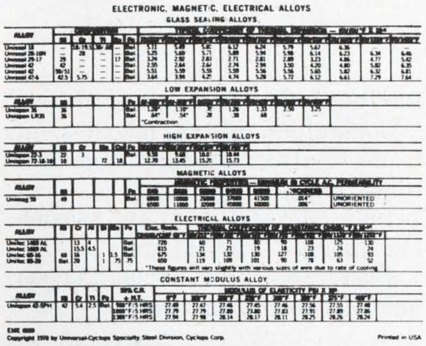
CIRCLE NO. 424

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
LOW EXPANSION ALLOYS
HIGH EXPANSION ALLOYS
MAGNETIC ALLOYS
ELECTRICAL ALLOYS
CONSTANT MODULUS ALLOY
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Low-loss dielectrics

Twenty-one low-loss dielectric materials are descriped 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

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

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 nondestructive 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

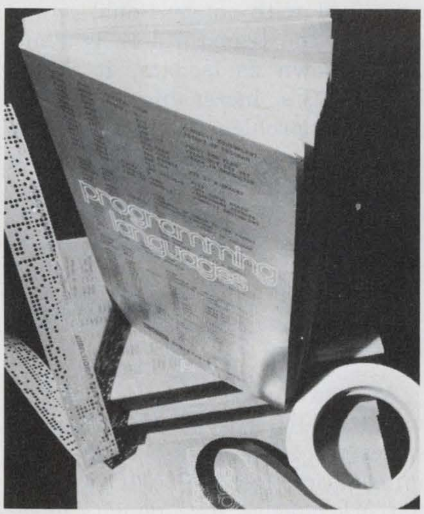
A protection circuit for gate oxides when testing and handling MOS devices is described in a new application note. It discusses problems encountered when working with MOS devices and how this new protection circuit eliminates these problems. A schematic drawing of the protection circuit and other typical 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

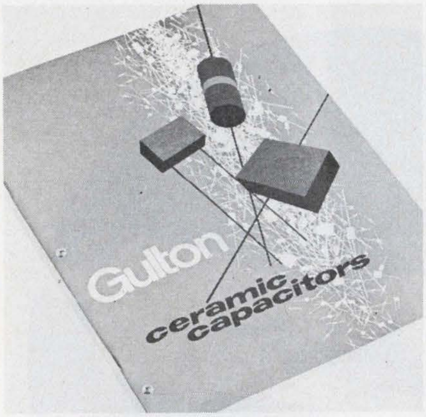


Programming languages

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

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 volt-ohmmeters, 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

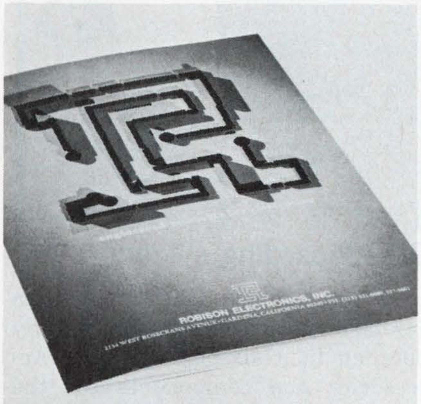
An eight-page catalog lists a broad assortment of digital accessories for IC handling. It provides information for in-line IC sockets, flatpack holders, high-density wire-wrap PC cards and extenders. Cambridge Thermionic Corp.

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 booket. 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

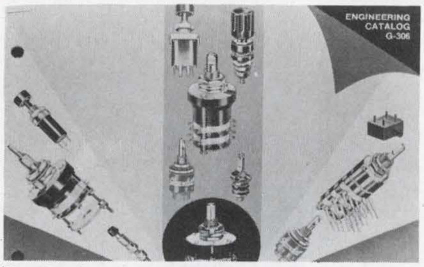
A 32-page catalog lists 15 high-purity metals for electronics. Technical data, including vapor pressure and analytical data are given. Alfa Inorganics, Inc.

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



Switches

Information on enclosed pushbutton 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

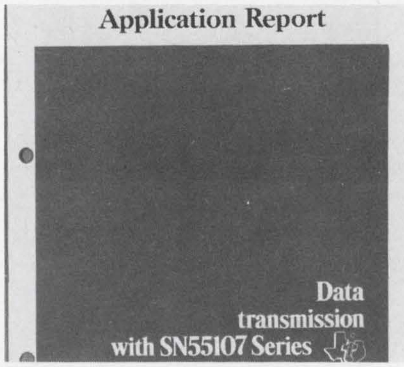
A four-page application note describes an unusual and versatile approach to high-accuracy phase measurements at frequencies up to 15 MHz. Phase measurements, which were formerly cumbersome and expensive and sometimes required a computer, are made by a computing counter and its programmable keyboard. 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

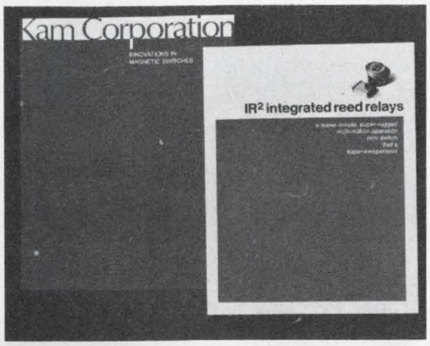
A comprehensive 44-page catalog provides complete details about wire-wrap plate assemblies, male headers, and edge-card connector wire-wrap plate assemblies. In addition to cross-section drawings, product dimensions and specifications, it contains extensive guidance for the design engineer. Masterite 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.

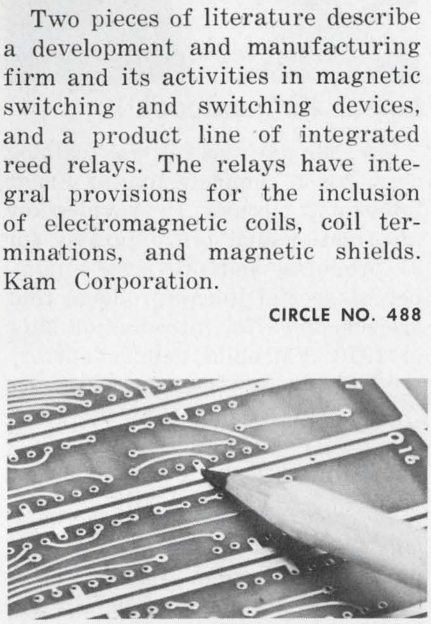
CIRCLE NO. 487



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

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

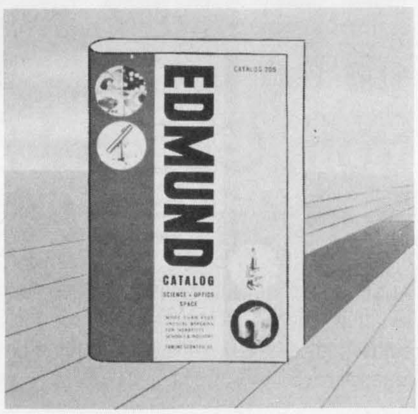
A process input-output system, a card punch, and a line printer for the Prodac minicomputer system are described in three illustrated publications. Westinghouse Electric Corp.

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.

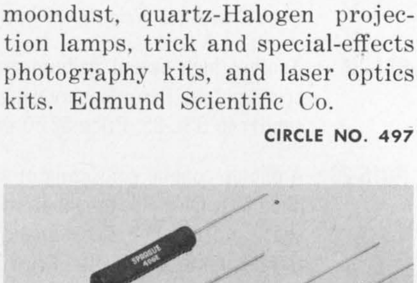
CIRCLE NO. 496



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 moondust, quartz-Halogen projection lamps, trick and special-effects photography kits, and laser optics kits. Edmund Scientific Co.

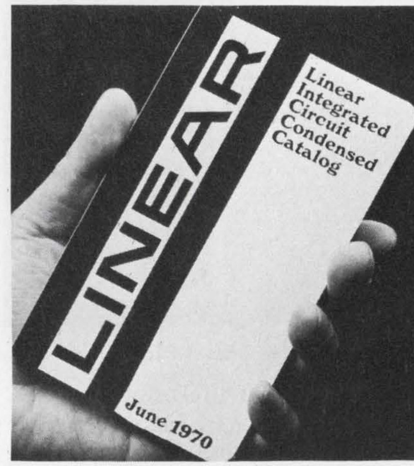
CIRCLE NO. 497



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

Themocouples

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

Anlytical 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

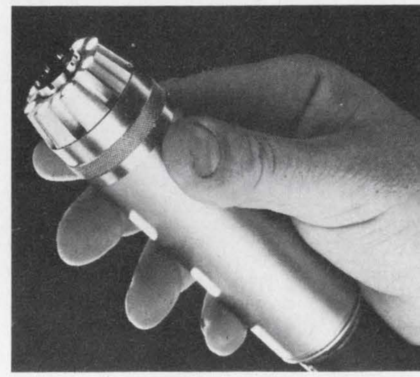
Control modules

"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

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-striped 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

INFORMATION RETRIEVAL NUMBER 102

INFORMATION RETRIEVAL NUMBER 103

Electronic Design

ELECTRONIC DESIGN'S function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
- To give the electronic design engineer concepts and ideas that make his job easier and more productive.
- To provide a central source of timely electronics information.
- To promote two-way communication between manufacturer and engineer.

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- To publish prompt corrections whenever inaccuracies are brought to our attention. Corrections appear at the end of the Letters column.
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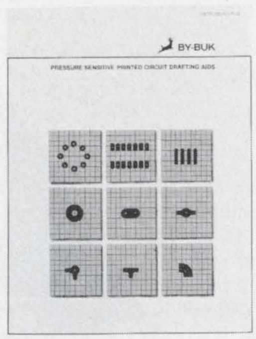
Design Data from

New PC Drafting Aids Catalog

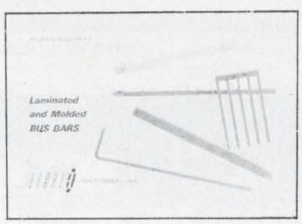


The By-Buk 1970-71 catalog of pressure sensitive printed circuit drafting aids is now available. With thousands of ideas to promote accuracy and efficiency in printed circuit master artwork layouts. Featured are new artwork patterns for: TO cans, multi-pads, dual in-lines and flat packs. Also the most comprehensive listings of conductor line tapes, pads, donuts, connector strips, elbows, corners, etc. Available in opaque black, transparent red and transparent blue materials. Send for your free catalog and samples.

CIRCLE NO. 171

By-Buk Company
4326 W. Pico Blvd.
Los Angeles, California 90019
(213) 937-3511

Bus Bars For Noise Reduction



A 16 page Technical Bulletin is now available, describing a new concept in power or signal distribution. Basic mechanical and electrical design principles, along with descriptive pictures and diagrams, are included in this bulletin. These compact buses can replace bulky cable harnesses and repetitive wiring for computer or modular application. This method of construction satisfies the demanding requirements of low inductance and resistance of high speed, solid state systems, while controlling electrical noises.

Send For Free Sample CIRCLE NO. 172

Eldre Components, Inc.
1239 University Avenue
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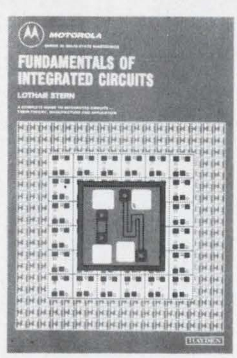
FUNDAMENTALS OF INTEGRATED CIRCUITS



A practical guide to integrated circuits, their theory, manufacture, and applications. This new guide by Lothar Stern offers compete, highly readable coverage of the various techniques of circuit fabrication, and their effect on circuit design and performance. As to marketing considerations, it compares the characteristics of the numerous IC structures devised to date in terms of economics and logistics. A volume in the **Motorola Series in Solid-State Electronics.** 198 pages, 7 x 10, illustrated. $8.95, clothbound. Circle the reader-service number below for 15-day examination copies.

CIRCLE NO. 173

Hayden Book Company, Inc.
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PEM® Self-clinching Captive Studs

PEM self-clinching captive studs are designed for quick, easy installation in steel or aluminum panels. Providing permanently mounted threads, they are simply squeezed or pressed into drilled or punched holes. They are available in two styles — PEM flush-head studs for panels 0.040" and thicker, and PEM thin-head studs for 0.020" to 0.039" thick panels. Heads of the latter project above the panel surface 0.025". PEM self-clinching studs are stocked in 1/4" to 1 1/2" lengths and #2-56 to 5/16-18 thread sizes. Send for Free Bulletin.

CIRCLE NO. 174

Penn Engineering & Manufacturing Corp.
Box 311
Doylestown, Pa. 18901

Mini-Computer Mated with Real-Time Analyzer for Automatic Testing

Complete Spectrum Processing System SP-6-1 automatically scales, equalizes, processes underwater acoustic data and noise/vibration signatures for production testing. Monitors on-line signals (nuclear reactor noise, heart sounds, machine tool vibration), recognizes aberrations, gives alarm. Setup conditions are entered via teletype unit as requested by computer. System prints out **all** spectral data or only frequency amplitude above preset levels. Data also pre-recordable on tape, played back often faster than real time. Analysis over frequency bands as wide as 40 kHz are possible. Many options.

CIRCLE NO. 175

Federal Scientific Corporation
a subsidiary of Elgin National Industries, Inc.
615 West 131st Street, New York, N. Y. 10027.

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PRE-ETCHED, PRESSURE-SENSITIVE COPPER COMPONENT PATTERNS FOR INSTANT PC BOARDS. Circuit Zaps® are 1 ounce copper circuit components patterns, pads, and conductor paths, precision-etched on 5 mil (.005") glass epoxy base material, backed by a special pressure-sensitive adhesive. Circuit Zaps® completely eliminate the artwork, photography, photoprinting, touch up, etching, stripping, and other time-consuming steps in PC board development. Circuit Zaps® provide maximum flexibility.
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CIRCLE NO. 176

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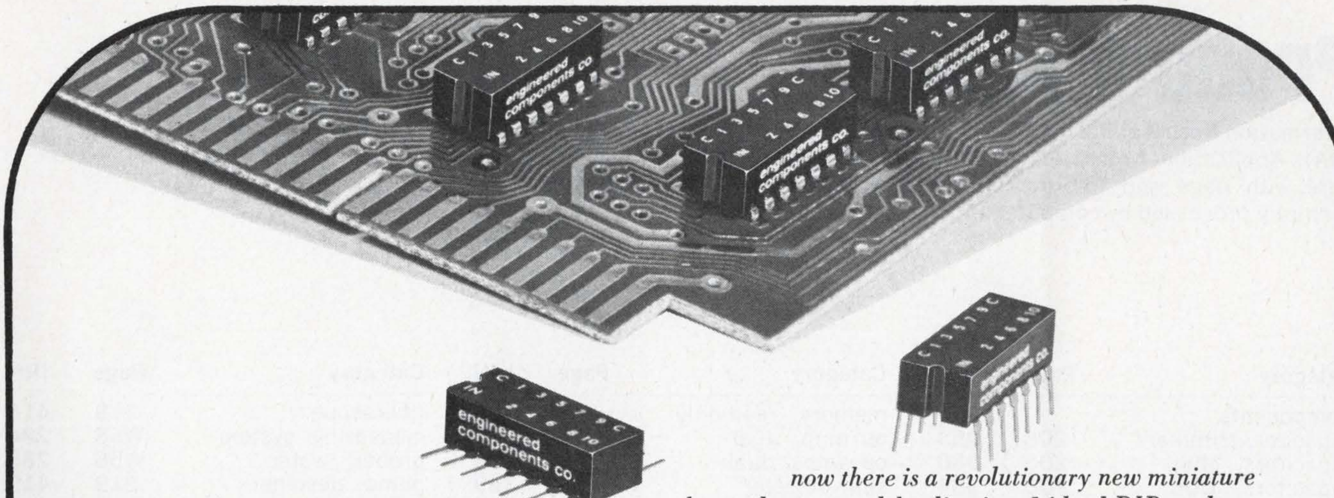
Advertisers' Index



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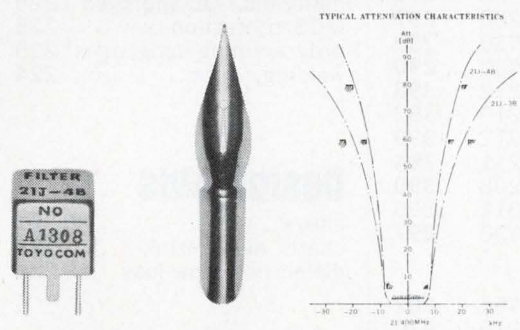

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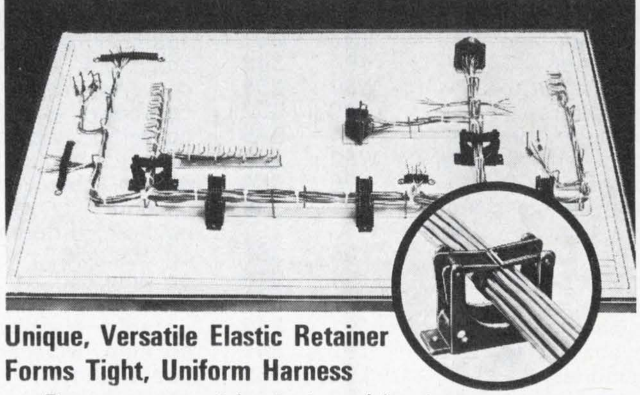

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Product Index

Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days.

New Literature

Application Notes

Design Aids

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