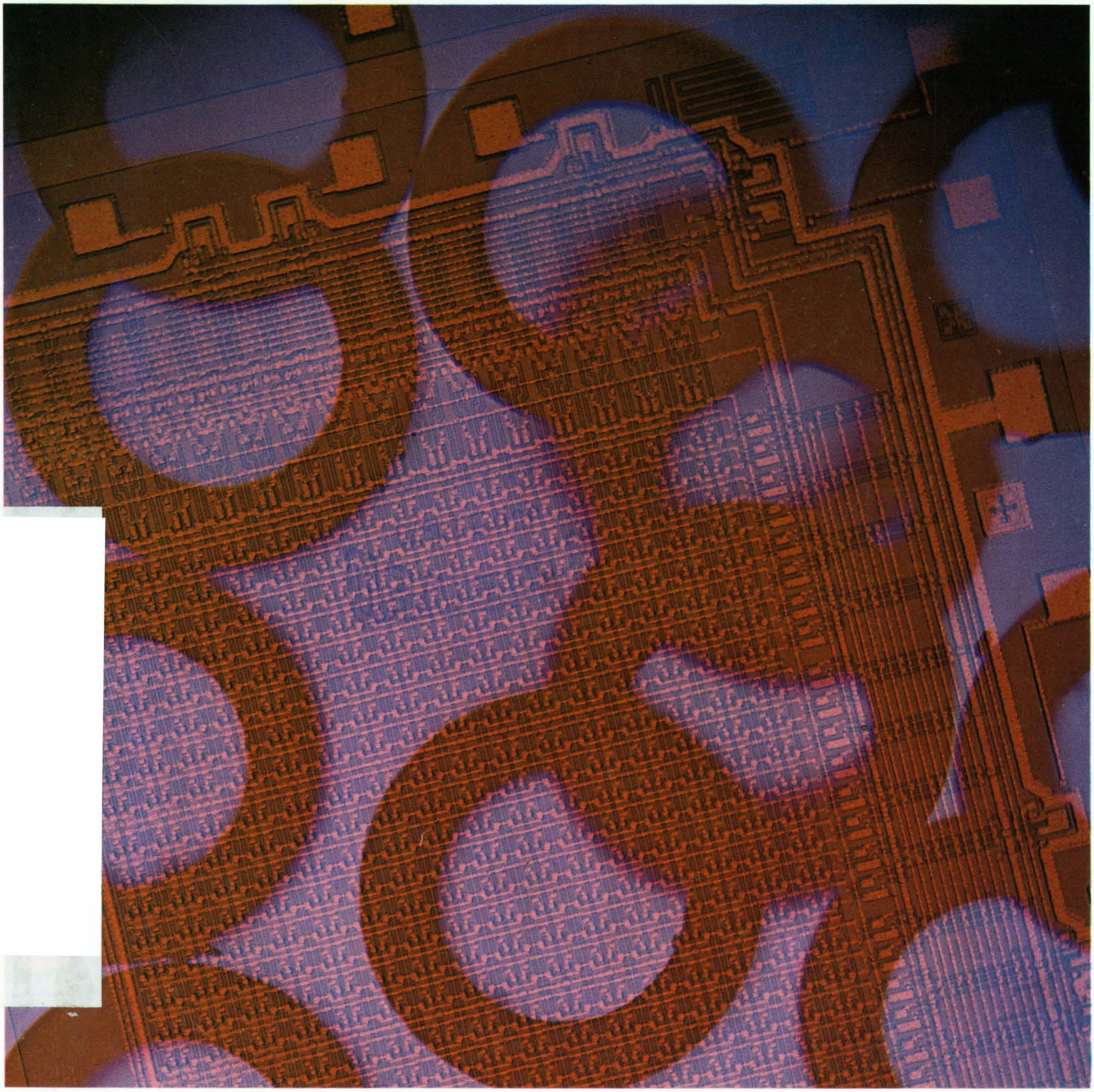
Electronic Design

VOL. 18 NO. 15
FOR ENGINEERS AND ENGINEERING MANAGERS
JULY 19, 1970

Semiconductor memories are in— most experts will agree. They can be tailored for speed, size or low cost, and are already widely used in read-only applications. But for random-access, read-write use, core memories are still king, and plated wire is making strides. How, then, can a designer best choose a memory? See page 70.



Trounce trimmer troubles

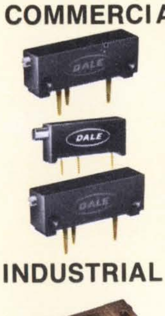
with Dale Industrial and Commercial T-Pots

RCA's widely-used Spectra 70 computer is a good example of Dale Trimmers' year-in, year-out dependability. The models shown here are from Dale's 2100 wirewound series...sealed to meet tough RCA immersion requirements. Used in a number of Spectra 70 control and voltage reference applications, they're part of Dale's workhorse line of industrial and commercial trimmers. Nothing fancy...but you get what you need, when you need it—and you can use all you receive. Dale trimmers have a record of less than 1% customer rejection for *all* causes. Join the growing number of trimmer users who've found there's less trouble when you specify Dale.

Call 402—564-3131 for complete information or write for Catalog B.

DALE ELECTRONICS, INC.
DALE®
1300 28th Ave., Columbus, Nebr. 68601
In Canada: Dale Electronics Canada, Ltd.
A subsidiary of The Lionel Corporation

COMMERCIAL GRADE ECONO-TRIM T-POTS



WIREWOUND ELEMENT

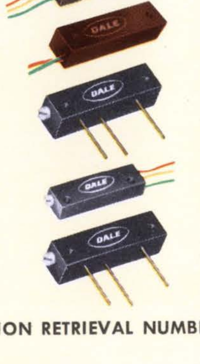
2300 Series: Sealed/Unsealed; 10Ω to 50KΩ, ±10%; 0.5 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

2400 Series: Sealed/Unsealed; 10Ω to 50KΩ, ±10%; 1 watt at 40°C, derated to 0 at 125°C; .31 H x .16 W x .75 L.

FILM ELEMENT

8300 Series: Sealed/Unsealed; 10Ω to 2 Meg., ±10% 100Ω thru 500K, ±20% all other values; .75 watt at 25°C, derated to 0 at 105°C; .36 H x .28 W x 1.00 L.

INDUSTRIAL GRADE T-POTS



WIREWOUND ELEMENT

100, 200, 300 Series: 10Ω to 100KΩ.
100 Series: ±5%; 0.8 watt at 70°C, derated to 0 at 135° C.
200 Series: ±10%; 0.5 watt at 70°C, derated to 0 at 105°C.
300 Series: ±15%; .25 watt at 70°C, derated to 0 at 85°C.
Dimensions: .22 H x .31 W x 1.25 L (also 1.32 L for 100, 200).

1100 Series: 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 175°C; .28 H x .31 W x 1.25 L.

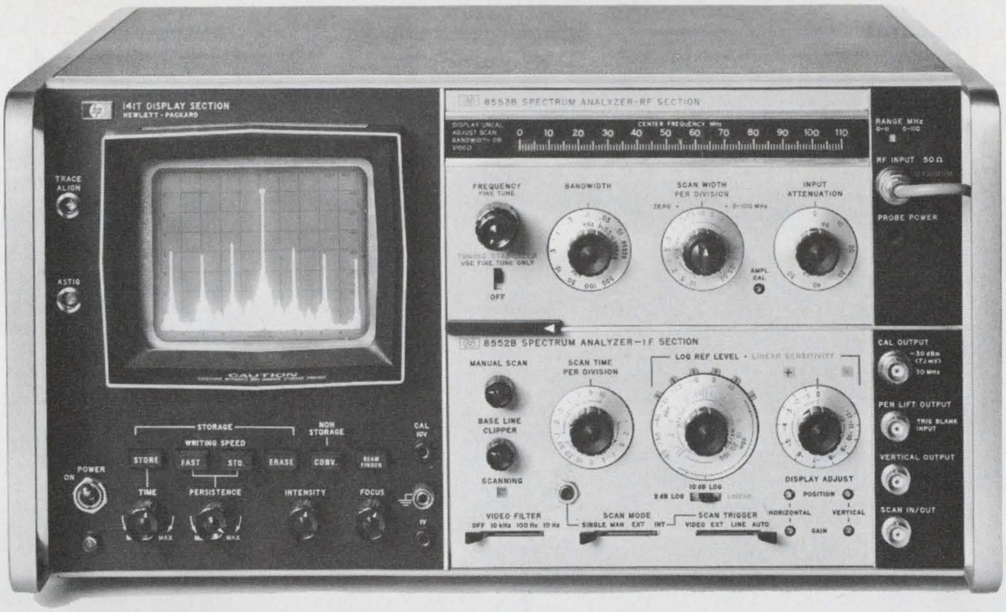
2100 Series: Industrial counterpart RT-11; 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

2200 Series: Industrial counterpart RT-10; 10Ω to 100KΩ, ±10%; 1 watt at 70°C, derated to 0 at 125°C; .18 H x .32 W x 1.00 L.

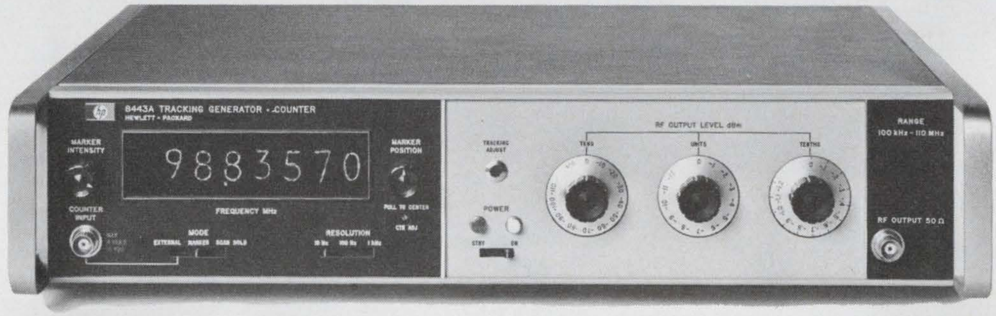
FILM ELEMENT

8100 Series: Industrial counterpart RJ-11; 10Ω to 2 Meg., ±10% 100Ω to 500K, ±20% other values; .75 watt at 70°C, derated to 0 at 125°C; .28 H x .31 W x 1.25 L.

INFORMATION RETRIEVAL NUMBER 232



How do you improve the world's best spectrum analyzer?



Add counter accuracy and a tracking signal source.

Combine HP's new 8443A Tracking Generator/Counter with the HP 110 MHz Spectrum Analyzer and you can make the most precise, complete frequency-domain measurements ever. The 8443A produces a visible marker that you can place anywhere on the spectrum analyzer display and immediately get 10 Hz resolution digital measurement of that point. The 8443A is more, too: a precision signal source that will make swept measurements over a 120 dB range and still produce the marker to determine any specific frequency with counter accuracy.

The 8553B/8552B Analyzer itself covers 1 kHz to 110 MHz with scans as wide as 100 MHz and as narrow as 200 Hz. It provides absolute amplitude calibration, better than −130 dBm sensitivity, over 70 dB dynamic range, 10 Hz resolution, plus exceptional stability (<1Hz FM) and flatness. The 8443A capitalizes on all the qualities of the analyzer to function both as an accurate frequency counter and as a precision source for complete swept frequency measurements.

With the system you can make much more precise design and production line measurements of filters, mixers, modulators, oscillators, amplifiers and RF systems. For example, you can now:

- measure to 10 Hz the frequency of nanovolt signals in the presence of much larger ones. Use the tuneable marker to find the signal and measure its frequency on the 8443A counter readout. You can easily identify IM distortion products, hum sidebands, spurious signals, and the like, because the 8443A is a frequency-selective counter with the analyzer's incredible sensitivity.
- completely characterize devices such as narrowband, high Q devices with simple, quick measurements. Use the tracking generator to sweep the spectrum and measure the frequency of any point on the response curve to 10 Hz. You can precisely measure passband flatness and shape factor on filters as narrow as 20 Hz, and make swept-reflection or return loss measurements. In other words, the tracking generator combines with the analyzer to provide a complete swept test system.
- test and align RF communications systems with unprecedented ease, thoroughness and precision. The high resolution and stability of the analyzer lets you see each and every signal, and the 8443A measures their frequency to 10 Hz. The system is also a natural for surveillance applications since you can scan broad and narrow ranges, resolve all signals of interest and count their frequency.

Call us for a demonstration. The system is easy to set up and you'll find it simple to use as an oscilloscope. If you've already got an HP 110 MHz spectrum analyzer, you can add the tracking generator/counter for $3500. The high-resolution 8553B/8552B with variable persistence display costs $6750. Ask your HP field engineer for details. Or write Hewlett-Packard, Palo Alto, California 94304; Europe: 1217 Meyrin-Geneva, Switzerland.

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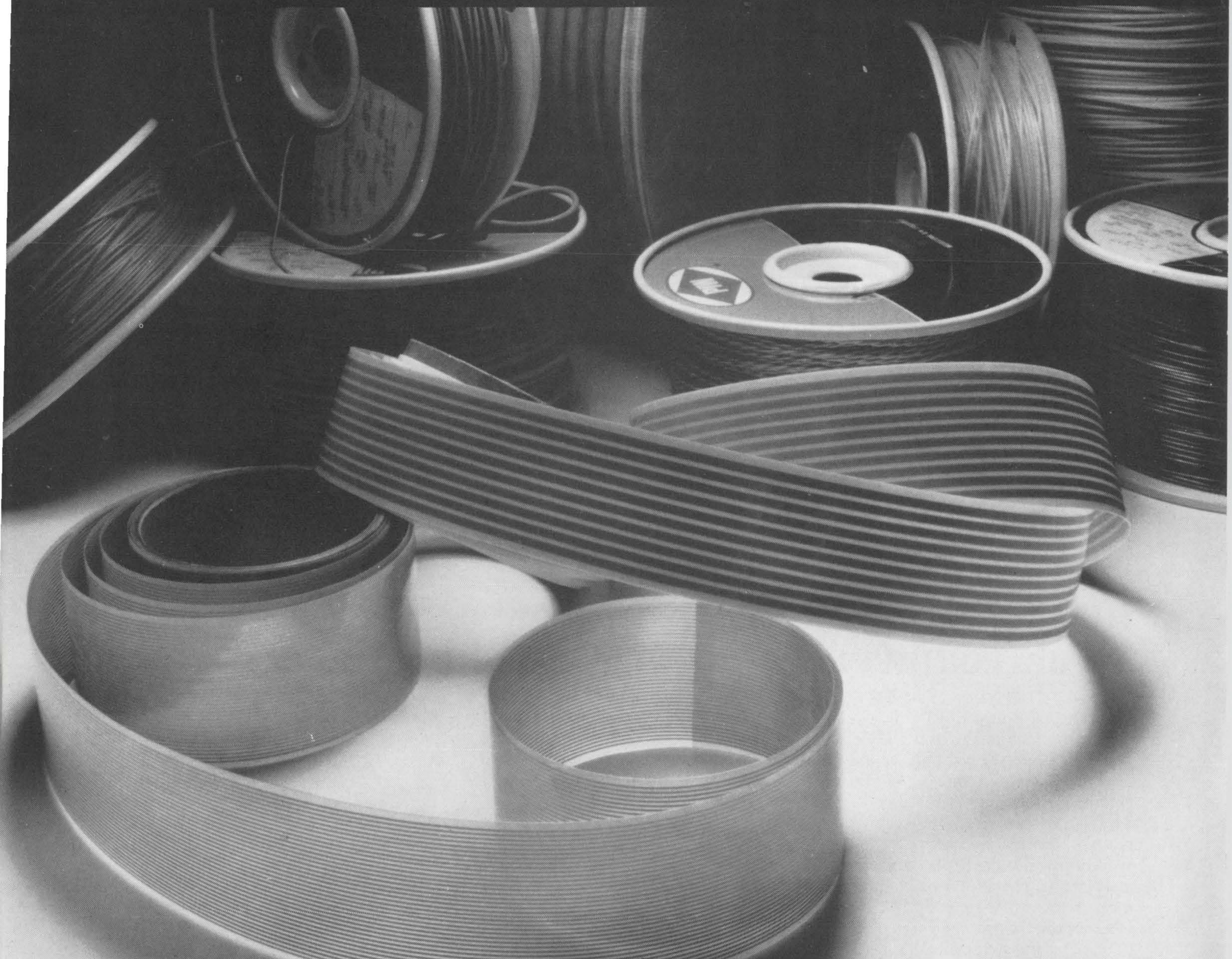
HEWLETT hp PACKARD

SIGNAL ANALYZERS

INFORMATION RETRIEVAL NUMBER 2

We've made our cable line bigger, so you can make things smaller.



Flat-wire cable can help you make equipment smaller, lighter and lower in cost.

That's nothing new.

What's new is that now you can buy it from Sylvania.

What's more, we've also developed an "instant capability" in flexible insulated wire and cable products.

If you are wondering how we achieved this capability overnight, the answer is simple: We integrated Philadelphia Insulated Wire Co. into our Parts Division.

PIW is one of the oldest wire companies in the country. Although they are old, their capabilities are brand new. Their product line includes wires insulated with Kynar,* and Teflon.†

Recently, PIW engineers perfected a technique for overcoating Teflon with polyimide enamels to meet the needs of the aircraft industry.

In development operations, they are working with a brand new material, Tefzel.† This resin combines the excellent electrical properties of Teflon with mechanical properties similar to Kynar.

Your Sylvania sales representative now has one of the broadest lines of wire and cable products in the industry. He's the man to talk to when you've got wiring problems.

Sylvania Precision Materials, Parts Division, 12 Second Ave., Warren, Pa. 16365

SYLVANIA
GENERAL TELEPHONE & ELECTRONICS

*-Trademark of Pennwalt Chemical Company.
†-Trademark of DuPont.

Electronic Design

VOL. 18 NO. 15

FOR ENGINEERS AND ENGINEERING MANAGERS

JULY 19, 1970

NEWS

TECHNOLOGY

PRODUCTS

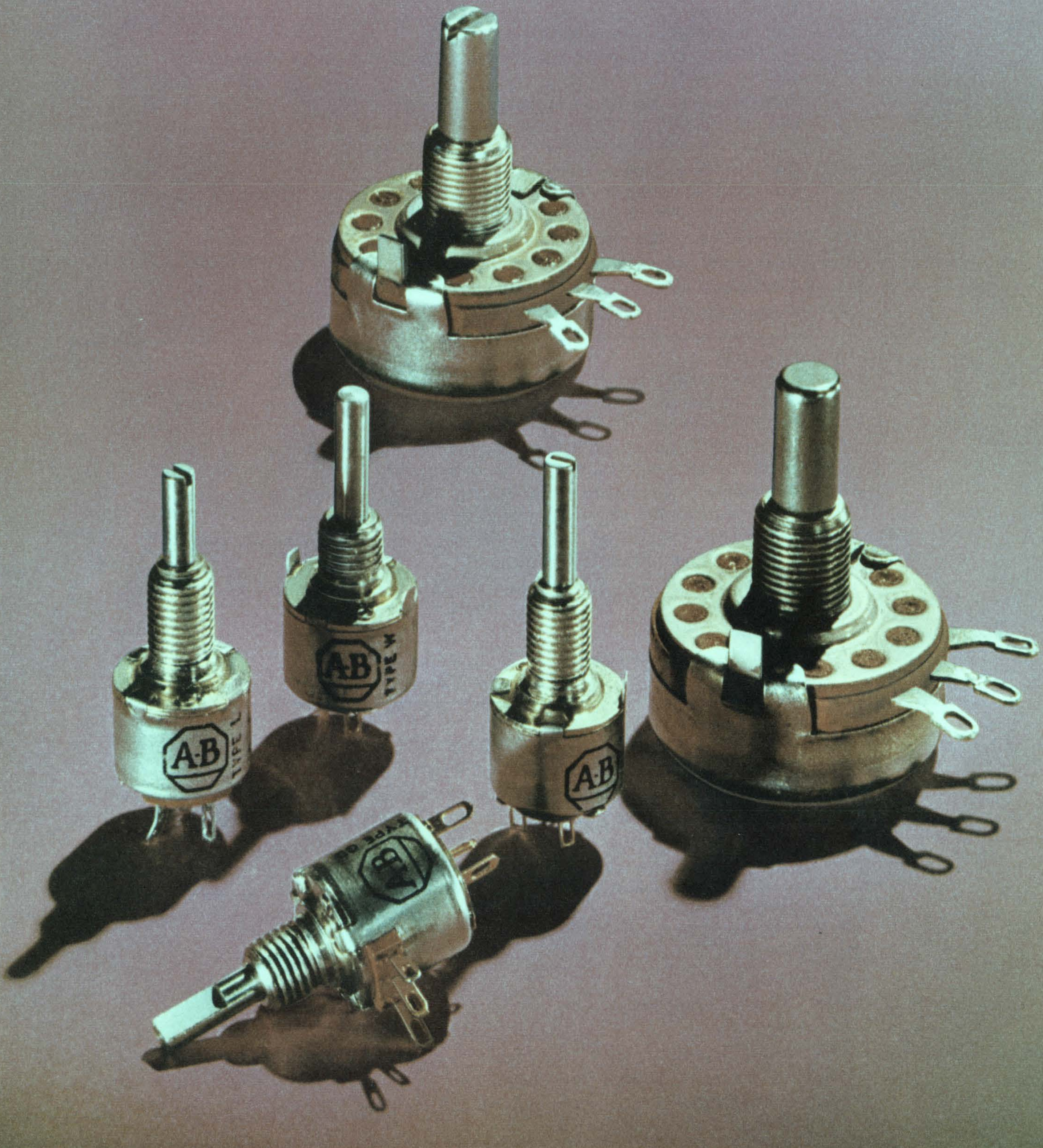
Departments

Cover: Cores superimposed over semiconductor memory. Photo by Richard Steinheimer.

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.

Fight noise pollution



with this quiet family.

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

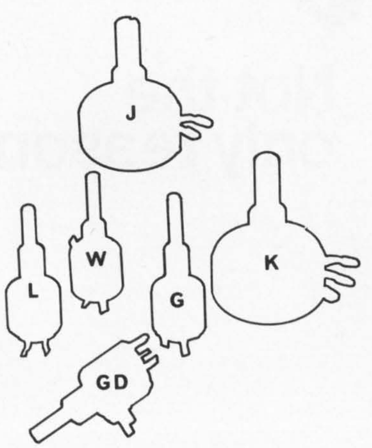
This important Allen-Bradley difference means better short-time overload capacity and a long operating life. Control is smooth, resolution almost infinite. These variable resistors are ideal for high frequency circuits. Why should you trust the performance of your designs or your reputation to anything less than Allen-Bradley quality? Use the most thoroughly "field tested" (over 20 years) variable resistors available today. Quantity stocks of popular types J, G, W and GD available for immediate delivery from your appointed A-B industrial electronics distributor.

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

SPECIFICATIONS

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

ALLEN-BRADLEY



INFORMATION RETRIEVAL NUMBER 4

Program reliability is the key to a successful minicomputer. And microprogrammed firmware is the lock. Firmware gives the CIP/2000 a memory that can't forget and a program that can't change unless the firmware package is altered.

Firmware makes the computer program reliable. Cincinnati makes the computer reliable. Sensitive production operations are done in dust-free rooms separated from other air conditioned manufacturing areas by air locks and air showers. We designed and built our own computer controlled testing equipment to check component assemblies and finished computers. And we do our testing in different temperatures and humidities because systems-oriented computer applications often require operation under hostile conditions.

These are some reasons our mini is the most reliable on the market. For complete information on the minicomputer that starts at less than $3,100, write to Cincinnati Milacron, Dept. R-54, Lebanon, Ohio 45036. For immediate action, call (513) 494-5444.

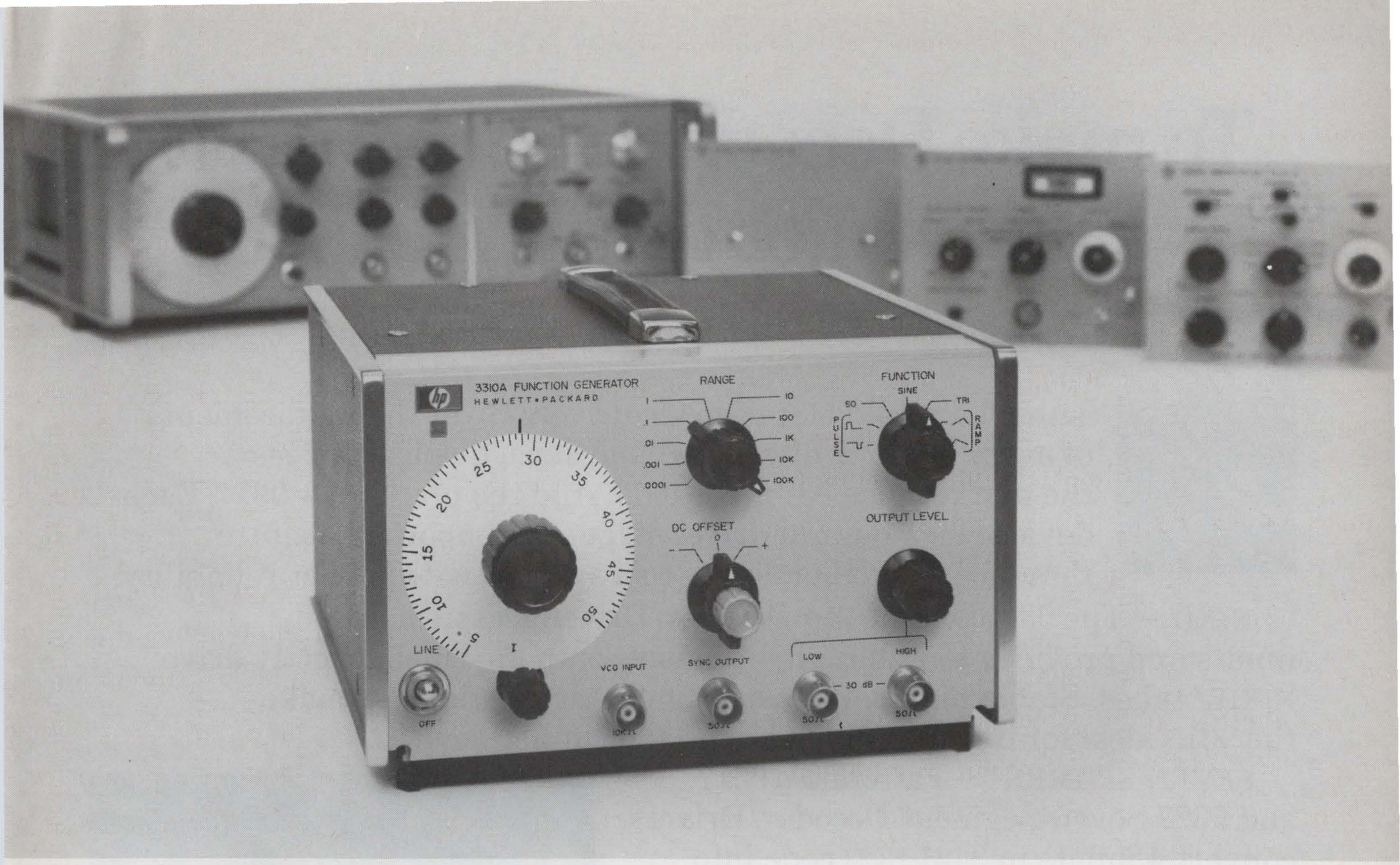
Is Cincinnati firmware the only reason our minicomputer is so reliable?

Not the only reason.

CINCINNATI MILACRON

Machine Tools/Process Controls/
Chemicals/Plastics/
Plastics Processing Machinery/Abrasives

INFORMATION RETRIEVAL NUMBER 5



Need a function generator? Don't waste your money!

Make sure you get the function generator that best fits your needs... in both price and capability. It's that simple.

Or at least it sounds simple. Then you sit down to make a list of all your technical requirements . . . present and future. Next you try to match those requirements against all of the instruments available. Finally, you make trade-offs of specific performance features versus X dollars saved.

When you are all done, hopefully you wind up with a function generator that has the best performance/price ratio for your particular needs and budget.

But there is an easier way!

HP manufactures, sells and services a complete line of function generators with a long history of proven performance. Even the newest function generators take advantage of HP's experience and conform to the high quality standards you have come to expect in any HP instrument.

To get all the information you need to determine exactly what you want in a function generator... just turn to page 267 of your 1970 HP catalog. You get more than just a list of products, you get the background information you want to determine your specific needs.

If you need a low-cost general purpose function generator, pay special attention to the HP 3310A. This one does so much that it's actually more than just a function generator.

You not only get the usual sine, square and triangle functions—but both positive and negative going pulses and ramps. Add dc offset, a frequency range of 0.0005 Hz to 5 MHz, all solid-state reliability and a price tag of only $575 and you will see why we say this one is more than just an ordinary function generator. You save both money and space.

With the HP 3310A you can test and demonstrate the response of differentiator and integrator circuits. Use the triangle output to show how a sine wave may be synthesized. Use the ramps to demonstrate the action of a comparator circuit.

You can even use a combination of pulses and ramps to simulate the action of a mechanical function to an analog computer. This is a function generator with such potential that you'll be using it for more applications than any other signal source you now own.

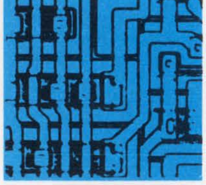
If you need more information, just call your local HP field engineer. He will be glad to help you solve any measurement problem you may have. Or, write to Hewlett-Packard, Palo Alto, California 94304. Europe: 1217 Meyrin-Geneva, Switzerland.

090/4

HEWLETT hp PACKARD

SIGNAL SOURCES

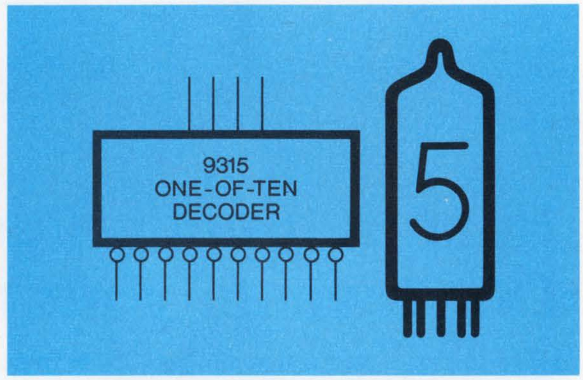
To make Decoders that can drive every major display device,

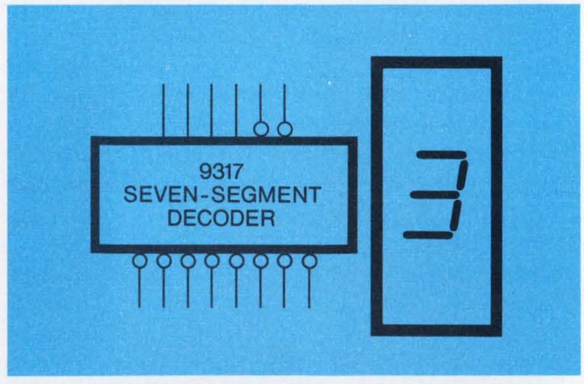


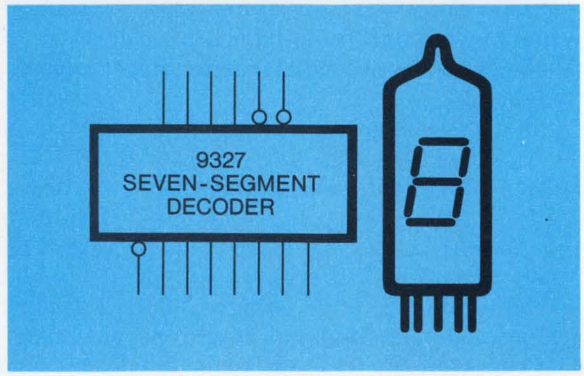
Three Fairchild MSI decoder/drivers cover the requirements of every major military and industrial display device on the market. The 9315. The 9317. And the brand new 9327. Each device has a built-in driver stage—an important feature that means smaller, lower-cost systems with higher reliability.

NIXIE—The 9315 One-of-Ten Decoder/Driver accepts decimal inputs and provides ten mutually exclusive outputs which directly drive NIXIE* tubes. Stable high-voltage output characteristics also make the 9315 ideal for driving relays, lamps and similar devices.

SEVEN-SEGMENT—Fairchild's 9317 and 9327 Seven-Segment Decoder/Drivers convert 4 inputs in 8421 BCD code into appropriate outputs for driving seven-segment numerical displays. The 9317 is designed for use with incandescent lamps, neon, electroluminescent and CRT displays, as well as light emitting diode indicators. The 9327 is used for DIGIVAC S/G** vacuum fluorescent readouts. Both devices feature automatic ripple blanking, lamp intensity modulation, lamp test facility, and blanking output. Outputs are disabled by codes in excess of binary 9. Flags are removed on the 6 and 9, which reduces the number of ambiguous states.







*NIXIE is a registered Trademark of Burroughs Corporation.
**DIGIVAC S/G is a registered Trademark of Wagner Electric Corporation.

To order these Decoder/Drivers, call your Fairchild Distributor or ask for:

PART NUMBER	PACKAGE	TEMPERATURE RANGE	(1-24)	PRICE (25-99)	(100-999)
U4L931551X	Flat	−55°C to +125°C	$22.00	$17.60	$14.65
U4L931559X	Flat	0°C to + 75°C	11.00	8.80	7.30
U6B931551X	DIP	−55°C to +125°C	20.00	16.00	13.30
U6B931559X	DIP	0°C to + 75°C	10.00	8.00	6.65
U4L9317513	Flat	−55°C to +125°C	28.00	22.40	18.70
U4L9317593	Flat	0°C to + 75°C	14.00	11.20	9.35
U7B9317513	DIP	−55°C to +125°C	25.40	20.30	17.00
U7B9317593	DIP	0°C to + 75°C	12.70	10.15	8.50
U4L9327591	Flat	0°C to + 75°C	13.05	10.50	8.80
U7B9327591	DIP	0°C to + 75°C	11.90	9.55	8.00

you have to get serious about MSI family planning.

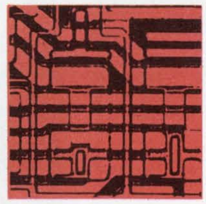
We put together a family plan by taking systems apart. All kinds of digital systems. Thousands of them.

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.

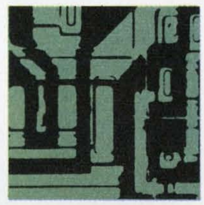
Inside each of the seven categories, we sifted by application. We wanted to design the minimum number of devices that could do the maximum number of things. That's why, for example, Fairchild MSI registers can be used in storage, in shifting, in counting and in conversion applications. And you'll find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

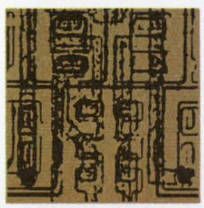
The Fairchild MSI family plan. A new approach to MSI that's as old as the industrial revolution. It started with functional simplicity, extended through multi-use component parts, and concluded with a sharp reduction in add-ons. Simplicity. Versatility. Compatibility. Available now. In military or industrial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



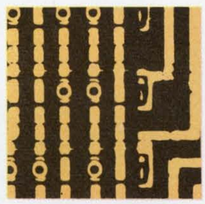
OPERATORS
9304 – Dual Full Adder/Parity Generator



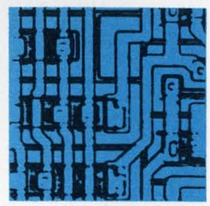
LATCHES
9308 – Dual 4-Bit Latch
9314 – Quad Latch



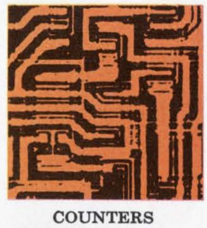
REGISTERS
9300 – 4-Bit Shift Register
9328 – Dual 8-Bit Shift Register



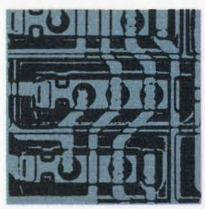
MULTIPLEXERS
9309 – Dual 4-Input Digital Multiplexer
9312 – 8-Input Digital Multiplexer



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

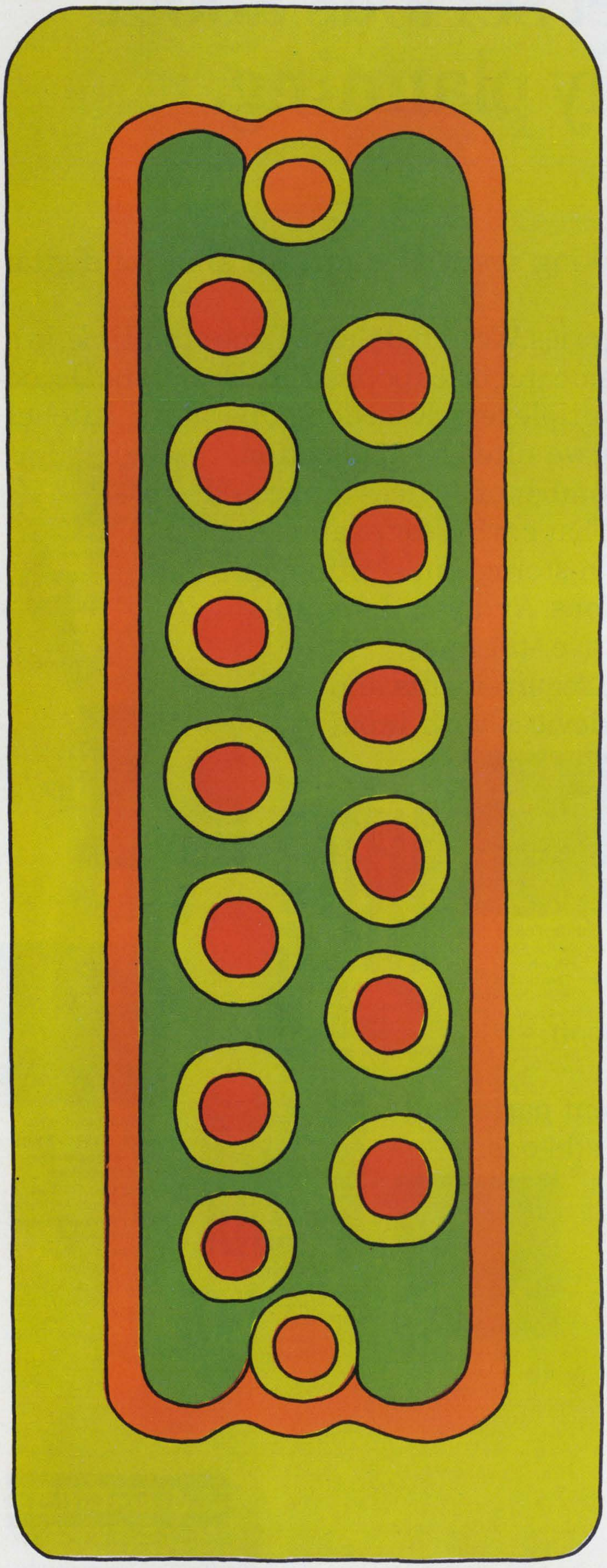


ENCODERS
9318 – Priority 8-Input Encoder

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 7



Winchester Electronics

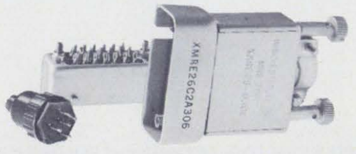
the
innovative thinking
needed to solve
today's
problems.

Looking for a quick solution to a particularly knotty connector problem? Look to Winchester Electronics first.

We've got a reputation for producing answers to problems before they exist. So there's always a chance yours might not be a problem after all. For example, we produced our MRE series of miniature rectangular connectors before any specs existed. They've since become the standard for mil spec MIL-C008384. Our MRAC crimp-contact connectors set the standard for MIL-C-22857.

So you see, it's a good idea to contact Winchester Electronics first before you call a problem a problem. With our pioneering spirit, we may have solved your problem years ago. To find out, write or call Winchester Electronics, Main Street and Hillside Avenue, Oakville, Conn. 06779.

WINCHESTER ELECTRONICS
DIVISION OF LITTON INDUSTRIES



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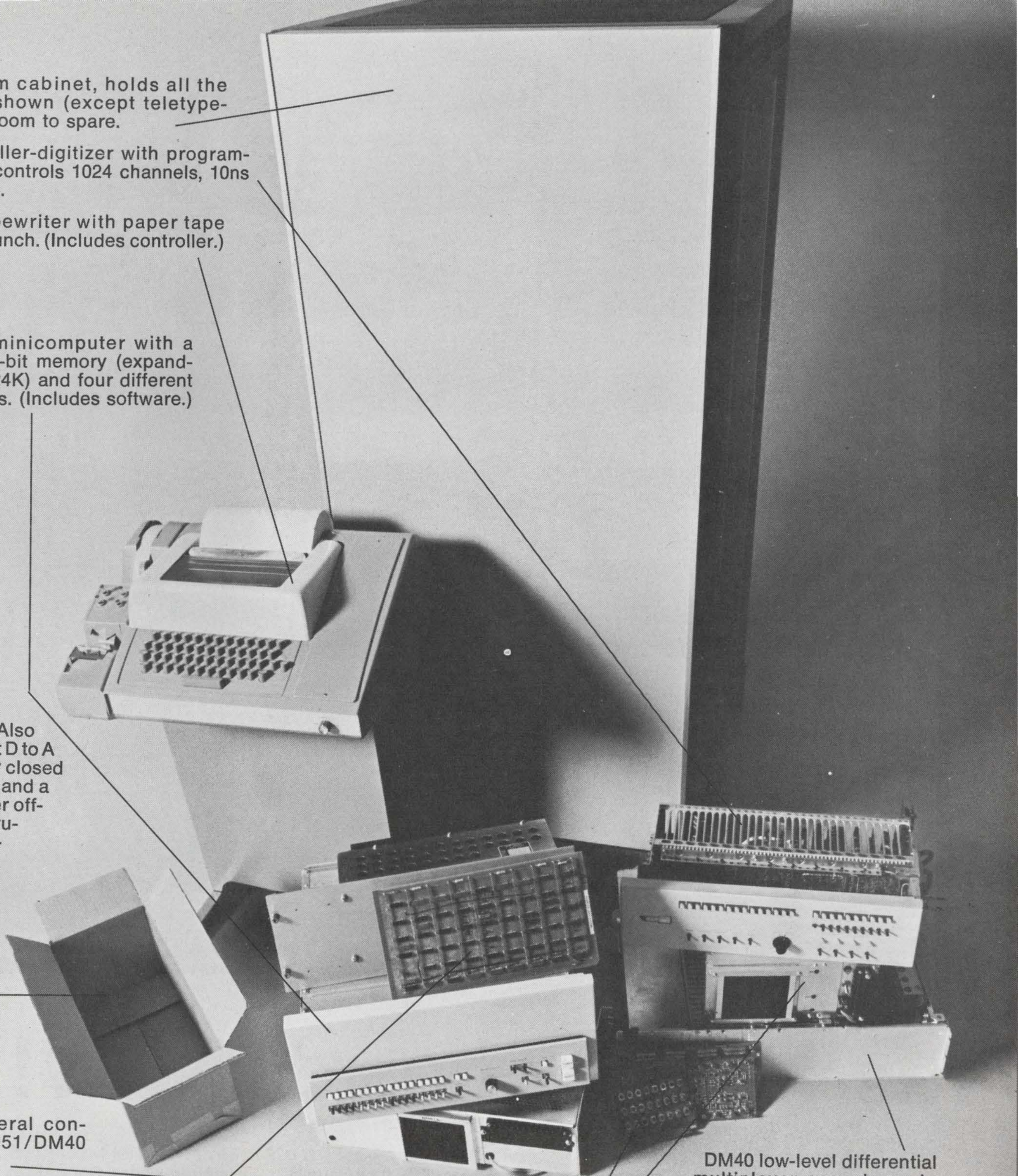
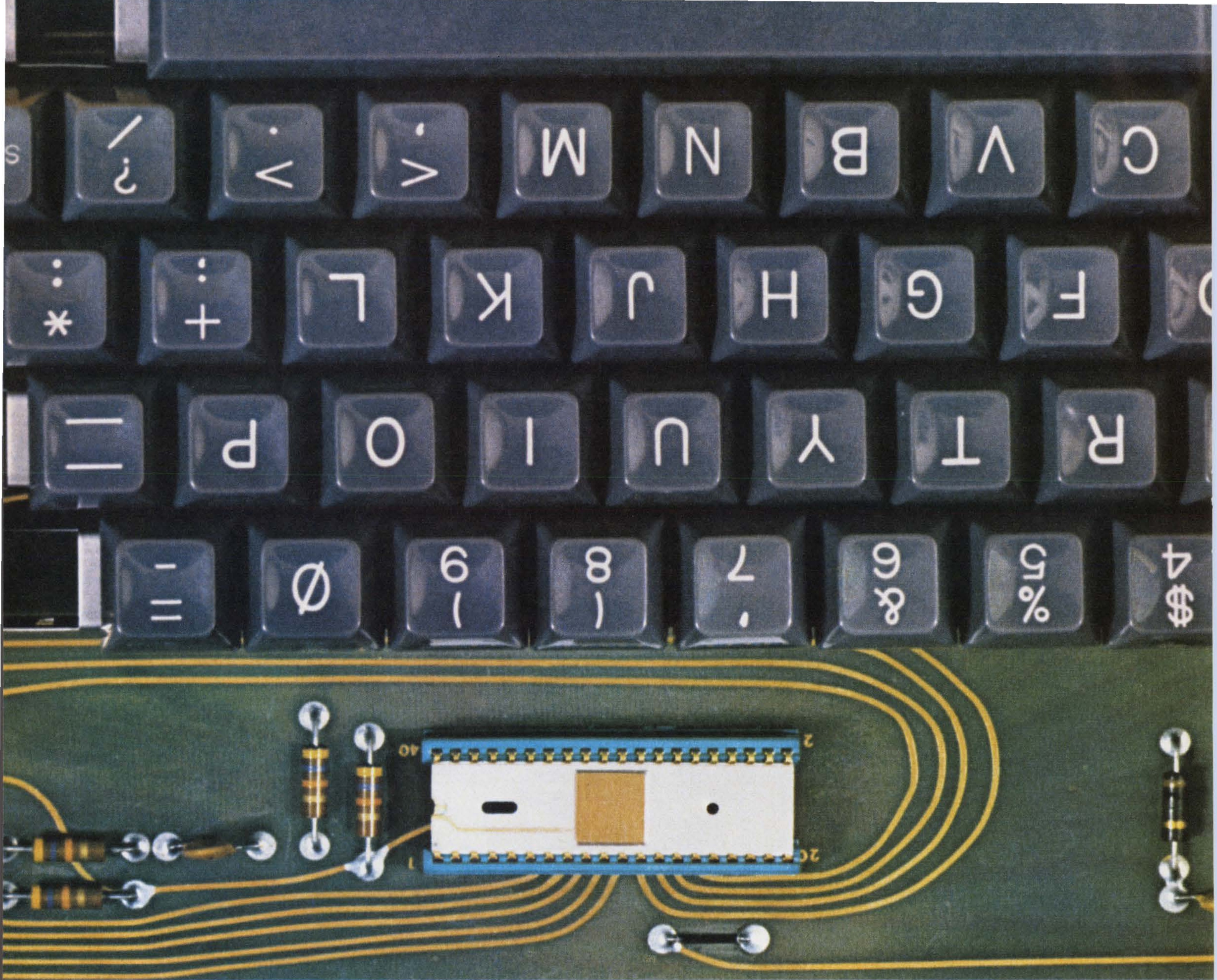


All instruments and interfaces will be cabinet mounted and functionally tested together prior to delivery. If you're in a hurry, call (213) 679-4511, ext. 3668 or 3391.

XDS
Xerox Data Systems
El Segundo, California

The last reason you should buy our data acquisition system is the price: $21,600.



MOS keyboards NOW!

Start your own protest about keyboard vendor promises. Clare-Pendar *delivers* MOS Keyboards, not just promises. Production quantity MOS Keyboards NOW, not next year.

MOS Keyboards in stock, too: Teletype Model 37 format, or Model 33/35 format. Or we'll build to your layout—keypunch, CRT display, interactive, portable—you name it.

Choose from the industry's broadest selection of keyboard ROMs. And if we don't have the code you need, a simple mask change can produce any code you want—bit or non-bit compatible, up to 9 bits/word.

Reliability? Consider this: A fully encoded trimode ASCII Keyboard with 3 major components—an LSI/MOS circuit, reed keyboard switches, and a printed circuit board. How can a keyboard be more simple? And how can a keyboard be more reliable?

You can learn more about super smooth space bars, lighted keytops, 12 and 16 station small keyboards from your nearby Clare Sales Engineer. Call him for a demonstration or call us in Post Falls for MOS Keyboard action. Clare-Pendar Co., Post Falls, Idaho 83854. Phone 208-773-4541

12 station
BCD output

CLARE-PENDAR™

The Other Keyboard Company!

Designer's Calendar

AUGUST 1970

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For further information on meetings, use Information Retrieval Card.

Aug. 25-28
Western Electronic Show & Convention (WESCON) (Los Angeles). Sponsors: IEEE, WEMA. WESCON Office, 600 Wilshire Blvd., Los Angeles, Calif. 90005.

CIRCLE NO. 401

SEPTEMBER 1970

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Sept. 1-3
Association for Computing Machinery Conference (New York City). Sponsor: ACM. ACM 70, 1133 Ave. of the Americas, N.Y., N.Y. 10036.

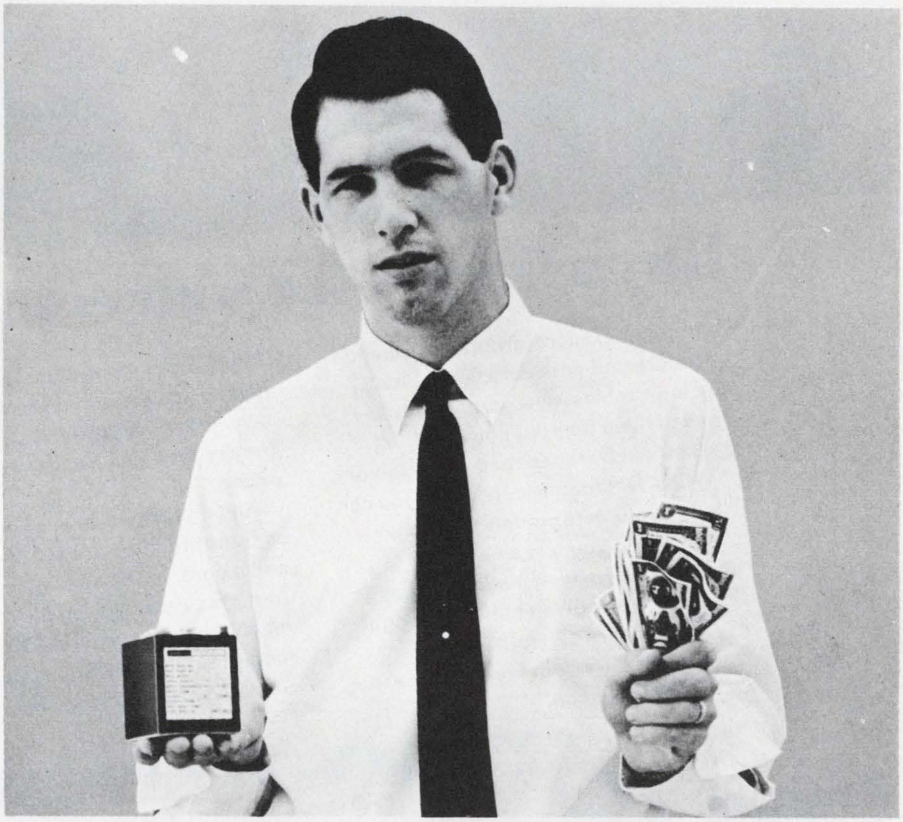
CIRCLE NO. 402

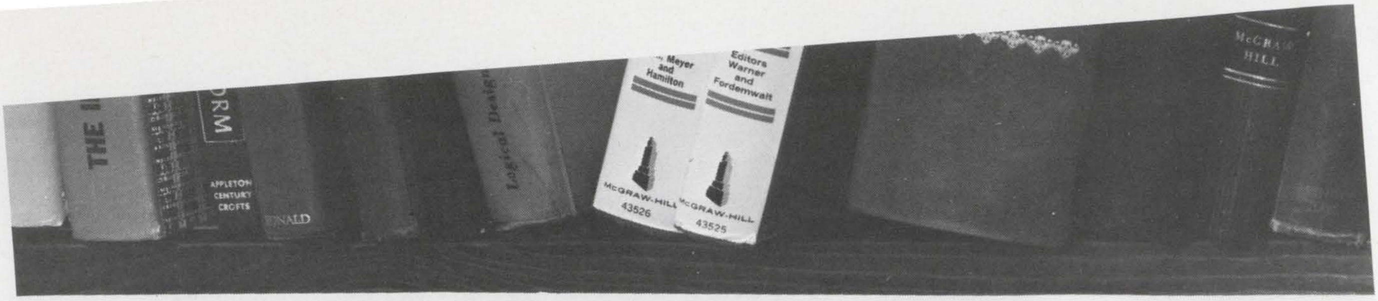
Sept. 21-24
International Conference on Engineering in the Ocean Environment (Panama City, Fla.). Sponsor: IEEE. Lewis Winner, 152 W. 42nd St., New York, N. Y. 10036.

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





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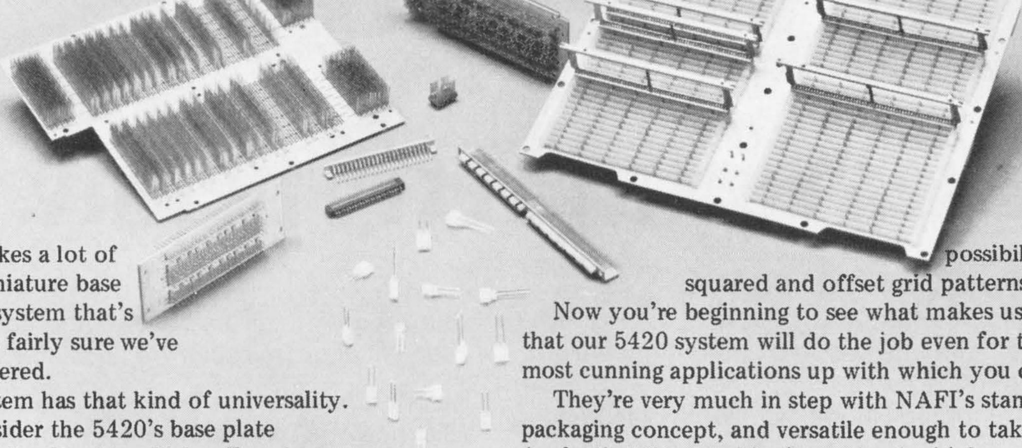

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And all the 5420's components provide the metal-to-metal contact required by MIL-E-5400. (No relation.)

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Now you're beginning to see what makes us so sure that our 5420 system will do the job even for the most cunning applications up with which you can come.

They're very much in step with NAFI's standard packaging concept, and versatile enough to take hundreds (make that thousands) of non-standard jobs neatly in their stride.

What we haven't said here we say in our catalog. Write for it. You'll find the 5420 specs on Page 14. Elco Corporation, Willow Grove, Pennsylvania, 19090, (215) 659-7000, TWX 510-665-5573. Or 2200 Park Place, El Segundo, California, 90245, (213) 675-3311, TWX 910-325-6602.

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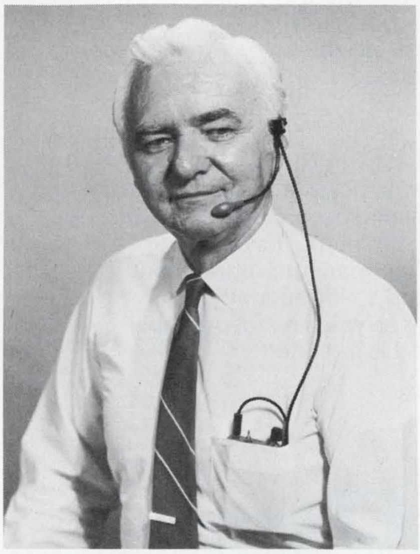
INFORMATION RETRIEVAL NUMBER 16

Highlighting THE ISSUE



Where hands-free communications are needed—for policemen, fire-fighting teams and others—there's nothing quite like the new Bendix locked-oscillator communications system.

With it, multiple conversations can be held on the same vhf channel at the same time. Although the transmitter and receiver of each set are both permanently connected to a single antenna, the transmitter operates continuously without interfering with reception.

The inventor, a former ELECTRONIC DESIGN "Ideas for Design" winner, is John M. Tewksbury, principal engineer at the Bendix Communications Div., Towson, Md. He is shown wearing the device.

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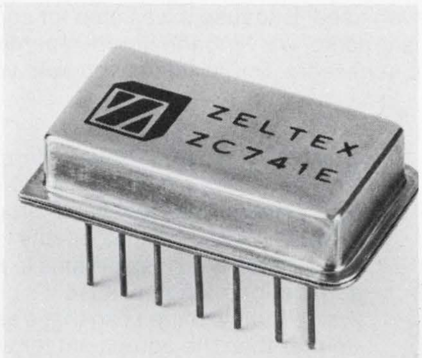

Two new pin-programmable operational amplifiers make possible over 500 combinations of gain, from 0.004 to 250. Both devices also feature selectable-mode operation—they can be used in follower, inverter or summing configurations.

These hermetic DIP devices use integral thick-film input/feedback resistor networks for temperature stability.

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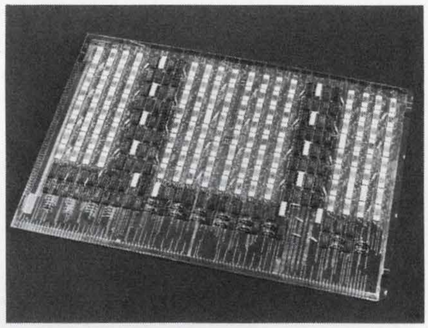

For 15 years, cores have reigned supreme in the commercial random-access, read-write memory market. In this time their price has continued to fall rapidly and their speed has doubled every two and a half years. They have "buried" at least two challengers—cryogenics and planar thin films. Now suddenly a new challenger has appeared—semiconductor memory.

"In 10 years," says Wally Raisanen, operations manager for IC memory and MOS products, Motorola Semiconductor Products Div., Phoenix, Ariz., "semiconductor memories will have the whole business—to a first approximation."

Page 70

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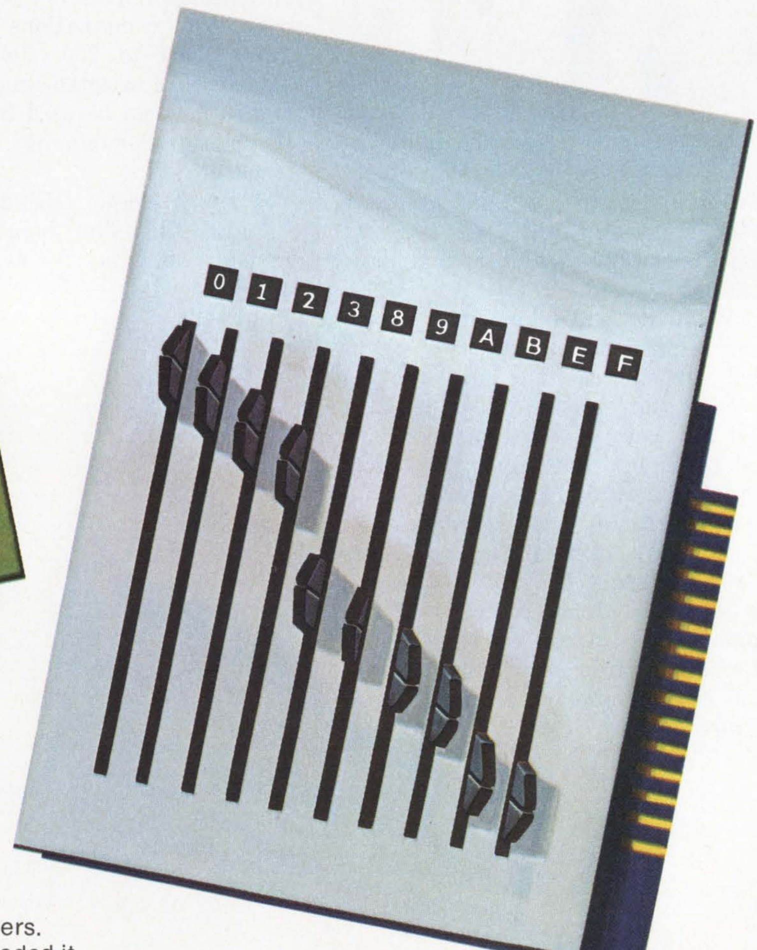

Our Slide Switch is a different story. Because it's seen, we've made it handsome . . . covered it with wipe-clean stainless steel and designed the inside sandwich style so no dust or dirt gets in to foul contacts. And because it is used frequently, we've built in a life-span to bridge a generation gap among engineers. All because you said you needed it.

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IBM unveils System 370 with accent on speed

The first elements of a new line of computers to succeed the System 360 have been announced by IBM. At first glance, the greater potential seems to be in the auxiliary equipment, which includes a new high-speed line printer.

The new computers, models 155 and 165 in a line called System 370, are aimed at replacing the System 360/50 and the 360/65, respectively. The new disc drive (Model 3330) makes use of a 12-disc pack that can store 200 million 8-bit bytes with an access time to a random bit of 30 ms. Up to four such disc drives can be used to provide up to 800 million bytes or 1.6 billion decimal digits of storage. The increased storage is achieved by doubling the number of tracks on each disc and doubling the bit density per track.

The line printer (Model 3211) can turn out 2000 lines per minute of a 48-character set or 2500 lines per minute of a 36-character set. This is twice the rate of previous IBM line printers.

The 370 computers are said to operate at three to five times the speed of the 360 models. The memory cycle time of the 370/165 is 80 ns. Conventional ferrite core memory is used. The fast cycle times result from placing an 8000-bit MSI semiconductor buffer memory between the core memory and the central processing unit. The CPU also contains a high proportion of integrated circuits. There are 72 functions per chip in the buffer and 2 to 8 functions per chip in the CPU. This use of integrated circuitry is a departure from previous practice by IBM.

Rentals for the new computers range from $50,000 to $100,000 a month; the purchase prices run from $2.25-million to $4.7-million. Deliveries will begin next spring.

Spokesmen for IBM declined to characterize the 370 line as the long-awaited fourth generation. They said that the new computers were evolutionary rather than revolutionary.

55-lb weather stations can be air-dropped

Expendable remote weather stations — known as Erows — are being built for the Air Force to air-drop in otherwise inaccessible places. They are designed to implant themselves in the ground on a spear-like tip and make a variety of meteorological measurements, which are then telemetered to a master station approximately 50 miles away. The battery lasts at least 10 days.

Designed and built by Honeywell's Aerospace Div., St. Petersburg, Fla., under a contract from the Air Force Cambridge Research Laboratories, Bedford, Mass., the small weather stations use frequency-modulated, frequency shift keying (FM-FSK) in the uhf band for telemetry.

The master station, designed for one-man operation, includes a digital recording system for readout of telemetered data, an interrogation module to display the exact status of the remote station being interrogated, and the built-in self-test equipment. The control station is able to interrogate up to 31 remote stations with coding isolation to prevent site confusion.

Each weather station is 104 inches long and 6 inches in diameter, and it weighs approximately 55 pounds.

"There are many applications for this droppable system," according to John W. Anderson, division vice president at Honeywell. "It could be used by the Army, the Weather Bureau or any number of agencies."

No follow-the-leader 'yet' on HP cutback

Hewlett-Packard's recent announcement that it planned to give its employees—including corporate officers—a day off every second week and a corresponding reduction in salary has evoked little response from other instrument manfacturers. Companies contacted by ELECTRONIC DESIGN either said they had no plans for following HP's lead or refused comment.

Frank Marble, vice president of administration for Systron-Donner Corp. Concord, Calif., says his company does not plan to give its employees uncompensated time off. Systron-Donner had a 5 to 10% layoff as a result of a normal staff review at midyear, he says, but he foresaw no further changes at the moment.

William Thurston, vice president of marketing for General Radio Co., West Concord, Mass., says domestic business is down right now but overseas business is better than expected. The company says it has no plans to reduce either workdays and/or pay. In fact, at the moment they have some paid overtime and have had no general layoffs, he noted.

IEEE alters handling of CAD information

The IEEE has disbanded its Committee on Computer Aided Design, Analysis and Realizability. The reason: Information on computer-aided design [CAD] should be handled by each discipline area in which it is being used and should not be considered as a separate discipline, the IEEE says.

The move, announced in the final issue of the committee's publication, CADAR Newsletter, carried a statement by John A. Dumanian, editor, in which he asserted: "Computer-aided design will play a lasting role in all fields of electronic and electrical engineering. But it is being retarded by the short-sightedness of IEEE group leaders who have failed to detect the importance of CAD."

The IEEE will handle CAD in the future under the auspices of the group using it. Computer-aided design of circuits, for example, will

News Scope CONTINUED

be covered by the Circuit Theory Group; of electron devices, by the Electron Devices Group, and so on.

Air Force will test laser reconnaissance

Airborne laser reconnaissance devices have reached the flying stage, and the sensor test range at Eglin Air Force Base, Fla., is preparing for them.

Large oblong panels, ranging in shade from black to white, are being laid out on the range to test the sensitivity of various laser-sensor combinations. These will be mixed among the existing targets —"Vietnamese" villages, trucks, missile sites and tunnels that are spread throughout the 64-square-mile range. These targets are used for testing airborne radar, infrared and low-light-level television.

Some of the lasers soon to be tested will be used to illuminate ground targets for an aircraft's low-light-level TV. Others will use a plain cathode-ray tube and film. For storing the data, some lasers will be equipped with video tape.

All have the advantage of providing a real-time reconnaissance readout. They operate at night, and they're not as big and bulky as radar.

In the area of foliage-penetrating radar, the Air Force is shying away from low-frequency radar that transmits long wavelengths that spill between leaves to detect enemy movements underneath. The low-frequency equipment is reported to be too big. The Air Force is now hoping to get through leaves with side-looking radar equipped with moving-target indicators. The logic goes that a movement detector will "see through" foliage because the radar scans from so many angles as a plane flies over it that some of the pulses are bound to get through.

An Air Force spokesman noted the following trends in reconnaissance aircraft: multi-sensor systems rather than a single sensor; sensors that operate at night; and real-time readouts to provide "kill" as well as "hunt" capability. This rules out those infrared and side-looking radar systems that must be processed on the ground, he said.

New company announces large-scale computers

A new computer manufacturer —Computer Operations, Inc., of Costa Mesa, Calif—has announced a new line of large-scale computers called the Gemini generation. The computers, while more powerful than the IBM 360 series, will be entirely software-compatible with them.

David Stein, vice president of marketing for Computer Operations, notes further that all IBM peripherals can be driven by the new systems.

The logic in the Gemini computers will be all MSI and LSI on laminated, multilayer printed-circuit boards.

Up to 1024 time-shared users at 9600 baud or 16,384 users at 300 baud will be able to communicate with the largest system simultaneously, Computer Operations says. This compares with 16 users at 300 baud on the IBM 360/65.

Stein contends that the Gemini system will be "10 times more cost effective" than the 360/65 and "two to five times more cost effective" than the new 370/165. The Gemini system can execute programs at speeds exceeding two million instructions a second, Stein says. He adds that "while the 360/65 has a maximum of 2 million bytes of directly addressable core and the 370/165 has a maximum of 3 million bytes, the Gemini system has a maximum of 16 million bytes."

Prices for the Gemini systems start at $3-million without peripherals. According to Peter Warkenton, president and chief executive officer.

Initial shipments are to begin in the fourth quarter of 1971.

Laboratory pacemaker doesn't need batteries

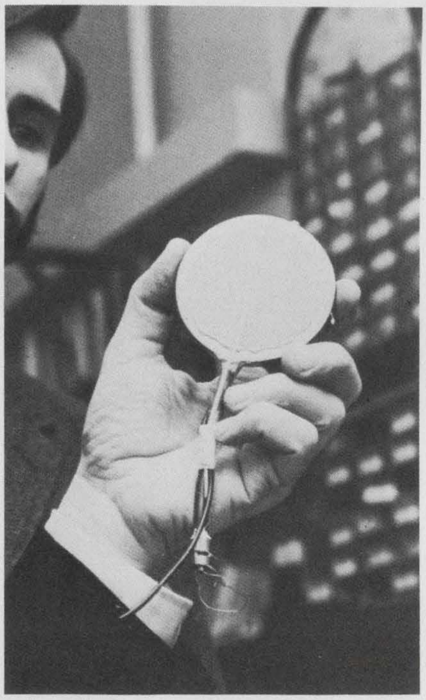
A biological feedback loop may someday eliminate the need for batteries in pacemakers. An experimental pacemaker uses piezoelectric disks to convert variations in blood pressure to electricity.

Today's pacemakers are powered by batteries that are implanted, along with the device, in the body. These batteries must be replaced about every year and a half, and a patient must undergo minor surgery for this.

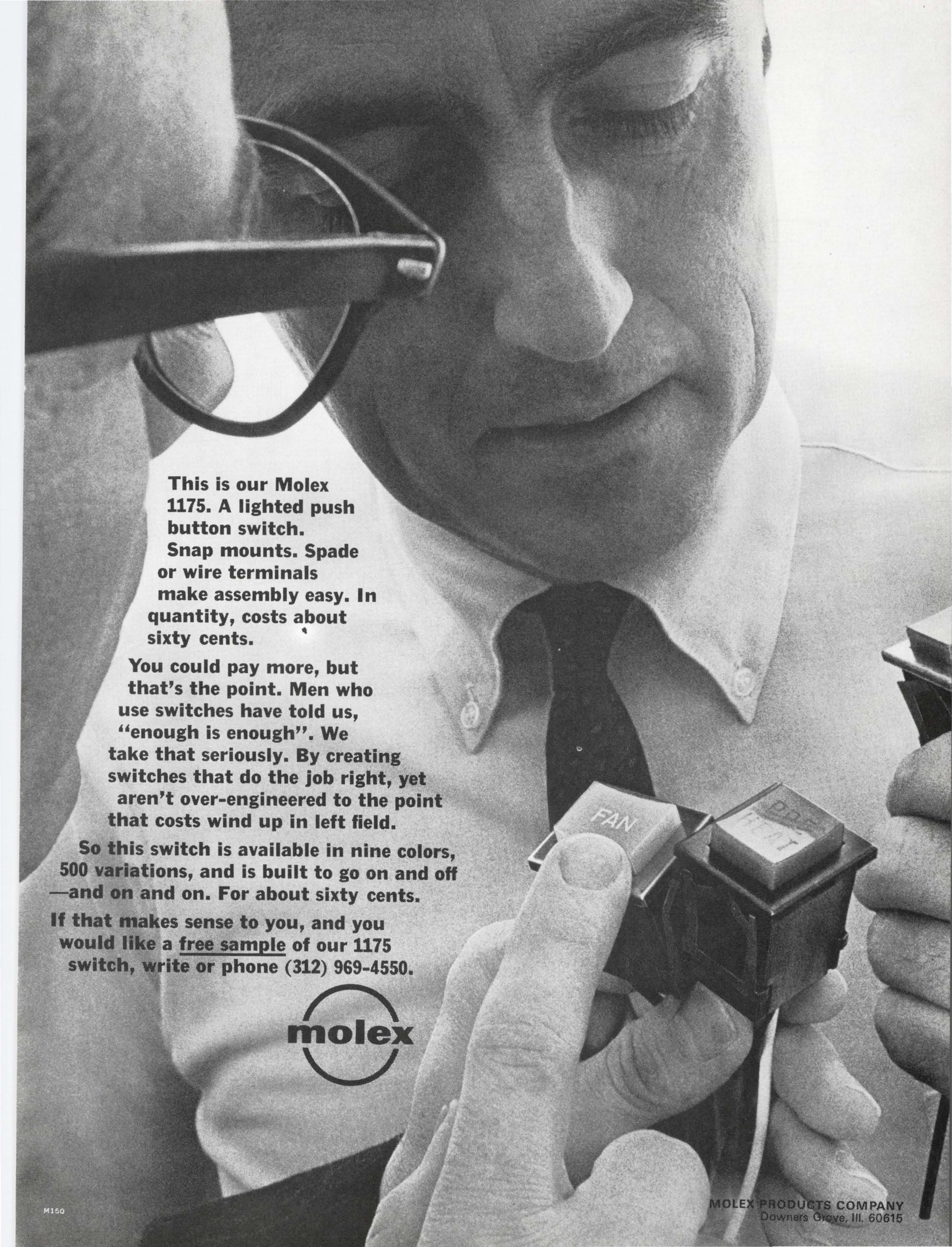
With the experimental design, a small plastic tube is inserted through a vein into the right ventricle of the heart, following the same path as the electrode in a conventional pacemaker. At the end of this tube inside the heart is a small balloon filled with water. As the heart contracts, there is a change in blood pressure, the water is squeezed up the tube, and this produces a mechanical strain in the piezoelectric disks.

The disks convert the mechanical energy to electricity, which is stored in a small capacitor in the pacemaker. The pacemaker, in turn, emits impulses that stimulate the heart muscle, and the loop is closed.

The new pacemaker was devised by Donald L. White and Michael R. Rocchi of Bell Telephone Laboratories in Murray Hill, N. J., and by Dr. Peter J. K. Starek and Dr. C. Wilton Lillehei of the New York Hospital-Cornell Medical Center.



Experimental pacemaker uses biological feedback loop that eliminates the need for battery power.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The 'impossible' communications system

Transmitter and receiver operate simultaneously on the same channel without interference

Jim McDermott
East Coast Editor

Where hands-free communication is needed—for policemen during emergencies, for fire-fighting teams and others—there's nothing quite like the new Bendix locked-oscillator communications system.

With it, multiple conversations can be held on the same vhf channel at the same time. Although the transmitter and receiver of each set are both permanently connected to a single antenna, the transmitter operates continuously without interfering with reception.

It sounds almost impossible, but ELECTRONIC DESIGN received a convincing demonstration that the system really works. No push-to-talk buttons or electronic voice-operated controls are needed.

Invented by a former ELECTRONIC DESIGN "Idea for Design" winner who merited an "Idea of the Year Award"—John M. Tewksbury, principal engineer at the Bendix Communications Div., Towson, Md.—the system employs two principles in operation: the use of a variable-repetition-rate pulse train for voice transmission and the use of a frequency-modulated master oscillator (operating at 12 kHz) that is phase-locked to both transmitted and received pulses.

FM pulse modulation used

The voice information is transmitted as a string of constant-amplitude, 20-μs pulses on which the modulation has been impressed by varying the time between pulses—in essence, FM pulse modulation.

These pulses can be transmitted as 20-μs bursts of an rf carrier. The present system, designed for short-range communications—up to 200 feet—operates in the 450-to-500-MHz band with an average power output of 5 mW.

The uniqueness of the system lies in the fact that the pulses not only contain the voice modulation, but are also used for both local and remote phase-lock control of the 12-kHz sawtooth oscillators—which themselves generate 20-μs pulses in step with the local or received modulation.

For each cycle of the 12-kHz oscillator, a 20-μs pulse is generated (Fig. 1) and applied to a diode switch, which gates the output of a vhf crystal oscillator. The diode switch output is a 20-μs burst of rf that is applied to the transmitter amplifiers, which apply the burst to the antenna.

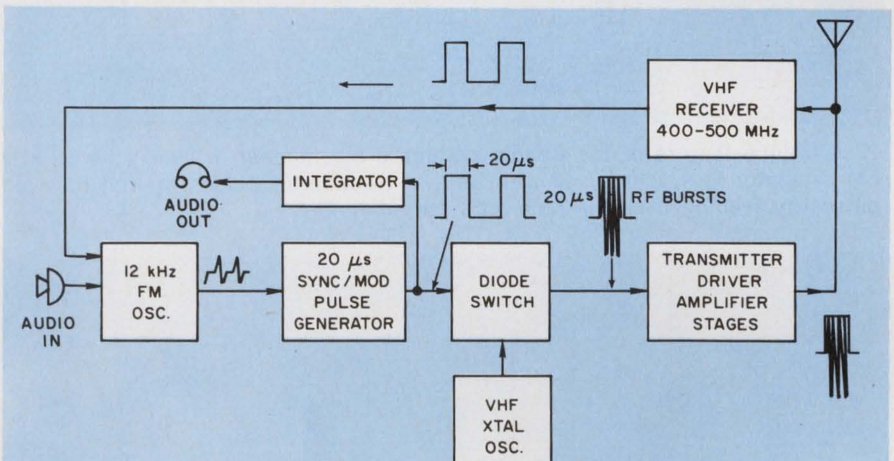
The transmitted pulse rate, with no modulation, is determined by the free-running frequency of the 12-kHz oscillator. When not receiving pulses from another transmitter, the set feeds its own pulses back through its receiver and around a closed loop to the 12-kHz oscillator input to establish a stable oscillator rate.

Each station's own transmitted pulses are always present at its receiver input, but this does not interfere with reception of pulses that are ahead of or behind it, because the receiver has been especially designed with a recovery time of about 0.020 μs.

When a second station is operating in the vicinity, it transmits its own string of 20-μs pulses. The receivers in both stations detect early or late arrivals of the incoming pulses with respect to their own pulses, applying a correcting signal to their own oscillators that tends to correct the error. The signals from both transmitters lock into synchronism and the 12-kHz oscillators in both sets become phase-locked at some frequency that is a compromise between the free-running rates of both. When more stations are added to the loop, they all synchronize their pulse transmissions at some common, compromise frequency.

When anyone speaks into the microphone, the 20-μs time-varied pulses are generated in step with the modulation frequencies. When the pulse train passes through a triple integrator, the voice signal is recovered. This signal is amplified and applied to the earphones.

These same pulses are also transmitted as rf bursts, which are received and locked onto by the other sets in the vicinity. The outputs of the receivers are applied



1. **In the new Bendix vhf transceiver,** the 12-kHz oscillator is frequency-modulated by local voice or received signals, producing a time-varied string of 20-μs pulses that are demodulated by an integrator.

(**Bendix,** *continued*)
to their 12-kHz oscillators, causing them also to lock in step and produce pulse trains identical to that in the transmitting set.

One of the really new features of the Bendix system is the manner in which the 12-kHz FM oscillator produces the 20-μs pulse stream while simultaneously responding to the phase lock signals in the receiver output (Fig. 2). The 12-kHz oscillator is a unijunction transistor with an RC circuit in its base circuit. A sawtooth wave appears across the capacitor, and as the voltage reaches about 50% of V_{cc}, it abruptly discharges as the unijunction conducts. During this fall-time period, a 20-μs, one-shot delay circuit is activated.

At the end of 20 μs, the delay circuit output triggers the 20-μs pulse generator, which gates the diode switch, causing a 20-μs rf burst to be transmitted. This is picked up by the set's own receiver, and the collector of the output stage Q_2 is driven to ground, thus reducing the voltage at point A to 1/2 V_{cc}.

For the next 20 μs, the sawtooth voltage remains constant (Fig. 3a), and when the 20-μs pulse is finished, the sawtooth voltage continues to rise to the conduction level of Q_1, which fires and starts the cycle over again.

Any audio input voltage appears in series with the capacitor voltage; so that for a positive ac voltage, the sawtooth will trigger faster, while for a negative voltage, it will take longer to reach conduction. In this manner the frequency is either increased or decreased. At present, the maximum excursion is 12 ±1.5 kHz.

Tracking the pulses

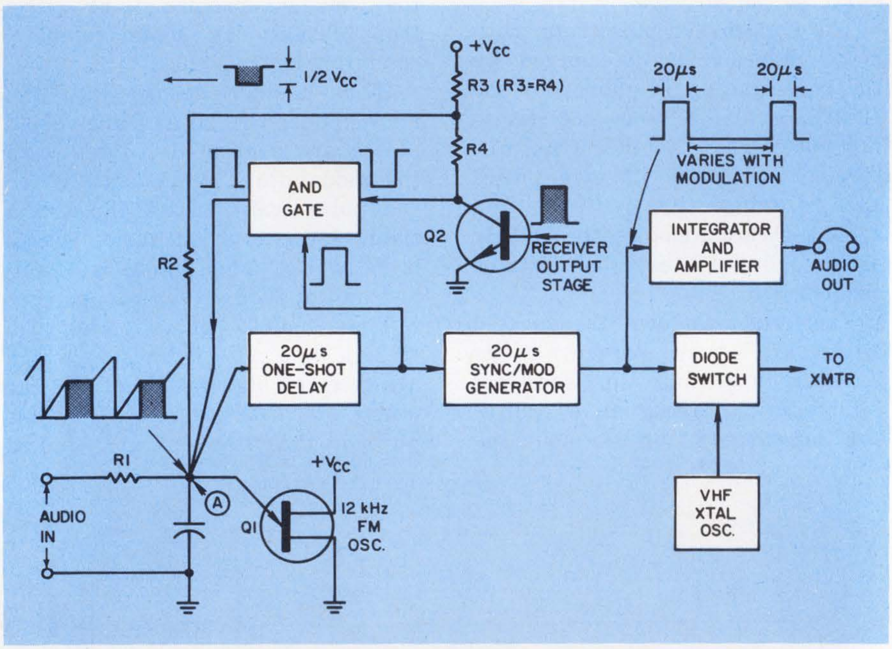
When an incoming signal is received, and is retarded with respect to the local 20-μs pulse, the local receiver "sees" both pulses as a single one that is longer by the duration of the overlap (Fig. 3b). The widened pulse then is applied to the sawtooth as a delay that increases the time between the 20-μs sync/modulator pulses and causes these pulses to catch and track the incoming pulses.

The output of the 20-μs keyer is also fed to the integrator/amplifier, and when the local pulses accurately track the incoming ones, the demodulated signal is heard.

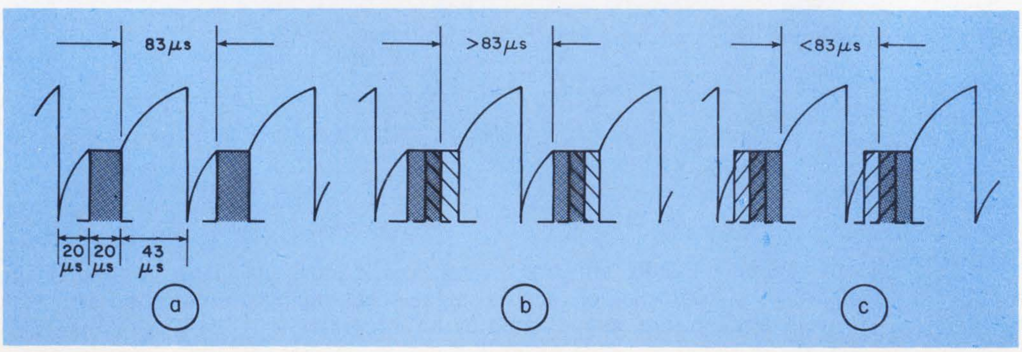
When the incoming pulse leads the local pulse, an AND gate comes into play. The output of the 20-μs, one-shot delay and the output at the Q_2 collector are applied to the AND gate to produce a positive voltage for the duration of the leading pulse overlap.

If the incoming pulse leads the keying pulse, it falls into the first 20 μs of the rising sawtooth. But the AND gate is now open for the first 20 μs, and a positive voltage is applied to point *A* (Fig. 2), thereby sharply increasing the voltage at that point and driving it higher than normal.

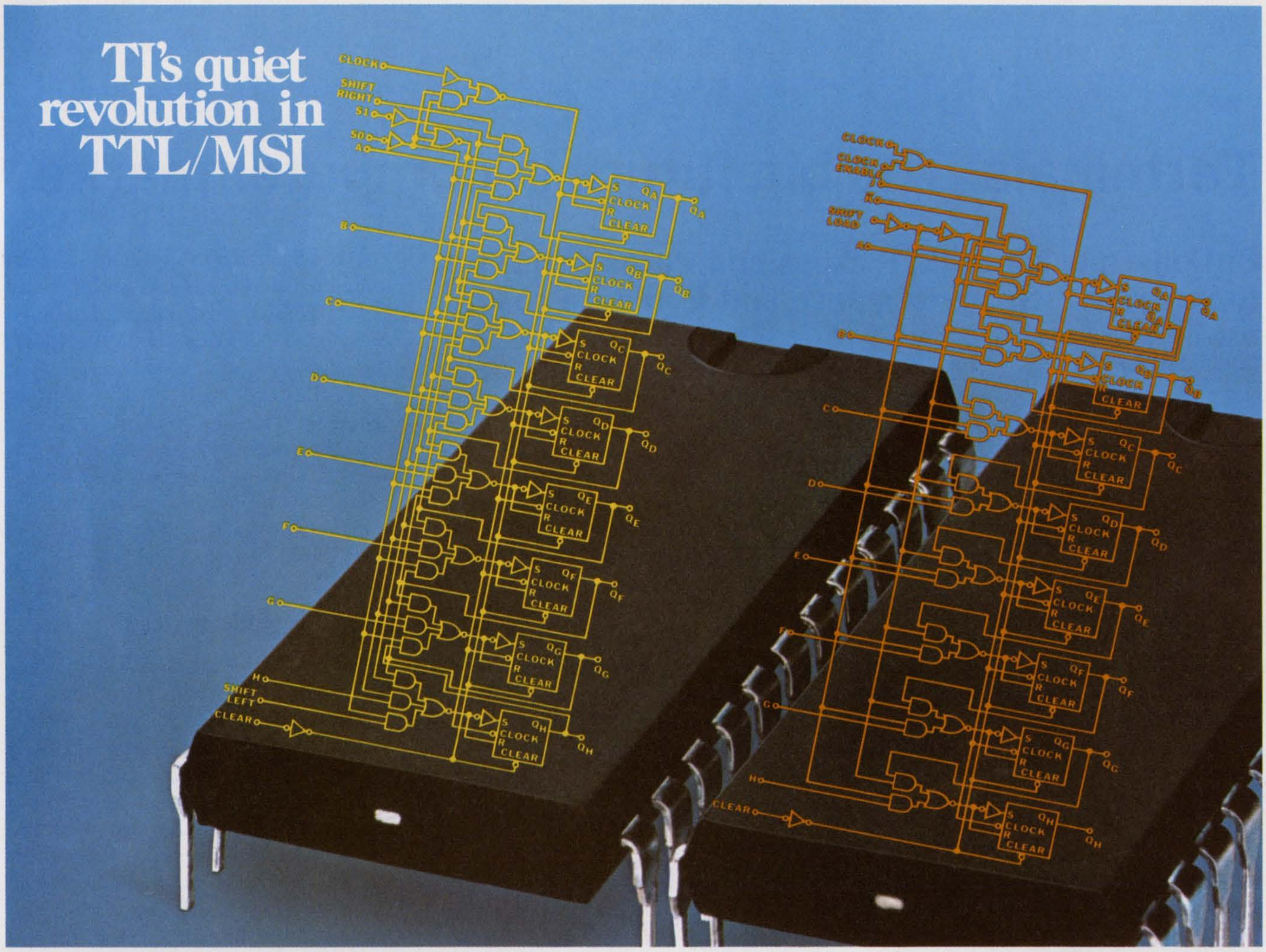
When the AND gate is turned off at the end of the first 20 μs, the local 20-μs pulse is applied to point *A*, which then remains at a higher than normal voltage for the remainder of the second 20 μs. The voltage then rises again but reaches the conduction point earlier than it normally would, shortening the time between the local 20-μs keyer pulses and causing the local pulses to track incoming ones. ■■



2. **A unique feature of the Bendix system** is the manner in which the 12-kHz FM oscillator is synchronized with its own transmitter pulses or with received pulses by feeding back the receiver's output to Q_1.



3. **The waveforms shown appear at the 12-kHz oscillator base** (Fig. 2) for (a) Free running conditions; (b) A late received pulse; and (c) An early received pulse. The overlaps have been exaggerated for purposes of illustration.



Either <u>one</u> of TI's new 8-bit shift registers outperforms any <u>two</u> 4-bit SRs—for two-thirds the cost.

Combine any two 4-bit shift registers—you still can't match the flexibility, performance and economy of one of TI's new 8-bit TTL/MSI universal SRs. The SN54/74198 and SN54/74199 each offers twice the complexity (87 equivalent gates) at only two-thirds the cost.

At less than 9¢ per gate, they are excellent buys. The SN54/74198 and SN54/74199 each cost $7.32 (100-999 quantities) in 24-pin plastic DIP.

What's more, they are fast (20 ns typical propagation delay) and operate at input clock frequencies up to 32 MHz...yet require only 360 mW, or a little more than a 4-bit shift register.

As for logic flexibility, the bidirectional SN54/74198 shifts left or right without external connections, and has full parallel access to each of 8 flip-flops. No need to turn off system clock, either, since a "do-nothing" state is also provided. Try the SN54/74198 as a shift register, parallel-to-serial converter, serial-to-parallel converter or in an accumulator. Inputs are buffered for a fan-in load of 1, including clock.

If your needs dictate, consider the SN54/74199. It shifts left, loads parallel data, inhibits clock, and has important J and $\overline{K}$ serial steering inputs. Use it also as a Johnson counter, a code converter, a ring counter and a shift register generator counter. Both registers have a direct clear which overrides all other inputs.

For data sheets, write on your letterhead to Texas Instruments Incorporated, P.O. Box 5012, M.S. 308, Dallas, Texas 75222. Or ask your authorized TI Distributor.

TEXAS INSTRUMENTS
INCORPORATED

Terminals: The big future in computer market

But one speaker at IEEE exposition warns of need to improve their performance and to reduce costs

Milton J. Lowenstein
Computer Editor

Terminals stole the show at the International Computer Group Conference and Exposition, held in Washington, D.C., under the sponsorship of the IEEE Computer Group. CRT displays and intelligent input-output devices predominated, both in the technical papers and the exhibit booths.

All forecasts at the convention indicated that terminal manufacturers would increase their share of the market while computer mainframe builders would encounter a decrease. But at least one speaker warned that present terminal equipment had serious shortcomings in performance and was unduly expensive. He called for improvements and lowered costs to capitalize on the growing market opportunities.

New memories announced

Two new memory developments were announced at the conference.

Hughes Aircraft disclosed that its magnetic-domain memory had been licensed for production by Digital Development Corp., San Diego. This memory is a mass-storage type that can replace disc, drum and tape.

Honeywell Aerospace Div. told of its 2-mil plated wire memory, which is compatible with MSI drive circuits.

Many of the reasons for growth in the terminal market were discussed by Lowell D. Amdahl, president of Compdata, Inc., Tarzana, Calif., in a paper, "Tomorrow's Technology." He said:

"Technology improvements will be concentrated on serving the user on his terms. This will include a strong trend to place I/O devices, primarily terminals near him."

In addition, Amdahl continued, there will have to be improvements in software, because "the user will want to use his computer system directly with his data and in his language."

More and better terminals are on the way, Amdahl said.

"Central processors are showing an increase in performance to price ratio of from 40% to 70% per year," he reported. "This has resulted primarily from increases in performance rather than reductions in price. The only exception is in the low end of the range, where minicomputers have been decreasing in price at 30% to 35% per year."

The conclusion is inescapable that relatively more money will go into terminals, Amdahl asserted.

He also touched on auxiliary memories. "Disc memory systems are expected to evolve to higher performance through higher recording densities and greater emphasis on head-per-track organization," he said. Manufacturers showing head-per-track disc systems at the show added that access time had been significantly reduced by this design.

Terminals must be designed for the convenience of the user. This injunction from the IEEE Computer Group conference is here carried out by Ultronic System's new Videomaster terminal, intended for use by stockbrokers.

Strong criticism of terminal performance and cost was sounded by L. C. Hobbs, president of Hobbs Associates, Corona Del Mar, Calif. He said:

"While the cost of the central processor is decreasing rapidly, and software and operating costs are assuming larger roles, peripheral equipments are rapidly dominating the system hardware costs."

A call for static devices

Hobbs called for new approaches and new technologies to provide higher performance and lower costs. He indicated that it was particularly desirable to divorce mass storage from such electromechanical components as drums, discs and tape drives. A better approach, he said, is to go to static devices—magnetics and semiconductors. But he added that he did not expect to see this goal easily achieved.

Hobbs also pointed out that on-line usage was growing very rapidly. He was supported in this observation by J. Peter Ross of Quantum Science Corp., New York City, who said that dispersed remote computing would dominate the domestic market in the 70s.

Intelligent terminals on the way

"Among the features to be expected," Ross said, are "more intelligent, job-oriented terminals, central processors optimized by new architectures and improved software, immense mass memories—originally disc but giving way to MOS and LSI technology—and increased communication costs."

Ross added: "The foreign markets are growing 50% faster than those in the U.S., and so is foreign competition. Right now, foreign markets are more profitable than domestic ones. Without their world trade profits, International Business Machines' 1969 net would have been below that of 1968." ■■

Outlook for European electronics: No slump

Exhibitors at Mesucora Automation Show see 10-to-40% general increase in sales this year

Raymond D. Speer
Managing Editor

PARIS

In spite of the slowdown in the U.S. economy, it's "business as usual in Europe." This was the view of many of the exhibitors at the giant Mesucora Automation Show here. Their projections were for sales of their products to grow at a rate of 10 to 40% this year.

And computer and peripheral-gear sales are expected to grow the fastest. Representatives of Systems Engineering Laboratories in Rueil-Malmaison and of Mohawk Data Systems, Aéromaritime Electronique, and Viatron-France, all of Paris, were very optimistic. All of these companies represented American firms at the Paris Show, which ran from May 27 through June 4.

There were some, however, who saw faint clouds on the economic horizon. Sales will grow, they said, but not as fast as many expect.

Jean Desplanches, sales engineer for Packard Instrument S. A., Paris, for example, was happy, but not deliriously so.

"Business is not going down," he said, "our sales are increasing slowly in France and throughout the Common Market. But we don't expect large increases.

"One of the reasons," he continued, "is that our products are used largely in research and medicine. Our sales are dependent on budgets allotted to research, and in Europe there isn't much money available for research projects."

Bernard Hauseux, ingénieur electronicien E.S.E. with AFE Manufacturing and Sales, Inc., Paris, saw a moderately good market for Hickok instruments, which his company handles.

"In France," he said, "money has been extremely tight; the level of credit has been lowered drastically by the government in the last few years. But now business is on the increase, and with France's recent devaluation, it is easier to export French products. The result has been a stimulation of business in France."

Pierre Forgeas, ingénieur technico-commercial with Hewlett Packard, France, saw a "so-so" market, with "a growth in HP sales of 15% in 1970—certainly not more."

"This is much slower than last year," he noted.

Forgeas expected HP's growth to come largely from the industrial and atuomation markets, and he listed also the telecommunications area as a likely market.

"In France," he said, "there has been a great motivation to buy French products first. Since de Gaulle this has been changing, and engineers are becoming primarily concerned with finding solutions to their technical problems. They're getting more interested all the time in buying imports—instruments and systems, as well as components.

At least one company, though—Ceta Electronics, Ltd., Dorset, England, a firm with no U.S. ties—saw its brightest sales future in the U.S., even though the American electronics business has been relatively poor in recent months. Ceta's sales director, Peter H. Bowker, explained:

"We feel that there's a considerable market for our products in Europe, too, and we're having a go at Western Europe. But we feel the U.S. will be our best market in the future, even though things aren't going too well now."

Up to now, Ceta has limited its sales efforts to Britain.

Exhibitors were optimistic at the huge Mesucora automation show in Paris. Most predict sales increases in their product lines of 10% to 40% for 1970.

Show considered a success

The exhibitors at Mesucora were basing the forecasts for electronics growth in Europe largely on their success at the show, and that success was considerable.

Among the more optimistic, James Baconnet, director of international operations for Systems Engineering, said he definitely expected growth in the European economy this year. Systems Engineering is a supplier of real-time computer systems, both hardware and software. In the process-control, scientific and industrial-computer markets, industry growth should be 17 to 35% in 1970, Baconnet said. Business machines, he added, will grow less swiftly.

Mohawk Data Systems' Pierre Zambaux, director of the Original Equipment Market Div., noted that there was a dip in computer and data-processing sales in February, but he said he expected virgorous growth from now on. Mohawk is selling peripheral equipment—card punches and readers, paper-tape punches, magnetic data recorders and tapes, and high-speed printers.

Zambaux said that, to date, in its first two and a half years of operation, Mohawk had sold over 2000 machines in France alone.

He saw sales to the Soviet-bloc

"**The U. S. is four to five years** ahead of Europe,' and Europe is four or five years ahead of the Soviet"—Pierre Zambaux, ingenieur E. S. E. and division director at Mohawk Data Systems, Paris.

countries as a good possibility, although he hadn't sold any machines there yet. And he observed that the gap between Soviet and American technology was very wide.

"The U.S. is four to five years ahead of Europe," he said, "and Europe is four to five years ahead of the Soviet."

Representatives of Aéromaritime Electronique (AEREL), who sell calculators and minicomputers for Wang Laboratories, Digi-Data Corp., Optronics, Vector and others, predict sales exceeding $1-million in 1970 for Wang products alone. The market for calculators is widening, they observed, and they see strong growth through 1970 and 1971.

Since the French labor troubles of two years ago, business in general has been growing steadily, according to AEREL's Philippe Clouard, ingénieur technico-commercial. He noted that the calculators and computers that AEREL sells will be used in France for scientific, construction, surveying and business applications. But the largest field of use will be scientific—scientific and statistical calculation

(**no slump,** *continued*)
in research centers and universities. This will account for 60% of their business, Clouard said.

And Gilbert Derbyshire, public relations manager for Viatron France, saw a demand for 2000 System 21's in France alone in 1970. "The problem," he said, "will be delivery. If we can deliver, we'll sell $5-million in 1970."

Many seek French reps

Bowker of Ceta Electronics, gauged as "reasonable" the response at the show to his company's products. Ceta manufactures IC testers and considers Teradyne its chief competition in Europe. "One of the things we wanted to accomplish here," the sales director reported, "was to find a good agent to represent us. We've met about 20 interested companies, and we'll select one in the next few days."

Many of the U.S. companies that exhibited at Mesucora were looking for European business partners, and many found them. Bruce Strong, director of business relations for the U.S. exhibition area at Mesucora, reported that of the area's 39 exhibitors, nine were new to the French market and were looking for representatives. All concluded agreements or were negotiating with French companies by the end of the show.

Warm greeting to Americans

U.S. participation in the show was greeted warmly by European engineers. AFE Manufacturing and Sales had two booths, for instance—one in the U.S. exhibition area and one on a different floor. It reported its U.S.-affiliated exhibit had more visitors.

Mohawk's Zambaux saw it this way: "European engineers are interested in U.S. companies because that's where they expect to find high-performance, state-of-the-art products. But U.S. companies producing run-of-the-mill items don't command any special attention."

Less advanced products are produced well, and cheaply, in Europe, Zambaux observed.

Bernard Hauseux, ingénieur electronicien E.S.E. with AFE, noted that the typical French manufacturer could product test instruments that were the equivalent of those of U.S. manufacturers. But they are more expensive, he added. "Engineering costs are very high," he said, "and European companies can't produce in high enough volume to support extensive development efforts." ■■

"**. . . Now business is on the increase,** and with France's recent devaluation, it is easier to export French products. The result has been a stimulation of business in France" —Bernard Hauseux (left), ingénieur electronicien E. S. E. with AFE Manufacturing and Sales, Paris, chats with ELECTRONIC DESIGN's managing editor, Raymond D. Speer, at the Paris Show.

When in Europe, do as Europeans do

Interviews by ELECTRONIC DESIGN among exhibitors at the Mesucora Automation Show in Paris produced these tips for American electronics companies that want to sell in Europe:

Marketing U.S. products in Europe involves considerably more than hanging out a sign. The prestige of the U.S. electronics technology will take you far—but often not far enough to close a sale. You must demonstrate a commitment to the European market.

You must be prepared to talk over with the customer, in his own language, the technical problems that you are offering to solve. And you must provide adequate, visible technical support for your products in Europe.

How do you demonstrate a commitment? By having a good, respected European agent or representative, or by forming a subsidiary in a European country. It's best to have a permanent agent in each country in which you plan to do business.

One exhibitor at the show, Ceta Electronics of Dorset, England, spent much of its time in Paris hunting for a good French company to represent it in the future. Ceta's sales director, Peter H. Bowker, noted: "In France, people aren't prepared to buy direct from an overseas manufacturer unless he is well-established in France."

A typical French businessman's comment, he said, was: "Your equipment looks very good. As soon as you have an agent established in France, let us know."

The need to speak the customer's language was emphasized by Arturo Krüger, director of technical services in Europe for Motorola Semiconductor Products, Inc. He said that his application engineers must speak four languages—English, French, German and Italian—to operate effectively from their Geneva base.

James Baconnet, director of international operations for Systems Engineering Laboratories, Rueil-Malmaison, France, observed:

"Europe is 15 nations with at least nine languages, and though the prestige of U.S. electronics makes selling easier, it's much better to use the native tongue when you deal with a customer. The subtleties of negotiations in contracts, for instance, may escape you completely if you don't know the language intimately."

As for technical support for the product, Pierre Zambaux, director of the Original Equipment Market Div., for Mohawk Data Systems, Paris, said it was utterly essential. It takes too long to communicate with the American parent firm on routine problems, he stressed. The customer won't wait.

Component and Circuit Design

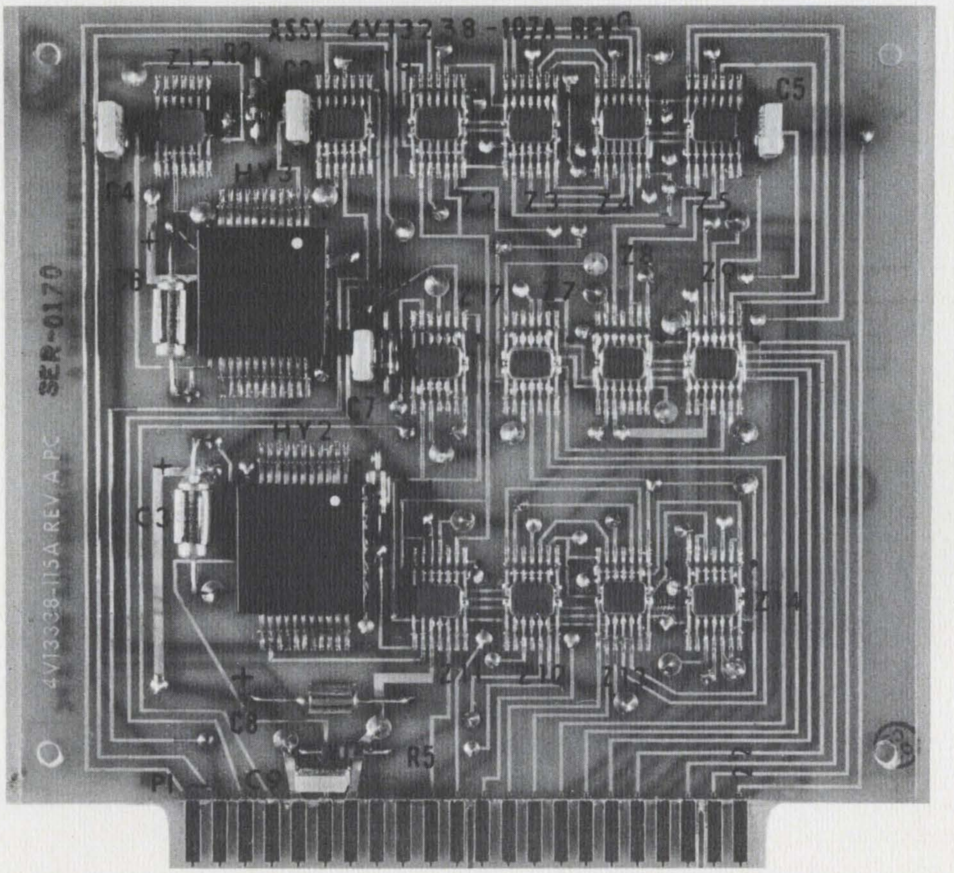
IDEAS

FROM SYLVANIA

CUSTOM ASSEMBLIES

From circuit boards to complete assemblies, we've got the capabilities.

Before you get to final design, talk to us. We'll show you the best and least expensive way to produce your system.



Circuit board assembly for avionics system made and tested at our Muncy, Pa. facility.

Because we've got the experts, we are willing to accept any challenge on the design and assembly of printed-circuit cards. First of all, we make our own circuit boards—single-sided, double-sided and multilayer. We also have the equipment to insert components on the board. And we are experienced at designing specialized equipment to test out the finished assembly.

The result? A completely integrated facility that can take care of all of your circuit assembly headaches. And we have the production facilities to produce your assemblies in volume.

Because of our wide range of capabilities, we can start with you at any point in the design/production schedule. We'll sit down with you at the beginning of design, or we'll make the board that you designed. We'll insert components, if you want, or give you the finished board for component insertion in your own plant.

Talk to our engineers right at the beginning of your design. They'll show you where to relax tolerances to get a better yield and lower cost. They'll analyze thermal conductivity to give you a layout with better heat dissipation. In fact, they will even run a temperature profile of the entire board and give you a prediction of its reliability. In short, they can cancel out potential problems long before your equipment gets to the production stage.

If you have your board already designed, we'll take over from there and produce them in any volume you require. At that point, we can either deliver the boards to you or turn them over to our component insertion people. They'll set up a production line that will turn out your completed circuit board assemblies at high speed.

And again, at the end of that production line our test equipment people will take over and set up specialized test equipment to make sure that each assembly meets your specifications.

In short, we have the capability to pick up at any point in your design cycle, and drop out wherever you wish.

What more can we offer?

CIRCLE NUMBER 300

This issue in capsule

MICROWAVES

Better step-recovery diodes improve multiplier design.

Multiplier efficiency is increased by diodes having minimum transition times and lower thermal resistance.

Our new step-recovery diode family is designed for use in both low- and high-order multipliers. The devices are oxide-passivated, mesa epitaxial silicon diodes mounted in the 023 package. Modern bonding techniques have been used in attaching the chip to the package to obtain low thermal resistance. Minimum transition times are obtained by careful control of the intrinsic layer thickness and resistivity.

In multiplier applications, the diode stores charge and appears as a low impedance when driven into forward conduction by one half of the RF signal. On the second half of the cycle, the diode conducts until the stored charge is removed. It then switches off very rapidly at a speed determined by the transition time. Ideally, in multiplier design, the transition time should be less than the period of the output frequency.

Another important factor in multiplier design is the minority carrier lifetime. It is desirable that this lifetime be greater than the period of the input frequency. This lifetime is the time required for all charge stored on both sides of the PN junction during the forward biased state to be returned across the junction when the RF signal reverses phase.

Figures 1 and 2 show the relationship of minority carrier lifetime and maximum transition time to frequency. With these charts and the table of data on our new step-recovery diodes you can see exactly what our diode family can do for you in your next design.

The chart in Fig. 3 shows the junction capacitance variation with bias voltage for three types of microwave diode: microwave tuning varactors (MTV), punch-through varactors (PTV) and the step-recovery diode (SRD). These curves show the step-recovery diode characteristics in comparison to the other types. CIRCLE NUMBER 301

Step-recovery diode characteristics

Type	V_B(1) Volts min	C_{j-6}(2) pf min	C_{j-6}(2) pf max	τ(3) ns min	T_t(4) ps max	Θth °C/watt typical	C_{jo}/C_{j-6} max	f_{c-6}(5) GHz min
DVB-6101	30	0.3	0.5	10	100	30	1.6	400
DVB-6102	45	0.5	1.0	25	250	20	1.6	300
DVB-6103	60	1.5	2.5	60	400	15	1.6	200

Test Conditions:
(1) $I_R = 10\mu A$
(2) 1 MHz and $V_R = 6$ volts
(3) I_{fs} 10 mA and $I_R = 6mA$
(4) $V_R = 10$ volts and $I_F = 10$ mA
(5) 1 GHz and $V_R = 6$ volts

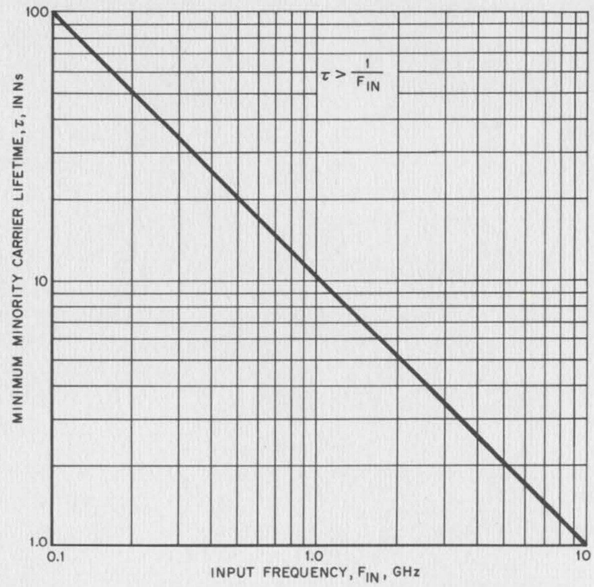


Fig. 1. Minimum minority carrier lifetime compared to multiplier input frequency.

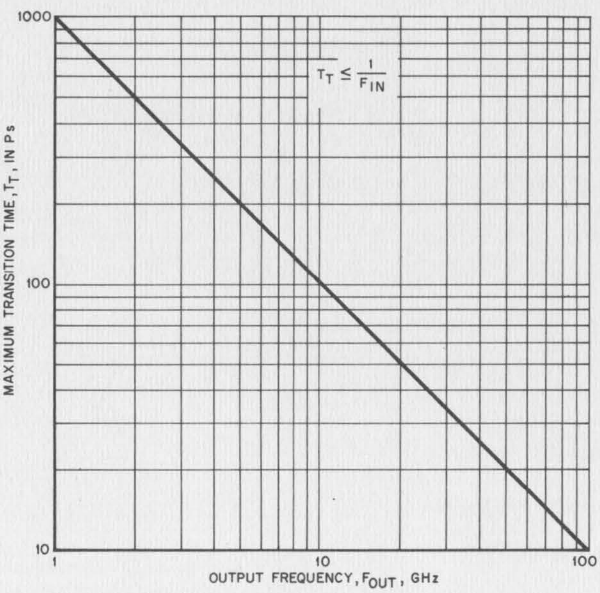


Fig. 2. Maximum diode transition time compared to output frequency of multiplier.

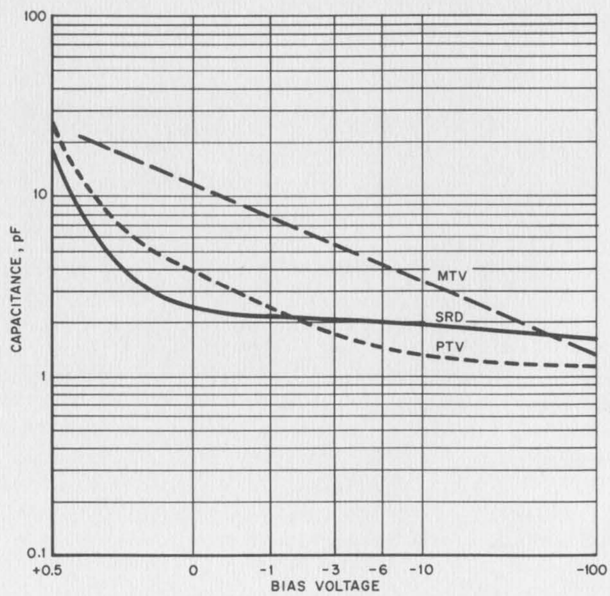


Fig. 3. Capacitance characteristics of three types of microwave diodes.

HYBRID MICROELECTRONICS

Flexibility is the key to hybrid packaging.

Trying to force everything into a "standard" package can destroy the advantages of hybrid circuit design.

There is no such thing as a "standard" hybrid microelectronics package. In fact, to impose such restrictions on a designer would defeat one of the most important features of this technology. Design and packaging flexibility is one of the key advantages of the hybrid approach.

The trick is to let your environmental and system parameters dictate what would be the optimum package. Then talk to our hybrid circuit engineers to develop the most efficient and least expensive approach to meeting your requirements.

The design flexibility we can provide is illustrated in the photographs. The first example is a character generator. This is one of a family of devices in a stroke type display system. Over 100 different types of circuit are used in a single display system, and each device differs in the values of the input, or summing, resistors. The general circuit is shown in Fig. 1.

As an additional requirement the amplifier had to be hermetically sealed and replaceable within the module. The amplifier also had to be set at a level to match the other amplifiers in the system. This required dynamic trim of the finished device.

Because of our long experience in this field we have the equipment to do this resistor trimming quickly, accurately and easily and—perhaps most important—at minimum cost.

A final, and important, requirement of the design was that, due to system packaging constraints, the entire module had to be in a dual in-line configuration.

Because of the large number of differing precision resistors required for the range of modules, our engineers designed a substrate that would accommodate more than one module type. This approach had many economic benefits.

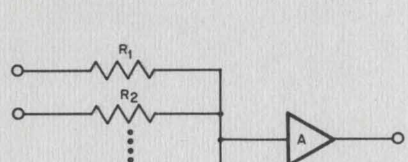
The amplifier is constructed using a hermetically sealed TO-5 can for the semiconductor elements of the amplifier. This package is entirely replaceable. After the amplifier is mounted on the substrate containing the precision resistors the amplifier output is adjusted. This is done by monitoring the amplifier output while trimming one of the resistors on the substrate. When the proper output value is reached, the character generator is ready for mounting in custom-designed header. The final product is shown in Fig. 2.

A second example of the flexibility of hybrid packaging is shown in Fig. 3. Here, the requirement was for a hybrid module that would identically replace the discrete component assembly shown.

The hybrid assembly could, of course, be made much smaller, but because of the direct replacement requirement, the hybrid circuit is designed into the same package. In addition to being more economical, the hybrid circuit also offers advantages in size, weight and system reliability.

These are only two examples of how we can apply our hybrid packaging technology to design problems. Do you have a design right now that might be improved by the use of hybrids? Talk to our engineers. You'll be surprised at what they can save you in both work and money.

CIRCLE NUMBER 302



1. RANGE OF R's : 50:1
2. RESISTOR TOLERANCE: ≤ 0.2 %
3. AMPLIFIER GAIN: 1 (DYNAMIC ADJUST)

Fig. 1. General circuit of character generator.

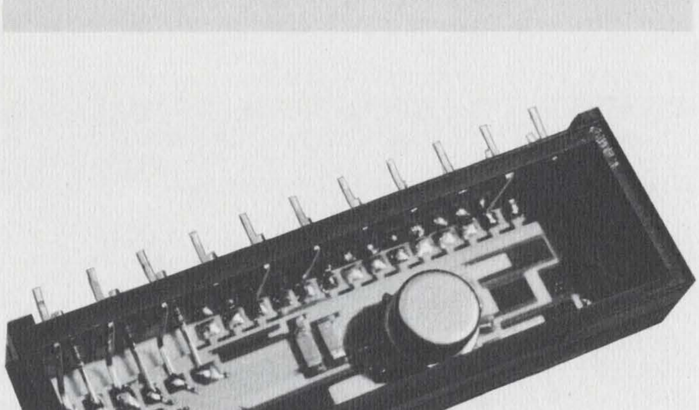


Fig. 2. Hybrid assembly of character generator.

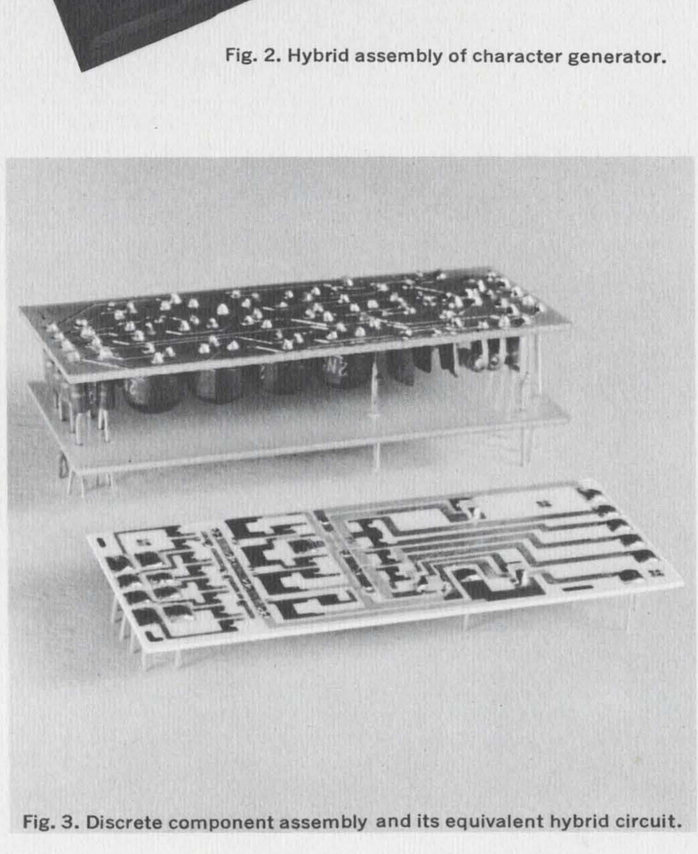


Fig. 3. Discrete component assembly and its equivalent hybrid circuit.

INTEGRATED CIRCUITS

Take advantage of Gray code in your counter designs.

Use of Gray code for counters offers some desirable features that you can't get from binary systems.

If you want up/down counters that give you ease of construction, reduced noise, reduced errors in reading, and a system that won't overflow, you should think about using Gray code.

The key advantage of Gray code is that only one bit can change at a time. Thus, if the clock pulse should occur while the counter is being read, the maximum error in the reading is only "one". Noise on the power line caused by flip-flops changing state is also reduced. This decreases power drain in high-frequency operation.

In addition, you can't generate "sliver" pulses with Gray code as is the case in binary operations. It is also very easy to change the direction of counting in a Gray-code counter. You simply invert parity. Another advantage is that the Gray-code counter stops counting when it reaches its maximum value, whether it is counting up or counting down. If this doesn't happen to be a valuable feature in your design, simple logic can be provided to eliminate it.

The logic diagram of a four-bit Gray-code up/down counter is shown in Fig. 1. Parity of the number is generated in an SM-120 parity generator. The parity generator outputs can be inverted by adding a "1" at pin 6 of the SM-120. The maximum value and zero are decoded at pins M_X and Z, respectively. These signals can be used as enable inputs for additional stages of Gray-code counters, or as controls at the input of the first stage to eliminate the hang-up at maximum or zero.

Figure 2 shows how two Gray-code up/down counters can be connected to produce an eight-bit counter. If pins M_X and Z of the last stage are logically "ORed" with pins P and $\overline{P}$ of the first stage before they are connected to pins

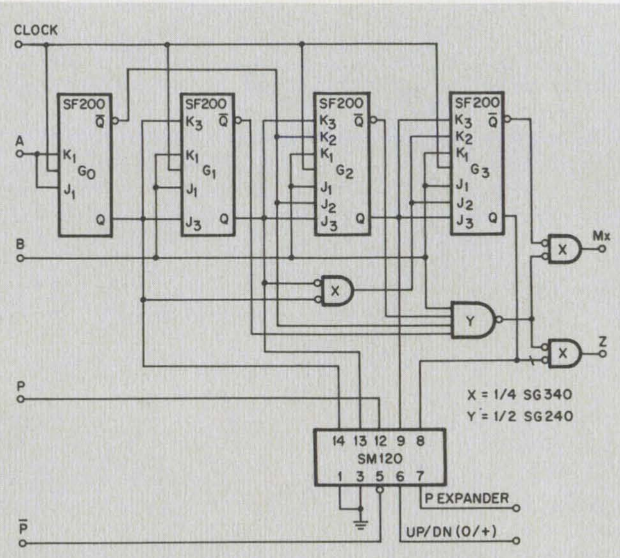


Fig. 1. Four-bit Gray-code up/down counter.

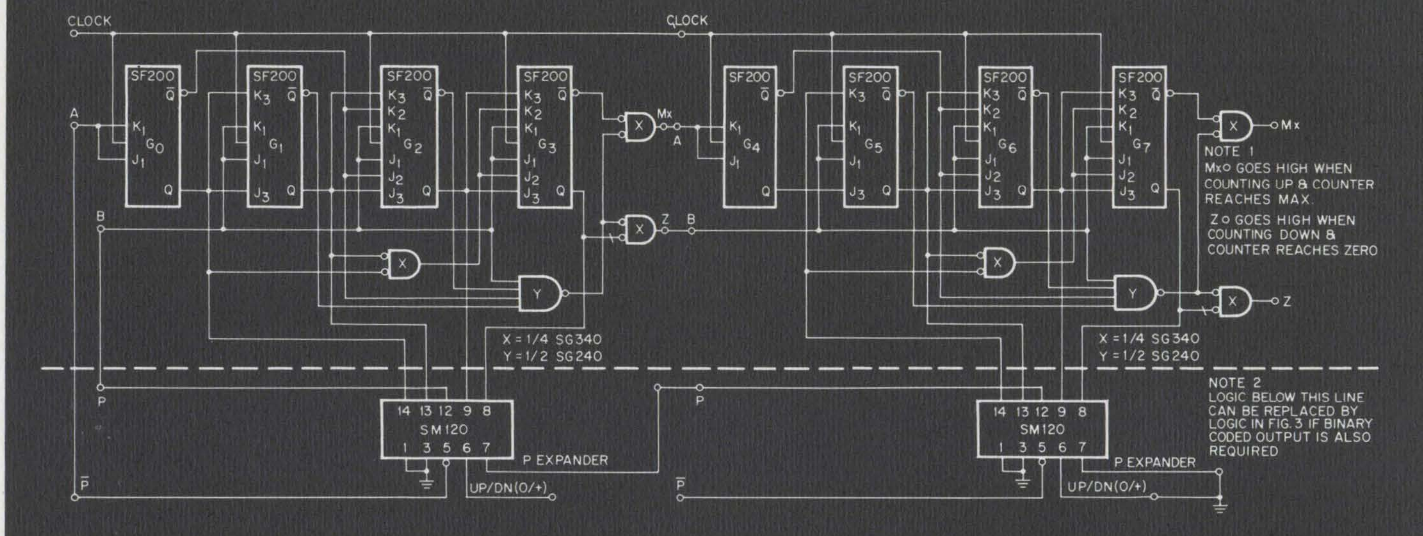


Fig. 2. Connection of two four-bit counters to make an eight-bit counter.

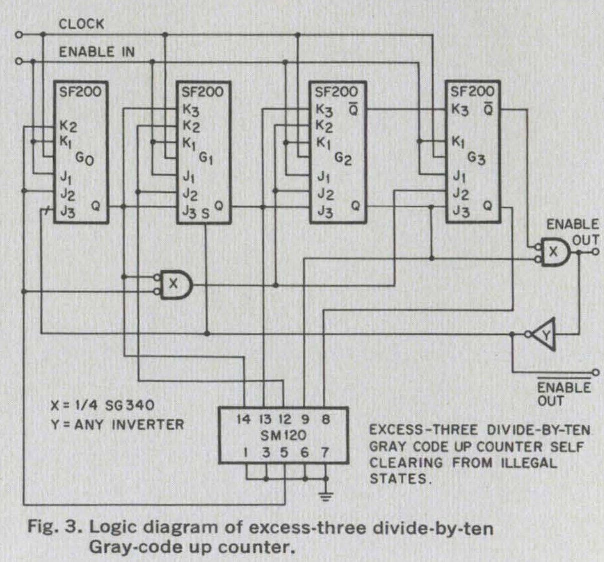


Fig. 3. Logic diagram of excess-three divide-by-ten Gray-code up counter.

A and B, the counter will not hang up at the maximum or zero values.

An excess-three divide-by-ten Gray-code up counter is shown in Fig. 3. This counter will not hang up at its maximum value of 12, but will go to the minimum value of three. The last stage of this counter has a square-wave output. An important point in this design is that all illegal states in this design are self-clearing.

This Gray-code excess-three counter can be very useful in logic systems using decimal notation where the excess-three code is desired. Also, when used in conjunction with excess-three Gray-code to ten-line decoders, this counter has many advantages over straight binary systems.

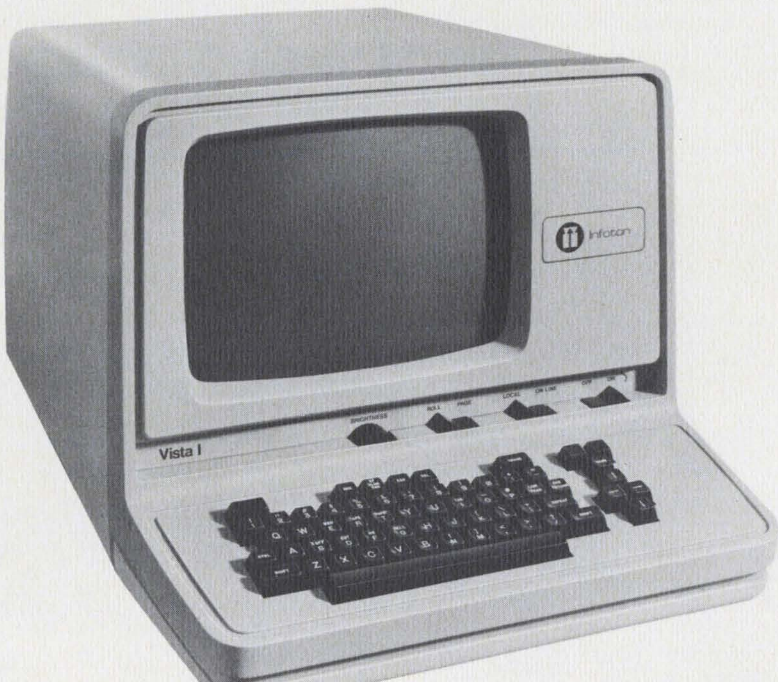
If it is necessary to clear the counter to a Gray-code three (binary zero) a negative pulse applied to the clear inputs of G_0, G_2, G_3 and to preset input of the flip-flop G_1 will do the job.

Our application note #24 covers the design of Gray-code counters in greater detail. If you are interested we will be glad to send you a copy. CIRCLE NUMBER 303

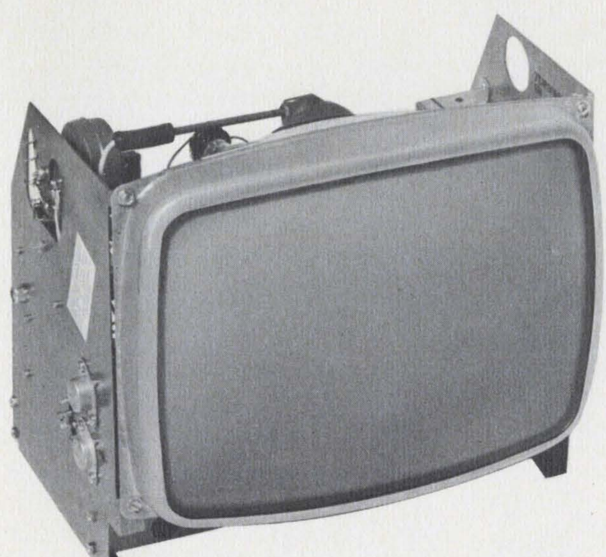
CRT MODULES

Integrated display module fills computer terminal needs.

Our 12-inch display package fits in nicely with Infoton's system for local or remote computer time-sharing.



Infoton Vista 1 Computer display terminal.


Sylvania 12-inch monitor module chassis.

Infoton needed a CRT display for their Vista 1 and Vista 2 computer display terminals. They came to us and picked out our off-the-shelf 12-inch CRT module. By doing this, they saved themselves a lot of design time because our module comes complete with all-solid-state power supplies, video and blanking amplifiers. They also saved a lot of money, too, because we build these modules at a lower cost than most people can.

These advantages, combined with Infoton's expertise and design know-how enabled them to offer a reliable, flexible unit at a highly competitive price. In fact, the low cost of Vista 1 and 2 will make display terminals available to educational institutions that previously could not afford them for computer aided instruction.

The Infoton units are designed for time-sharing applications in such places as brokerage houses, airline reservation systems and medical information systems.

Because Infoton designed their own cabinet, they used our 12-inch monitor in the chassis form shown in the photograph. However, if you need it, we can supply the monitor complete with its own attractive cabinet.

We can also custom tailor display modules to your needs. Because we build CRTs, we know their characteristics and can pick the best one for your job. And because we know CRTs, it doesn't take our design engineers long to come up with the proper drive circuitry. The result is fast turnaround, flexibility and lower cost for you. In addition, you get exactly the right display system for your application.

In fact, about all you have to do is give us the X, Y and Z input voltages and any special requirements you have, and we will get right back to you with the specifics on design and cost for the exact display module you need.

CIRCLE NUMBER 304

DIODES

Diode arrays contribute to low-cost, high-speed computers.

New family of computers use 16-diode arrays to cut assembly time and increase memory switching speed.

Two new medium-size computers, introduced by Systems Engineering Laboratories, use from 600 to 800 Sylvania 16-diode arrays as core selectors in their memory system. The advantage to SEL was lower assembly cost, higher speed and greater reliability. In addition, these high-speed computers use Sylvania-developed SUHL logic throughout.

Both of these 32-bit computers have a high throughput. The input/output transfer rate is 1.66 million words per second. Because of the modular design and task orientation, these computers are equally suited to real-time, patch processing and general purpose scientific applications. In most cases, they can handle all three at the same time.

The core memory, where the 16-diode arrays are used, can be obtained in capacities from 8,192 to 131,072 words. The arrays are mounted in dual in-line packages.

The arrays, which are available in both common anode and common cathode configurations are shown in Fig. 1. Their typical characteristics are shown in Fig. 2. They provide high forward conductance, fast recovery, low capacitance and tight tolerances. These units have a forward current rating of 300 mA and a power rating of 300 mW per diode.

Reverse recovery time of the diode arrays is a maximum of 60 ns, even under extreme switching conditions with a forward current of 300mA and an I_r or 30 mA. Typical recovery times under the same conditions are in the 35 ns range.

Because of the manufacturing process used to produce these arrays, electrical characteristics are closely matched over a wide temperature range.

In addition, units are available with 2 to 16 diodes. All of these arrays are available in 10 or 14 lead dual in-line packs or in flatpack configurations. They all meet MIL-S-19500 standards.

CIRCLE NUMBER 305

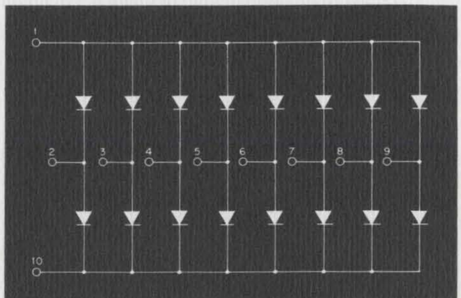


Fig. 1. Circuit configuration of 16-diode array.

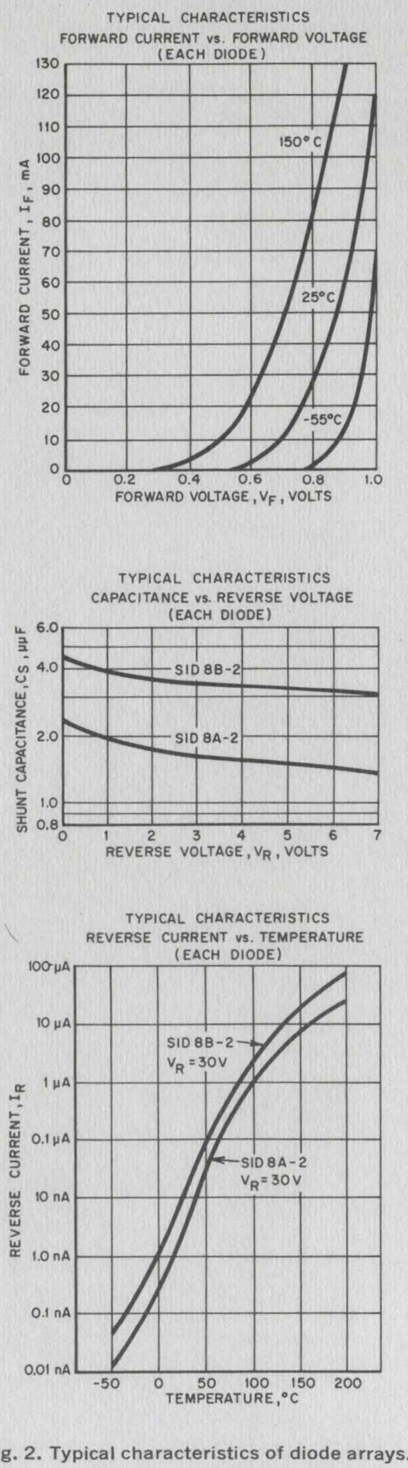
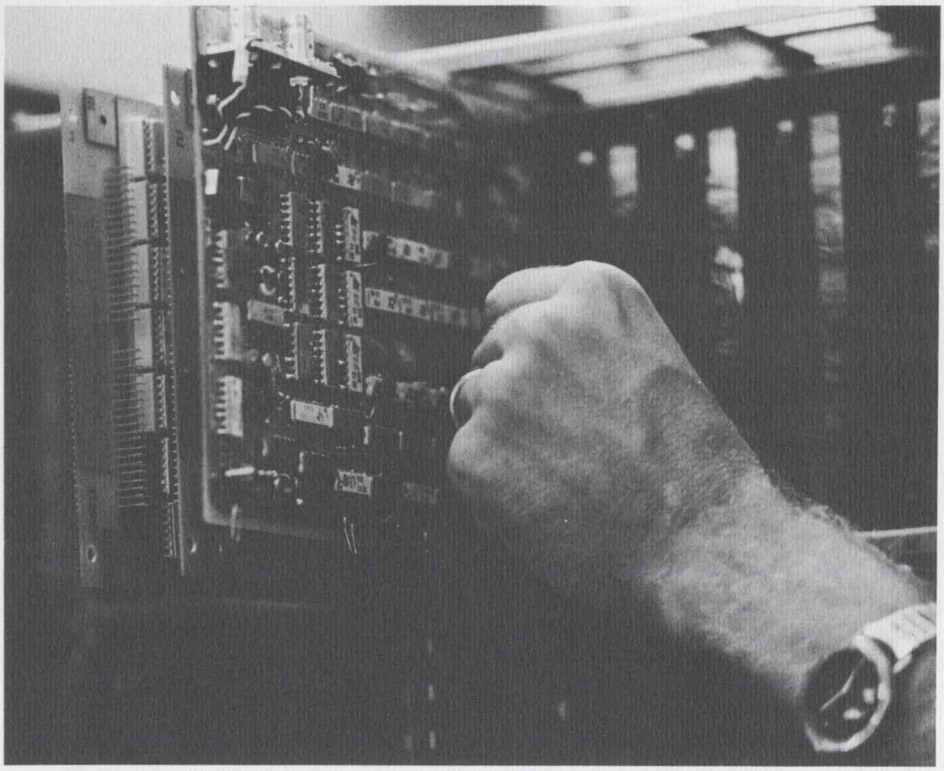


Fig. 2. Typical characteristics of diode arrays.



Sixteen-diode array packages are used as memory core selectors in SEL's new high-speed, low-cost, medium-size computer.

TELEVISION

We've done it again! A brighter color tube.

Using a brighter phosphor and a black mask, we've got a new tube that gives sharper contrast and 103% more brightness than our 1968 tube.

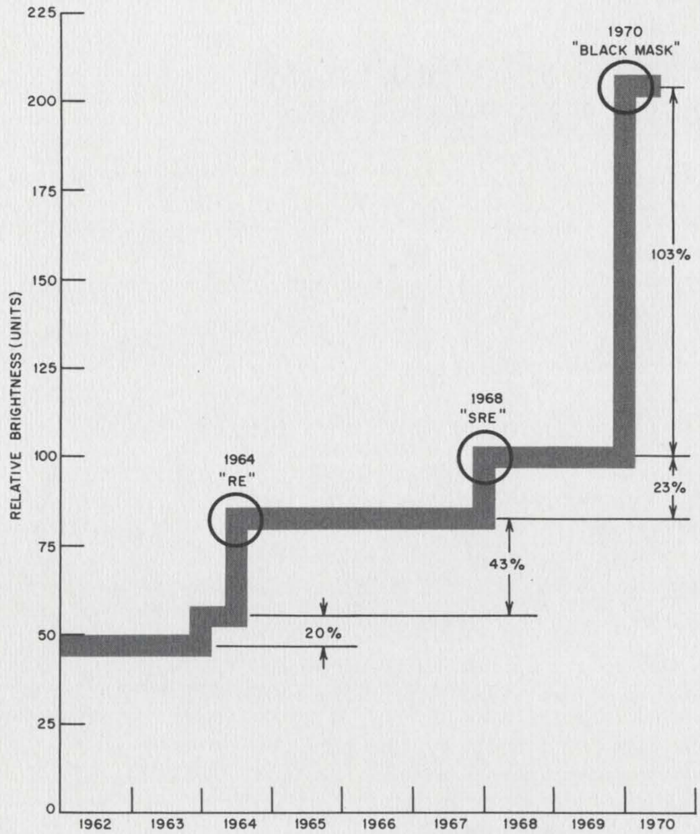
Sylvania has been the traditional leader in color tube brightness and contrast. The reason is simple: we have better phosphors and better methods of deposition. Recently, we introduced a new phosphor system that was competitive with other manufacturers' tubes which use "black" systems to improve brightness without loss of contrast.

Now, we have developed an entirely new *color bright 85*® "Black Mask" picture tube which combines our superior phosphor system with a new black masking technique. The result is a picture tube that combines the best of all possible worlds: a 103% increase in brightness over our 1968 tube, improved color purity and the highest contrast in the industry.

We've always held the edge in phosphor brightness because of the inherent advantages of our phosphor production techniques and our patented phosphor dusting system. The "black" systems, on the other hand, enabled other manufacturers to approach the brightness and contrast of our tubes because the black systems reduced reflectants and allowed the electron beam to cover the entire phosphor dot without splash-over.

When you combine our phosphors with the advantages of a black mask, you get a tube that's 103% brighter than the tube we introduced in February 1968. You also get vastly improved contrast with greater color purity than ever before.

To give you an idea of why Sylvania's *color bright 85* line has traditionally led the brightness race, take a look at the graph. Sylvania developed the first rare earth europium phosphor screen system in 1964. The whole industry followed. And until the development of the black-mask system, they couldn't come near us.



Sylvania brightness increases through the years.

Now, by combining our high brightness MV phosphors with Sylvania's Black Mask technique, we're in front again with the highest contrast in the industry.

Other picture tube manufacturers are using black system methods to reduce the reflectivity of the color tube. Our approach has been to increase the light emitted from the phosphor screen by the development of better phosphors. Both approaches work. But, what do you get when you combine them? The best tube. And Sylvania has it.

CIRCLE NUMBER 306

MANAGER'S CORNER

Hybrid Microcircuits: A packaging concept

Too often, design engineers think of hybrid microcircuits as just another component to plug into their system. If they do, they are wrong. Properly designed and applied, a hybrid circuit is a complete subsystem. To think of it in any other way is to lose many of the advantages of this design approach.

Basically, the hybrid microcircuit is a packaging concept that employs thick- or thin-film passive components coupled with either discrete or chip active devices mounted on a ceramic base. The hybrid module is packaged in either a hermetic or non-hermetic enclosure or a combination of both. There are an endless number of package forms that can be employed. This packaging flexibility is a primary advantage of the technology. In addition to size, weight and reliability advantages inherent in hybrids, they are now economically comparable to a discrete version when volume is significant.

In general, any electronic circuitry that cannot justify a monolithic approach is a potential hybrid application. Hybrid packaging complements monolithic designs as a second level of system integration. We see the emergence of the film passive substrates as the next generation of PC board. This, coupled with low-cost chip placement, such as beam-lead devices, will further broaden the economic justification for the use of hybrids.

Sylvania now offers standard off-the-shelf modules ranging from IF amplifiers to digital high-speed networks and power drivers. These modules are packaged in commonly used forms such as flat packs and TO-5 cans. It makes sense to examine these standard devices first in a new design. However, a custom hybrid can make economic sense if the usage can justify the tooling. As a guide, hybrid prototypes charges generally are of the same magnitude as the fabrication of a discrete module with PC board layout.

One area which is becoming increasingly important is hybrid MSI—or multichip digital modules employing TTL devices and a film interconnect pattern. Sylvania believes that multichip modules or hybrid MSI will allow the designer a new dimension in system design.

As a leading supplier of all types of TTL devices, Sylvania will be able to provide economical hybrid MSI modules for a wide variety of applications.

Our long experience in the design and production of hybrid circuits will enable us to offer the designer MSI and LSI arrays in hybrid form. But, perhaps most important, we can offer him RSI—Right Scale Integration. And we can give it to him today.

Barry Friedman
Product Sales Manager, Hybrid Microelectronics

Wheatstone bridge used to count and photograph fish

Automatic fish counting has been initiated at Willamette Falls in Oregon. The new counter has been set up on the fishway to eliminate the round-the-clock manual count used on other fishways.

Fishways are steps that rise, on the average, 1 foot for every 10 feet of horizontal travel. They allow fish such as chinook and coho salmon and steelhead trout to migrate up rivers past waterfalls and dams in order to spawn in the headwaters.

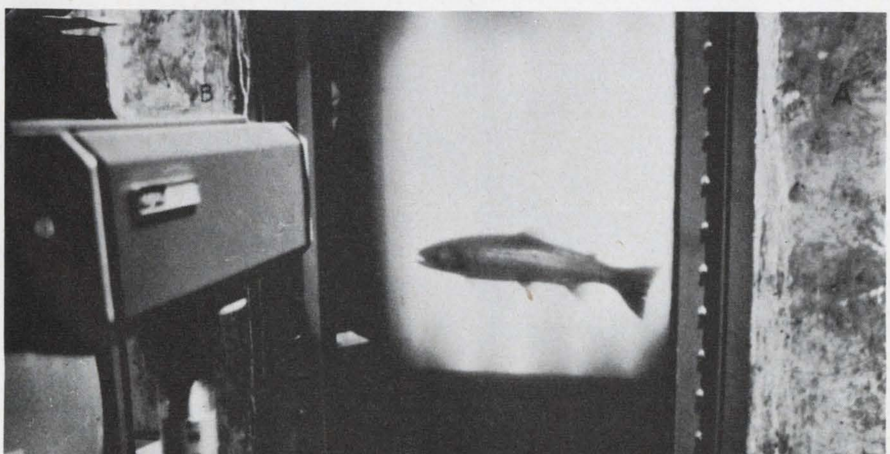
Integral to the system are a TV camera, a video tape recorder, a TV monitor, two detection chambers and a logic-control unit. Each detection chamber is a tunnel 14 inches wide and 2 feet high through which the fish must swim. The chambers are in series, and the fish must swim through both. An electric field is set up in each chamber so that if a fish more than 14 inches long swims through, the field will be grossly disturbed.

The two chambers are arranged in the arms of a Wheatstone-bridge type of circuit. Thus, when the field is disturbed in the lead arm of the bridge, the automatic counter is triggered. Burton E. Carnegie, project engineer for the fishway from the State of Oregon Fish Commission, told ELECTRONIC DESIGN, "Once a fish triggers the counter, a video tape recorder starts and runs for about three seconds. The fish swimming through is then photographed through a viewing window and a digit counter indexes them."

Video recording is necessary since the automatic counter cannot yet differentiate between the various species of fish. However, a person need not sit for 24 hours in front of a viewing window; he can wait for the count to reach a certain point and then merely turn on the tape recorder, play back the fish passage, and quickly note the proportion of one species of fish to another.

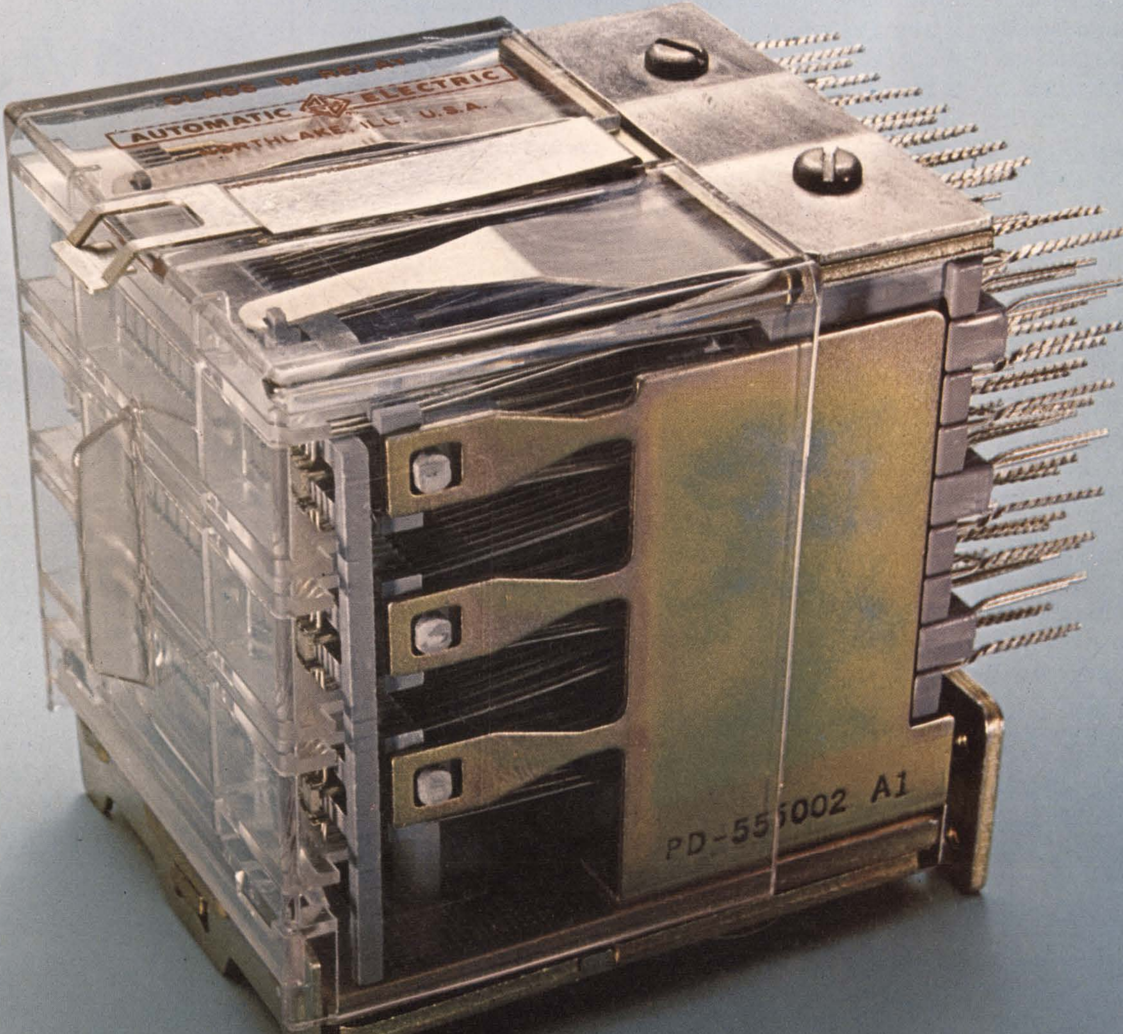
Occasionally, fish drift downstream through the fish ladder rather than swimming upstream. The system can also count fish going downstream since it is the second chamber that will be disturbed first. In the downstream case, the recorder turns on for about 7 seconds. The logic-control unit can adjust the upstream and downstream viewing times to suit current conditions.

The automatic counting system was developed by David Smith of Smith, Root, Inc., of Seattle. ■■



Salmon passes viewing window at the Willamette Falls, Ore., automatic counting station. A closed-circuit TV camera relays the picture to a video tape recorder later used in fish identification.

Reliability is staggered steps and a hunk of DAP.



Expect over a billion operations.

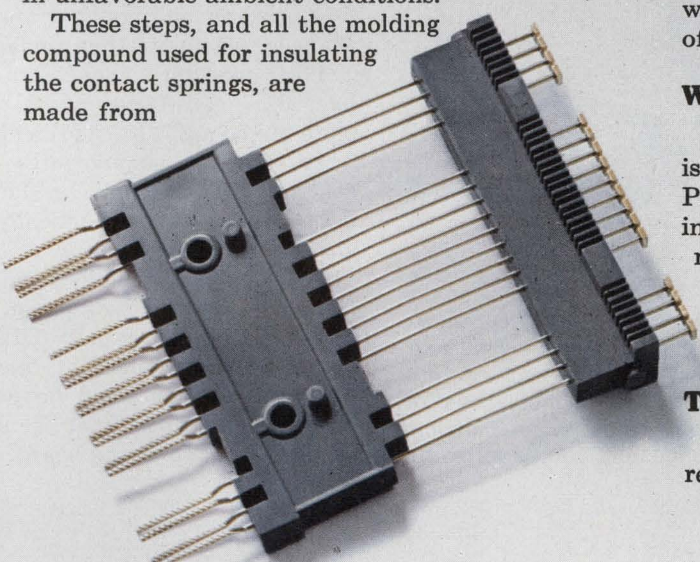
Our Class W wire-spring relay is different. In fact, there's nothing like it in the entire industry. Where else can you find a relay with lots of contacts and a mechanical life of more than a billion operations! That's about two and a half times the life of the best conventional relay around.

Another nice thing about our Class W is that it takes up a lot less space and costs less than using a bunch of other relays. That's because we build our Class W relay with one, two or three levels of contact assemblies, with 17 form C combinations per level. By the way, they're available with gold contacts for low-level switching.

Making it tough on creepage.

All those staggered steps you see on the side were put in to raise the breakdown voltage between terminals. These molded steps add extra creepage distance between the terminals. This really counts for high voltage testing, or when using our Class W in unfavorable ambient conditions.

These steps, and all the molding compound used for insulating the contact springs, are made from



diallyl phthalate. (They call it DAP for short.) It has great insulating properties and it wears like iron. Even if the humidity is high, you have excellent protection.

Redundancy—two springs are better than one.

Each of our long wire-spring contacts has an independent twin with the same function. One tiny particle of dust could prevent contact on other relays. Not with our Class W. You can be sure one of the twins will function. That's back-up reliability.

The twin contacts are twisted together at the terminal end. Then we give them a spanking (you might call it swedging) to provide solderless wrap.

We're for independence.

Our springs are longer, because the longer the spring, the more independent they get. And the better contact they make. Don't forget, the wire-spring relay is the most reliable way to get a permissive make or break contact. You can rely on it.

The middle contact springs have to be stationary. To make sure they stay that way forever, we actually mold them between two thick pieces of DAP on both ends. Just try to move one.

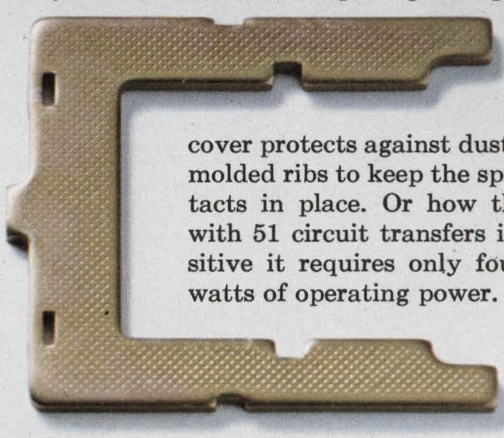
When we say flat, it's flat.

Each frame, banged out by a gigantic machine is extra thick and extra flat. Then they're planished. Planishing is another step we go through in forming the frame to add strength and stability by relieving surface strain.

We've made our spring-loaded pile-up clamp extra thick, too. Once it's tightened down, the whole pile-up is nice and tight, and stays tight.

There's more.

We could tell you a lot more about our Class W relays. Like how the tough high-temp molded



cover protects against dust and has molded ribs to keep the spring contacts in place. Or how this relay with 51 circuit transfers is so sensitive it requires only four to six watts of operating power.

But why don't you let us prove how much reliability we put into our Class W? We'll be waiting to hear from you. Industrial Sales Division, Automatic Electric Company, Northlake, Ill. 60164.

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GENERAL TELEPHONE & ELECTRONICS

Back-panel interconnections go hybrid

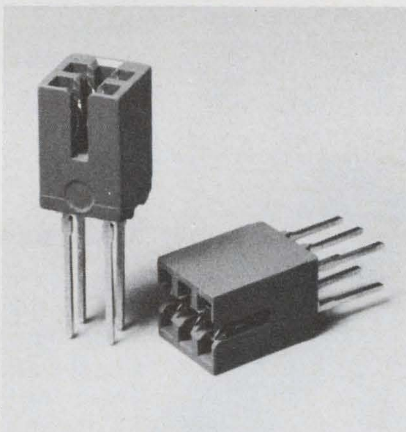
New approach does away with soldering problems while maintaining cost and flexibility advantages

Back-panel interconnections in much electronic equipment are taking on a different look as designers turn to hybrid interconnection techniques. These hybrid methods combine the technologies of automatic point-to-point wiring and printed circuit wiring in order to maximize cost and flexibility.

A common type of hybrid assembly consists of a double-sided printed-circuit board with connectors mounted on one side and the contact tails, suitable for automatic wiring, protruding through the other side of the board. All fixed connections, such as signal grounds and power, are made to the connectors by printed-circuit wiring. Signal paths that vary depending on individual circuit configuration or that may be subject to later design changes are provided by point-to-point wiring between contact tails.

Thus, the economy of printed-circuit wiring is combined with the flexibility of automatic point-to-point wiring.

The newest hybrid approach, pioneered by Elco Corp. of Willow Grove, Pa., eliminates a major problem associated with other hybrid techniques—namely, connecting the contact tails of the connectors to the printed circuit lines.



There are two types of MOJO contact modules: an end module with four contacts and a center module with six contacts. With combinations of these modules, most sizes of double read-out connectors can be formed.

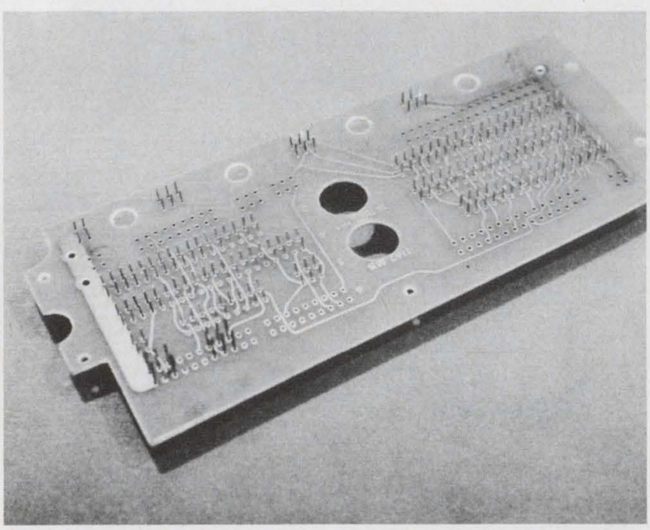
Hand-soldering these connections is extremely slow, while automatic soldering methods are expensive and often pose heat problems.

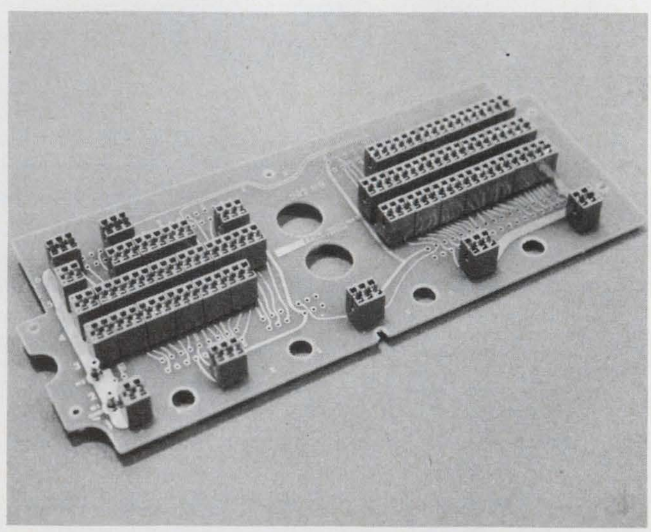
The Elco system does away with soldering. Instead, special modular connectors are used that, when press-fitted into the printed-circuit back panel, form gas-tight connections between the connector contact tails and the plated-through holes in the printed-circuit board.

According to Dr. Herbert E. Ruehlemann, vice president of engineering at Elco, "the gas-tight connections are immune to corrosion, vibration and extremes of temperature, and equal or surpass the soldered joints they replace."

The modular connectors are basically card-edge types with state-of-the-art specifications. There are two module sizes: four contacts and six contacts. This allows a build-up to practically any size.

The maximum module size of six contacts was chosen from the standpoint of field repair. This was the maximum number of contacts, it was felt, that could be pushed out of the board without the strain causing damage to the board. ■■





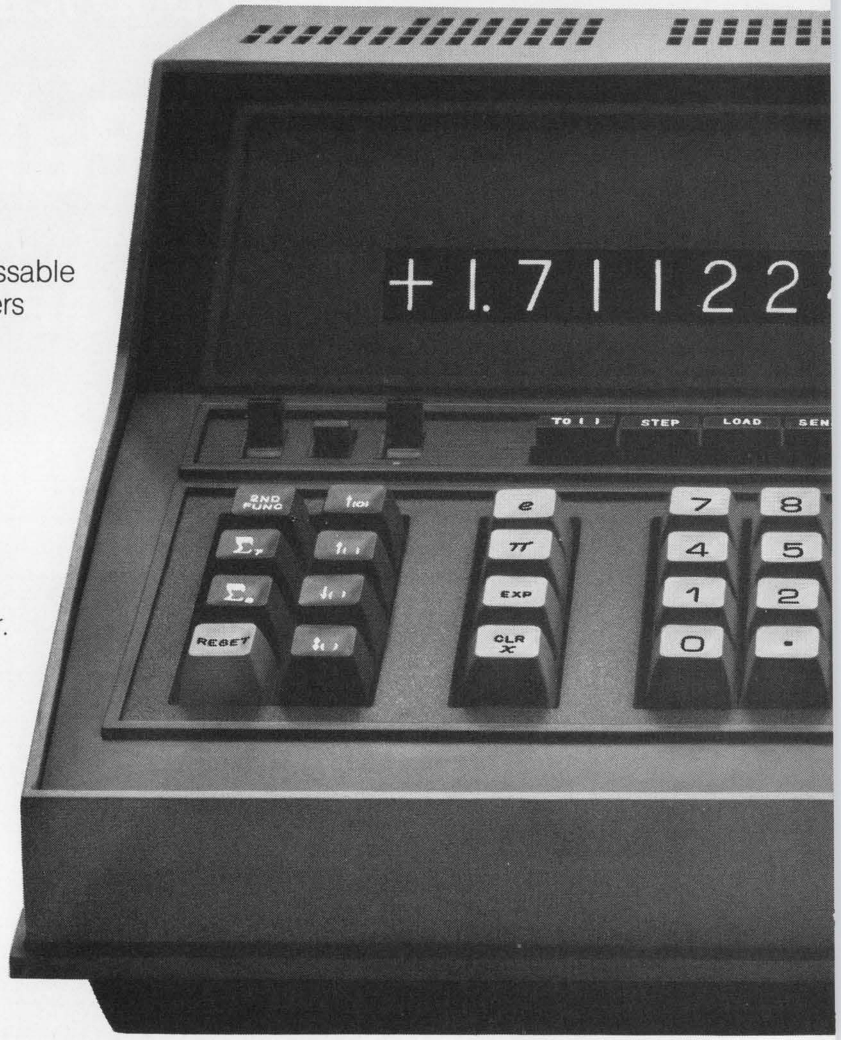
The latest hybrid back-panel interconnection technique establishes the frozen interconnections with the use of a relatively low-cost, double-sided printed circuit board, thereby omitting repetitive automatic wiring cost. The wire-wrap tails of the Elco Corp. connector, called MOJO, permit use of efficient programmed wiring for variable and complex back-panel interconnections (left photo). The MOJO connector (right photo) makes this hybrid application attractive, because the contact tails are press-fitted into plated-through holes of the printed circuit board, creating gas-tight joints and omitting costly solder operations.

Decimals: Autopoint and scientific notation.

Automatic entry of e and π.

Ten directly addressable storage registers

Programming: Up to 128 steps. Conditional branching and automatic entry of programs with card reader.



Model 1655. Size: 13″ x 13½″ x 6½″.

Announcing an important breakthrough for engineers and scientists. Calculators based on the latest MOS/LSI technology. In both printing and display models. Available in over 350 cities coast to coast. And supported by more than 3,300 sales and service technicians.

New airborne unit planned for tactical loran

Air Force wants more programmable computer for variety of missions made possible with loran C/D

John F. Mason
Military-Aerospace Editor

Several mornings a week, an F-105 pilot takes off from Eglin Air Force Base, Fla., climbs several thousand feet and feeds the coordinates of his target into a computer. In moments, a needle points the way, and two rows of eight alphanumeric gas-tube displays light up. On these he reads the distance, the bearing, track error, ground speed, true air speed, and estimated time en route.

Responsible for all this instant information is a test version of a receiver-computer unit—called AN/ARN-92—in the aircraft that takes signals from ground-based loran radio navigation transmitters and uses them to accomplish far more than simple navigation.

With data from loran, plus the other airborne sensors and navigation instruments, the computer guides the plane to its bomb run and turns it over to the toss-bomb computer. It also enables the pilot to pinpoint reconnaissance targets and to drop air cargo at night and through clouds. All are capabilities never contemplated with earlier loran.

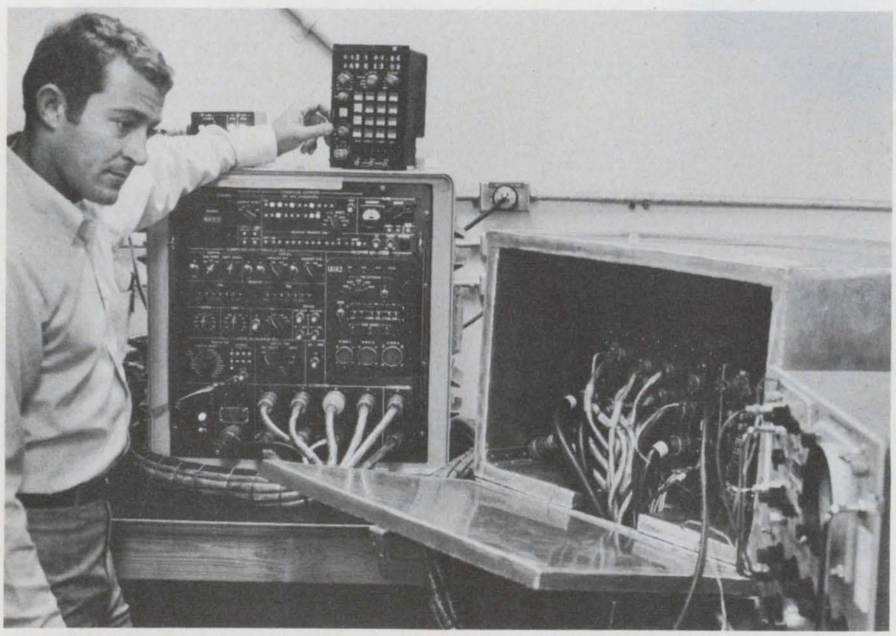
The tests are run with a loran C network at Eglin and its tactical offspring, loran D. The D network is lightweight and movable by air, and can be set up for operation in less than two days. Loran C and its predecessors, A and B, are permanently based and take months to construct.

Tests with the airborne unit over the past three months have been so successful that a tactical loran system is being pushed, according to a spokesman for the Loran Program Office of the Aeronautical Systems Div., Wright-Patterson Air Force Base, Ohio. The Air Force will soon buy several ground-based transmitter networks. And contracts will be awarded to develop an even better version of an airborne receiver-computer unit.

The present airborne unit has done a good job, the Loran Office spokesman says: "But technology has advanced—such as the availability of more flexible computer software—and we can now make some significant improvements," he adds.

ITT Avionics in Nutley, N. J., built the unit's receiver and Lear-Siegler, Grand Rapids, Mich., the computer. Sperry Gyroscope, Great Neck, N. Y., built the ground transmitter networks and auxiliary equipment.

Loran C and D work on the same principle that was used by the World War II loran A and B series. A master station transmits its pulse along base lines to two slave stations, which, after a slight delay, retransmit the signal to the airborne receiver. The time difference in the arrival of the signals at the receiver is then translated into a position on the earth.



ITT field engineer Randy Smith, at Eglin Air Force Base, Fla., checks an AN/ARN-92 receiver-computer unit before it goes into an F-105.

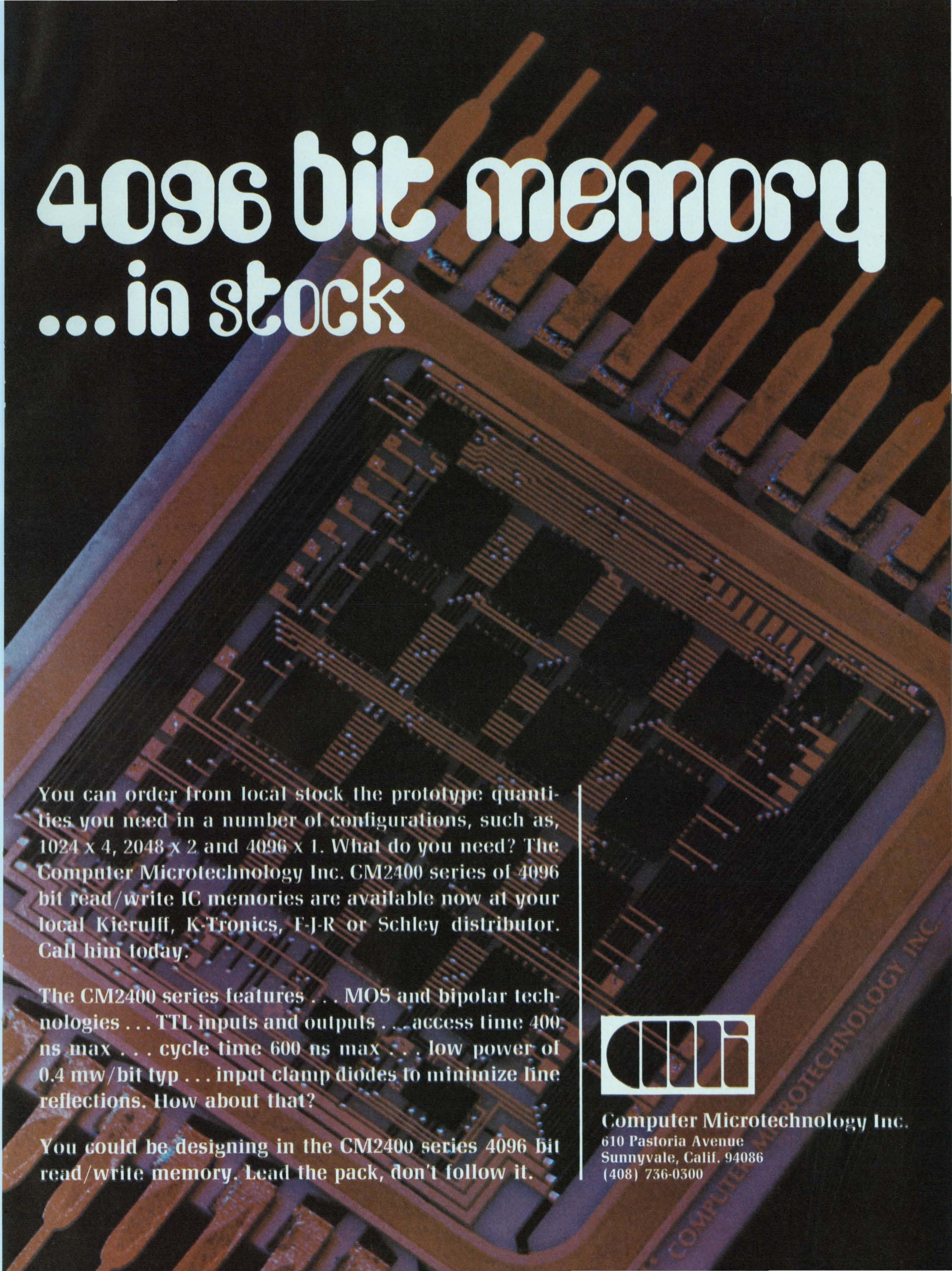
Goal is variety of missions

Besides the successful bomb runs with the F-105, other tests are under way at Eglin with an RF-4C reconnaissance plane. When the pilot finds his target he takes a photograph. Printed on the film are the loran's special coordinates —the time-difference measurements from the master transmitter and its slaves. These time differences can be fed into a loran-equipped attack plane's computer, which guides the plane to the target.

The next test at Eglin will use an F-4D attack plane that can bomb, without radar, by the ARN-92 alone.

The ARN-92's computer is a 30-bit serial, digital machine. It converts time-difference readings into geographic coordinates. The computer uses a 4096-word read-only memory. Program changes are mechanical and time-consuming.

"The new computer must be electronically programmable for different missions. It must be capable of working out the bomb trajectory equation itself. And it must be easily integrated with other airborne sensors," an officer says. ■■



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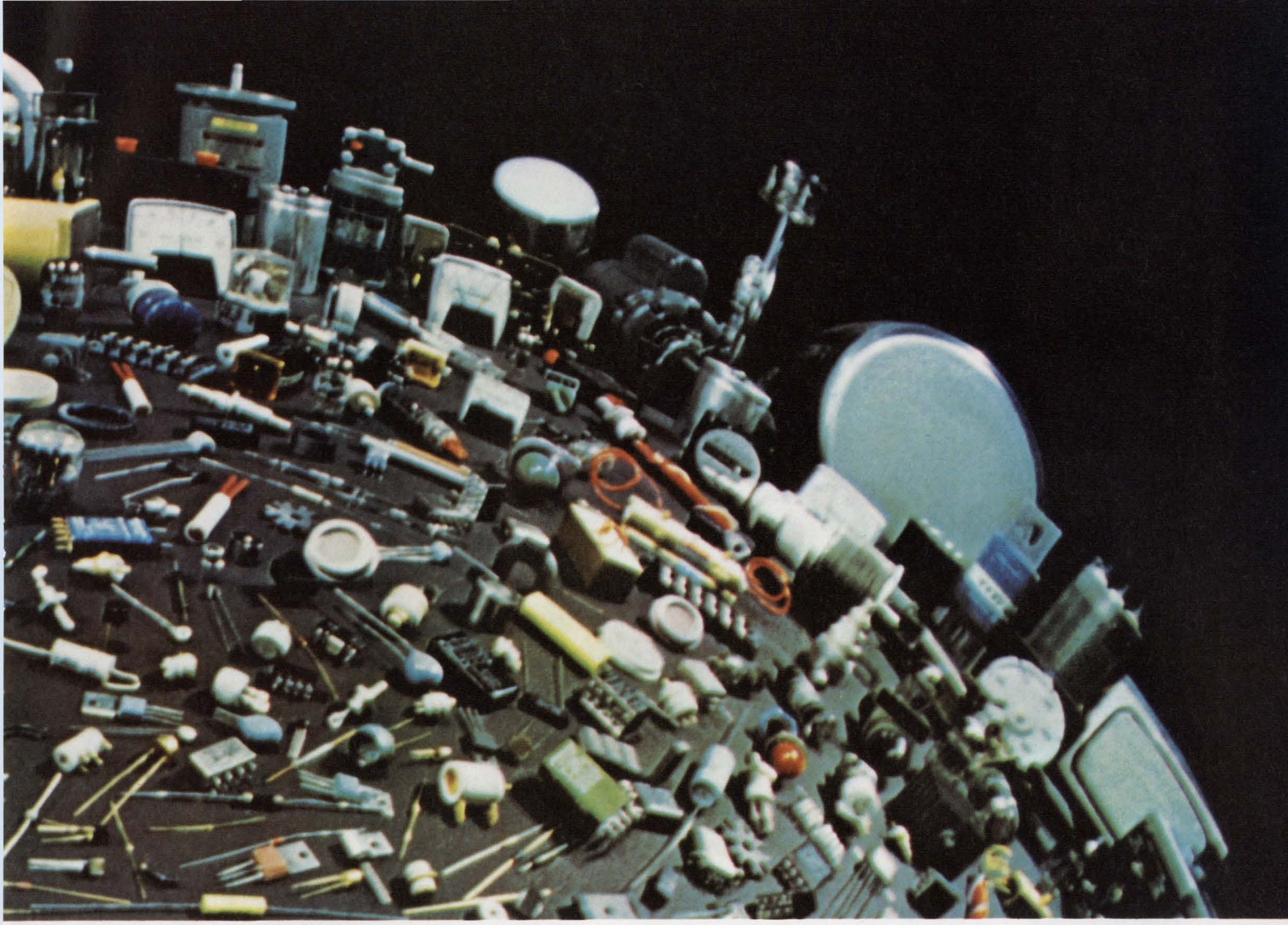

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And the new BIG LOOK Frequency Meters in three ranges . . . 45–55Hz, 55–65Hz and 380–420Hz . . . are now available for engine generator sets, panel boards and inverters. For complete catalog, circle 217.

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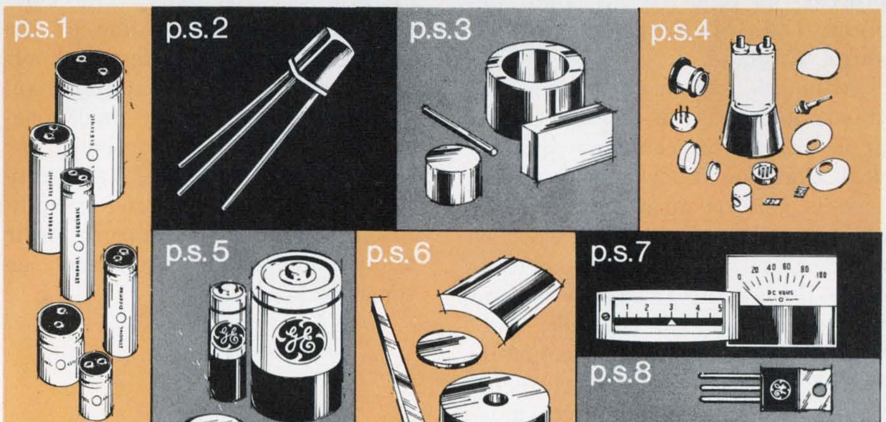

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GENERAL ELECTRIC

Technology Abroad

210-foot space antenna to rise near Madrid

Ground has been broken about 40 miles west of Madrid, Spain, for construction of a 210-foot space tracking antenna—a duplicate of the steerable antenna at Goldstone, Calif. When it begins operating in 1973, the new facility will be the third and final link of a new worldwide tracking system which, according to NASA, will more than triple the tracking distance of spacecraft in deep-space missions. A second 210-foot unit is being built at Tidbinbilla, near Canberra, Australia.

English firm develops new interconnect method

A new method of interconnecting integrated-circuit chips—a possible alternative to the beam-lead process—is reported by Logic Designs Ltd. of Ringwood, Hampshire, England.

Although extremely guarded at this time because of pending patent application, the company did reveal that an interconnection pattern is printed on a dielectric. As one company official noted: "The conductors can be persuaded to come through to the other side of the dielectric at any desired point." One drawing shows the conductors in the center of a dielectric sheet with connection pads on both sides of the sheet.

Fuel cells power navigation beacon

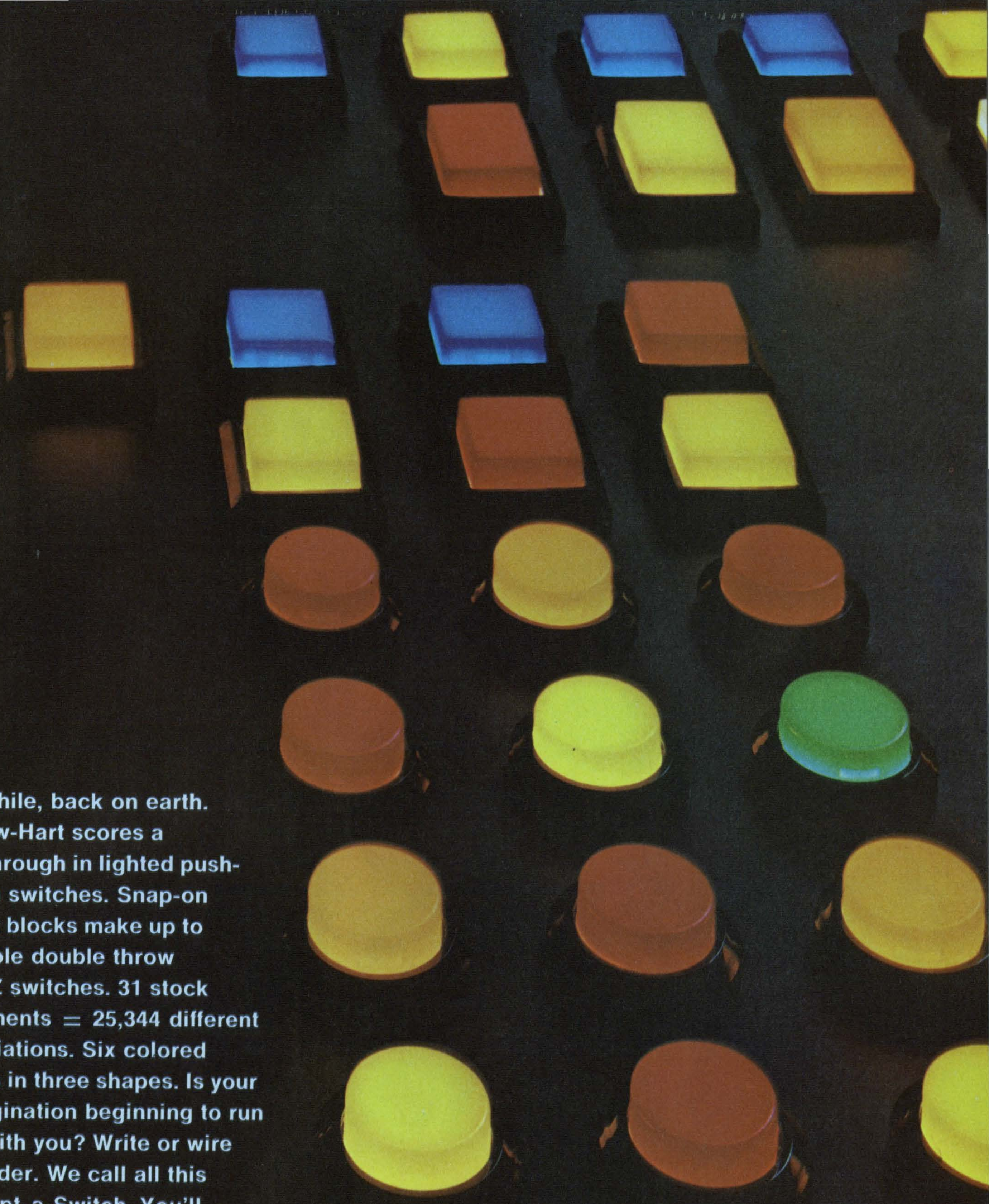
A navigation beacon powered by fuel cells has been put into operation at Stora Hogarn in the Stockholm archipelago.

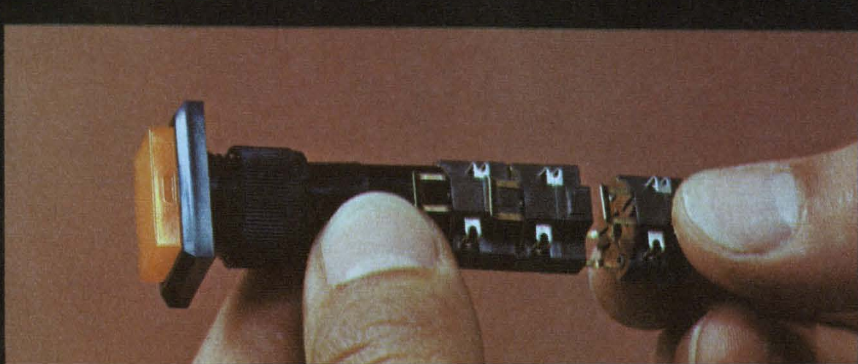
The cells in the automatic beacon are refueled once a year with a mixture of formate and potassium hydroxide by means of a hose from a boat. Buffer batteries are charged by the fuel cells to cope with peak loads. The fuel cells are automatically shut down when the beacon is shut off during the day.

The beacon is one of several prototypes developed by the Swedish Administration of Shipping and Navigation and ASFA, a Swedish electrical engineering group for applications where low average power is required for long time periods. One prototype is being developed as a power source for telecommunications systems.

A solution to the shortage of trained computer personnel may have been found by Siemens AG of Munich, Germany. The company has opened up one of the largest data-processing schools ever founded by a computer manufacturer. The new school contains 30 instruction rooms, one lecture hall, two computer training centers and a dozen computers. Nearly 100 lecturers train about 800 Siemens' staff and customers at a time.

An inexpensive and compact closed-circuit television system designed for home and industrial plant use has been introduced by Tokyo Shibaura Electric Co., Ltd. (Toshiba). The system sells for about $395 and comes with one camera and one monitor. The monitor has a 4-inch screen. It turns itself off automatically.





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.

bring ERIE in early.

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

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Washington Report

DON BYRNE, WASHINGTON BUREAU

Litton contract to require $600-million in electronics

The Government's $2.1-billion order for 30 new destroyers, which Litton Industries will build over the next 10 years, will generate about $600-million in business for electronics manufacturers. Each DD963-class destroyer will carry $20-million in electronic gear, exclusive of Government-furnished equipment, Litton estimates. In addition the company's yard in Pascagoula, Miss., expects to hire approximately 700 engineers for work on the ship's electronics. In all, some 4000 jobs will be created by the decade-long contract at the shipyard.

Final selection of the subcontractors is under way now, Litton told ELECTRONIC DESIGN. Meanwhile, with the ink on the contract barely dry, Sen. Margaret Chase Smith, Republican of Maine, took to the floor of the Senate to demand an investigation by the General Accounting Office of the award. She also asked that further action on the contract requiring allocation of Government funds be halted until the investigation is complete. Bath Iron Works of Maine was a losing bidder on the contract, the Navy's biggest for shipbuilding.

House committee backs $5-billion mass-transit aid

Urban mass-transit plans have received a big boost from the House Banking and Currency Committee, which has approved a $5-billion air program for cities over the next five years. The committee has backed a bill that would allow the Department of Transportation to sign long-term contracts with cities, enabling them for the first time to lay out complete programs and not rely on year-to-year Congressional appropriations. A similar bill has already passed the Senate. The House is expected to pass the legislation when it comes to the floor later in the summer. The money would be used to buy rolling stock and updated electronic equipment to help existing, but badly overcrowded mass-transit systems.

FAA to spend millions on electronics in the 70's

The Federal Aviation Administration will spend about $600-million in the 70s for improvements to the air traffic control system, and the bulk of the money will be spent on electronic equipment. Administrator John M. Shaffer says his agency expects to spend $290-million to equip domestic air traffic control centers with automatic flight data processing equipment (basically computers), alphanumeric radar displays and collision prediction and resolution equipment. A total of $120-million more will be spent on terminal approach radars and $36-million on long-range radars. In addition, Shaffer says, 100 or so airport surveillance radars will be purchased at a cost of $152-million.

Environment-technology clearinghouse sought

Sen. Warren G. Magnuson, chairman of the Senate Commerce Committee, is calling for establishment of a Federal agency that would be, among other things, a clearinghouse for data that related technology to environment. Magnuson has promised that his committee will hold extensive hearings on his bill, which would establish an Independent Technology Assessment and Environmental Data Collection Commission. The commission would study proposed technological advances and their effect on the earth's environment. It would then issue recommendations for the implementation of curbing of the technological advance and at the same time collect and make public all the data that led to its recommendations. Chances of completing action on the proposal this year appear slim because of the Senate's work load.

Similar, but less comprehensive, legislation has already been introduced in the house.

Senate unit restores cut communications funds

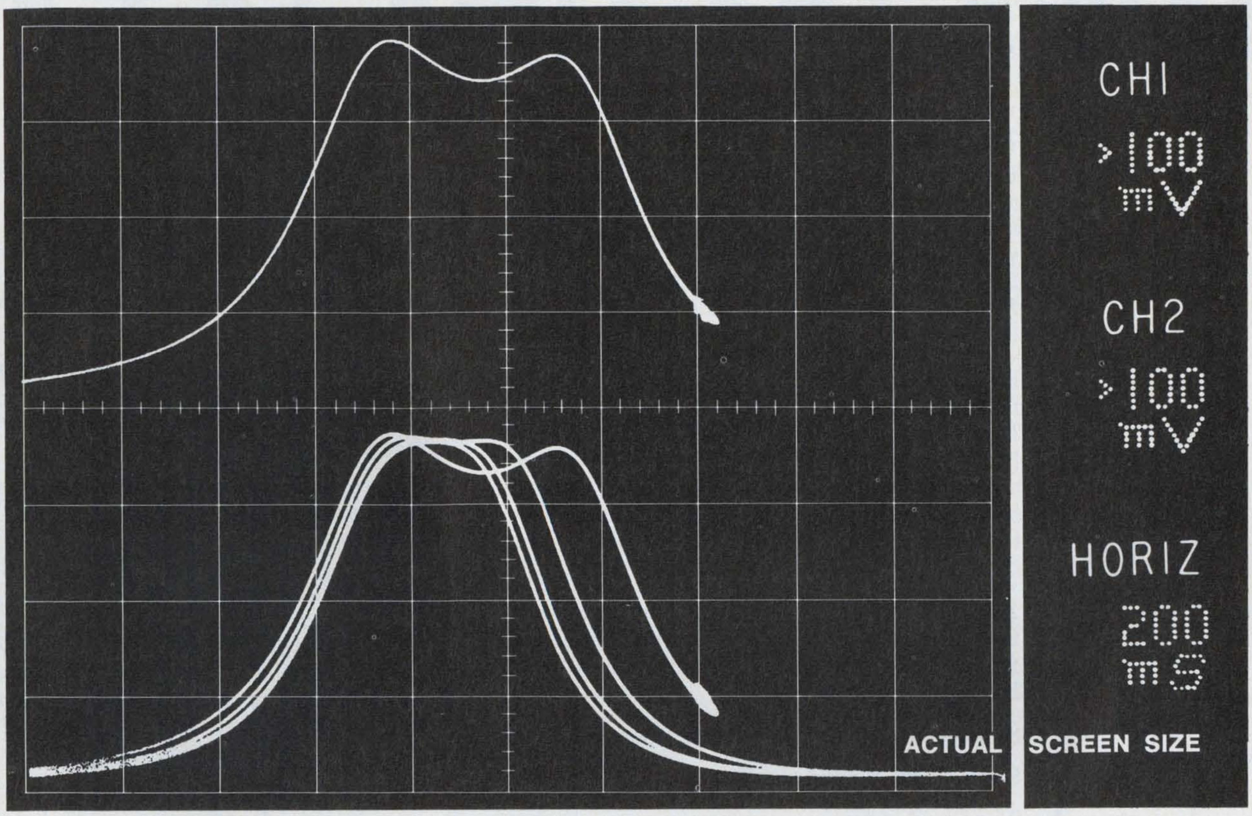
The Senate Appropriations Committee has restored funds cut by the House from budgets for the new Office of Telecommunications Policy and the Federal Communications Commission. The committee put back $3.3-million cut from the Office of Telecommunications Policy and $175,000 cut from the FCC. In another action, the White House named Dr. Clay T. Whitehead, a special assistant to the President for communications matters, to head the Office of Telecommunications Policy. For three months, Dr. William Niskanen was assumed to be in line to head the new office, but industry sources were unhappy with his lack of telecommunications experience. Dr. Whitehead, too, lacks industry experience, but he did run the White House study that resulted in the reorganization plan that created the Office of Telecommunications Policy.

Standardization of telephone computer terminals urged

The National Academy of Sciences has called for enforced standardization of customer-owned computer terminal equipment designed for linkup to the nation's telephone network. A study panel found that "various kinds of harm can occur" from uncontrolled interconnections and that technical limits on the equipment are needed to protect the telephone system. The report called for a "properly authorized" program of standardization, certification, installation and maintenance of the terminal equipment. Such a program, it said, would not interfere with innovation or the improvement of equipment.

Capital Capsules:

AWACS (the Air Force's Airborne Warning and Control System), which earlier this year fell victim to a Government-wide economy move, may once again be alive and kicking—thanks to a sagging economy. Sources indicate that the contract may be awarded soon to jack up the badly hurt aerospace industry . . . . The Dept. of Transportation has let contracts totaling $7,767,501 for construction of a car that hopefully will be safer than anything around today. American Machine and Foundry of Santa Barbara received a $3,240,000 contract; Fairchild Hiller of Farmingdale, N. Y., $4,547,500, and General Motors, $1-million. Delivery is to start in 15 months . . . . Is the B-1 bomber, for which a developmental contract was recently awarded to North American, a "paper" airplane? Speculation is widespread in Washington that the plane will never be built and that its chief function will be to serve as a negotiating tool at the Strategic Arms Limitation Talks now going on with the Russians.



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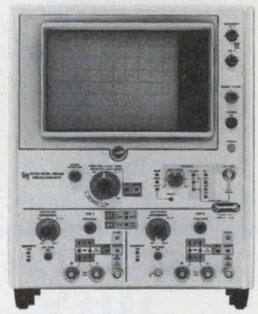

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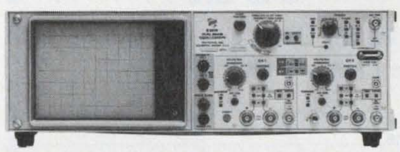

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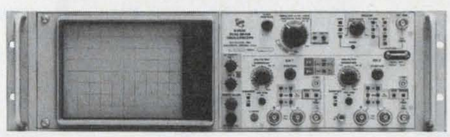

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INFORMATION RETRIEVAL NUMBER 30

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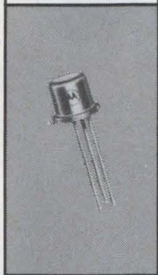
	Unijunction	Peak Point Current @ V_{B2B1} uA(max)	Valley Point Current mA(min)	Intrinsic Standoff Ratio Min	Intrinsic Standoff Ratio Max	Emitter Reverse Current (max)	Interbase Resistance kohms Min	Interbase Resistance kohms Max
	2N2646	5 @ 25V	4	56	75	12uA	4.7	9.1
	2N2647	2 @ 25V	8	68	82	200nA	4.7	9.1
	2N3980	2 @ 25V	1	68	82	10nA	4.0	8.0
	2N4851	2 @ 25V	2	56	75	100nA	4.7	9.1
	2N4852	2 @ 25V	4	70	85	100nA	4.7	9.1
	2N4853	0.4 @ 25V	6	70	85	50nA	4.7	9.1
	2N4948	2 @ 25V	2	55	82	10uA	4.0	12.0
	2N4949	1 @ 25V	2	74	86	10nA	4.0	12.0
	JAN2N4948**	2 @ 25V	2	55	82	10nA	4.0	12.0
	JAN2N4949**	1 @ 25V	2	74	86	10nA	4.0	12.0
	2N5431	0.4 @ 4V	2	72	80	10nA	6.0	8.5
	2N4870	5 @ 25V	2	56	78	1uA	4.0	9.1
	2N4871	5 @ 25V	4	70	85	1uA	4.0	9.1
	MU4891	5 @ 25V	2	55	82	10nA	4.0	9.1
	MU4892	2 @ 25V	2	51	69	10nA	4.0	9.1
	MU4893	2 @ 25V	2	55	82	10nA	4.0	12.0
	MU4894	1 @ 25V	2	74	86	10nA	4.0	12.0
	MPU131	2 @ 10V†		(Programmable)		5nA	(Programmable)	
	MPU132	0.4 @ 10V†		(Programmable)		5nA	(Programmable)	
	MPU133	0.15 @ 10V†		(Programmable)		5nA	(Programmable)	
	MU851	2 @ 25V	2	60	80	100nA	4.7	9.1
	MU852	2 @ 25V	4	70	85	100nA	4.7	9.1
	MU853	0.4 @ 25V	4	70	85	100nA	4.7	9.1

**Conforms to Mil-S-19500/388
†R_G = 1 MΩ

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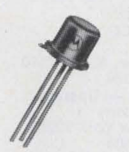

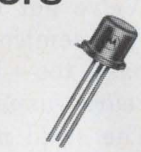

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INFORMATION RETRIEVAL NUMBER 31

How emotional can memory people get?

"I was amazed," said West Coast Editor Elizabeth de Atley, after a recent tour of the memory industry, "to find how emotional people get about 'their' memory technology—whether core, plated-wire, or semiconductor. I commented on this to a noted memory specialist, Reese Brown, manager of memory techniques, Burroughs Corp., Piscataway, N. J., and he agreed."

Brown said that people become so involved with a particular memory technology that they tend to forget they are all in the memory business. "This attitude," he said, "has led to disaster in the past—for example, when people who worked for the railroads forgot they were really in the transportation business." They lost to competition when they forgot the passengers.

Not all semiconductor manufacturers are quite as bullish as Wally Raisanen, operations manager for IC memory and MOS products, Motorola Semiconductor Products Div., Phoenix, who said, "In ten years, semiconductor memories will have the whole business—to a first approximation." But the others are optimistic, too.

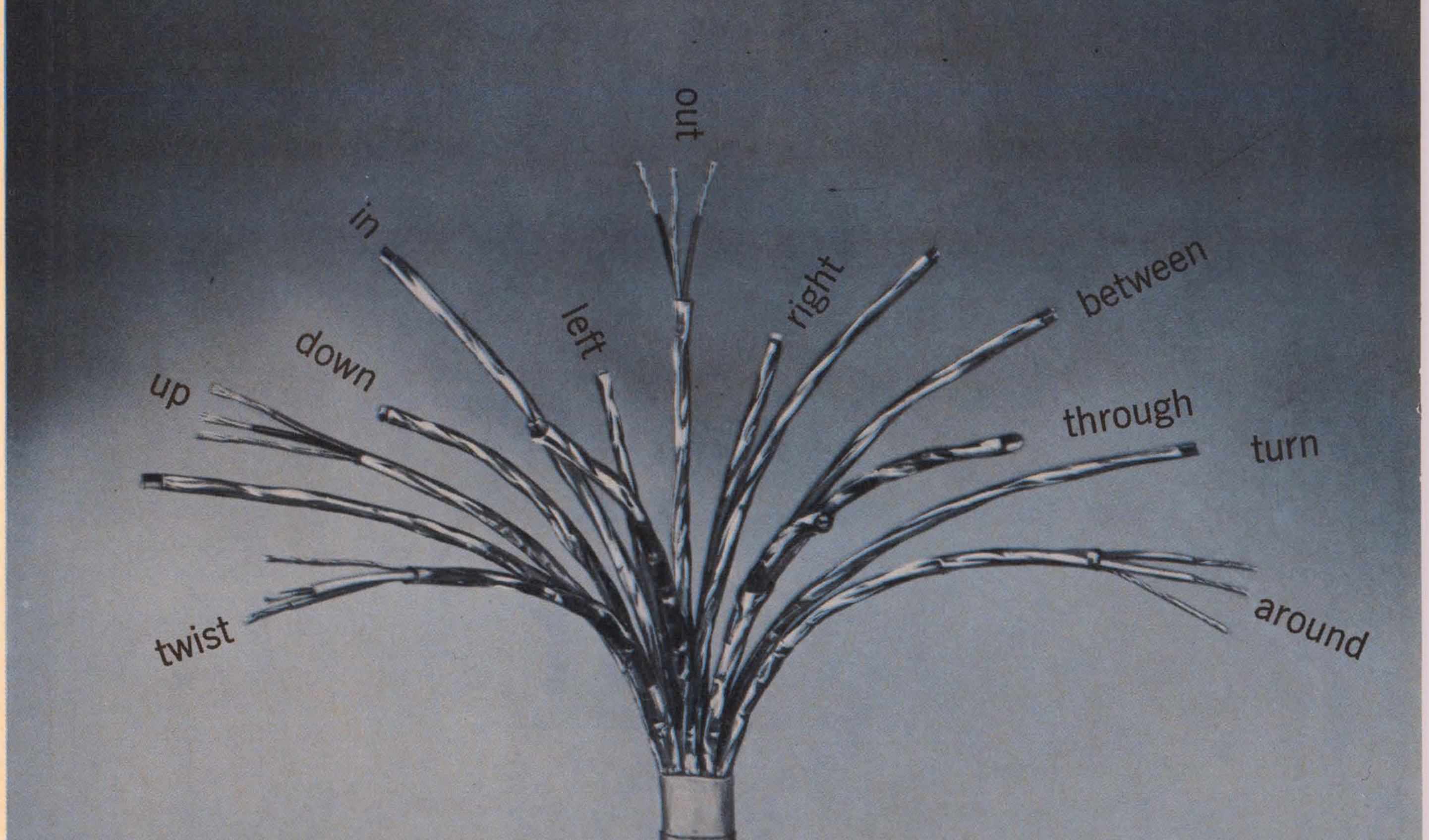
The magnetics manufacturers are none too happy about the threatening noises from the semiconductor industry. A core manufacturer called it psychological warfare. "By making wild predictions about how cheap semiconductors are going to get," he said, "they're trying to swing everybody over their way—because unless they can get the business their prices certainly won't come down." He added, "It's a lot harder for us to make projections about next year's costs because we've had a product for years. We've got to extrapolate from there."

A semiconductor manufacturer replied, "We've got a past, too—ICs. Prices on those have been dropping for years—usually a lot faster than we thought they would. The staid magnetics industry just doesn't know what's hit it yet."

Elizabeth's special report begins on p. 70.

Why is he optimistic about semiconductor memories? Wally Raisanen of Motorola Semiconductor Products Div. tells his reasons to Electronic Design's Elizabeth de Atley.

Feel Free To Flex



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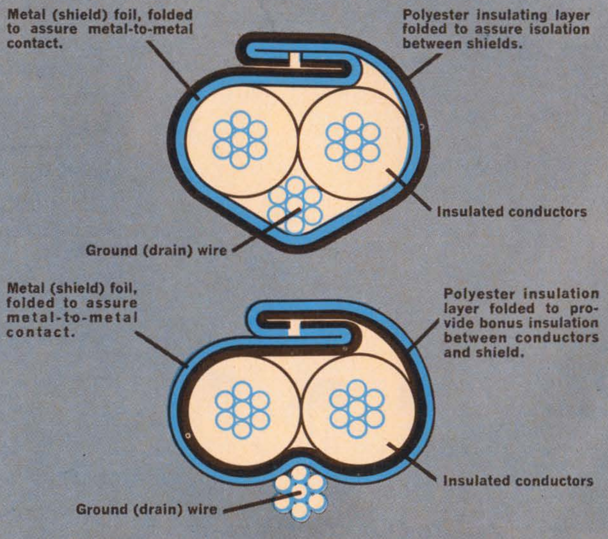

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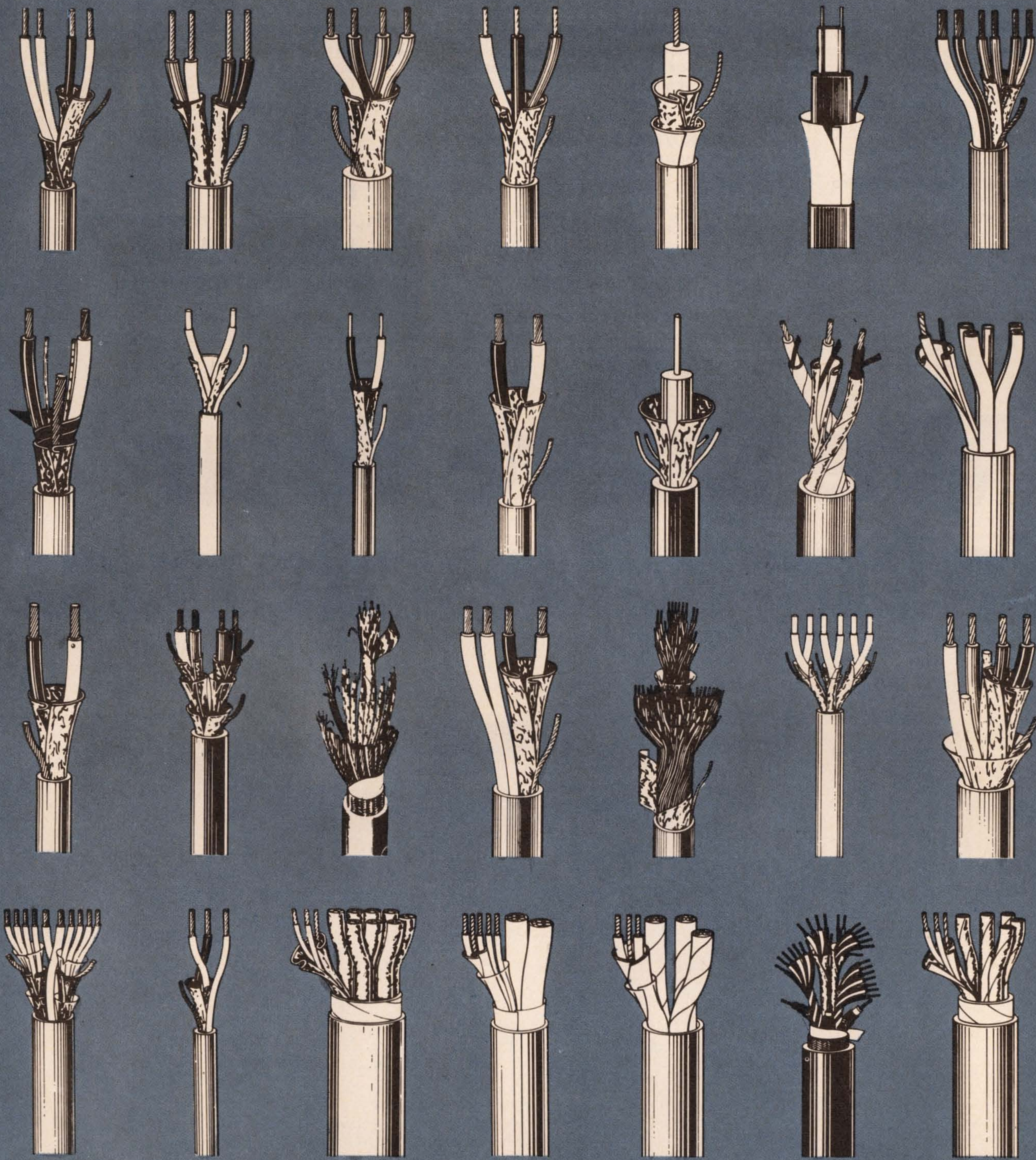

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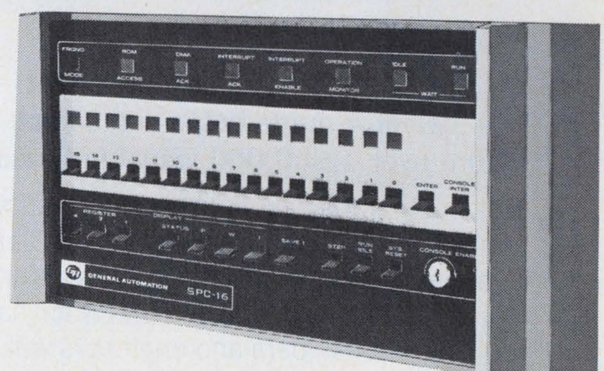

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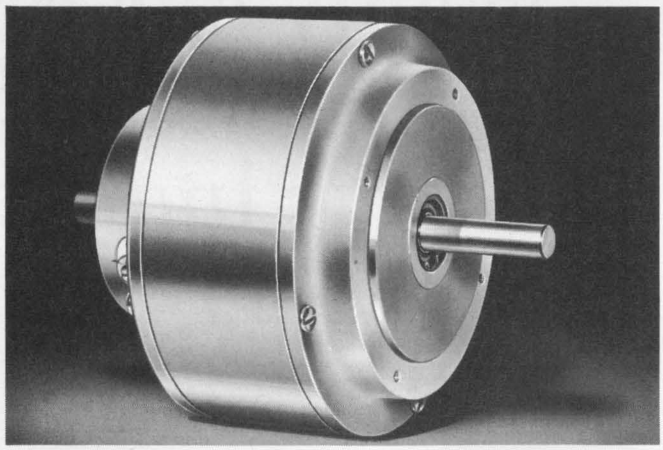

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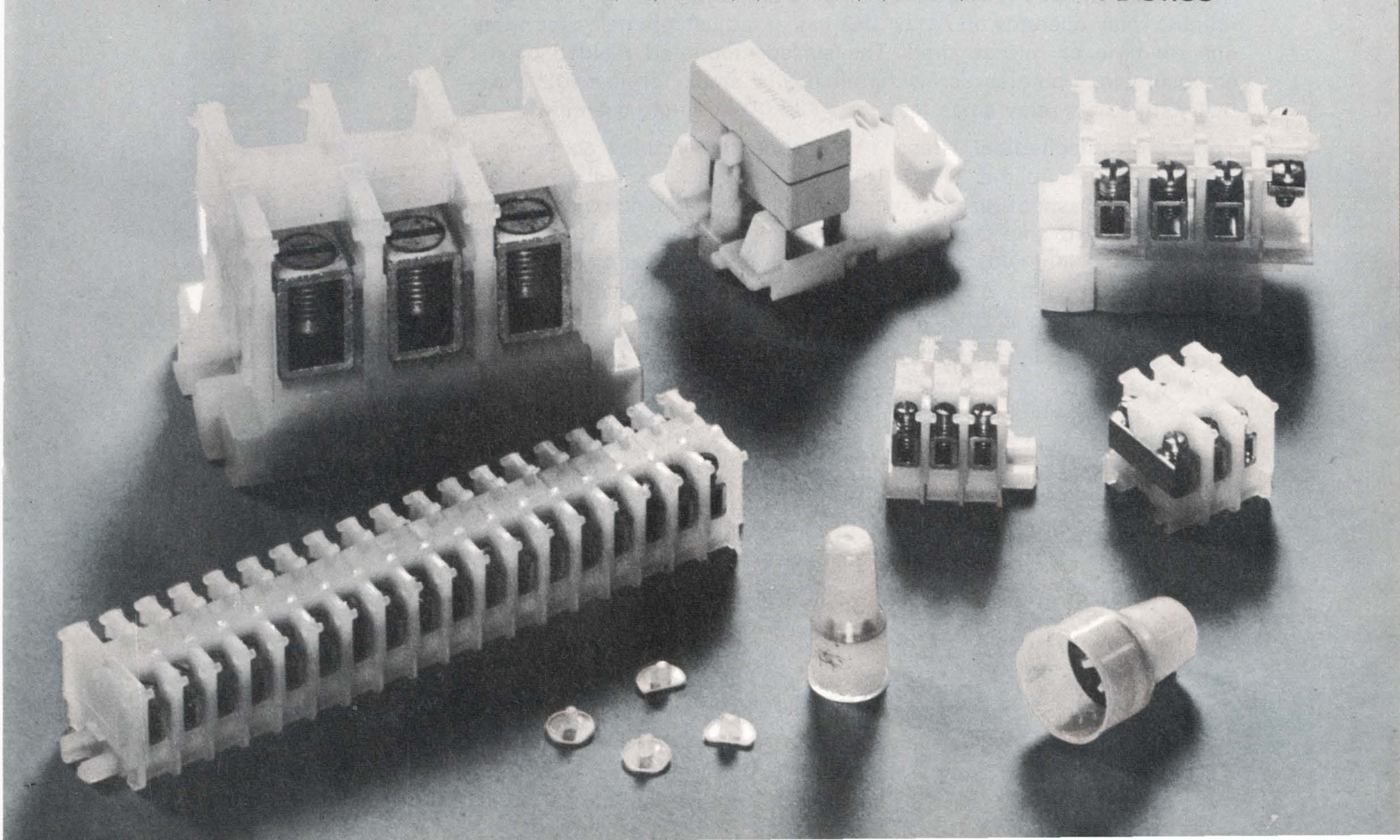

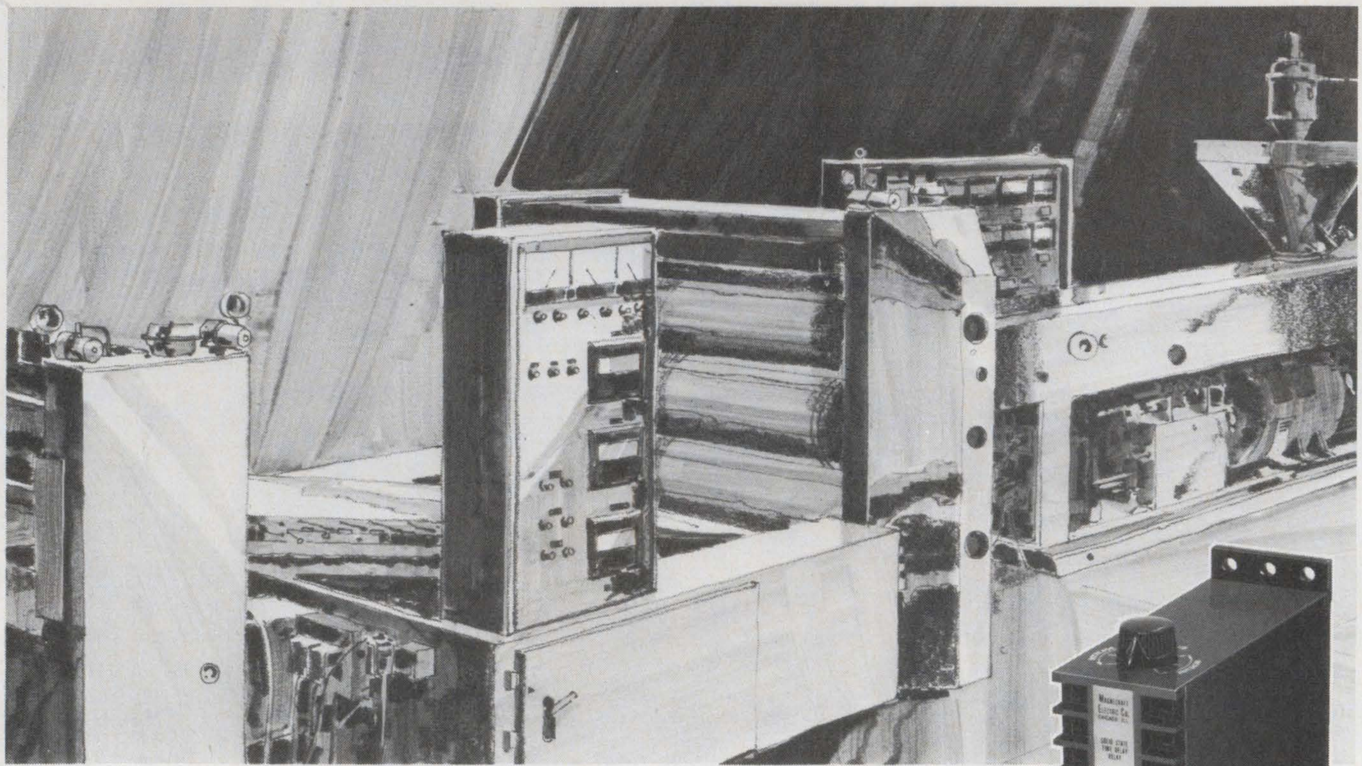

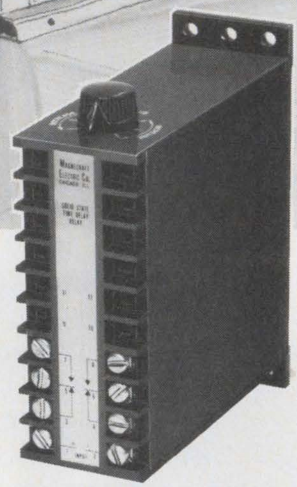

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Class 112M
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Relay

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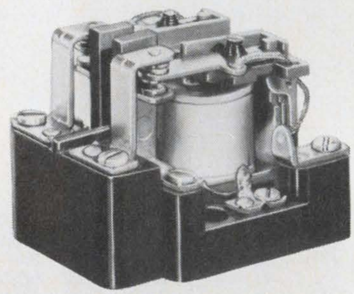

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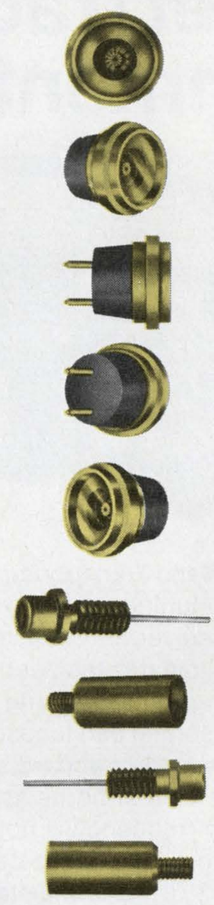

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008-SC	8	25	6
013-SC	13	40	9
023-SC	23	75	15
040-DC	40	75	15 x 15
100-RC	100	40	45 DIAM.
150-RC	150	75	55 DIAM.
200-RC	200	75	55 DIAM.
500-FC*	500	75	—
1,000-FC*	1,000	75	—

*Available in late summer, 1970

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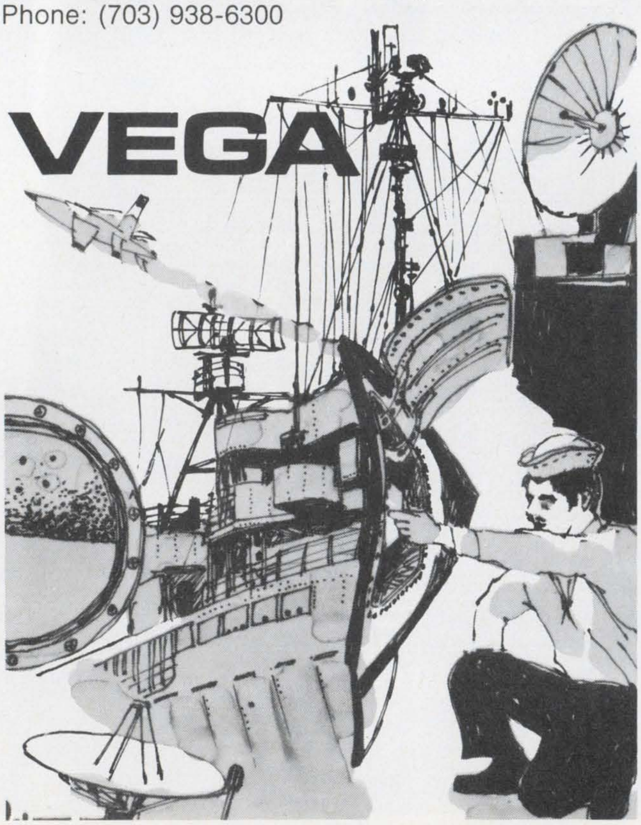

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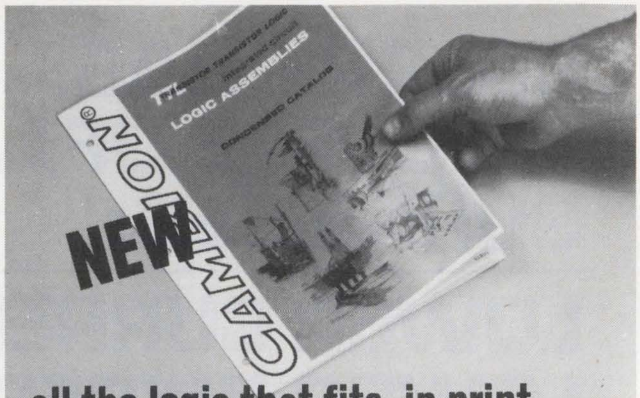

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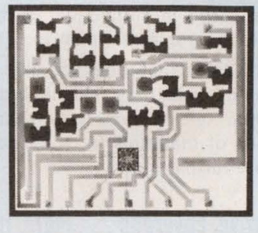

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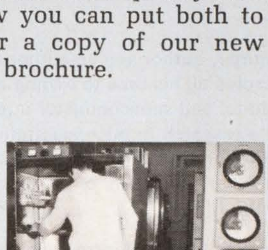

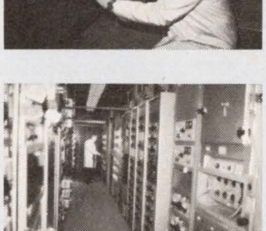

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For the complete story on the 1331A or 1331C, contact your HP field engineer. Or, write to Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland. Price: $1575; OEM discounts available.

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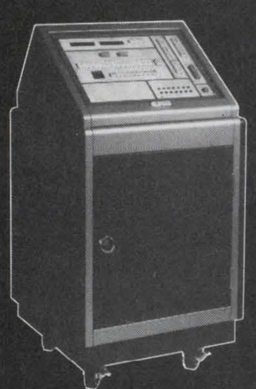

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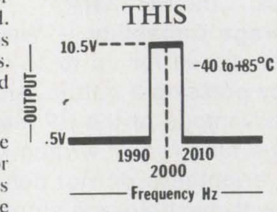

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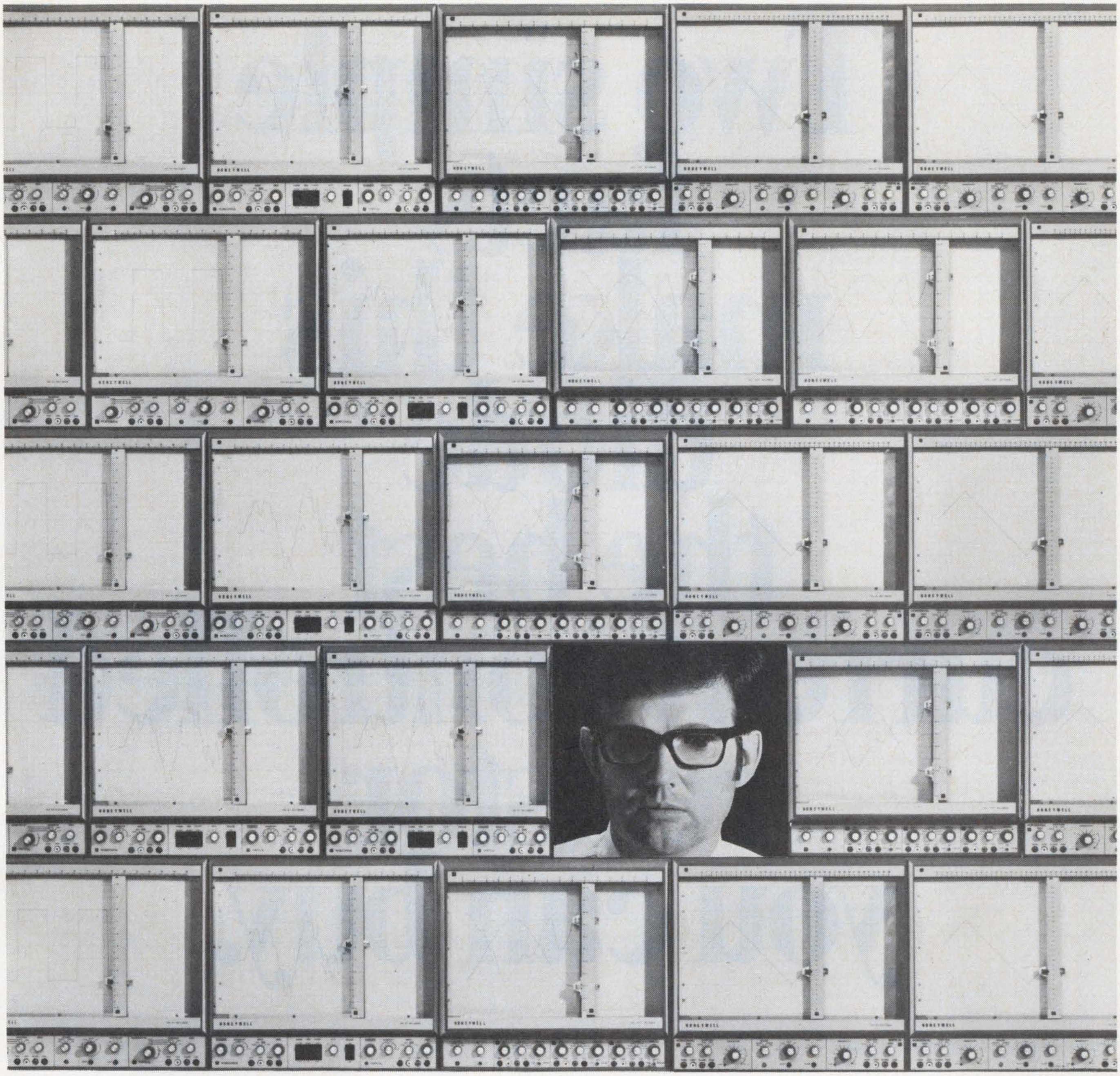

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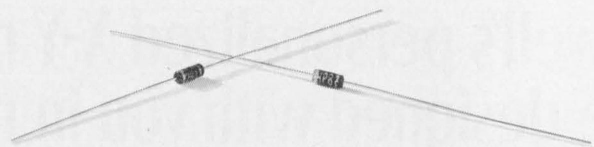

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EDITORIAL

Can we afford the price of engineering unemployment?

Our country has become the greatest throw-away culture in the history of civilization. Never before has any one nation discarded so many billions of tons of refuse, including no-rust aluminum cans, no-return bottles and used cars. We toss technical talent aside with nearly as much ease, and we can't afford to.

We not only toss aside an experienced engineer, but we exhibit little concern for his welfare after he's gone. We were glad to use his abilities and knowledge, but in the end, we find no way to keep him, so we throw him away as if he were an aluminum can.

Because of increasing job insecurity in engineering, more and more engineers are forsaking it for other livelihoods. Add to that the report that students are entering engineering school each year at a decreasing rate, and you've got the makings of a shortage of technical talent at a time when the rest of the world is expanding in its technical knowledge.

If we can't afford to discourage talent from working in technology, what can be done to assure that we have enough on tap? The answer depends, of course, on the Government, and on industry.

Not much can be done about Government spending habits, since cutbacks and contracts are usually the pawns of world affairs. But the electronics industry could help the engineer find work. Some firms lay off experienced engineers with no intention of rehiring them. Management would rather invest in a recent college graduate who has boned up on the latest technology, and who can be hired at a lower salary than his older counterpart.

But some companies do attempt to help their engineers during periods of layoff. Lockheed in California, for example, started an employee referral program some time ago called LEND (Lockheed Employees for National Deployment), by which aerospace companies that use the same kind of engineering talent, can agree on reciprocal temporary trade-offs of personnel while still keeping the talent on the payroll. Other firms might well look into establishing similar agreements.

It's vitally important that the industry does all it can to stimulate engineering employment. As Deutsch, Shea and Evans, Inc., a technical advertising agency, said recently, "Without a sufficient supply of engineering talent, we would rapidly become one of the backward nations of the world."

RICHARD L. TURMAIL

The big memory battle: Semis

Elizabeth de Atley
West Coast Editor

For 15 years, cores have reigned supreme in the commercial random-access, read-write memory market. In this time their price has continued to fall rapidly and their speed has doubled every two and a half years. They have "buried" at least two challengers—cryogenics and planar thin film. Now suddenly a new challenger has appeared—semiconductor memory.

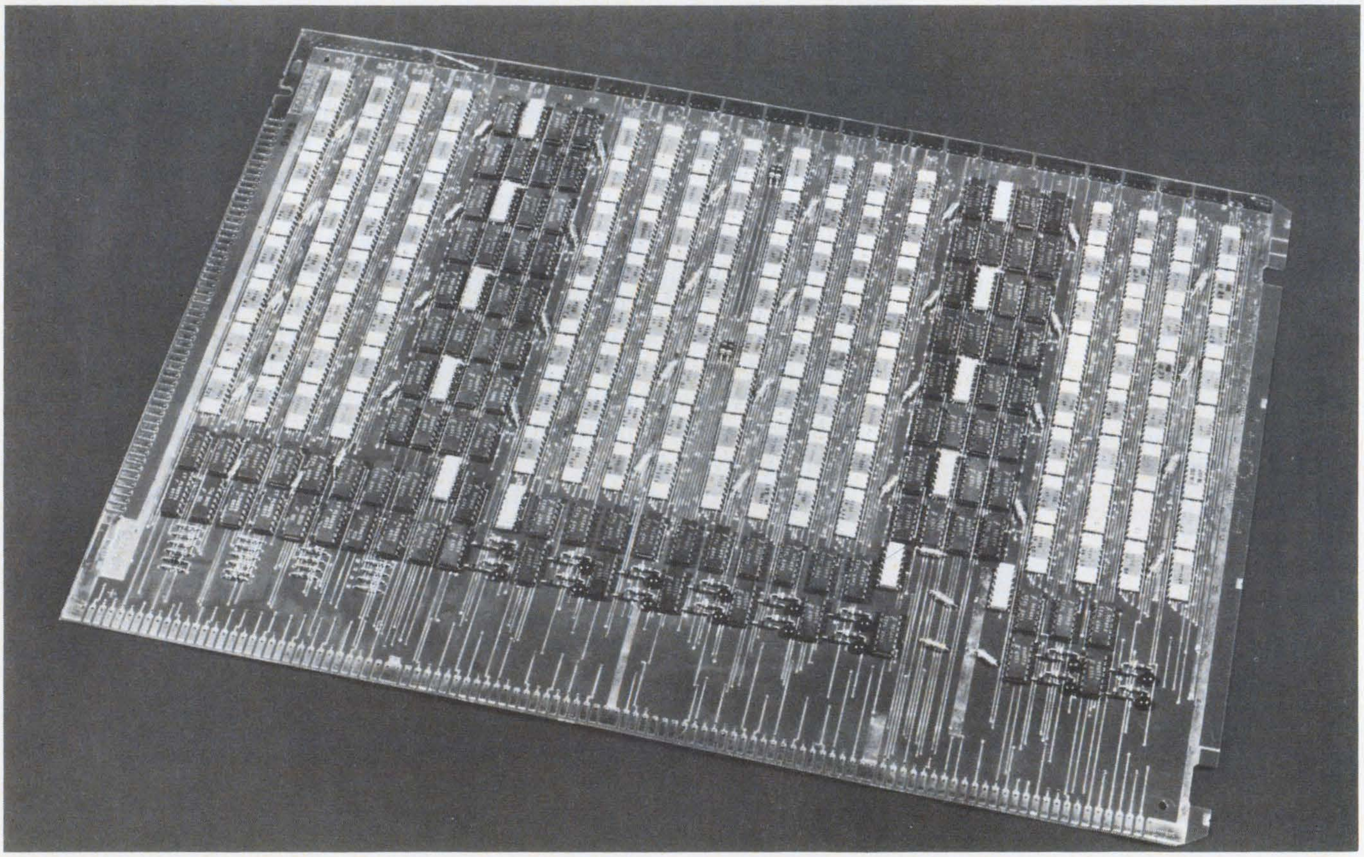
"In 10 years," says Wally Raisanen, operations manager for IC memory and MOS products, Motorola Semiconductor Products Div., Phoenix, Ariz., "semiconductor memories will have the whole business—to a first approximation. Of course, anybody can hang onto 10% of anything one way or another."

That's a tall order. Today semiconductors probably constitute less than 0.1% of the total dollar volume of the random-access memory market. They are used only where core is most vulnerable —that is, where high speed or very small size (a few thousand bits) is required. In large memories core is cheap and hard to beat. Yet Dr. Robert Noyce, president of Intel Corp., Mountain View, Calif., predicts semiconductors will constitute half the dollar volume of the memory market by 1975 (Fig. 1).

To do this, semiconductor memory must take over not only in the mainframe of the small mini or midi computer, in sizes up to 200 K to 300 K bits, but also in the larger mainframe memories of a million bits or more.

What qualifications must they offer to gain entry into these markets?

The smaller computers generally do not require high-speed memories, because they are used with peripheral equipment that has relatively low speed. Therefore to enter this market, semicon-



One of four memory boards, each containing 2 K words x 16 bits, is used in the Illiac IV memory system designed and manufactured by Fairchild Semiconductor for Burroughs Corp. The Illiac IV memory, which is in full production, is a 2-K word x 64-bit system with a full system cycle time of less than 200 ns.

take on cores

ductor memories will have to be cheaper than core but not necessarily faster—500 ns to 2 μs in a system is adequate. The large machines, on the other hand, will require high speed because they are used to perform rapid calculations. Reese Brown, manager of memory techniques, Burroughs Corp., Piscataway, N. J., estimates that large machines being designed this year and next will require memory cycle times in the range of 200 to 500 ns. To enter this market, semiconductor memories must be lower in cost than their magnetic competition. But in this speed range, the competition probably won't be core. In production systems core can be manufactured economically only up to speeds of about 500 ns. Some magnetics manufacturers think plated wire will be the competition semiconductor memories must meet in the high-speed mainframe market.

But regardless of how semiconductor memories edge into the market—whether through extra

Who's who, in mainframe RAMS?

Semiconductor companies are climbing onto the mainframe RAM bandwagon fast. As of June, 1970, the following companies told ELECTRONIC DESIGN *that they were or would be in the market by January, 1971:*

Advanced Memory Systems, Inc.
American Micro-Systems, Inc.
Cogar Corp.
Computer Microtechnology, Inc.
Electronic Arrays, Inc.
Fairchild Semiconductor
General Instruments.
Intel Corp.
Intersil, Inc.
Mostek Corp.
MOS Technology.
Motorola, Inc., Semiconductor Products Div.
Philco-Ford Corp.
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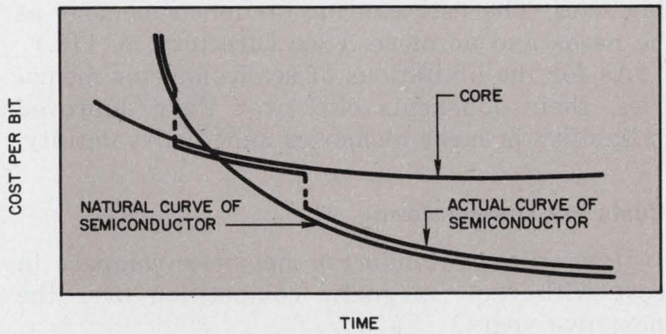
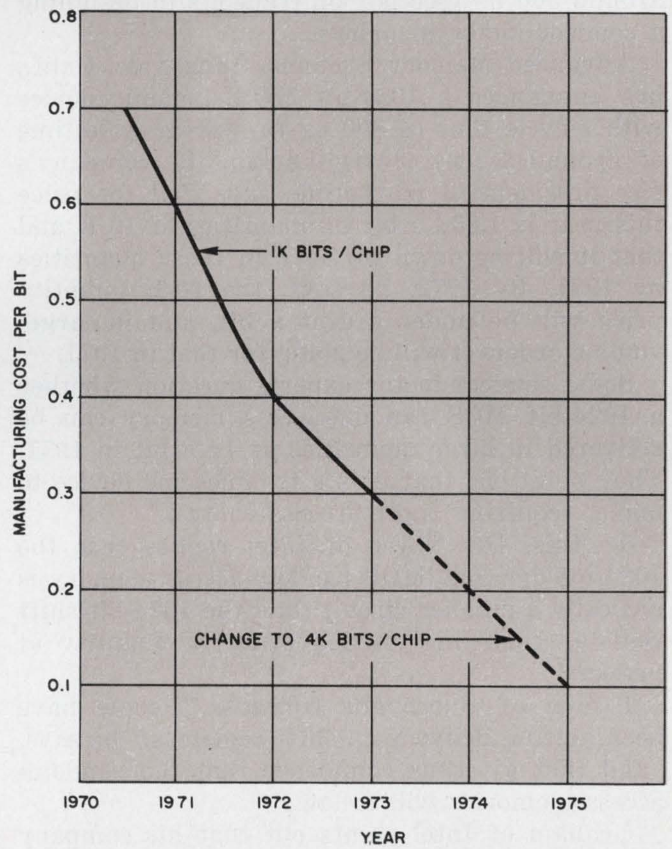


1. **The natural curve of semiconductor memory cost** per bit vs time will be distorted by competitive manufacturing pressures as it gets close to the price of core, Intel Corp.'s Dr. Robert Noyce points out. "It will then come down to meet the core price earlier than it should," he says, "but then it will remain at the core price a little longer than it normally would have to, just because of the competitive pressures in the market."



2. **Manufacturing costs for a dynamic MOS chip** with a cycle time of 0.5 to 2 μs can fall to 0.1¢ per bit by 1975, according to a projection by Lee Boysel, president of Four-Phase Systems, Inc., Cupertino, Calif. He is projecting a change in chip density from 1 K bits today to 4 K bits in 1973. Boysel points out that if he were a semiconductor vendor, he would have to multiply these manufacturing costs by a factor of 4 to cover overhead and profit.

speed or lower cost—they will offer one big advantage over their magnetic competitors: organizational flexibility. Because they require less in the way of supplementary electronics than core, they can be cost-effective in much smaller modular sizes. The user can buy as much memory as he needs and no more. (See Directory, p. 113.)

As for the limitations of semiconductor memories, their opponents cite two: their unproved reliability in large memories and their volatility.

Costs are coming down

How will semiconductor memories compare in cost with their magnetic competition over the next five years?

Robert Graham, director of marketing at Intel Corp., says that MOS products will soon be economical enough to undercut low-cost core even into the megabit sizes. "By early 1971," he says, "MOS dynamic memory will be going for a cent a bit in 100-K quantities."

Intel is taking orders now for a 1024-bit dynamic MOS device with a cycle time of 350 to 400 ns. It would have a system cycle time of around 500 ns (see box on tradeoffs in designing a semiconductor memory).

Advanced Memory Systems, Sunnyvale, Calif., has announced a 1024-bit MOS dynamic device with a cycle time of 800 ns (a system cycle time of around 1 μs.). Jerry Larkin, the company's vice president of marketing, says that the price this year is 1.83¢ a bit in quantities of 10 K and that it will be down to 1.47¢ in those quantities by 1971. By 1972, he says, the 10-K quantity price will be under a cent a bit, and in large-volume orders it will be going for that in 1971.

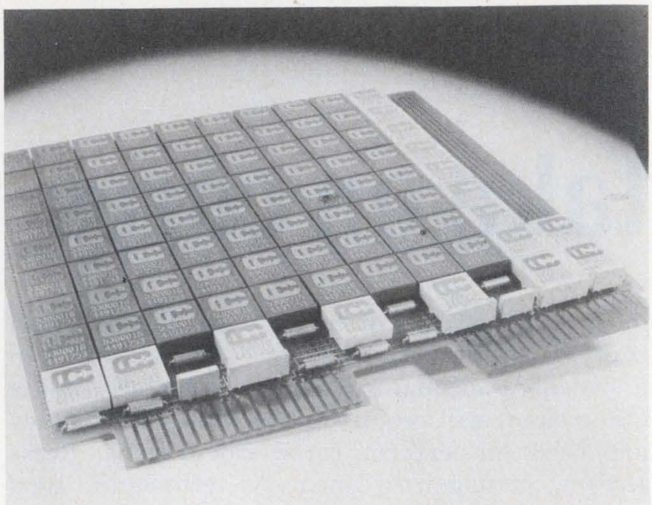
Some semiconductor experts question whether a 1024-bit MOS random-access memory can be delivered in large quantities at 1¢ a bit in 1971. They point out that it is a troublesome device to make, requiring tight process control.

To this, Dr. Noyce of Intel replies that the 1024-bit dynamic MOS random-access memory is basically a simpler circuit than the 1024-bit shift register that Intel is delivering in quantity at present.

Brown of Burroughs concurs. "People have been getting delivery on shift registers," he says, "and that gives us confidence that the random-access memories will follow."

Graham of Intel points out that his company has already delivered between 200 and 300 prototype 1024-bit random-access memories.

Lee Boysel, president of Four-Phase Systems, Cupertino, Calif., notes that his company's manufacturing costs on a similar device are already below 1¢ a bit. Boysel and his associates have designed a 1024-bit dynamic MOS memory with a cycle time of about 2 μs and are using it as



This 1-K word x 9-bit memory card has a full cycle time of 80 ns. Manufactured by Cogar Corp., it is one of three performance levels offered by the company: (1) The "high-performance" level, with 80-ns cycle time and using bipolar technology; (2) The "medium performance" level, with 150-ns cycle time and also using bipolar technology, and (3) The "cost-performance" level, with cycle time of 300 ns and using n-channel MOS technology.

the basic building block for the mainframe memory of their midicomputer. The manufacturing cost with today's yields, Boysel says, is about 0.7¢ per bit. However, he points out, a semiconductor manufacturer with the same manufacturing costs would have to multiply them by a factor of four to cover overhead and profit, bringing the cost per bit to 2.8¢ this year. By putting more bits on a chip, using larger wafers and improving the yields, Boysel expects his manufacturing costs on a 500-ns-to-2-μs MOS dynamic chip to fall to .1¢ per bit by 1975 (Fig. 2).

Semiconductor manufacturers say there will be a number of candidates for the high-speed market (200 to 500 ns). Melvyn Snyder, vice president of Intersil Memory Corp., Cupertino, Calif., predicts that it will be N-channel MOS for the 200-to-400-ns range and P-channel MOS above 400 ns (Fig. 3). Cogar Corp. is using N-channel MOS in an 8-K word by 18-bit memory system with a cycle time of 300 ns.

Bipolar memories will be in the running for cycle times of 200 ns or faster. Fairchild Semiconductor's Illiac IV memory is a good example. This 131 K bit system has a cycle time of 188 ns.

David C. Conrad, vice president of marketing, Computer Microtechnology, Inc., Sunnyvale, Calif., says his company's hybrid MOS/bipolar 4-K bit module has a cycle time of 400 ns at present (Fig. 4), but he expects improvements to bring it down to a 325-ns cycle time by the end of this year. Motorola's 8-K hybrid MOS/bipolar module is considerably faster—around 125 ns.

Graham says Intel has a silicon-gate MOS de-

What causes semiconductor prices to fall?

Most semiconductor experts agree that the prices of semiconductor products fall for three reasons: (1) Increased yields; (2) Greater chip density, and (3) Volume. How will these factors work in the case of semiconductor memory? Harry Neil, director of semiconductor subsystems marketing of Fairchild, puts it this way:

"Obviously if we knew how to get the yields up right now, we would lower the costs in 1970. So the question is, since we don't know how right now, how long is it going to take us to learn? In the past, prices have dropped about 30% a year with any IC, just due to increasing yields.

"Then, in addition, you have an even greater cost reduction when you put more function on a chip. I think a $5 cost on a package is a reasonable bottomed-out cost for any type of chip. In a 256-bit chip that works out to 2¢ a bit—which is probably two to three years away for bipolar. Right now in the 256-bit bipolar, we're running in the $20 range [8¢ per bit], and I think it takes about three years to go from $20 to $5. If we take a 512-bit chip, that would be 1¢ per bit."

Neil cautions, however, that these time estimates depend upon large-volume production. And that may not be so easy to achieve in the case of random-access memories, which must dislodge well-established competition.

"People bought ICs," he says, "regardless of price because they were the cheapest thing around. So we were able to get our volume up—which automatically brought the price down. The manufacturing costs of semiconductors are very volume-dependent—much more so than core—because of the batch processing and mass production techniques."

But—and it's a big but—how can you get high volume at high prices when you've got competition?

"It gets to be a chicken-and-egg kind of thing," says Neil. "Are you going to commit the capital to building up that kind of production, force the price down and then catch up with it later—in other words, sell at less than cost?"

vice with a component cycle time of 225 ns (access time of 150 ns).

Competition at low cost: Core

In the low-speed, low-cost market, core is the only competition semiconductors face, but it is formidable competition—particularly in sizes of 100 K bits or above. In general, the larger the core system, the lower the cost per bit, since the peripheral electronics are amortized over many bits. For example, a core memory 1 K words by 8 bits would cost about 5¢ today, whereas a system of 10 million bits would cost as little as 1.5¢, including the power supply.

The size/cost trade-off is reversed for semiconductor memories. In general, semiconductors require much less in the way of peripheral electronics than cores, and therefore are less expensive in small sizes than they are in large. Thus there is a crossover point below which semiconductor memories are definitely cheaper than core, even in today's low-cost systems. Most semiconductor manufacturers set this crossover point at about 4 to 8 K bits today—where, they say, both technologies cost around 6¢ to 7¢ a bit. But at least one core manufacturer hotly denies this. He says, "I'd be happy to buy semiconductors at this price range, but I haven't been able to—even for a large-volume order."

Whatever the crossover point, there is no doubt that large core systems are cheap—and getting cheaper all the time. Dr. Karl Hinrichs, director of engineering, Lockheed Electronics Co., Data Products Div., Los Angeles, estimates that the cost of manufacturing a core system is coming down at a rate of about 10% a year (Fig. 5). This is due, he says, to two principal factors:

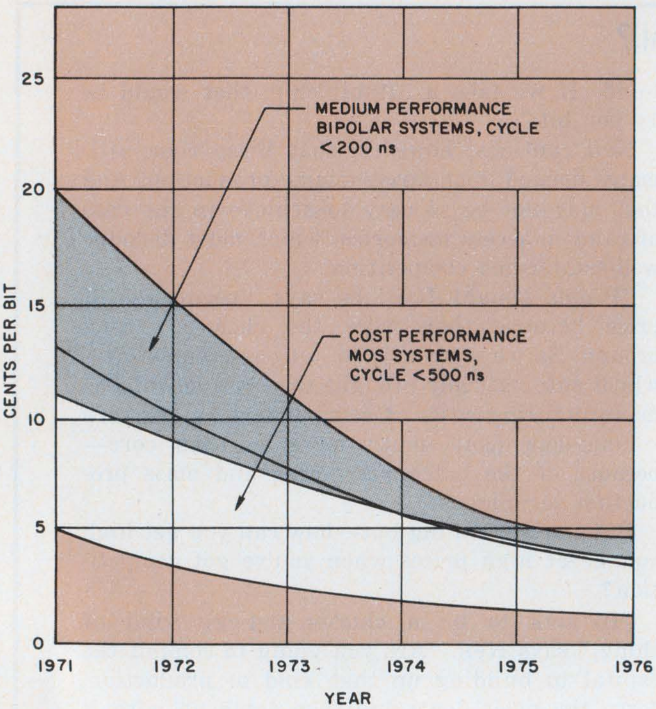
(1) Increased volume of production, thanks to the burgeoning memory market. As a result, he says, core manufacturers continue to improve production techniques—the development of more automatic machinery, for example—so that the cost of the product continues to fall despite increasing labor costs. "We are making 10 times as many cores today as we did five years ago with the same number of people," Hinrichs points out.

(2) Continued cost reduction of semiconductors used in the peripheral electronics of a core system—that is, the TTL medium-scale integration circuits, diodes, etc. The cost of these semiconductors is coming down at a rate of about 20% a year, says Hinrichs, and he expects it to continue to fall at about this rate for some time.

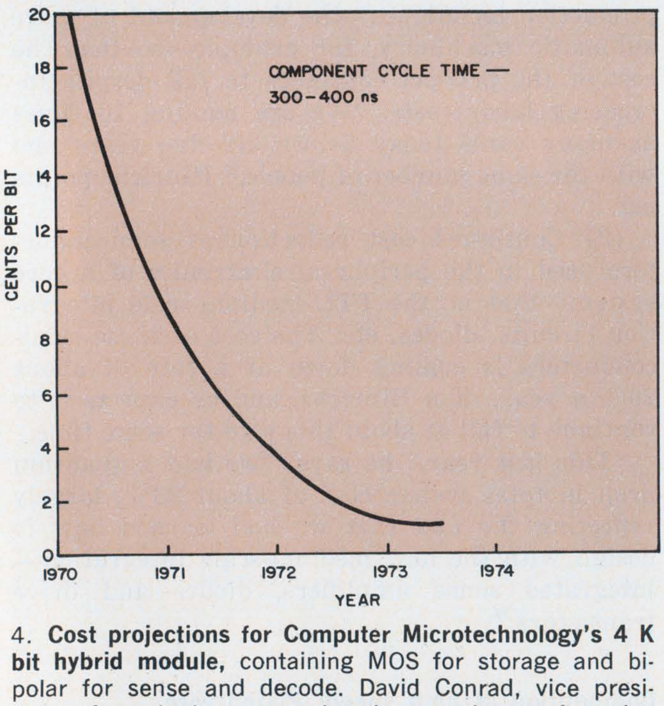
"This last year," he says, "we had a quantum drop in total system cost of about 23%, largely reflecting the fact that we had learned how to design with the new medium-scale integration—integrated sense amplifiers, diodes and drive transistors."

Competition at high speed: Plated wire

At cycle times very much faster than 500 ns, the competition to semiconductor memory is not core but plated wire. Although core systems with cycle times as fast as 250 ns have been produced,



3. **Cost projections for two of Cogar Corp.'s memory cards:** a medium-performance bipolar card, 1 K x 18, with a cycle time of 150 ns at a cost per bit in 1971 of 12¢, and a "cost performance" n-channel MOS card, 8 K x 18, with a cycle time of 300 ns at a cost per bit in 1971 of 5¢. The low end of the band in each curve represents the cost of a card that is fully loaded and thus makes maximum use of support circuitry on the card.



4. **Cost projections for Computer Microtechnology's 4 K bit hybrid module,** containing MOS for storage and bipolar for sense and decode. David Conrad, vice president of marketing, says that increased manufacturing efficiencies will bring the cost to 2¢ a bit. By 1972-73, he anticipates that "we will be putting more bits on a chip, using larger wafers and a nonhermetic form of packaging, which will easily bring the cost down to 1.5¢ or less."

they are costlier than most computer manufacturers are willing to pay. Dr. Hinrichs points out that the fastest production system Lockheed makes has a cycle time of 500 ns.

In general, he says, going to higher speeds in a core system means using smaller cores, which produce a smaller output signal when they change state, and thus require more expensive drive electronics and sense amplifiers.

Lockheed is turning to plated wire for speeds above 500 ns, Hinrichs says, because it can be manufactured largely by automated techniques and therefore offers the potential for lower cost at high speed. It is inherently faster than core, he says, because the element that is analogous to the core is merely a magnetic coating on the surface of a wire about the size of a human hair. Like the core in a small diameter core system, the very fine plated wire requires expensive drive and sense electronics because its signal level is low. But, says Dr. Hinrichs, the high cost of the electronics is offset by plated wire's potential for low-cost automated production.

George A. Fedde, manager of data processing at the Univac Data Processing Div., Philadelphia, says that plated wire has a potential for a cycle time of less than 100 ns but that production systems today are typically 250 to 300 ns.

In general, plated wire, like core, requires considerable peripheral electronics that must be amortized over many bits to get the cost per bit of the system low. Thus, just as in the case of core, there is a crossover point below which a plated-wire system could not compete with a semiconductor system at any given time. Dr. Jerry Sallo, manager of magnetic films, Lockheed Electronics Co., Data Products Div., puts this crossover point at 10 K bits today. James P. McAllister, manager of Univac's solid-state memory research section, puts it at around 30 K bits and expects it to remain there for the next four years (Fig. 6).

Brown of Burroughs disagrees. He says that by 1972 the crossover point will be over 250,000 bits—"if plated wire ever gets into real production." He adds that today "you can't draw a valid comparison, since neither technology is being widely produced for the open market."

The big advantage that semiconductor memories have over core—organizational flexibility—is only beginning to be exploited by the computer industry. Brown of Burroughs points out that if the memory can be made in small modules instead of one big piece, the user can purchase only as much as he needs.

Robert D. Miller, director of business and market development, Lockheed Electronics Co., Data Products Div., cautions, however, that if a large memory is built from small modular pieces of high-speed technology, the performance of the

Trade-offs in designing a semiconductor memory

Semiconductor memories generally require much less in the way of drive electronics than cores, because most of the decode and sense circuitry is on the chip. Even when the chips are completely undecoded, the drive circuitry required is less expensive than that of a core system, because lower energies are involved.

In a bipolar or a static MOS memory, the basic element is a flip-flop. Thus if the drive, sense and decode circuitry are included on the chip, small amounts of memory can be mixed directly with the logic. As the memory grows in size, however, peripheral decode and drive circuitry must be added. Thus the cost per bit remains fairly linear over a range of sizes.

In dynamic MOS, the storage element is not a flip-flop but a capacitor with charge stored on it, which must be continually refreshed because of the leakage. Thus a dynamic MOS system requires special refreshing circuitry. In addition it runs off a clock or set of clocks. Just as in the case of a core system, this peripheral circuitry is less costly per bit if it can be amortized over a large number of bits. Thus the optimum modular size for such a system is the number of bits that can be driven with one set of MOS interface circuits.

According to Reese Brown, manager of memory techniques for Burroughs Corp., Piscataway, N. J., the optimum modular size for a memory system made from 1024-bit MOS packages, with drive and decode on the chip, is on the order of 30 K to 60 K bits. A larger memory would normally be made by adding multiples of that modular size. In addition, he says, there is some logic that is slight and can be ignored.

Brown points out that because the peripheral electronics in a static MOS system increase fairly linearly with the number of bits in the system, there is a crossover point in system size above which a dynamic MOS memory system would be cheaper than a static system. This crossover point, he says, is about 20 K bits. Below 10 K bits, he says, it would not be practical to use a dynamic MOS memory.

Brown points out that it is impossible to make a general statement on the cost of putting a semiconductor array into a system since it depends on the system organization, speed, chip complexity and other factors. However, as a rough rule of thumb he estimates that in a medium-speed (350-to-500-ns) semiconductor system that has more than 250,000 bits, anywhere from 40% to 75% of the total system cost may relate to the array. The remainder represents the cost of building the system. He cautions that this estimate applies to the leveled-off production cost of the system. Whether the cost of putting a paricular array into a system is at the high or the low end of the range, he says, depends on the system speed and the type of chip. For example, he says, an MOS dynamic array requires refreshing circuitry and clocks. Furthermore, if a number of such arrays are placed in parallel, supplementary drivers are required, and thus the system cost would be at the high end of the scale. A package like Computer Microtechnology's hybrid module, or a static MOS or a low-speed (of greater than 500 ns) MOS dynamic chip would be at the low end of the scale.

Estimating system speed

Brown points out that as a rule of thumb for estimating the speed of a semiconductor component in a practical production system of 100 K bits or more, one would add to the component speeds the amounts shown in the table below.

Brown cautions that these estimates are for a practical production system rather than for a laboratory prototype, which does not have to be designed with production tolerances.

Type of Component	Component Speed*	Estimated increment to obtain system speed
Dynamic MOS	Access time Cycle time	Add 50% Add 25%
Static MOS, bipolar, or hybrid MOS/bipolar array, such as the Computer Microtechnology module	Access time Cycle time	Add 20 - 25% Add 10 - 15%

Exception: In a very high-speed system (total cycle time under 100 nsec), where the logic circuits are being pushed to the limits of their speed capabilities, the system access time might approach one and a half to two times the component access time. The cycle time would be only slightly longer than the access time.

*Throughout this report, speed has been given as cycle time, which is defined as the time between successive requests for memory access. The worst-case cycle time is the cycle time of a read that follows a write. To write information into a location in memory creates transients that must have time to die down before it is possible to read. Thus a read cycle time that follows a write is longer than a read cycle time that follows another read. Access time is defined as the time required to obtain information from memory after it has been addressed. The time is determined by the number of stages of delay through which the information must travel.

The magnetics viewpoint

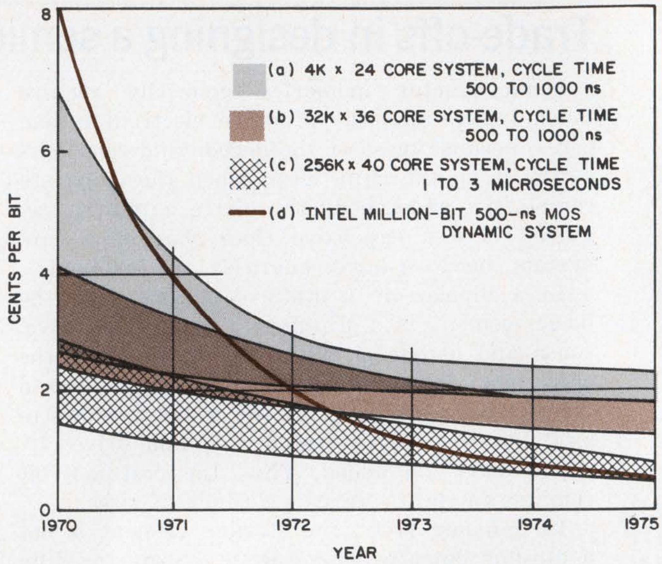
What do magnetics experts say about semiconductor memories?

H. Frederick Koehler, chief engineer for core and semiconductor memory products, Ampex Computer Products Div., Culver City, Calif., believes that as much as 40% of the memory market may go to semiconductors by 1975. "It will be in the area of mainframe memory," he says, "and will be in sizes up to a million bits. But I think that over a million bits, core will still have the market in 1975."

Richard J. Bravo, director of marketing for systems products, Electronic Memories, Inc., Hawthorne, Calif., says: "You can pretty well forecast the future of magnetic memories by envisioning what semiconductor memories are likely to achieve in any specific time period. In our view, they will take over the 4 K x 18 memory size—which is more or less the heart of the minicomputer market—within another 18 to 24 months. The next size you might consider is the half-million-bit memory. Our best estimate at this time is that within three to four years, semiconductor memories will be in production and have their production costs low enough to effectively eliminate the magnetic competition in that capacity."

Dr. Karl Hinrichs, director of engineering, Lockheed Electronics Co., Data Products Div., Los Angeles, agrees that semiconductor memories have great potential, but he cautions that that's all they have right now. "We haven't been able to buy them from anybody at a price that would make them competitive with core in a memory bigger than 1 K bits," he says.

"**I think it will be 1975 before we really see the impact of semiconductors** on the memory market. Most of the computers that are being designed between now and 1972 won't go into production until 1975"—Dr. Robert Noyce.



5. **The price of a million-bit dynamic MOS system** (d) crosses both the 100-K-bit (a) and the million-bit (b) core price bands in 1972 and approaches the lower edge of the 10-million-bit core price band (c) in 1975. The MOS projections are based on the component cost of an Intel 1024-bit dynamic device, doubled to estimate the cost of the complete system, and including refresh circuitry and clocks. The projections assume no increase in chip density that would lower the cost per bit still further between now and 1975. All core estimates were supplied by Lockheed Electronics Co., Data Products Div., Los Angeles. They include the power supply and are based on a minimum sustained production rate of 50 million bits a year.

system is likely to be slower than that of the individual pieces because of "real-world problems, such as extra line lengths."

Yet the small modularity of semiconductors can greatly increase the throughput of a well-designed system, Boysel of Four-Phase Systems points out. The Four-Phase computer has a mainframe memory that consists of up to 32 cards, each containing 1024 24-bit words.

"Since core comes in 4 K solid blocks," says Boysel, "you can only address one location out of 4 K words. Ours comes in 1 K solid blocks, so we can access each one independently. So even though the elemental MOS gates are slower than core, the data interaction rate is much faster."

Are semiconductor memories reliable?

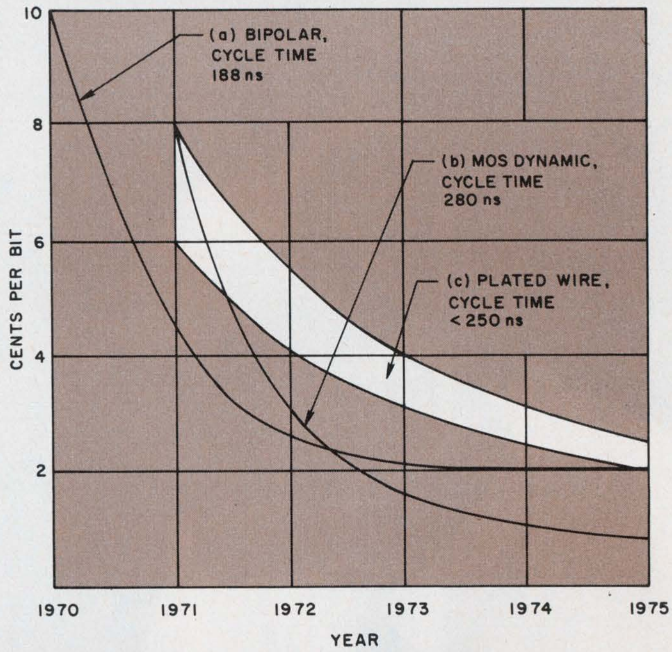
The question of the reliability of semiconductors in large memories is debated vigorously in the industry.

Richard J. Bravo, director of engineering Electronic Memories, Inc., says that "in memories above a half million bits, the memory market is still somewhat suspicious of semiconductors as reliable storage, primarily because the failures that occur in core memories now are usually semiconductor failures."

Raisanen of Motorola answers this argument by asking: "What causes semiconductors to fail? High temperatures, high levels of electrical stress, high currents, high voltages. What kind of environment does a core memory provide for semiconductors? High temperatures, high levels of electrical stress, high currents, high voltages. Core people drive the stuff to its very limit. The reason semiconductors fail in core memories is not because they are poor semiconductors; it's because they're poorly used. Now, what do you find in a semiconductor memory? Extremely low power dissipation—like 1/4 mW per bit—low voltages, conservative design. They'll last forever!"

However, Raisanen agrees that "nobody knows if these memories are reliable enough to use in large sizes or not, because it takes a long time and a lot of money to find out; you have to build a lot of memories and put them on test and see how long they last."

Brown of Burroughs believes reliability could be a problem in modular sizes of over a million bits, but he says there should be no big problem at or below that size.



6. **A 100-K-to-1-million-bit bipolar system** (a) is expected to cost less than a million-bit plated wire system (c) until 1975. A million-bit dynamic MOS system (b) crosses over the low edge of the plated wire price band in the middle of 1971 and continues to fall. Curve "a" is based on an Illiac IV type of system manufactured by Fairchild Semiconductor. The cycle time of the system is 188 ns. The projection assumes a change in chip density from 256 bits today to 512 bits in 1972-73. Curve "b" from Intel Corp. was obtained by taking cost projections for a high-speed dynamic MOS 1024-bit device and doubling it to obtain the estimated cost of building the system. The device cycle time is 225 ns, and the system cycle time is assumed to be 280 ns. No change in bit density is assumed. Curve "c" represents cost projections from Lockheed Electronics Co. on a 32 K x 36 plated-wire system with a cycle time of less than 250 ns.

The problem of volatility

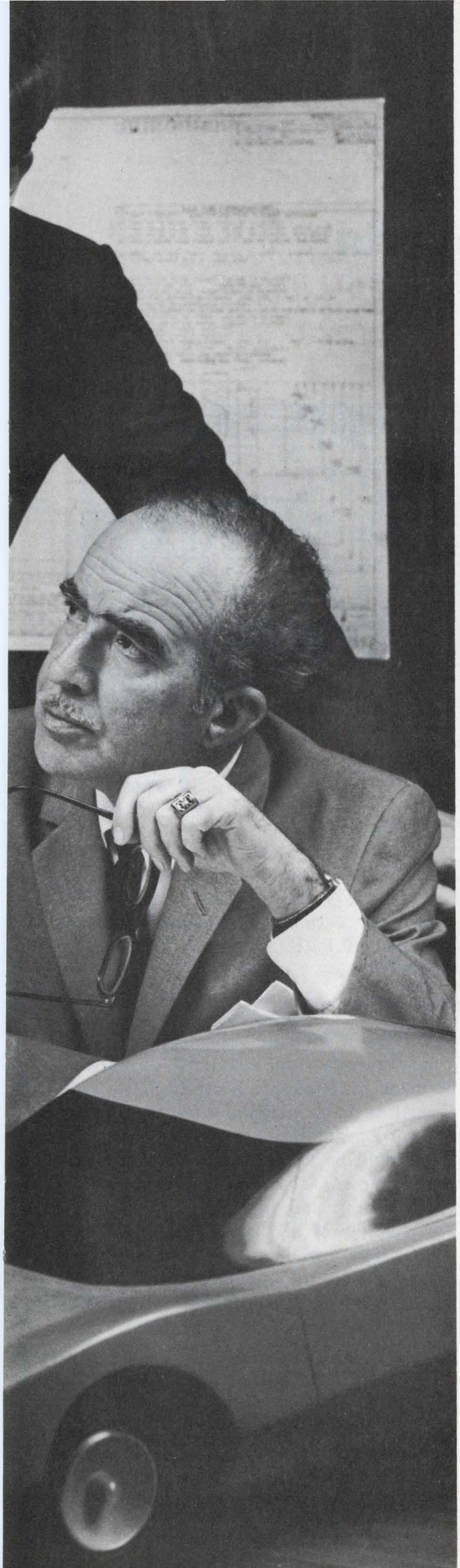
In a semiconductor memory, when the power goes off, the contents of the memory disappear. Proponents of magnetic memories argue that this volatility will preclude the widespread use of semiconductor memories. They concede that a core memory may also lose information during a power failure but point out that this is due to the volatile semiconductor registers in it. If the power fails while any data is stored in these registers, that data will be lost. But, they point out, core memories can be designed to dump the contents of the registers back into the nonvolatile core if the power starts to fail.

Semiconductor proponents reply that if the problem can be solved in cores, it can also be solved in a semiconductor memory. The solution, they say, is battery back-up. Cloyd Marvin, vice president of marketing for Four-Phase Systems, puts it this way: "We haven't run into an application yet that has said 'no' to a volatile memory. If we do, we will hang a battery on the system, and the memory will dump itself onto a disc when there is a power failure. We can unload the whole memory in around 100 ms."

William F. Jordan Jr., manager of memory products engineering, Honeywell Computer Control Div., Framingham, Mass., thinks volatility has been greatly overstressed. "Personally, I think the prime motive for using battery back-up is so we can sell semiconductor memory computers on an equal basis," he says. "If we don't have battery backup, the core memory people will keep stressing the volatility of the semiconductor memory and the salesmen will have a hard time selling it."

Nonetheless there are applications in which even battery backup would not solve the problem in a semiconductor memory—for example, on-line applications such as process control or satellite tracking, as well as storage of permanent data.

One interesting example of such an application is the storage of a permanent but alterable program for a point-of-sale terminal. Anar Asbow, manager of terminal development for Singer's Friden Div., San Leandro, Calif., says he could not use semiconductor random-access memories in this application because of their volatility. The terminal, which is a kind of "smart cash register," contains a program that guides the sales clerk through the steps of the sales transaction. This program must be permanent, but it must also be alterable, since the sales procedure varies from store to store. Thus, Asbow says, he could not use read-only memories; the best solution was a core memory. ■■



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22942

For design flexibility, go hybrid!

You can frequently improve circuit performance by mixing monolithic and discrete components.

Hybrid microcircuits may not be your first choice in designing for high performance and small size, but they may well be the best. They offer design flexibility in choosing circuit components not available with monolithics alone. They give some circuit functions that may not be obtained with monolithics. And they sometimes do the job at less cost.

The hybrid approach can be thought of as a packaging technique in which monolithics and discretes are used as components (Fig. 1).

The major emphasis in hybrid microcircuitry has been in military applications, but cost reduction has been so great that industrial and consumer applications are now being considered by manufacturers.

It is a simple matter for a circuit engineer with no knowledge of semiconductor processing to have his breadboard transformed into a production hybrid circuit in as short as four to six weeks.

Let's examine some of the characteristics of hybrids and monolithics and why hybrids may be better:

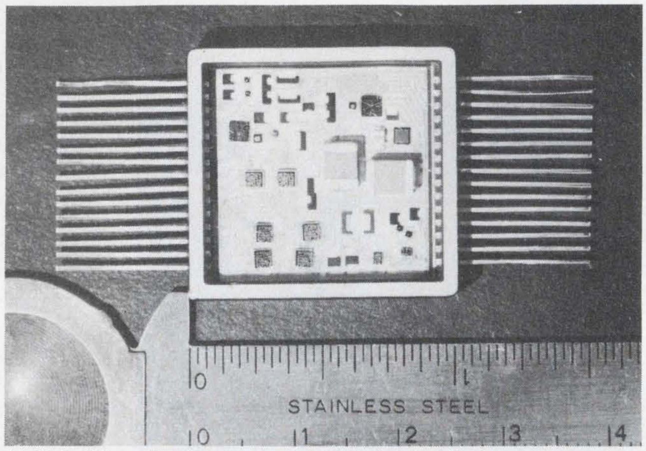
Resistors

The diffusion process associated with monolithic circuits results in resistors that are limited in value and exhibit relatively poor tolerance and temperature coefficients when compared with thin-film and trimmed thick-film resistors. They also are characterized by parasitic effects that limit their use in high-frequency and high-voltage applications. The high sheet resistivities of cermet material are particularly useful in low-power circuits requiring resistors above 100,000 ohms. To exceed this value within a monolithic circuit would require too much chip area.

Capacitors

The maximum practical value for MOS capacitors used in monolithic circuits is typically 100

Paul Schwartz, Division Manager, Integrated Circuits Div., General Instrument Corp., Hicksville, N.Y.



1. **Hybrid technology as a packaging technique** for monolithic chips is demonstrated by this one-inch-square ceramic flat pack. The circuit contains 10 monolithic chips five diode chips, four capacitors and two high-performance transistor chips.

pF. Here again, higher values are limited by the available real estate. Hybrid circuits use both MOS and multilayer ceramic chip capacitors to achieve values above 0.1 μF.

Transistor Device Parameters

The necessity for a top-side collector contact, geometry considerations and compatible materials and diffusion schedules to yield both resistors and transistors in monolithic circuits limits certain transistor parameters. In particular, the $V_{CE}SAT$ of a monolithic transistor is seldom below 200mV. Breakdown voltages exceeding 25 V are difficult to obtain, and high-frequency performance (above 200 MHz) is limited by the relatively high R_bC_c product. Power-handling capabilities are limited by available chip area, and it is not, in general, practical to integrate power transistors with small signal devices.

Device Flexibility

Perhaps the most serious limitation of monolithic ICs in high-performance circuits is the difficulty in integrating a variety of components on one silicon chip. Circuits requiring complementary transistors, zener diodes, resistors, capacitors and field-effect transistors would be difficult, if not impossible, to produce because of the large number of processing steps necessary. High-performance pnp transistors are very difficult to achieve in monolithic ICs. Hybrid technology, by definition, allows the use of all of these devices.

Typical hybrid applications

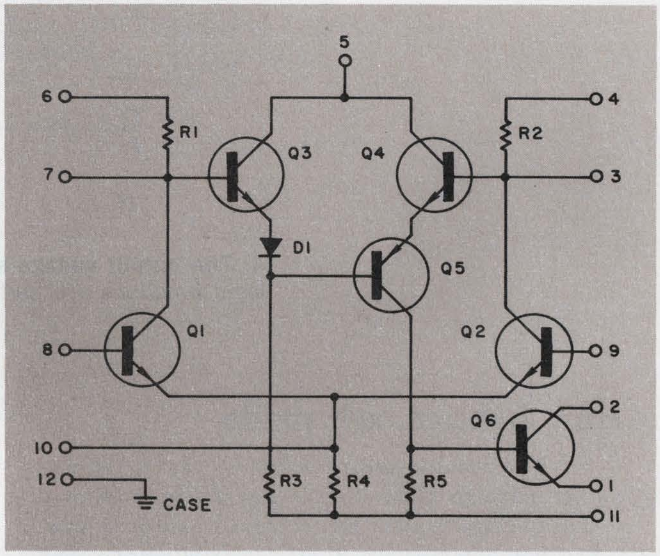
Hybrids have potential application in linear circuits, power-supply regulators, logic and interface circuits and analog switches.

In operational amplifiers, for example, hybrids offer lower input voltage and current offset than is possible with monolithics. Adjustable thick-film resistors can be used with monolithic ICs to balance out offsets. Low-input currents can be achieved in monolithic amplifiers that incorporate junction FETs. However, offset voltage must be sacrificed because adjacent FETs from the same wafer give typical offsets of 25 to 50 mV. The hybrid approach of using individually matched FETs and adjustable thick-film resistors provides the required performance.

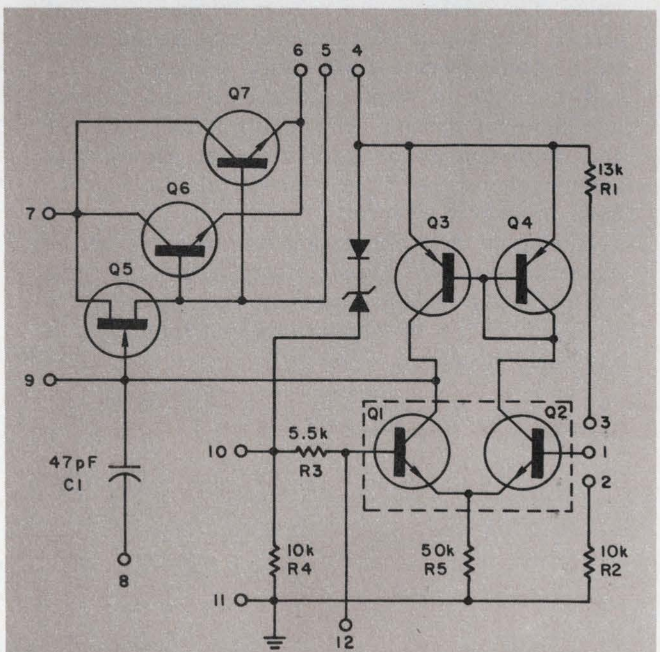
The circuit of Fig. 2 is a wideband op amp that uses complementary high frequency transistors. Proper selection of components results in a typical gain bandwidth product of over 1 GHz, with open loop gain of 50 dB at 10 MHz. The slewing rate is typically 100 V per microsecond. Slew rates of this order are difficult to achieve in monolithic circuits because of the necessity to use low-gain lateral pnp devices. Composite devices used in monolithics to provide high-gain pnp transistor action are limited in speed by the Miller effect of the associated capacitors.

In the circuit of Fig. 2, the input npn transistor pair consisting of Q_1 and Q_2 is a single chip, with dielectric isolation providing low-input voltage offset.

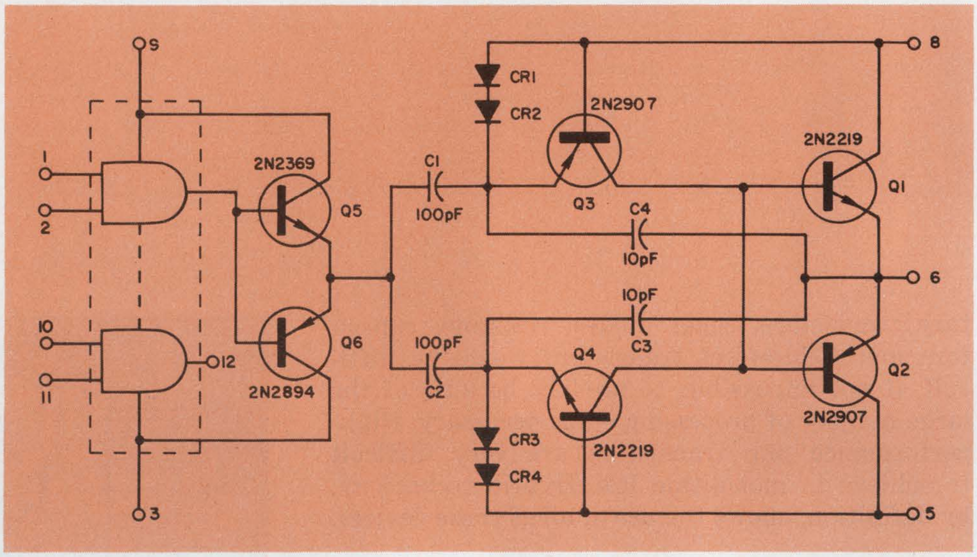
One of the first applications of hybrid techniques was in dc voltage regulators. In the last year several companies have introduced some rather impressive monolithic regulators. The question naturally arises: Why do hybrid manufacturers continue to introduce new regulators



2. **This wideband operational amplifier** has a slew rate of 100 V per microsecond, which is difficult to obtain with monolithic op amps.



3. **Resistor trimming techniques are used** to set the output voltage of this 12-V regulator. The external compensation that monolithics require is not necessary.



4. **The output voltage swing of this hybrid** clock driver circuit is above 28 V. Input logic functions are performed with a monolithic dual gate.

How hybrids are made

In the manufacture of hybrid circuits, a conductor pattern is fired onto a ceramic substrate. Cermet resistors are then screened and fired, and other components, such as semiconductors and capacitor chips, are applied by conventional microcircuit assembly techniques.

Resistors can be adjusted in value either by abrasion to increase the value or by a high-voltage pulsing technique that decreases the value. The advantage of voltage trimming is that circuit functional performance can be adjusted in the testing process after final sealing.

The range of values, tolerances and ratings available for passive components is adequate for the requirements of most circuits. Almost any semiconductor or monolithic IC device can be used in hybrid circuits.

It is true that almost any breadboard can be manufactured in hybrid form. However, the ultimate cost is dependent on the yield, and a judicious choice of components and tolerances is obviously needed.

into their product line? The answer: performance. You can build high power hybrid regulators that can't be made from monolithics.

The main advantage of hybrid regulators is that hybrid trimming techniques can be used to preset the output voltage; thus no external resistors are required. And no additional compensation elements are needed, as in monolithic regulators. Because of monolithic limitations, the hybrid versions can be operated at substantially higher output voltages and currents.

In high-power monolithic regulators, the temperature rise must be minimized to avoid drift of the control and reference circuits. The component layout of hybrid regulators can be optimized from a thermal viewpoint.

For normal operation of the hybrid voltage regulator (Fig. 3), no external components are required. Typical of hybrid regulators, this circuit is thermally and electrically more efficient than an equivalent monolithic version because of the use of parallel pass transistors Q_6 and Q_7, which have low saturation resistances. The control amplifier uses high-gain npn and pnp transistors for both high open-loop gain and minimum standby current. A junction FET supplies a constant current independent of input voltage to the reference element. The reference element is compensated to provide excellent temperature characteristics for this regulator.

In the digital world, the economics of using monolithic circuits is unquestionable. However, the system designer is faced with the problem of interfacing these devices with other equipment. Interface circuits are required between low-voltage bipolar devices and relatively high-voltage MOS devices. Hybrid circuits are successfully finding applications as voltage translators, high-speed clock drivers, lamp drivers, memory-core drivers, low-power logic circuits and a variety of other circuits.

Interfacing digital circuits

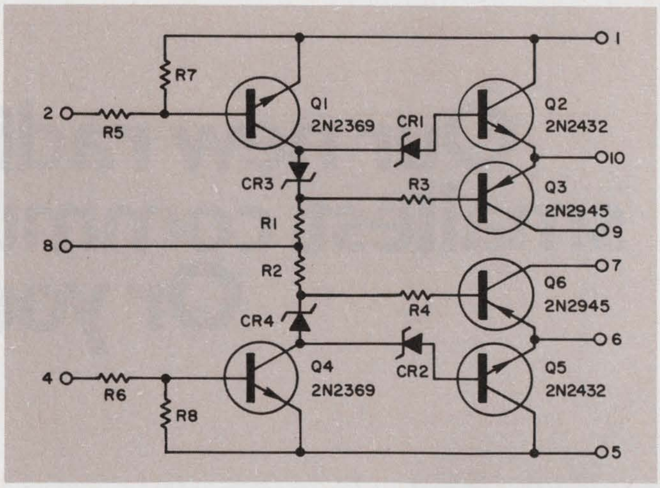
Typical of the interface circuits is the hybrid clock driver output stage shown in Fig. 4. The MOS logic that this circuit drives is equal to a 1000-pf capacitive load that must be driven at rates exceeding 5 megacycles. The use of a monolithic TTL dual gate at the input allows logic functions to be performed. AC coupling, complementary transistors and positive feedback result in a high-efficiency driver stage. The output voltage swing of the driver is above 28 V.

Circuits for both d/a and a/d converters require the performance characteristics of hybrid circuits. High-slew-rate operational amplifiers with low offsets are used in conjunction with very-high-performance analog switches and resistive networks. For high-speed d/a conversion, a parallel approach is used in which one analog switch is necessary for each bit. The response of the converter is limited by the speed of the switch, the parasitics of the resistors and the slew rate of the summing amplifier.

A series-shunt switch using bipolar devices is preferred to connect the reference voltage to the resistors. This is because the switch offsets in the ON and OFF conditions are similar and can therefore be partially compensated. In addition the source impedance at the summing-amplifier input remains constant. Figure 5 is a schematic of a dual series-shunt switch designed for a d/a converter. The hybrid circuit was assembled in a 1/4-by-3/8-inch ceramic flat package.

In this circuit a reference voltage is connected to Pin 7, and Pin 5 is grounded. The resistor network is connected to Pin 6. Standard digital logic levels of 0 to 5 V are fed into the base of Q_1 to operate the switch. Q_5 and Q_6, the actual switching transistors, are operated in the inverse mode to obtain less than 1 mV offset from either the reference or ground. For highest-speed operation, some compromise must be made between ON resistance and speed. Low ON resistance requires considerable base drive, which in turn increases the storage time of the output switches.

In the layout of this circuit it is critical that the output transistors be die-bonded with extreme care. Even though gold-backed chips are used, silicon-gold preforms are required to lower



5. **Parallel switching for each bit is required** for high-speed d/a conversion. This hybrid 2-bit switch combines both high speed with low offset voltage. The response time is limited by the speed of the switch.

the saturation resistance. The geometry and conductivity of the conductors is an important consideration in maintaining low offset.

In a straightforward d/a converter, the analog switches operate only on constant voltages. However, if the analog output is ac, the characteristics of the switch required are somewhat different. Bipolar transistor switches should not be used for ac operations because their offsets change as a function of the input-signal level. The ON resistance of a MOSFET switch varies hyperbolically with the gate-source voltage, V_{GS}. With positive input signals, V_{GS} is large and R_{ON} is small; for negative input signals, V_{GS} is small and R_{ON} large. Therefore both MOSFET and bipolar switches distort the ac signal, and system errors are introduced. ▪▪

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Our new radio. It'll solve your smallest communications problem. Or your largest.

Program your minicomputer in FOCAL.

This conversational language conserves memory and is adaptable to a wide variety of applications.

Small, general-purpose, digital computers are being used increasingly. But what about an easy-to-use computer language for machines with small core memories? FOCAL* (FOrmula CALculator) was developed to meet this need. No programming experience is necessary to understand it, and it permits a minicomputer to perform many operations formerly restricted to a remote terminal on a time-shared computer.

A high-level language for small computers should have two basic design objectives: It must operate effectively within 4000 words of core memory and it should have complete editing capability and interpretive execution. It should also have a high degree of user orientation that is compatible with engineering needs.

Commands described to save memory

It is desirable for clarity that commands (Fig. 1) be spelled out completely to avoid ambiguity. However, abbreviations are often desired for speed and economy of core-memory space, since all text is resident in core. The FOCAL compromise is to choose commands so that each has full mnemonic value, while beginning with a different letter. By ignoring extra letters, the language accepts either abbreviations or expanded forms.

Many of the user-oriented features of FOCAL come from the concepts of RAND Corp's JOSS language. One of these is the line-number, group-number structure, which allows use of a set of lines as a subroutine for repeat computations. It also is possible to execute a single line as a subroutine. These subroutines are even recursive —they permit computation involving successive approximations.

The language has a natural format and readable structure with a minimum of arbitrary formats and few cryptic character codes. Finally, the program is a left-right, top-down interpreter, which makes it easily understood. This, too, makes it adaptable to re-entrant time-sharing.

The diagnostics are flexible

FOCAL has been provided with a large set of precise error diagnostics that describe and locate programming mistakes (Fig. 2). They provide immediate and accurate indication of errors. The error diagnostic is accompanied by the line number in which the error occurs. If further debugging facilities are required, a trace feature is provided that allows the user to pinpoint his error to the offending character. A question mark in the command text causes succeeding letters to be typed until an error or another question mark is encountered.

Most important is the ability to make corrections within seconds. Recognizing that many users will not be skilled typists, the developers of FOCAL have let the user correct single and multiple character errors within a line by using the "modify" command. This is done by giving positioning information, then inserting or deleting at a given spot within a text string.

Another feature is the large number of operations and functions available, (Fig. 1). And there are input/output facilities that include real-time data acquisition and analysis, large array storage and update functions, complex scope control functions, an analog-to-digital converter control and a Calcomp plotter function.

FOCAL also has a wide numerical range and good accuracy. It normally has a seven-digit input and six-digit output with roundoff. There is also a 10-digit version. With a floating point format, there is an exponential range of 10 to the ±616 —greater than that conveniently available on nearly any other computer.

The input/output features provide a great deal of flexibility and utility in creating meaningful output. For example, a print-plot can be made on the teletype with a single interactive statement (Fig. 3):

```
FOR Y=0, 5, 15; TYPE!; FOR X=0,
FSIN (Y)+12; TYPE"*".
```

Histograms, line functions, multiple axes and non-monotonic values can be plotted. Plotting on the Teletype gives qualitative as well as quantita-

* TM Digital Equipment Corp.

Richard Merrill, Senior Programmer, Digital Equipment Corp., Maynard, Mass.

Focal Commands

Command	Abbre-viation	Example of Form	Explanation
ASK	A	ASK X, Y, Z	FOCAL types a colon for each variable; the user types a value to define each variable.
COMMENT	C	COMMENT	If a line begins with the letter C, the remainder of the line will be ignored.
CONTINUE	C	C	Dummy lines.
DO	D	DO 4.1	Execute line 4.1; return to command following DO command.
		DO 4.0 DO ALL	Execute all group 4 lines. Return to command following DO command, or when a RETURN is encountered.
ERASE	E	ERASE ERASE 2.0 ERASE 2.1 ERASE ALL	Erases the symbol table. Erases all group 2 lines. Deletes line 2.1. Deletes all user input.
FOR	F	For i=x,y,z; (commands) FOR i=x,z; (commands)	Where the command following is executed at each new value. x=initial value of i y=value added to i until i is greater than z.
GO	G	GO	Starts indirect program at lowest numbered line number.
GO?	G?	GO?	Starts at lowest numbered line number and traces entire indirect program until another? is encountered, until an error is encountered, or until completion of program.
GOTO	G	GOTO 3.4	Starts indirect program (transfers control to line 3.4) Must have argument.

IF	I	IF (X) Ln, Ln, Ln
		IF (X) Ln, Ln; (commands)
		IF (X) Ln; (commands)
			Where X is a defined identifier, a value, or an expression, followed by one to three line numbers. If X is less than zero, control is transferred to the first line number, if X is equal to zero, control is to the second line number. If X is greater than zero, control is to the third line number.

LIBRARY CALL	L C	LIBRARY CALL name	Calls stored program from the disk.
LIBRARY DELETE	L D	LIBRARY DELETE name	Removes program from the disk.
LIBRARY LIST	L L	LIBRARY LIST	Types directory of stored program names.
LIBRARY SAVE	L S	LIBRARY SAVE name	Saves program on the disk.
LINK	L	L	For disk monitor system; FOCAL types 4 locations indicating start and end of text area, end of variable list and bottom of push-down list.
LOCATIONS	L	L	For paper-tape system; types same locations as LINK.
MODIFY	M	MODIFY 1.15	Enables editing of any character on line 1.15 (see below).
QUIT	Q	QUIT	Returns control to the user.
RETURN	R	RETURN	Terminates DO subroutines, returning to the original sequence.
SET	S	SET A = 5/B*C;	Defines identifiers in the symbol table.
TYPE	T	TYPE A + B – C;	Evaluates expression and types out = and result in current output format.
		TYPE A – B, C/E;	Computes and types each expression separated by commas.
		TYPE "TEXT STRING"	Types test. May be followed by ! to generate carriage return-line feed, or # to generate carriage return.
WRITE	W	WRITE WRITE ALL WRITE 1.0 WRITE 1.1	FOCAL types out the entire indirect program. FOCAL types out all group 1 lines. FOCAL types out line 1.1.

(a)

Focal's Functions

FSQT( )	Square Root
FABS( )	Absolute Value
FSGN( )	Sign Part of the Expression
FITR( )	Integer Part of the Expression
FRAN( )	A noise Generator (.5 – .9)
FEXP( )	Natural Base to the Power
FSIN( )	Sine
FCOS( )	Cosine
FATN( )	Arctangent
FLOG( )	Naperian Log
FDIS( )	Scope Functions
FADC( )	Analog to Digital Input Function
FNEW( )	User Function
FCOM( )	Storage Function

(b)

Focal Operations and Their Symbols

Mathematical operators:

↑	Exponentiation
*	Multiplication
/	Division
+	Addition
–	Subtraction

Control Characters:

%	Output format delimiter	
!	Carriage return and line feed	
#	Carriage return	
$	Type symbol table contents	
( )	Parentheses	(mathematics)
[ ]	Square brackets	(mathematics)
< >	Angle brackets	(mathematics)
" "	Quotation marks	(text string)
? ?	Question marks	(trace feature)
*	Asterisk	(high-speed reader input)

Terminators:

SPACE key (names)
RETURN key (lines) (nonprinting)
ALT MODE key (with ASK statement)
Comma (expressions)
Semicolon (compounds and statements)

(c)

1. This is the FOCAL language, which includes commands (a), functions (b) and operations (c). With these instructions, a complete program can be written.

tive information. This is possible because one can cause the carriage to return without a line feed and can give a carriage return/line feed wherever desired.

FOCAL is handy in the laboratory

Among other I/O capabilities are some real-time interactions. Thus FOCAL can be used in the laboratory with devices controlled through an output bus by means of FOCAL functions. Where suitable FOCAL functions do not exist, the user can write his own in machine language and access them via a special FOCAL function that he sets up. This function can be used as any other. It can be imbedded within a set of computations, have any number of arguments and allow complex control functions to be performed in conversational language. The computer system is fast enough to allow interaction with devices that need servicing 10 times a second.

FOCAL is one of the first standard programs for the small computer to run asynchronously. It buffers data to and from the Teletype—a distinct advantage when running FOCAL on slower computers, because it allows data to be fed into the computer at a higher speed than the computional cycle. An enormous decrease in the response time of the program is possible and operation of the keyboard is smoother.

Focal's Error Diagnostics

Code	Meaning
?00.00	Manual start given from console.
?01.00	Interrupt from keyboard via CTRL/C.
?01.40	Illegal step or line number used.
?01.78	Group number is too large.
?01.96	Double periods found in a line number.
?01.:5	Line number is too large.
?01.;4	Group zero is an illegal line number.
?02.32	Nonexistent group referenced by 'DO'.
?02.52	Nonexistent line referenced by 'DO'.
?02.79	Storage was filled by push-down-list.
?03.05	Nonexistent line used after 'GOTO' or 'IF'.
?03.28	Illegal command used.
?04.39	Left of " = " in error in 'FOR' or 'SET'.
?04.52	Excess right terminators encountered.
?04.60	Illegal terminator in 'FOR' command.
?04.:3	Missing argument in display command.
?05.48	Bad argument to 'MODIFY'.
?06.06	Illegal use of function or number.
?06.54	Storage is filled by variables.
?07.22	Operator missing in expression or double 'E'.
?07.38	No operator used before parenthesis.
?07.:9	No argument given after function call.
?07.;6	Illegal function name or double operators.
?08.47	Parentheses do not match.
?09.11	Bad argument in 'ERASE'.
?10.:5	Storage was filled by text.
?11.35	Input buffer has overflowed.
?20.34	Logarithm of zero requested.
?23.36	Literal number is too large.
?26.99	Exponent is too large or negative.
?28.73	Division by zero requested.
?30.05	Imaginary square roots required.
?31.<7	Illegal character, unavailable command, or unavailable function used.

2. **Error diagnostics are of great help** in debugging a program, and FOCAL's diagnostics are extensive, in spite of its small core requirements.

Another advantage of the interrupt system is that it permits the ending of program loops—for example, from the keyboard, by typing "Control-C." The recovery routine will then go into reset mode, type out the message code "?01.00" and return to command mode. Manual restart via the console switches, as well as all error diagnostics, also go to the recovery routine.

Error printing is witheld until prior printing is complete. Otherwise an error message could be printed prematurely, and the result might be misleading when attempting to trace specific errors within a character string.

Data formats are varied

There are several powerful output formats: floating point, fixed point and automatic right-shifting of the decimal point if numbers are larger than the allowed integer field. Any desired format can be specified by giving the total number of digits in the field and the number of digits to be allocated initially to the decimal field. Many input formats are acceptable: leading signs, leading blanks, E format, decimal format. Any reasonable specification of an input number is accepted by the machine. The program can accept alphanumeric strings, which it promptly compresses into a single code number. Thus an interactive program may accept the answers "YES," or "NO," or "MAYBE," etc. Such responses are recognized by comparison with "numbers" that begin with the digit zero—for example: IF (REPLY - 0YES) 2.1. In this example REPLY is a variable name and 0YES is a constant.

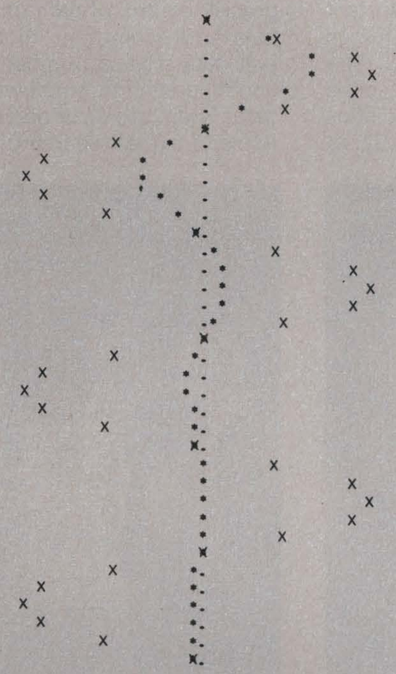
The compromise used to overcome the size limitation and still gain power is a sacrifice of speed and compatibility with other languages. The objective was to achieve maximum utility within the space allowed and still have enough user storage left to do fairly complex jobs.

User determines memory configuration

Since even the best intentioned design doesn't satisfy everyone, a good language lets the user establish the limits of the system. When FOCAL is first loaded into core from the tape on which it is supplied, it goes through an initial dialogue, which is actually an interactive FOCAL program whose variables are assessed by machine language. The dialogue requires no extra space, since it occupies the initially "blank" program tape area; it enhances user compatibility by causing changes in the structure of the program itself. In this way FOCAL asks the user whether he wishes to use certain of the extended functions, such as arctangent, logarithm and exponential. Users who do not need these can recover the unused memory space, create larger arrays or use the space as program text storage.

Size limitations place serious burdens on the core layout and on implementation of the program. However, the program is easily expandable to 8000 words. The 4000-word version accommodates a typical program of 20 lines and 40 variables, or about 1000 working cells. A dynamic allocation of resources is supplied in addition to the selection of configuration.

A user is not restricted to 20 lines, 40 variables, a fixed depth of subroutine calls or a fixed depth of nested expressions. The 1000 words of working space can be allocated to whatever purpose is required in a program: a short program with many variables or a long program with few variable assignments.



(a)

```
01.10 ASK "A1",A1,"OMEGA",W,"TO",TO,"DAMPING FACTOR",DAMPINGFACTOR
01.20 ASK "HOW MANY PERIODS DO YOU WANT TO PLOT ?",PERIOD
01.25 ASK "WHAT INCREMENT DO YOU WANT TO PLOT IN ?",INCREMENT
01.30 SET PI=3.14156
01.40 FOR T=0,INCREMENT*PI/180,PERIOD*2*PI;DO 2.0
01.50 QUIT
02.10 SET Y1=A1*FSIN(W*T-TO)
02.20 SET YD=A1*FEXP(-DAMPINGFACTOR*T)*FSIN(W*T-TO)
02.30 FOR Y=0,29;TYPE " "
02.40 TYPE ".",#
02.50 FOR Y=0,29+(Y1);TYPE " "
02.60 TYPE "X",#
02.70 FOR Y=0,29+(YD);TYPE " "
02.80 TYPE "*",!
02.90 RETURN
*GO
A1:20
OMEGA:1
TO:0
DAMPING FACTOR:.25
HOW MANY PERIODS DO YOU WANT TO PLOT ?:3
WHAT INCREMENT DO YOU WANT TO PLOT IN ?:30
```

(b)

3. **This simultaneous print-plot** of a damped and undamped sinusoid (a) results from the program (b) shown, and is a typical example of FOCAL problem-solving. By contrast, FORTRAN requires many more statements for the same results.

Punctation conserves memory

A special character can terminate a command string. Thus by using a semicolon to connect two commands, a user saves the data overhead associated with a line pointer, line number and carriage return; a semicolon saves three locations in the text buffer. This convention also fits naturally with the "FOR" command format:

FOR A = b,c,d; . . . This reads: "For the variable A, equal initially to the value of the expression b, incremented by c until A exceeds d, do the command string that follows the semicolon."

The command string can contain other commands and semicolons giving the language a powerful and easily understood iterative statement implemented in minimum core.

The IF command also was improved by the semicolon. The normal form, similar to that of FORTRAN is:

IF (expression) a, b, c; where a, b, c, are line numbers to go to if the result of the expression in parentheses is negative, zero, or positive, respectively.

The semicolon can shorten the IF command, and execution continues along the same line:

IF (exp) 1.45, 3.2; TYPE "GREATER THAN ZERO."

There is one other unique feature of FOCAL. It is possible to convert the computer operation into a desk calculator mode. Simple arithmetic calculations can be made, and the utility of the computer is enhanced for those who have no need for more elaborate programming. ■■

Test your retention

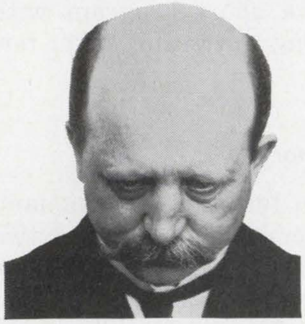
Here are questions based on the main points of this article. Their purpose is to help you make sure you have not overlooked any important ideas. You'll find the answers in the article.

1. What are the requirements for a language to be used with small computers?

2. Is asynchronous operation desirable in a conversational language?

3. Why are abbreviations desirable?

4. What is the trace feature?



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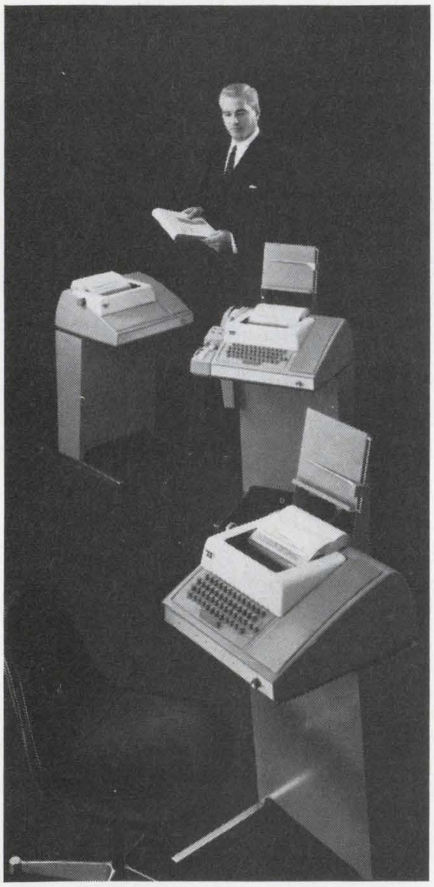
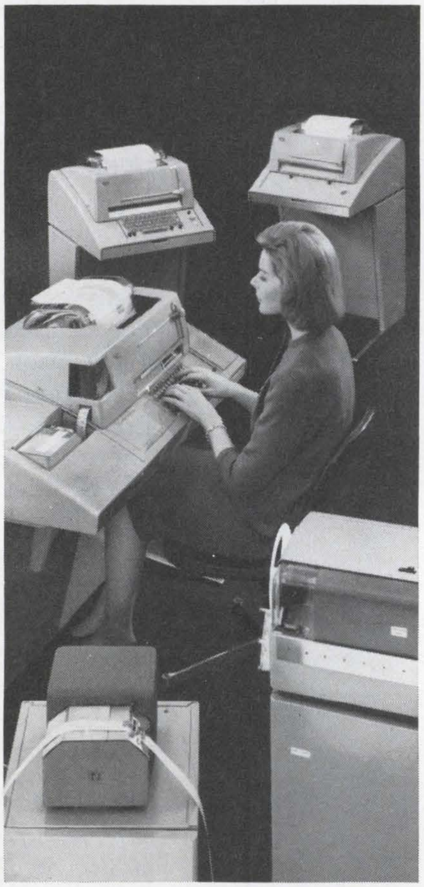


model 33 series: *An extremely economical 100 wpm terminal line. Has 4-row keyboard, uses 8-level ASCII code. The most widely used terminal in time-sharing systems today.*



model 35 series: *A rugged, heavy-duty line of 100 wpm terminals. Uses ASCII. Units in foreground are self-contained paper tape punch and paper tape reader.*

Telespeed™ equipment: *A line of high-speed tape-to-tape terminals capable of sending and receiving at speeds of 750, 1050 (shown above), or 1200 words per minute.*

keep data flowing faultlessly. Options such as pin-feed platens and form feed controls that make it possible to fill multiple copy business forms on-line. And many, many more. What did happen to the model 19? Believe it or not, there are still some of these old, diehard terminals around. And that's another advantage your data communications dollar buys when you specify Teletype equipment. It lasts. Moves data reliably, economically, for a long time. On a price/performance basis, Teletype equipment is in a class by itself.

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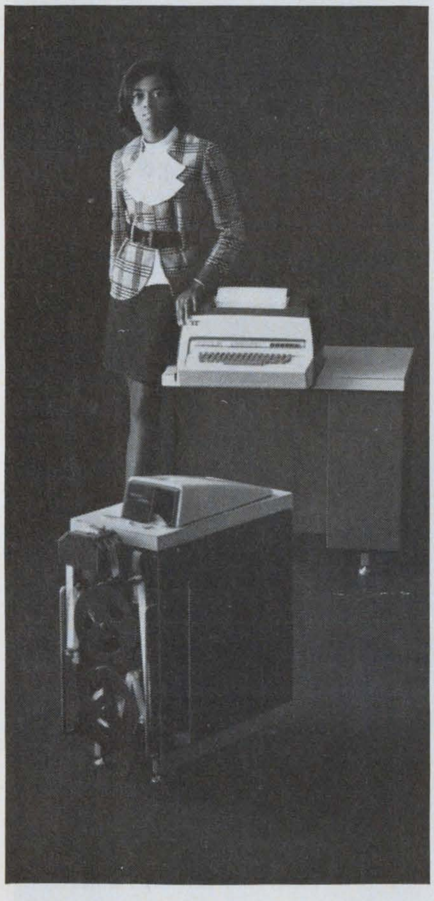
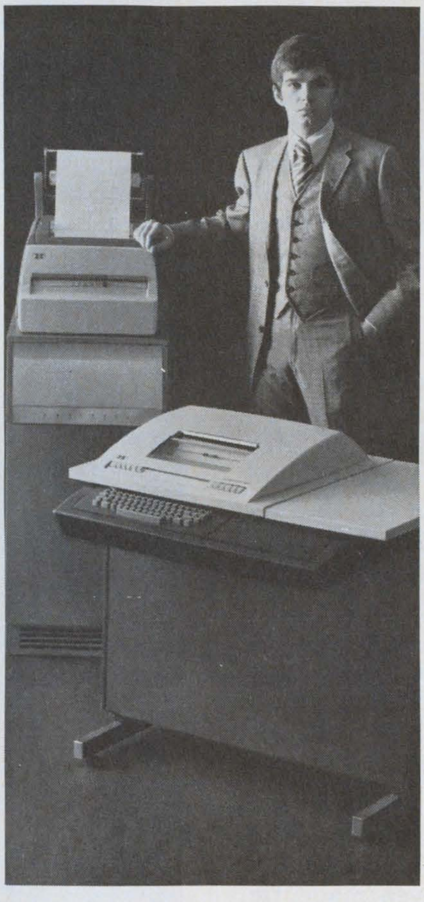


model 37 series: *One of the most versatile heavy-duty terminal lines going. Generates all 128 characters of ASCII. Operates at 150 wpm. Prints in upper and lower case.*



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machines that make data move

TELETYPE

INFORMATION RETRIEVAL NUMBER 54

Watch your specs! Get the most from instrument transformer vendors by defining performance, not design.

Engineers who specify instrument transformers can easily saddle themselves with poorly designed units, and get limited over-all system performance. Such transformers have some characteristics that exceed requirements—resulting in unnecessary cost—while other equally important parameters are degraded.

But there exists a well-tested system for defining instrument transformer requirements so that the optimum cost/performance ratio may be realized. Using this technique results in a possible 30% size reduction and 10% cost saving, with simultaneous performance improvement in such areas as common-mode rejection and reduction of microphonics.

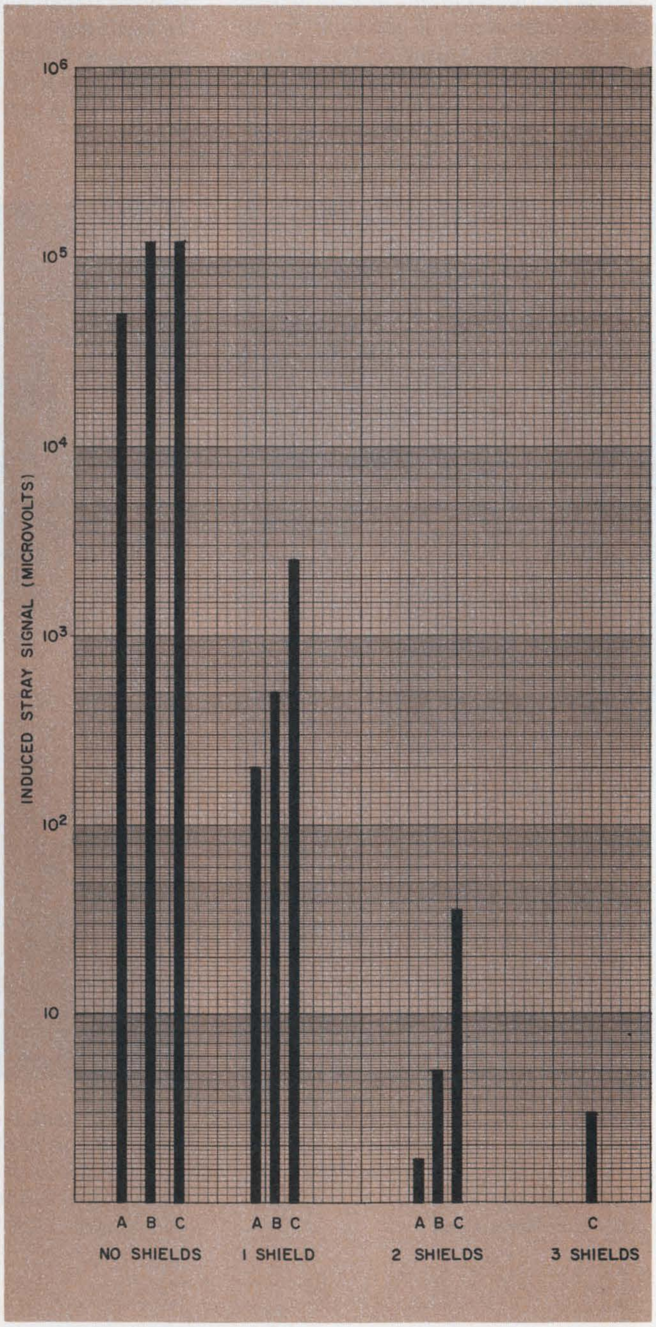
Specify results, not design

The transformer design expert cannot use his knowledge effectively unless the customer specifies desired performance rather than dictates design. Proper specifications should communicate desirable vs acceptable performance to the designer. Unnecessary customer involvement with the details of construction is a primary reason for poor cost/performance ratios.

This is illustrated by the various schemes used to define the important transformer characteristic—magnetic pickup. Many specifications call out the number of shield cans, while some go even farther and name the material (Mu-metal, high nickel, etc). Others dictate the nested shield-can attenuation in decibels. Not specified is the really significant item: the pickup in microvolts or nanovolts for a given magentic field intensity. And other factors besides shield cans may also affect the pickup level.

Stray field interference defined

External magnetic field interference is defined as the total stray voltage induced into the trans-



1. **Shields help cut stray signal pickup,** but it's not the whole solution. Superior core-coil construction makes unit A least sensitive to external fields, while unit C suffers from poor shield design.

Prepared by the Engineering Dept., Stevens-Arnold, Inc., South Boston, Mass. For further information, contact **G. M. Karon,** Project Engineer.

former by such fields. Normally, this stray voltage is referred to the transformer primary for uniformity. A proper description of transformer requirements will state the permissible level of the stray signal, together with the external magnetic field strength in which the device is expected to operate.

The following design parameters determine the stray induced signal magnitude:

- Core-coil design.
- Mechanical shielding design—drawn, fabricated, or welded.
- Number, spacing and thickness of shields.
- Shield material used and annealing quality.
- Transformer/external-field orientation.

These factors and their relative importance are shown in Fig. 1. The data is based on a magnetic field having an effective value of 5 gauss at 60 Hz and shows the induced magnetic voltage for three transformer constructions. Concurrent with the four illustrated variations in shield quantity, examples A and B have different corecoil construction with similar shielding, while B and C have identical corecoils but use different magnetic shield designs. Shield-can material is deep-drawn Mu-metal for all examples.

When two shields are used on identical core coil assemblys B and C, note that one set of shield cans is approximately five times as effective as the other in reducing magnetic influence. Also observe that core-coil assembly A with two shield cans is far superior to core-coil assembly C having three shield cans. This data demonstrates that optimum design results from accurate specification of the permissible induced voltage level and anticipated field strength.

When the exact external field strength is not known, a good estimate is 5 gauss at 60 Hz. Experience shows that this approximation holds for most electronic and laboratory equipment applications. In abnormal cases, where the external field exceeds 5 gauss, the exact value can be measured and inserted in the specification.

Vibration voltages accounted for

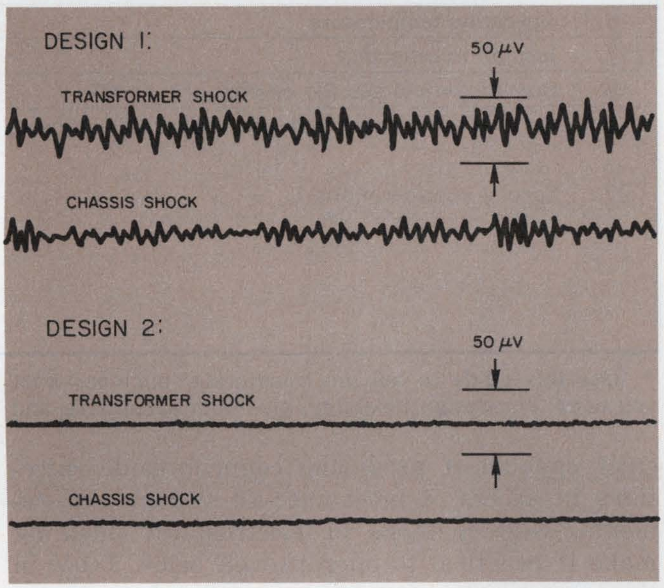
Shock and vibration generate unwanted voltages within transformers. Figure 2 gives data on two transformers that are identical except for their susceptibility to shock. If the minimum input signal level should exceed 50 μV, it would be unreasonable to spend extra for the improved unit with a 1 μV generation level.

Stray voltages caused by shock and vibration are produced both inside the transformer and along the connecting leads. Generation of this voltage is attributed to piezoelectric effects, contact potentials, mechanically varied interwinding capacitances and shielded leads vibrating in a magnetic field.

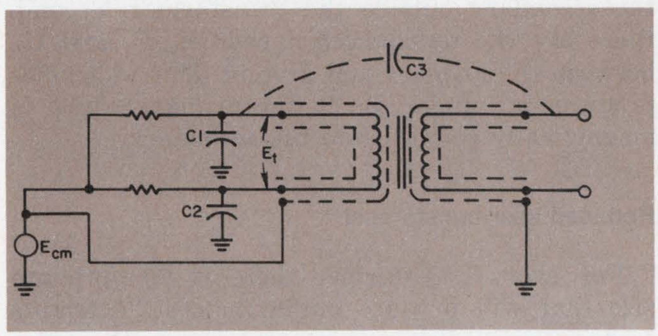
Again, as with magnetic interference, proper procedure is to specify a cause and effect relationship. A clear statement is needed regarding maximum permissible stray signal in microvolts at the anticipated level of vibration. Under nonmobile conditions, the nominal value is 1 g. For mobile or other high-shock applications, the actual vibration level must be measured and used. Shock-mounting the transformer is not recommended because any advantage gained by reduced generation inside the transformer is offset by increased generation along the connecting cable.

Common-mode rejection improved

Other unwanted voltages can develop within the transformer between a primary winding or the input and common. The transformer's ability to suppress such voltage is called common-mode rejection. The best transformer designs are pres-



2. **Shock and vibration can generate unwanted signals** inside the transformer or along the leads. Vibration voltage is a problem under severe environments or when the transformer input voltage is small and easily masked by noise.



3. **External wiring capacitance** can defeat the best shielding design. Error voltage E_t appears across the primary unless all leads are routed and terminated properly.

		Acceptable	Desirable
1.	Turns ratio		
2.	Primary inductance open circuit ______V. ______Hz		
3.	Primary resistance		
4.	Primary impedance open circuit ______V. ______Hz		
5.	Size		
6.	Maximum permissable stray signal referred to primary due to:	* * * *	* * * *
(a)	Magnetic influence 5 gauss or _____ gauss		
(b)	Maximum common mode voltage of ______ volts at ______Hz		
(c)	Shock of 1 g or ______ g's		
7.	Operating frequency		
8.	Secondary load impedance		
9.	Source impedance		
10.	Bandwidth		
11.	Cost		
12.	Input voltage range		
13.	Secondary resistance		
14.	Working voltage rms		
(a)	Coils to ground		
(b)	Coil to coil		
15.	Voltage unbalance		
16.	Operating temperature		
17.	Insulation resistance		
18.	Breakdown voltage (dc or rms ______Hz)		
19.	General application: (lab use, industrial, airborne, mobil, etc.)		
20.	Special considerations:		

4. **Use this guide** to tell the transformer engineer what you need. For design flexibility, give both acceptable and desirable values for all items. Be sure to include any special considerations.

ently capable of producing common-mode rejections in excess of most over-all system requirements. New methods of electrostatic shielding make it practical to operate well below 1 μV in the presence of 500 V common-mode voltages when proper attention is given to lead terminations and their location.

Figure 3 shows how transformer shielding can be defeated by external causes. First, there is capacity C_s that couples the primary winding to the secondary outside the transformer. Second, there are the unbalanced capacities, C_1 and C_2, between the primary and ground. This unbalance produces a voltage, E_t, in the primary which is magnetically coupled into the secondary.

Reduced size boosts cost

For every transformer there is an optimum size that will produce minimum cost. Attempts to reduce size below this point boosts the price very rapidly. Since cost is important to most projects, it is important to specify maximum acceptable transformer dimensions. The designer will then have the most favorable opportunity to provide economy.

Describe your application

When potential usage is given as one of the design parameters, it guides the transformer designer in arriving at lowest over-all cost. When only a few pieces are required, the most economical approach is to select a unit that has already been constructed but may be overbuilt in some respects. On the other hand, if a large number of transformers is required, making exactly what is needed can well justify custom design.

All the preceding remarks are tied together on the convenient check list in Fig. 4. Note that it is set up in terms of results rather than design. Transmitting customer requirements in this form allows the transformer expert to produce the best performance balance. This concept pays generous dividends to component engineers and system designers, who are responsible for total system operation. ■■

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1. True 0.1% DC accuracy. Virtually no kickback current*. Allows voltage measurements in high resistance circuits at stated accuracy.
2. High AC accuracy with nearly perfect AC linearity and 10 megohm input resistance.
3. Low profile design in shielded case with modular construction for ease in use and maintenance.

*There is virtually no internally generated current from the V-O-M input circuit to affect measuring accuracy. (Patent pending on this feature).

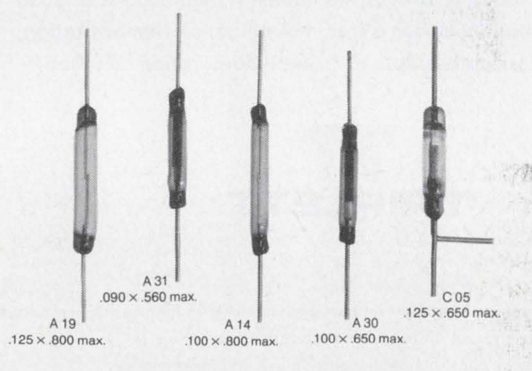
INFORMATION RETRIEVAL NUMBER 55

If you're reed-switching 5-10 V, 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 56

☐ OPERATING LIFE OF 10 YEARS ☐ PROVIDES 107 CFM AT FREE DELIVERY ☐ LOWEST NOISE LEVEL OF ANY 100 CFM FAN ☐ COMPACT-JUST 1½" DEEP ☐ IMPEDANCE PROTECTED ☐ U.L. YELLOW CARD RECOGNITION ☐ AVAILABLE FROM STOCK.

Compare it!
Install it!
Forget it!

The Rotron MUFFIN® FAN

® ROTRON INCORPORATED

Need price, delivery or other information? Call 914-679-2401 for immediate service, or write Rotron Incorporated, Woodstock, N.Y. 12498

Contracts aren't won by accident!

They are captured by outlines that are planned to win, says this proposal manager.

If your contract proposals are falling flat on their typeface, compare a recent loser with its outline. If they don't match up, you're probably committing marketing suicide. For the proposal that wins is the one that has been planned to win.

To improve our company's proposal approach, we decided to produce an outline that would integrate capture strategy, specification and technical proposal requirements (TPR) into a coherent presentation that would include personnel assignments, topic coverage, and estimated number of text pages and illustrations in the published edition.

Specifically, this outline had to:

1. Establish the minimum contents to be responsive to the request for proposals (RFP).
2. Add to the minimum requirements those additional factors needed to effectively present the capture strategy.
3. Organize the proposal contents so that the precise objectives of the engineering design phase could be clearly established.
4. Direct and implement the activities of the proposal team and indicate assignments, schedules and work to be accomplished.
5. Serve as the vehicle for keeping the plan up to date.

The medium was the message

We recognized that planning had to be a continuing process throughout the proposal preparation period, and up dating the outline was the best means for keeping everyone informed of changes and their impact on the plan.

What, then, were the ingredients that made the outline acceptable as a dynamic over-all proposal plan? We designed one that consisted of four different elements, including the operations schedule; form of the proposal outline; the assignment summary; and the schedule summary.

The proposal manager first used the operations schedule (Fig. 1) to assign initial start and finish dates and major milestones to each phase.

As partially shown in Fig. 2, the form of the outline indicated the contents and organization of the proposal, writing assignments, estimated number of text and illustration pages for each assignment, and due dates for submittal of manuscript and artwork sketches to the proposal editor.

So that everyone understood his responsibility in the over-all plan, an assignment summary (Fig. 3) was prepared for each person to show in proposal paragraph number order his specific assignments.

Similarly, the schedule summary (Fig. 4) was listed, in due-date order, when each person's assignments were to be turned in. With these two summaries in hand, each proposal team member knew exactly what his assigned talks were and when they were due.

Preparing the proposal outline

By analysis of these summaries, problem areas could be spotted before trouble arose. The summaries also enabled the publications department to plot the day-to-day flow of text and illustrations, permitting it to project its manpower requirements more realistically.

Determining the exact contents of the proposal and organizing an effective content outline requires several steps, each tied to a major event in the planning and engineering design phase. In our outline, only section titles and major paragraph headings were identified; assignments only considered the first wave of personnel allotted to the effort; page quantity estimated and due dates roughly established.

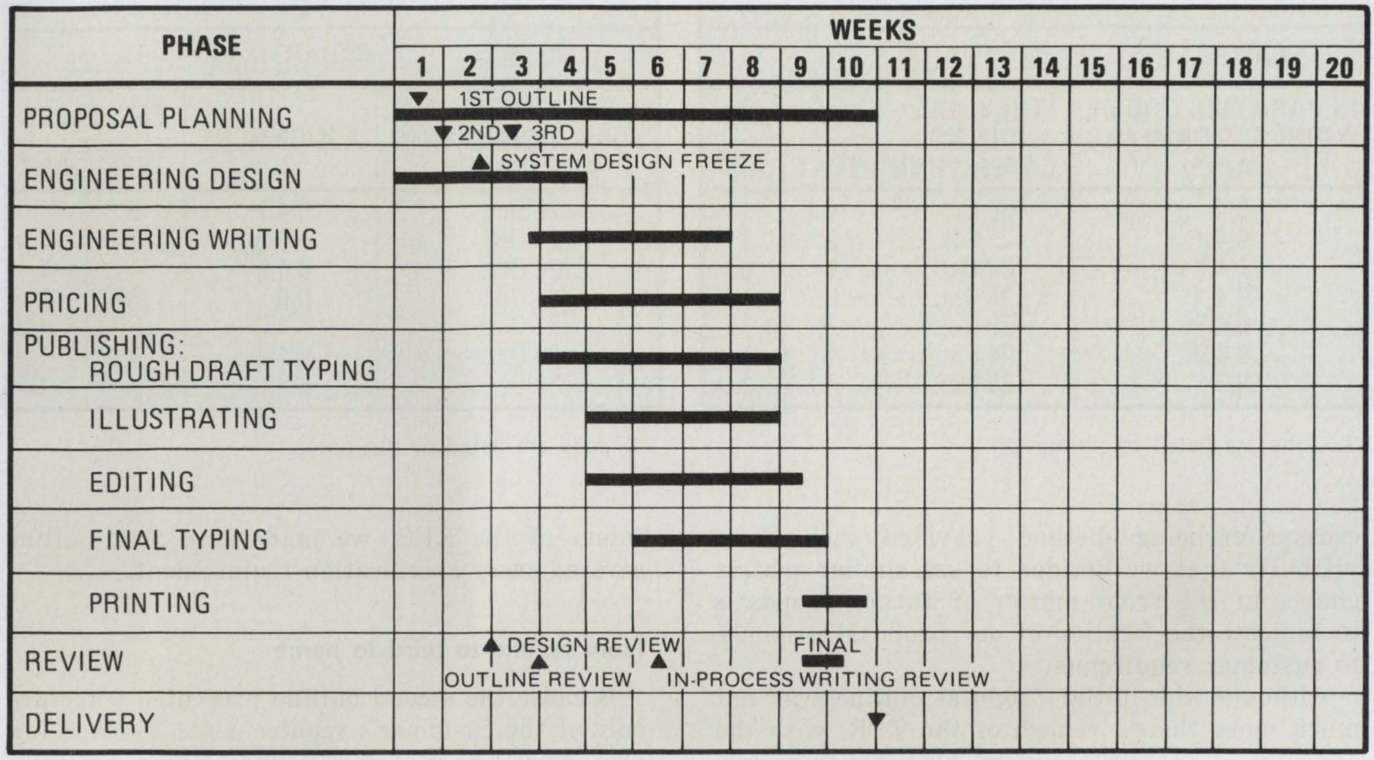
Though certainly far from being a polished program plan, the first issue of the outline served to get up a head of steam.

One effective technique used to determine the contents of the proposal was to make a survey of the hardware specifications and TPR (technical proposal requirements) by first outlining them and indenting secondary topics under major headings.

A point of caution about TPR's: Of any part

Charles E. Anderson, Manager, Proposals Dept., Reflectone, Inc., Stamford, Conn.

PROPOSAL OPERATIONS SCHEDULE



1. **Dual-purpose schedule** is used to assign due-dates and to track phases.

of a request for proposals, the TPR is usually the most vaguely written. It, therefore, requires an extremely careful analysis to determine its explicit and implicit requirements.

Outlining the specification in an indented format furnished an over-all view of hardware requirements and enabled an easy transition when converting them into proposal outline topics.

After the first outline was issued, and while the engineering staff sweated over developing a design approach, the proposal editor studied all parts of the RFP before preparing the second issue of the outline. The objective of the second outline was to marry the TPR and the specification, and to put into the perspective of an integated outline the total requirements of the RFP.

To assist in this TPR/specification integration task, we prepared a set of matrix charts. The first matrix plotted the TPR to the proposal outline (see example: Fig. 5); the second plotted the TPR to the specification; and the third plotted the specification to the proposal outline. This

Proposal Outline, Issue No. 3, 9 October 1969, Page 6 of 9

CONTENTS	ASSIGNED TO	EST. PAGES		DATE DUE
		TEXT	ART	
SECTION 6 DESCRIPTION OF FUNCTIONAL SYSTEMS				
6.1 Section Summary	F. Thomas	1	0	31 Oct.
6.2 Review of Functional Requirements of Spec.	F. Thomas	2	0	20 Oct.
6.3 Allocation of Functions and Description of Overall Systems Approach	B. Forrest	2	1	21 Oct.
6.4 Description of Computer System Functions	C. Hartmann	4	1	30 Oct.
6.4.1 General Functional Description	C. Hartmann	2	1	22 Oct.
6.4.2 Computer Requirements	C. Hartmann	1	0	23 Oct.
6.4.3 Computer Selection and Rationale	L. Materson	3	0	24 Oct.
6.4.4 Input/Output Requirements	K. Royal	2	1	24 Oct.
6.4.5 I/O Devices: Selection/Rationale	K. Royal	2	0	27 Oct.
6.4.6 Programming	L. Materson	10	4	27 Oct.
6.4.7 Method of Modifying Emitters	C. Hartmann	3	1	28 Oct.
6.4.8 Method of Modifying Aircraft Parameters	C. Hartmann	2	1	29 Oct.
6.4.9 Features Not Dependent on Digital Computation, Justification for and Description of Proposed Method of Obtaining Required Effect	C. Hartmann	4	1	24 Oct.
6.5 Description of Emitter Generation System	C. Hartmann	5	2	25 Oct.
6.6 Description of Antenna Simulation System	K. Royal	4	1	23 Oct.

2. **This outline format is designed** to highlight proposal content and organization.

ASSIGNMENT SUMMARY FOR PROPOSAL			
NAME: C. HARTMANN			
IN PARA. NO. ORDER, YOUR ASSIGNMENTS ARE:	THEY ARE DUE NO LATER THAN	EST. PAGES	
		TEXT	ART
6.4	30 Oct.	4	1
6.4.1	22 Oct.	2	1
6.4.2	23 Oct.	1	0
6.4.7	28 Oct.	3	1
6.4.8	29 Oct.	2	1
6.4.9	24 Oct.	4	1
6.5	25 Oct.	5	2

3. **Jobs are listed** by paragraph.

ASSIGNMENT SUMMARY FOR PROPOSAL			
NAME: C. HARTMANN			
IN DUE DATE ORDER, YOUR ASSIGNMENTS ARE DUE ON	ASSIGNMENT	EST. PAGES	
		TEXT	ART
22 Oct.	6.4.1	2	1
23 Oct.	6.4.2	1	0
24 Oct.	6.4.9	4	1
25 Oct.	6.5	5	2
28 Oct.	6.4.7	3	1
29 Oct.	6.4.8	2	1
30 Oct.	6.4	4	1

4. **Jobs are listed** by due-date.

cross-referencing method provided such great visibility that we decided to use similar matrix charts in the front matter of future proposals to indicate the location of our proposal response to customer requirements.

Although the initial proposal outline was not much more than a rehash of the TPR, with the addition of certain standard proposal elements, the first matrix chart (the TPR-to-proposal outline chart) served to verify that all TPR items did, in fact, find a home in the proposal outline. It also helped show where TPR requirements were redundant or unclear.

The function of the specification-to-TPR matrix was to determine the relationship of a single TPR requirement to a variety of specification requirements and vice versa. When completed, this matrix indicated what portions of the specification the customer emphasized and which areas seemingly did not require a proposal response.

Since good proposal practice is to at least touch on each specification requirement, regardless of TPR limitations, to ensure responsiveness to the intent of the RFP, we made sure that outline covered every specification requirement.

From second to third to home

Because the second outline presented a picture only of the customer's requirements, further improvement was needed to include all our planning factors.

It was the third outline that really began to shape the proposal. It was prepared after the over-all diagram of the system and a general picture of the over-all physical configuration of the hardware were firm. After this third outline edition was accepted by the proposal manager, the chief systems engineer and the proposal editor, it was validated by using a new set of matrix charts and then presented to the proposal review committee for approval.

The next step was to update the assignments, due dates and page estimates, and to revamp the operations schedule and the assignment and schedule summaries. Each individual's assignments and schedules were carefully examined, using the summaries, and an analysis was made of the activities vs time remaining.

Tradeoffs in scheduling vs resources were now accomplished. For example, the number of pages and the time involved to describe a unique approach to a major technical problem had to be increased significantly; therefore, the impact on the publishing and review phases had to be measured and resolved.

Now that our plan was complete we were ready to build our winning proposal from this foundation. In vying for contract awards, it's best to remember that, in this day of complex technology, *how* something is said is often just as important as *what* is being said. So if you want the brilliance of your engineering approach to glitter when you submit your proposal, plan it that way with your technical proposal outline. ■■

CROSS-REFERENCE MATRIX
TPR TO PROPOSAL
(Management Volume)

TECHNICAL PROPOSAL REQUIREMENTS

PROPOSAL PARA.	a.	b. (1) (a)	b. (1) (b)	b. (1) (c)	b. (1) (d)	b. (1) (e)	b. (1) (f)	b. (1) (g)		c. (1) (a)	c. (1) (b)	c. (1) (c)	c. (1) (d)	c. (1) (e)	c. (1) (f)	
Abstract																
Foreword																
Section 1																
Section 2																
2.1								•								
2.2								•		•						
2.2.1										•						
2.2.2								•		•						
2.2.3										•						
2.2.4										•						
2.3								•		•						

5. **It re-checks** the requirements.

INFORMATION RETRIEVAL NUMBER 58 ►

- Five full digits plus "1" for 20% overranging
- Basic unit measures 0 to 1100 volts dc in three ranges
- Auto ranging and polarity with active 3-pole switchable filter
- 25 millisecond sampling speed
- Full systems capability with timing signals and ready indicator
- Low cost options include ac voltage, millivolt-ohms, external reference (ratio) and fully isolated remote programming and data output.

The first really new DVM in a decade

Announcing the Fluke 8300A, a 0.005% digital voltmeter with full systems capability for $1395

There are a lot of good DVM's around. All but one share a common set of faults—overwhelming complexity and high cost. And as you might guess, the DVM that beats the others cold is the new Fluke 8300A.

Why?

Because Fluke uses a new A to D technique which reduces componentry by up to 500 percent. Obviously, when components are eliminated, good things happen. Power requirements go down, reliability goes up, circuitry is simplified, troubleshooting is speeded and reduced. Most important to the system designer, lowered costs mean we can invest some of the savings in features you need in a DVM.

With all its features and accuracy, the Fluke 5-digit DVM sells for less than many 4-digit units. We price the options low, too. A fully loaded Fluke 8300A sells for $3095. Comparable but not equal competitive instruments cost as much as $5000.

And when the Fluke names goes on the front you know you're getting quality instrumentation... in keeping with the Fluke philosophy of bringing you standards lab performance in portable instrumentation.

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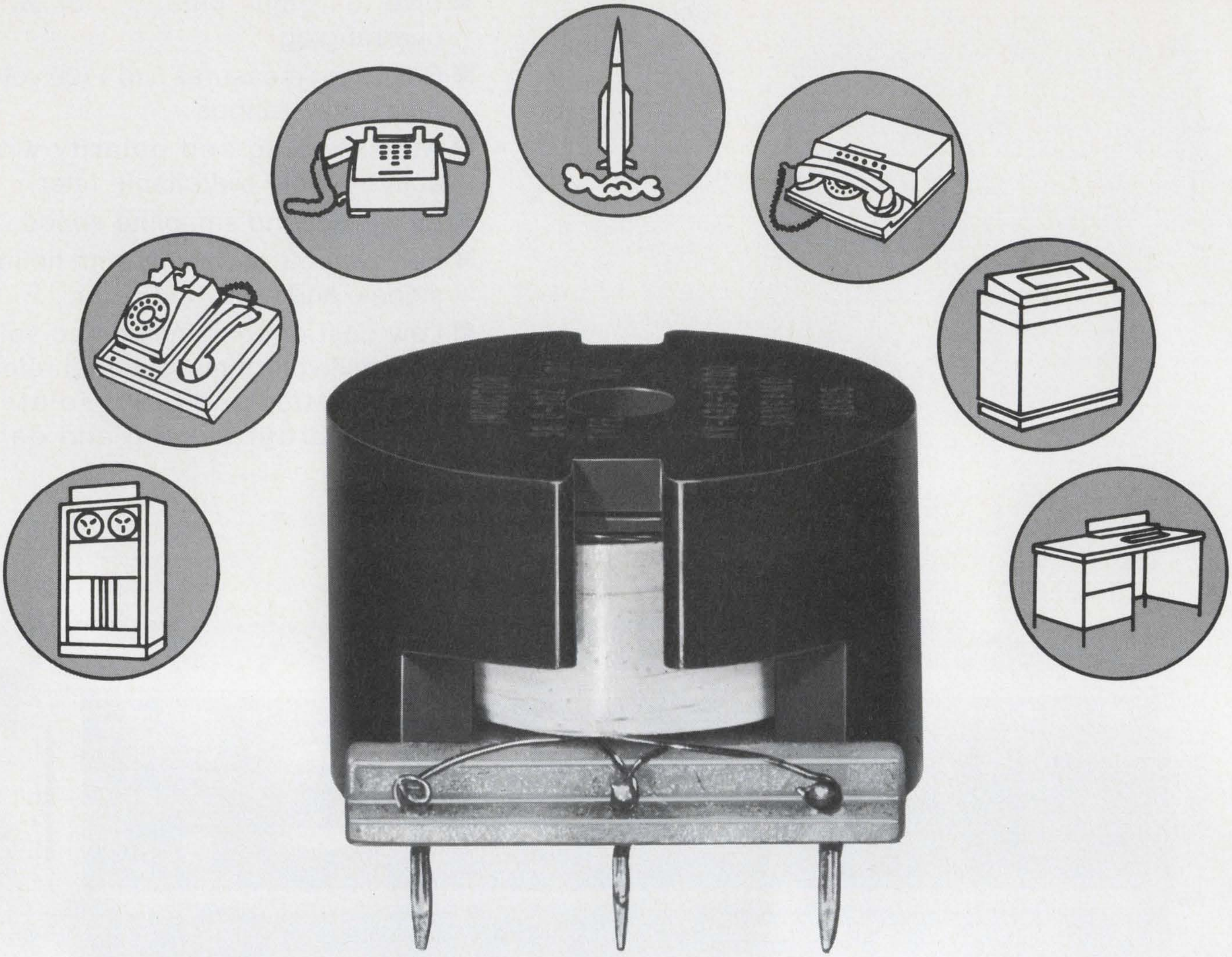
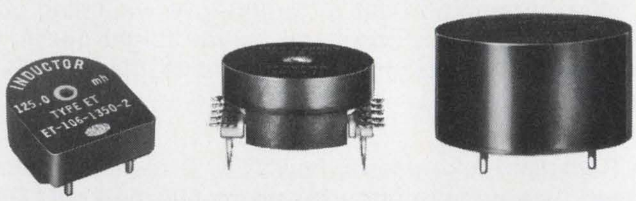
Fluke, Box 7428, Seattle, Washington 98133. Phone: (206) 774-2211. TWX: 910-449-2850. In Europe, address Fluke Nederland (N.V.), P.O. Box 5053, Tilburg, Holland. Phone: (04250) 70130. Telex: 884-50237. In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2 4TT. Phone: Watford, 27769. Telex: 934583.



From custom designs to volume delivery... Sangamo's precision line of communications grade inductor/transformers.

We've been designing and manufacturing communications grade inductor/transformers for years to the most rigid specifications in the data communication industry—*ours*. That's why we guarantee the high quality and reliability of our inductor/transformers. Custom designs are no problem for Sangamo's fully equipped and computerized lab. And our automated facilities make it possible to supply you with as many as you need, military or telephone grade, with the same high reliability. At a reasonable price, too. Sangamo inductors and transformers feature plug-in mountings, high Q and are available in a frequency range of 200 Hz to 500 kHz. For more information, write:



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T7022

INFORMATION RETRIEVAL NUMBER 59

The hybrid circuit: if you don't like what we make, we'll make what you like.

We're not proud.

We've designed many different standard hybrid microelectronic modules in what we think is the optimum package type for each one.

But, if they don't suit your system, we'll gladly change the package or the circuit to suit your needs.

Our off-the-shelf line spans the spectrum from digital to video. It includes a video amplifier, memory and clock drivers and translators, gated high-power drivers and a 30-MHz IF amplifier.

All of them are our own design and if they meet your needs, we are both ahead of the game.

If they don't, that's where our experience and advanced hybrid techniques come into play. We can translate your design into a hybrid microelectronic module quickly, easily, *and* economically, because we don't have to waste time getting familiar with the problems.

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That way we'll have a circuit we both like.

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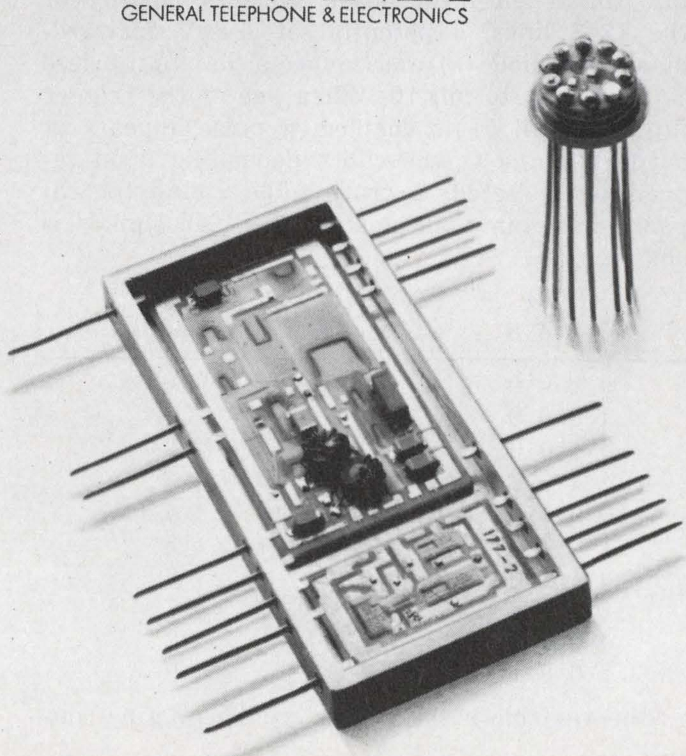


Improved digital converter offers speed and simplicity

In data processing it is often necessary to convert binary-coded decimal (BCD) signals into a train of serial pulses. This design offers advantages over conventional techniques in terms of simplicity and speed of operation.

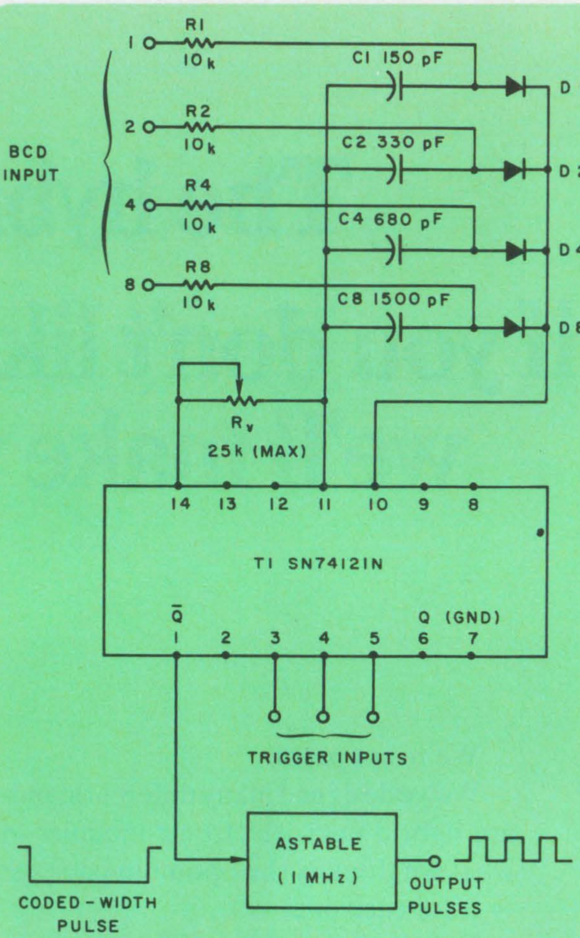
The timing circuit controls the output pulse duration from a TTL monostable by using four timing capacitors to provide nine different capacitor combinations. The resulting coded-width output pulse controls an astable circuit. The astable produces serial pulses, which correspond numerically to the BCD input signal.

Connection of the timing circuit for normal operation is shown in the figure. The values of resistance (between pins 11 and 14) and capacitance (between pins 10 and 11) set the duration of the pulse appearing at outputs Q (pin 6 positive) and $\overline{Q}$ (pin 1 negative). In the quiescent state, the dc voltage at pin 10 is +4.5 V with respect to ground (pin 7), while the dc voltage at pin 11 is +0.8 V with respect to ground. The output pulse is available only when one of the three trigger inputs (pins 3, 4, 5) receives an enable pulse.

In the absence of any BCD signals (in this case the code is 1248) the potential of the 1248 lines is zero and the four diodes are reverse biased, isolating capacitors C_1, C_2, C_4 and C_8 from pin 10. When information appears on any of the 1248 lines, a potential of +5 V forward-biases the diode(s) and connects the appropriate capacitor(s) to pin 10. When one of the trigger inputs (3, 4, 5) is enabled, a pulse appears at outputs Q and $\overline{Q}$, the width depending upon capacitance selected. A truth table giving the capacitor combinations against the 1248 signals is shown.

BCD 1 2 4 8	Capacitors selected	Number of pulses
0 0 0 0	0	0
1 0 0 0	C_1	1
0 1 0 0	C_2	2
1 1 0 0	$C_1 + C_2$	3
0 0 1 0	C_4	4
1 0 1 0	$C_1 + C_4$	5
0 1 1 0	$C_2 + C_4$	6
1 1 1 0	$C_1 + C_2 + C_4$	7
0 0 0 1	C_8	8
1 0 0 1	$C_1 + C_8$	9

The variable resistor, R_V, provides a fine control for final adjustment of the output pulse length. The component values shown produce pulse widths in the 0.5-9-μs range and control the 1-MHz astable circuit.



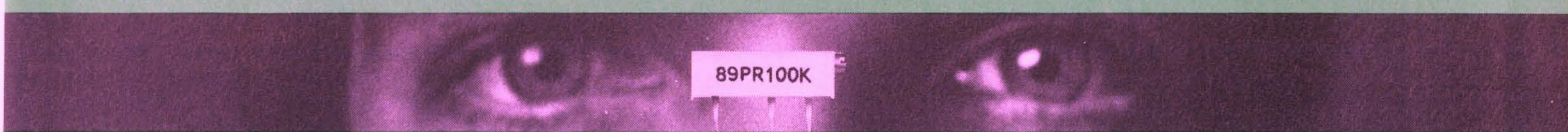
BCD input signals select the capacitance across pins 10 and 11 on the monostable by forward-biasing the diodes. This capacitance, together with trimmer R_V, provides coded-width pulse timing. The 1-MHz astable generates output pulses numerically proportional to the coded-width pulse input.

Where this coded monostable is used as a converter in large digital systems, a considerable reduction in components and in complexity over conventional conversion techniques is achieved. Astable speeds from 10 Hz to 10 MHz and monostable pulse widths from 100 ns to 1 second are possible. Input codes other than 1248 can be decoded and serialized.

P. B. Roberts, Electronics Group, Radiological Protection Service, Dept. of Health & Social Security & Medical Research Council, Belmont, Sutton, Surrey, England.

VOTE FOR 311

Helipot Trims Price & Profile



The new Helipot Series 89 industrial cermet trimmers feature:

Low Cost:

$1.35 each in 1-9 quantities; less than $1.00 in quantities over 1,000.

Low Profile:

Maximum height of .250 inches allows for closer p-c board stacking.

Series 89 trimmers with two different pin spacings are available "off-the-shelf" from 17 locations across the country.

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FULLERTON, CALIFORNIA

INTERNATIONAL SUBSIDIARIES: AMSTERDAM; CAPE TOWN; GENEVA; GLENROTHES, SCOTLAND; LONDON; MEXICO CITY; MUNICH; PARIS; STOCKHOLM; TOKYO; VIENNA.

Transformerless converter yields plus/minus voltages

Using both positive and negative power supplies often simplifies circuit design, but unfortunately it complicates the power-supply problem. In mobile equipment, it is usually impossible to fit another battery into the package. These circuits will serve as a voltage multiplier or as a symmetrical supply.

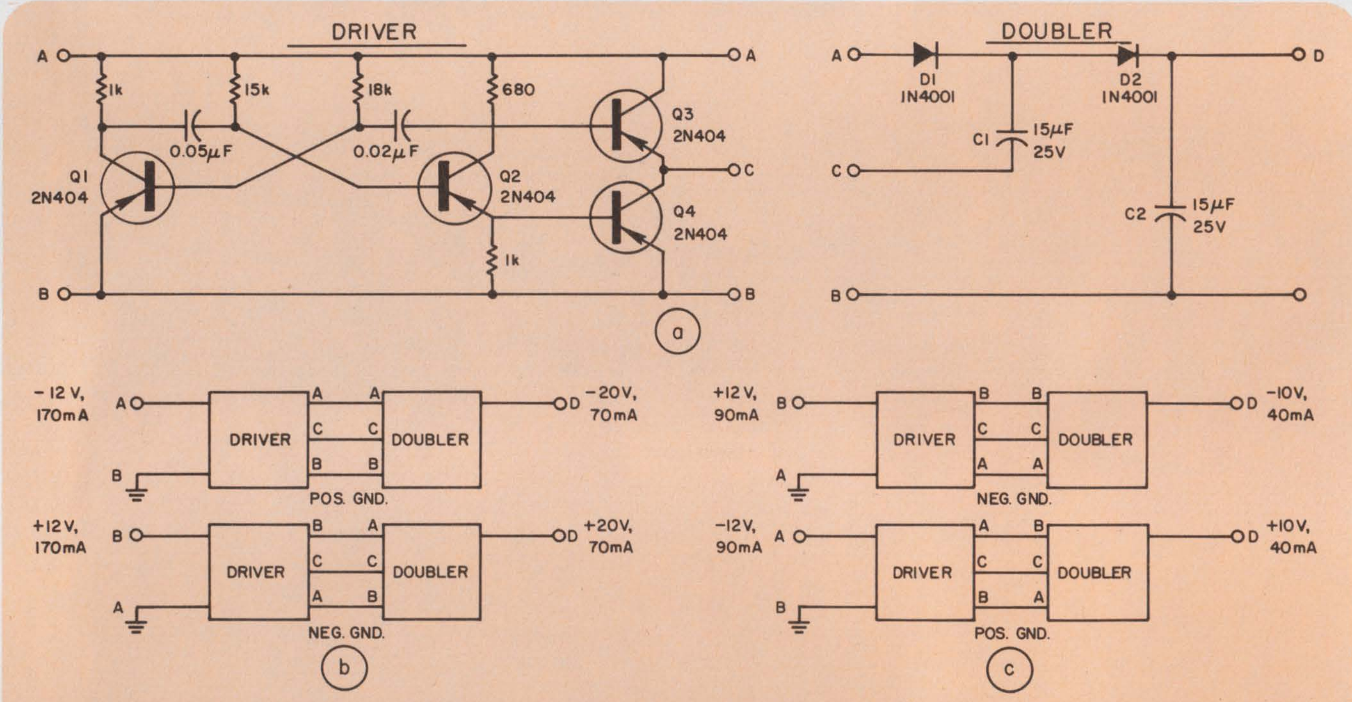
As a multiplier, the circuits will deliver 20 V at 70 mA from a 12-V 170-mA source. As a symmetrical supply, they will deliver minus 10 V at 40 mA from a plus 12-V 90-mA source.

In operation, C_1 and C_2 charge to the supply voltage through diodes D_1 and D_2. The multivibrator (Q_1 and Q_2) switches Q_3 on and Q_4 off, bringing the bottom end of D_1 to the supply voltage. This reverse biases D_1 and dumps the charge across C_1 through D_2 and into C_2, bringing the charge on C_2 to twice the supply voltage. This action is repeated at multivibrator repetition rate.

The unit can be made to operate from positive or negative grounds by simply reversing the polarity of the diodes and capacitors and reconnecting the doubler as shown in the diagram. By adding power transistors in a Darlington configuration to the output transistors, Q_3 and Q_4, the current capabilities can be increased to several amperes, enough for most 24-V mobile equipment.

Ray Kauffman, President, Electronics Engineering Group, Seabrook, Md.

VOTE FOR 312



Basic transformerless converter and doubler (a) can be connected for either ±20 V output (b) ±10 V output (c).

Inexpensive Schmitt trigger operates above 100 MHz

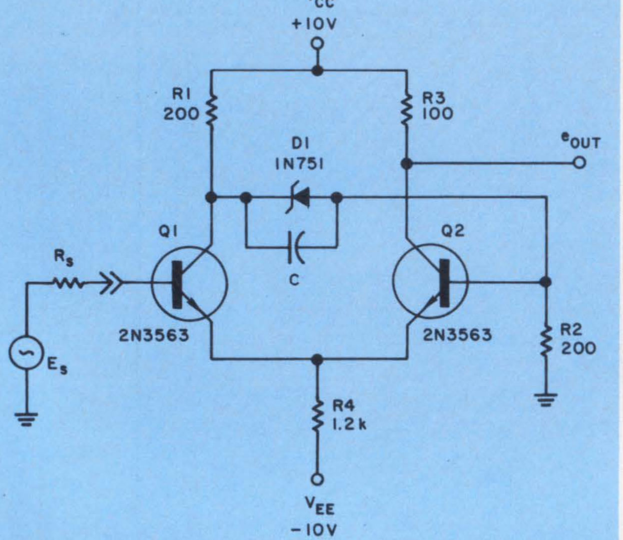
The low-cost Schmitt circuit is capable of switching speeds in excess of 100 MHz. Hysteresis at 100 MHz is about 1 V, which provides excellent noise immunity and "snap." Output risetime is 2 ns or less.

Standard collector-coupled Schmitt circuits use a resistor of several kilohms as the regenerative coupling element between collector and base. For high-speed circuits, coupling resistors of several hundred ohms must be used to minimize the effect of collector and base capacitances.

Ideally, the feedback element should have zero impedance to take full advantage of the regenerative current switched between the transistors.

To understand circuit operation, consider that initially $V_{in} = 0$ V, Q_1 is off and Q_2 is on, con-


Miniature price tags.



High-speed, low-cost Schmitt trigger may be further impoved by adding a small choke to collectors of both transistors.

ducting 10 mA. When V_{in} goes above Q_2's base voltage, regeneration takes place. Q_1 starts to turn on, and the Q_1 collector voltage drops. The Q_2 base voltage also drops because of the zener-diode coupling. This tends to cut off Q_2, turning Q_1 on harder, and further dropping Q_1's collector voltage. Regeneration continues until Q_2 is off and Q_1 is on.

The base of Q_2 is now 1 V below its previous value. The Schmitt will not switch back until the input voltage goes below the new Q_2 base voltage, when regeneration again takes place. Q_1 and Q_2 switch approximately the same current as long as the hysteresis is small compared to V_{EE}.

Feedback element D_1 is a 5-V zener diode that provides a low impedance feedback path and good temperature stability. D_1 is never switched off, and therefore its impedance remains relatively constant, regardless of the circuit's state. Capacitor C provides a low impedance path during switching, thus enhancing circuit speed. The capacitor's value is not critical, but a glass or ceramic unit of good quality should be used.

For $V_{EE} = -10$ V and $V_{CC} = +10$ V the initial voltage at Q_2 base is

$$(V_{CC} - V_{D1})\,[R_2/(R_1+R_2)] = +2.5\text{ V}.$$

For a bias current of 10 mA,

$$R_4 = \frac{2.5 - (V_{BE2} - V_{EE})}{10\text{ mA}} = 1.2\text{ k}.$$

Hysteresis is the product of the Q_2 emitter current and the impedance looking into the base, which is

$$R_2 || (R_1 + Z_{D1}) \approx R_2 || R_1 = 100\text{ ohms}.$$

Hysteresis is therefore (10 mA) (100 ohms) = 1 V. In the quiescent state, Q_2 is conducting 10 mA, with 12.5 mA flowing through R_1, D_1 and R_2. When Q_1 and Q_2 switch, Q_1 draws 10 mA, Q_2 is off, and 7.5 mA flow through D_1 and R_2. This current maintains good zener regulation and low zener impedance ($\approx$30 ohms).

The circuit configuration will work for negative input waveforms by replacing Q_1 and Q_2 with pnp transistors and reversing the polarity of D_1. The same thing may be accomplished by returning the base of Q_2 to V_{EE} through an appropriate resistor to give the base of Q_2 a negative bias.

Speed may be improved by adding a small choke in the collectors of Q_1 and Q_2. With this addition, the circuit will operate at speeds from dc to greater than 140 MHz. Cost of the circuit is under $2.

Stephen Kreinik, Senior Electrical Engineer, CBS Laboratories, Stamford, Conn.

VOTE FOR 313

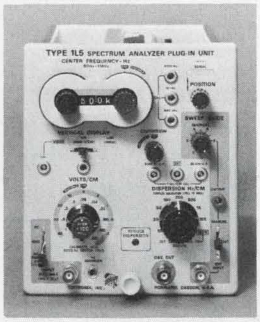
FET current source linearizes multivibrator

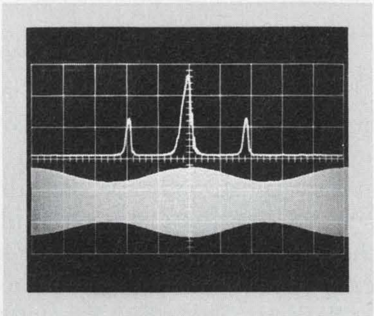
This voltage-controlled one-shot multivibrator generates an output pulse whose duration is a linear function of the applied control voltage. Deviation from linearity is less than 1% over a 25:1 pulse-duration output range. The essential modification over conventional one-shots is replacement of transistor Q_3's base-charging resistor with an FET, Q_4, operating in the pinch-off region (Fig. 1).

By utilizing the constant-current characteristics of Q_4 to supply the charging current for timing capacitor C_1, the duration of the pulse provided by Q_3 is dependent only on the size of C_1, collector voltage at Q_2, and capacitor-charg-

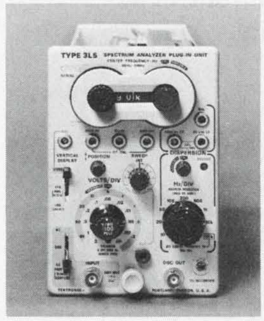
Calibrated frequency AND time measurements

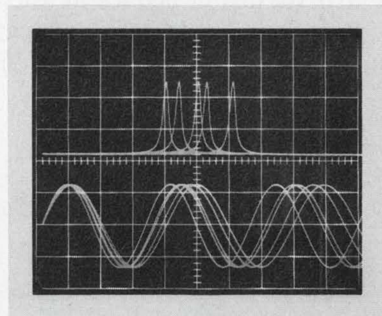
. . . with Tektronix 1L5 and 3L5 Spectrum Analyzers





Stored time and frequency display of an AM signal using the 549 Storage Oscilloscope and 1L5 Analyzer.





Stored time and frequency display showing oscillator drift using the 564B Storage Oscilloscope and 3L5 Analyzer.

The 1L5 and 3L5 Spectrum Analyzers display the 10 Hz to 1 MHz frequency content of a wide range of electromagnetic waveforms and events such as pressure, vibration and noise. Center frequency range is 50 Hz to 1 MHz. Dispersion is calibrated from 10 Hz/cm to 100 kHz/cm. At 100 kHz/cm dispersion, you can view the entire 10 Hz to 1 MHz spectrum in one display, at sensitivities to 10 μV/cm RMS.

MEASUREMENT EASE is a feature of both units. The difference between frequency components is simply the distance in CRT divisions between the components, times the calibrated dispersion. You measure the component amplitude of frequency-based displays just as easily: component amplitude in CRT divisions times the calibrated volts/cm setting.

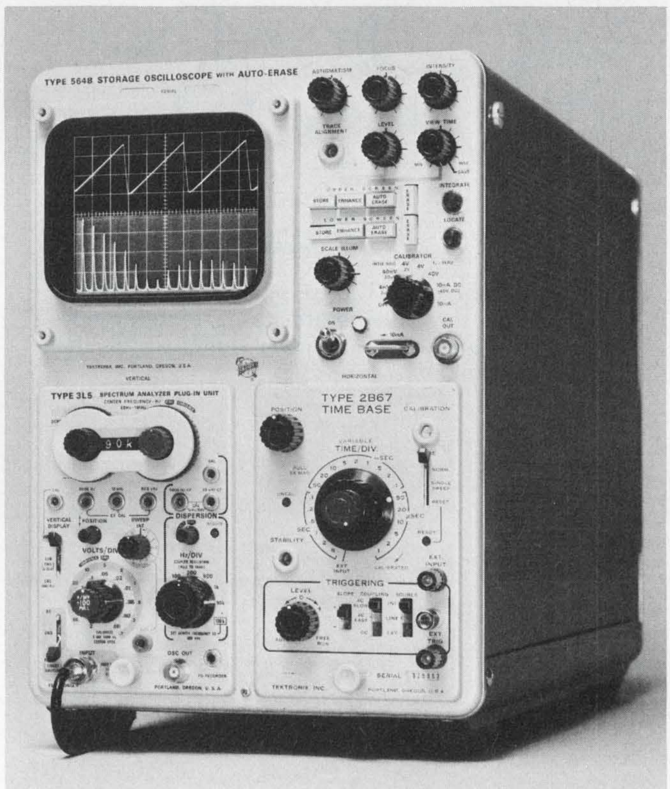
After completing your frequency measurements, you conveniently go to a time-base measurement. There's no plug-in changing to do — there's no new test setup to do. Change one switch position and the spectrum analyzer is a voltage amplifier. Bandwidth is 10 Hz to 1 MHz. The deflection factors are 1 mV/cm to 100 V/cm.

When your measurements call for IN DEPTH frequency and time analysis in the 10 Hz to 1 MHz range, choose a 1L5 or 3L5. You'll have calibrated frequency-based displays, AND calibrated time-based displays, AND measurement ease — ALL in the same unit.

Other Tektronix spectrum analyzers are available for frequency analysis to 40 GHz.

1L5 Spectrum Analyzer Plug-In Unit $1025
3L5 Spectrum Analyzer Plug-In Unit $1125

Available in U.S. through the Tektronix lease plan.
U.S. Sales Prices FOB Beaverton, Oregon



Price of Instruments Shown $2610

Spectral and time analysis using the Tektronix 564B Oscilloscope with rugged bistable storage. View time is as long as one hour.

For a demonstration call your local Field Engineer. For technical information consult your current Tektronix catalog or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005.

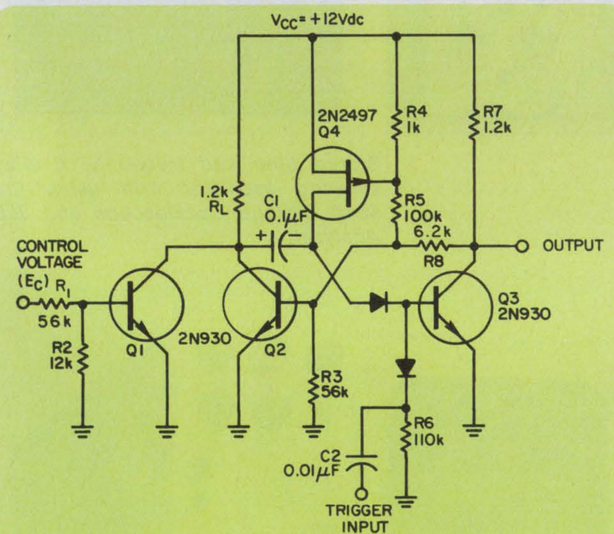
Tektronix, Inc. — committed to progress in waveform measurement

INFORMATION RETRIEVAL NUMBER 67

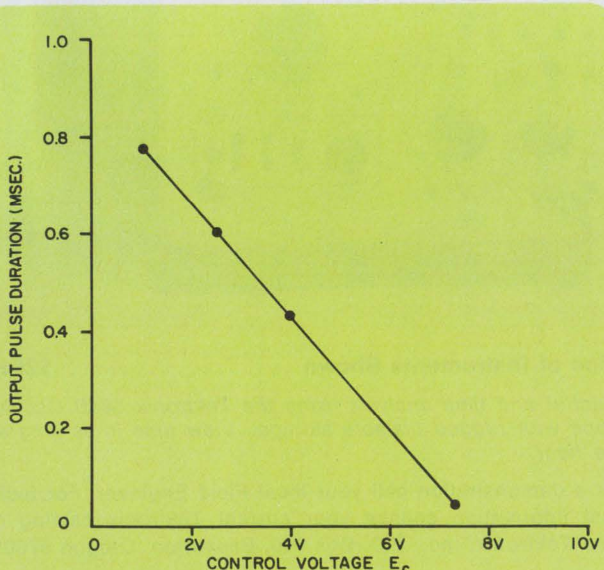
ing current supplied by Q_4. The collector voltage of Q_2 is varied by the control-voltage amplifier, Q_1. When one-shot action is initiated by a negative-going trigger at C_2, a corresponding pulse-width variation occurs at the output of Q_3.

Ignoring collector saturation voltages, the output pulse duration is given by

$t_p = (C_1 V_{ce2})/I_D$



1. **Replacement of Q_3's base charging resistor** by FET Q_4 allows the multivibrator to generate an output whose duration is a linear function of the control voltage.



2. **With C_1 equal to 0.1 μF** and the trigger rate at 1 kHz, the output pulse duration is adjustable between 0.04 and 0.78 ms. Coarse changes are possible by varying C_1 or R_4.

where C_1 = timing capacitor value, V_{ce2} = collector voltage of Q_2 just prior to triggering and I_D = drain current of Q_4.

Expressing the variation in output pulse duration in terms of the control voltage, E_c, and other circuit parameters yields

$\Delta t_p = \Delta E_c(-h_{fe} R_L C_1)/(I_D R_1)$.

Figure 2 illustrates the variation in output pulse duration obtained for different control voltages. Coarse changes in the duration of the output pulse may be accomplished by varying either C_1 or the drain current of Q_4. Variation of the latter is easily achieved by altering the FET gate source bias by means of R_4.

Phil M. Salomon, Instructor in Engineering, Pasadena City College, Pasadena, Calif.

VOTE FOR 314

VOTE! Go through all Idea-for-Design entries, select the best, and circle the appropriate number on the Reader-Service-Card.

SEND US YOUR IDEAS FOR DESIGN. You may win a grand total of $1050 (cash)! Here's how. Submit your IFD describing a new or important circuit or design technique, the clever use of a new component or test equipment, packaging tips, cost-saving ideas to our Ideas-for-Design editor. You will receive $20 for each accepted idea, $30 more if it is voted best-of-issue by our readers. The best-of-issue winners become eligible for the Idea Of the Year award of $1000.

IFD Winner for March 1, 1970
Harold Minuskin, Senior Engineer, California Computer Products, Inc., Anaheim, Calif. His Idea "Active Filter Design Uses BASIC Language" has been voted the Most Valuable of Issue Award.
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IFD Winner for March 15, 1970
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Though there's more room inside to give you all these advantages, the outside dimensions—top-to-bottom (.275″) and side-to-side (.370″)—are the same as any transistor-size relay.

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INFORMATION RETRIEVAL NUMBER 68

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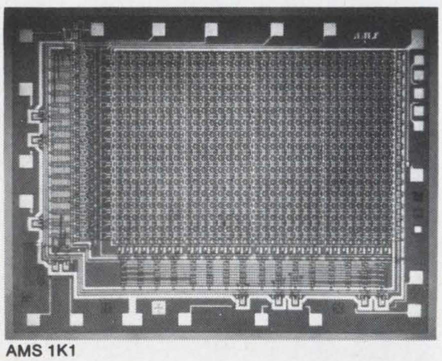

AMS 1K1

PRICES			FEATURES
Quantity	Price	¢/Bit	▪ Monolithic, fully decoded
1-24	$102	10	▪ 400 ns access time
25-99	82	8	
100-499	53	5.2	▪ 800 ns cycle time
500-999	37	3.6	▪ 50uW/bit dissipation
1K to 9.99K	24	2.3	
10K and up	19	1.84	▪ 24-lead DIP

For complete information, contact your nearest AMS Representative or write the factory

AMS

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Norvell Associates, 6440 Hillcroft Avenue, Houston, Texas 77036. Tel: 713-774-2568

Minnesota, Wisconsin, Iowa Special Electronic Sales, 8053 Bloomington Freeway, Suite 121, Bloomington, Minn. 55420. Tel: 612-884-4317

New England States Victor Associates, 12 Mercer Rd., Natick, Mass. 01760. Tel: 617-655-4143

Metropolitan New York/New Jersey Central Associates, 44 N. Dean Street, Englewood, New Jersey 07631. Tel: 201-568-0808

Central Associates, 11 Commercial Street, Plainview, Long Island, N.Y. 11803. Tel: 516-433-0808

Southeast (Florida, Georgia, Alabama) Atlantic Components Corporation, 1331 Harbor Lake Drive, Largo, Fla. 33540. Tel: 813-584-8257

Rockies (Colorado, Utah, Arizona, New Mexico, Wyoming, Idaho, Montana, North Dakota, South Dakota, Kansas, Nebraska) Elcom Electronic Components Sales, Inc., 209 San Pablo, S.E., Albuquerque, New Mexico 87108. Tel: 505-256-3663

Elcom Electronic Components Sales, Inc., 4783 S. Quebec, Denver, Colo. 80222 Tel.: 303-771-6200

Elcom Electronic Components Sales, Inc., 445 East Second South, Salt Lake City, Utah 84115. Tel: 801-355-5327

Elcom Electronic Components Sales, Inc., P.O. Box 27348, Tempe, Arizona 85281. Tel: 602-967-8809

Eastern Sales Office Advanced Memory Systems, Inc., P.O. Box 493, Randolph, Mass. 02368. Tel: 617-828-2181

Western Sales Office Advanced Memory Systems, Inc., 1276 Hammerwood Ave., Sunnyvale, California 94086. Tel: 408-734-4330

INFORMATION RETREVAL NUMBER 69

Product Source Directory

Semiconductor Memories

This Product Source Directory covers Semiconductor Memories.

Units covered are separated into two categories: Random Access and Read Only Memories. For each table, units are listed in ascending order of one major parameter. The column containing this parameter is color-coded white.

The following abbreviations apply to all semiconductor memories listed:

ina—information not available
n/a—not applicable
req—request

Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.

For a complete analysis of semiconductor memories see: The big memory battle: Semis take on cores, pg. 70.

Abbrev.	Company	Information Retrieval No.
American	American Microsystems 3800 Homestead Rd. Santa Clara, Calif. 95051 (408) 246-0330	**439**
AMS	Advanced Memory Systems 1276 Hammerwood Ave. Sunnyvale, Calif. 94086 (408) 734-4330	**440**
Cogar	Cogar Corp. All Angels Rd. Wappingers Fall, N.Y. 12590 (914) 297-4323	**441**
Comp	Computer Microtechnology 610 Pastoria Sunnyvale, Calif. 94086 (408) 736-0300	**442**
El Arrays	Electronic Arrays Inc. 501 Ellis St. Mountain View, Calif. 94040 (415) 964-4321	**443**
Fairchild	Fairchild Semiconductor 313 Fairchild Drive Mountain View, Calif. 94040 (415) 962-5011	**444**
GI	General Instrument Corp. 600 West John St. Hicksville, N.Y. 11802 (516) 733-3000	**445**
Intel	Intel Corp. 365 Middlefield Rd. Mountain View, Calif. 94040 (415) 961-8080	**446**
Intersil	Intersil Inc. 10900 Tantau Ave. Cupertino, Calif. 95014 (408) 257-5450	**447**
Mostek	Mostek Corp. 1104 Expressway Tower Dallas, Tex. 75205 (214) 526-8050	**448**
Motorola	Motorola Semiconductor Corp. 5005 E. McDowell Rd. Phoenix, Ariz. 85008 (602) 273-6900	**449**

Abbrev.	Company	Information Retrieval No.
National	National Semiconductor Corp. 2900 Semiconductor Drive Santa Clara, Calif. 95051 (408) 732-5000	**450**
Philco	Philco-Ford Microelectronics Div. 1400 Union Meeting Rd. Blue Bell, Pa. 19422 (215) MI 6-9100	**451**
Radiation	Radiation Inc. Microelectronics Div. P.O. Box 67 Melbourne, Fla. 32901 (305) 727-5412	**452**
Raytheon	Raytheon Semiconductor 350 Ellis St. Mountain View, Calif. 94040 (415) 968-9211	**453**
RCA	RCA 415 S. 5th St. Harrison, N.J. 07029 (201) 485-3900	**454**
SEM	Semiconductor Electronic Memories Inc. 3883 N. 28th Ave. Phoenix, Ariz. 85017 (602) 263-0202	**455**
Signetics	Signetics Corp. 811 E. Arques Ave. Sunnyvale, Calif. 94086 (408) 739-7700	**456**
Sylvania	Sylvania Electronic Components 100 First Ave. Waltham, Mass. 02154 (617) 893-9200	**457**
TI	Texas Instruments Inc. Components Group Box 66207/MS 333 Houston, Tex. 77006 (713) 522-9871	**458**
Transitron	Transitron Corp. 168 Albion St. Wakefield, Mass. 01880 (617) 245-4500	**459**

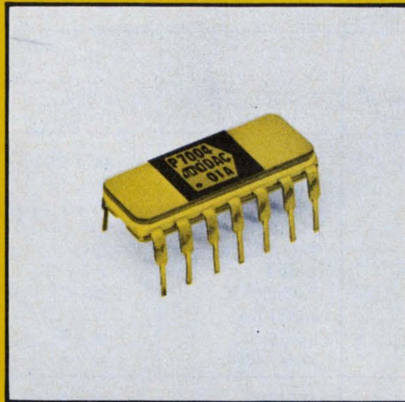
Random-Access Memories (bipolar) 101

Manufacturer	Model	Size (Words x Bits)	Access Time (ns)	Cycle Time (ns)	Supply Voltage (V)	Power Dissipation (mW)	Temperature Range (°C)	Notes	Price/Bit $
RCA	CD2155D	16 x 1	6.5	25	-5	250	-55 to +125	r	1.00
AMS	AMS0161	16 x 1	8	8	-5	400	0 to 70	p	1.00
AMS	AMS0329	32 x 9	15	10	-5	8.8 W	0 to 70	p	1.75
AMS	AMS0328	32 x 8	15	10	-5	8 W	0 to 70	p	1.75
AMS	AMS1289	128 x 9	17	15	-5	9.5 W	0 to 70	p	0.85
AMS	AMS1288	128 x 8	17	15	-5	8.6 W	0 to 70	p	0.85
Motorola	MC1037P	16 x 1	17	50	-5.2	250	0 to 75		0.62
Motorola	MC1036P	16 x 1	17	50	-5.2	250	0 to 75		0.62
TI	SN54/74170	4 x 4	19	45	5	500	-55 to +125	wx	0.37
Fairchild	9033	16 x 1	20	n/a	5	11/bit	-55 to +125		0.44
Fairchild	9030	4 x 2	20	n/a	4.5	44/bit	0 to 70		1.31
Intersil	IM5502C	16 x 1	20	30	5	300	0 to 75		req
Intersil	IM5502M	16 x 1	20	30	5	300	-55 to +125		req
Raytheon	RL80	16 x 1	20	100	5	250	-55 to +125	r	0.50
Transitron	TMC3162	4 x 4	20	60	5	300	-55 to +125		req
Transitron	TMC3163	4 x 4	20	60	5	300	0 to 70		req
Transitron	TMC3164	4 x 4	20	60	5	300	-55 to +125	y	req
TI	SN54/7484	16 x 1	20	n/a	5	275	-55 to +125	wx	0.29
TI	SN54/7481	16 x 1	20	n/a	5	275	-55 to +125	wx	0.285
AMS	AMS40961	4096 x 1	25	30	-5	35 W	0 to 70	p	0.80
Signetics	8220	4 x 2	25	n/a	5	400	0 to 70	u	1.00
Sylvania	SM80	16 x 1	30	30	5	300	-55 to 125		req
Fairchild	9035	16 x 4	35	n/a	5	7/bit	-55 to +125		0.656
Fairchild	4102 Assoc.	4 x 4	35	n/a	5	31/bit	-55 to +125	km	3.125
Motorola	MC4004F	16 x 1	35	100	5	250	0 to 75		1.10
Motorola	MC4005F	16 x 1	35	100	5	250	0 to 75		0.79
Motorola	MC4004L	16 x 1	35	100	5	250	0 to 75		0.74
Motorola	MC4005L	16 x 1	35	100	5	250	0 to 75		0.56
Motorola	MC4084P	16 x 1	35	100	5	250	0 to 75		0.54
Motorola	MC4005P	16 x 1	35	100	5	250	0 to 75		0.41
Cogar	08C09	128 x 18	40	80	-5.2	6.5	0 to 50	ab	0.45
Cogar	08C05	512 x 18	40	80	-5.2	5.6	0 to 50	ab	0.30
Signetics	8222	4 x 2	40	n/a	5	200	0 to 70	u	1.00
Cogar	08CA5	1024 x 75	45	80	-5.2	5.6	0 to 50	ab	0.33
Raytheon	RR5100	16 x 4	45	100	5	350	-55 to +125	r	0.45
Raytheon	RR6100	16 x 4	45	100	5	35	0 to 70	r	0.35
Sylvania	SM283	16 x 4	50	50	5	350	0 to 75		0.20
Comp	CM2100	16 x 4	60	60	ina	400	0 to 75		0.62
Fairchild	4103	16 x 4	60	n/a	5	5/bit	-55 to +125	k	0.375
Intel	31013	16 x 4	60	60	5	500	-55 to +85	p	0.50
Intel	3101	16 x 4	60	60	5	500	0 to 85	p	0.40
Intersil	IM5501M	16 x 4	60	60	5	500	-55 to +125		req
Intersil	IM5501C	16 x 4	60	60	5	500	0 to 75		req
Raytheon	RR6110	64 x 4	60	100	5	450	0 to 70	s	0.40
Raytheon	RR5110	64 x 4	60	100	5	450	-55 to +125	s	0.50
Transitron	TMC6464	16 x 4	60	65	5	500	-55 to +125	y	req
Signetics	1283	8 x 1	80	100	4	160	0 to 70		0.10
Fairchild	4100	256 x 1	85	n/a	5	2.2/bit	0 to 75	k	0.25
Intersil	IM5503M	256 x 1	100	100	5	600	-55 to +125		req
Intersil	IM5503C	256 x 1	100	100	5	600	0 to 75		req
Cogar	15C23	256 x 18	125	150	+5	3.3	0 to 50	ab	0.15
Cogar	15CA1	4096 x 36	125	150	+5	2.4	0 to 50	ab	0.115
Cogar	15C07	1024 x 18	125	150	+5	2.4	0 to 50	ab	0.115
SEM	RAM18A	128 x 8	180	200	+5, -5	2 W	0 to 85		0.30
SEM	RAM28A	256 x 8	180	200	+5, -5	2 W	0 to 85		0.23
SEM	RAM48A	512 x 8	180	200	-5, +5	3.4 W	0 to 85		0.16
SEM	RAM88B	1024 x 8	180	200	-5, +5	5.28 W	0 to 85		0.15
SEM	RAM29A	256 x 9	180	200	-5, +5	2.51 W	0 to 85		0.23
SEM	RAM49A	512 x 9	180	200	-5, +5	4.23 W	0 to 85		0.18
SEM	RAM89B	1024 x 9	180	200	-5, +5	6.1 W	0 to 85		0.15
SEM	RAM418A	256 x 18	180	200	-5, +5	ina	0 to 85		0.21
SEM	RAM50A	512 x 10	180	200	-5, +5	4.23 W	0 to 85		0.18

Random-Access Memories (hybrid) 102

Manufacturer	Model	Size (Words x Bits)	Access Time (ns)	Cycle Time (ns)	Supply Voltage (V)	Power Dissipation (mW)	Temperature Range (°C)	Notes	Price/Bit $
Cogar	30CA1	32,768 x 36	250	300	5, 10, -7	0.38	0 to 50	ab	0.054
Cogar	30C06	8192 x 18	250	300	5, 10, -7	0.38	0 to 50	abde	0.05
Cogar	30C04	2048 x 18	250	300	5, 10, -7	0.54	0 to 50	ab	0.07
Comp	CM2400-5	1024 x 1, 2, 4	250	400	5, 10	1.6 W	0 to 70	ef	0.30

MEET OUR monoDAC-01 D/A CONVERTER



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6 Bit Settling Time:	3 Microseconds
Input Logic Levels:	0 to +3V
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INFORMATION RETRIEVAL NUMBER 70

Random-Access Memories (MOS)

Manufacturer	Model	Size (Words x Bits)	Access Time (ns)	Cycle Time (ns)	Supply Voltage (V)	Power Dissipation (mW)	Temperature Range (°C)	Notes	Price/Bit $
Fairchild	3530	64 x 1	n/a	3500	-13, -27	500	-55 to +85		0.35
RCA	CD4005D	16 x 1	15	65	6 - 15	0.1	-55 to +125	rt	0.62
RCA	CD4005	16 x 1	15	65	6 - 15	0.1	-55 to +125	rt	0.69
Mostek	MK4001	256 x 1	50	70	-18	250	-55 to +85		0.10
TI	TMX4008JC	256 x 1	120	n/a	-12	200	-55 to +85		req
American	S1495	512 x 1	150	350	+5, -10	30 at 1 MHz	-55 to +125	ry	0.10
TI	TMS4003JC	256 x 1	150	n/a	-18	200	-55 to +85		0.075
AMS	AMS10241	1024 x 1	400	800	±15	50	0 to 70	p	0.052
Philco	pLR16x4C	16 x 4	400	ina	-15, -27	250	0 to 70	z	req
GI	RA-6-4803	32 x 1	500	500	5	90	-55 to +125		0.48
Motorola	MC1170L	16 x 4	500	1200	-30	250	0 to 75		0.215
Intel	11011	256 x 1	800	800	+5, -8	400	-55 to +85	p	0.12
Mostek	MK4002	64 x 4	800	1000	+5, -12	350	0 to 75		0.09
American	S1605	128 x 1 64 x 2 32 x 4	1000	1400	+5, -12	350	-55 to +125	ry	0.20
El Arrays	EA1400	64 x 2	1000	1000	-26	135	-55 to +85	j	0.15
Philco	pRW256x1C	256 x 1	1000	1200	-10, -25	250	0 to 70	pz	0.20
Intel	1101	256 x 1	1100	1100	+5, -8	400	-55 to +85	p	0.10

Read-Only Memories (bipolar)

Manufacturer	Model	Size (Words x Bits)	Access Time (ns)	Cycle Time (ns)	Supply Voltage (V)	Power Dissipation (mW)	Temperature Range (°C)	Notes	Price/Bit $
Signetics	8224	32 x 8	35	n/a	5	270	0 to 70		0.049
Sylvania	SM323	32 x 8	35	35	5	300	0 to 75		0.05
Cogar	06P07	512 x 32	40	60	-5.2	0.67	0 to 50	abc	0.08
TI	SN7488	32 x 8	40	n/a	5	240	0 to 70	wx	0.03
Motorola	XC171P	16 x 8	45	n/a	5	240	0 to 75		0.078
Motorola	XC170P	16 x 8	45	n/a	5	240	0 to 75	v	0.078
Fairchild	9034	32 x 8	50	n/a	5	0.8/bit	-55 to +125		0.058
Intersil	IM5601M	32 x 8	50	50	5	400	-55 to +125		req
Intersil	IM5601C	32 x 8	50	50	5	400	0 to 75		req
Fairchild	4104	128 x 4	60	n/a	5	0.8/bit	-55 to +125	k	0.68
Intel	Std 3301	256 x 4	60	60	5	500	0 to 85	p	0.05
Intersil	IM5602M	256 x 4	60	60	5	650	-55 to +125		req
Intersil	IM5602C	256 x 4	60	60	5	650	0 to 75		req
Radiation	PROM	64 x 8	65	ina	ina	400	-55 to +125 0 to 75	x	0.12 0.09
Fairchild	4003	64 x 16	70	n/a	5	0.8/bit	0 to 70	k	0.073
Motorola	XC270P	32 x 8	100	n/a	5	250	0 to 75		0.078
Motorola	XC271P	32 x 8	100	n/a	5	250	0 to 75		0.078
Cogar	15P06	1024 x 32	125	150	+5	0.34	0 to 50	abd	0.04
Cogar	30P06	4096 x 32	250	300	5, 10, -7	0.1	0 to 50	abde	0.013

a. Prices are for quantities of 10 or more.
b. Other organizations are available.
c. There is a one time mask charge of $8000.
d. There is a one time mask charge of $16,000.
e. Technology, MOS, bipolar.
f. Uses 21 or 22 IC chips, (16 MOS and 5-6 bipolar)
g. Standard pattern available, EA3101 - ASC11 to selectric and selectric to ASC11 code conversion.
h. Standard pattern available, EA3501, row scan dot code matrix character generator, 64 ASC11 characters.
i. Standard pattern available, EA3307, ASC11 to EbcdIC and EBDIC to ASC11 code converter.
j. Includes all decoding and output buffers on the chip.
k. Access time, maximum.
m. Access time is match time.
n. There is a masking charge of $1000.
p. 100 piece price.
q.
r. 1000 piece price.
s. 250 piece price.
t. Model CD4005D, 14 lead dual inline ceramic package, CD4005 14 lead ceramic flat pack.
u. Content addressable memory.
v. Character generator.
w. Series 54TTL, -55 to +125°C, Series 74TTL, 0 to 70°C.
x. 100-999 piece price.
y. Also 0 to 70°C temperature range available.
z. Dual inline package.

Manufacturer	Model	Size (Words x Bits)	Access Time (ns)	Cycle Time (ns)	Supply Voltage (V)	Power Dissipation (mW)	Temperature Range (°C)	Notes	Price/ Bit $
TI	TMS4500JC	128 x 6	100	n/a	-20	200	-25 to +85		0.012
TI	TMS4600JC	256 x 8	100	n/a	-20	200	-25 to +85		0.01
GI	RO-1-2240	5 x 7	500	500	25	250	0 to 70	nv	0.96
TI	TMS4100JC	64 x 7 x 5	500	n/a	-14, -25	350	-25 to +85	v	0.0075
TI	TMS2400JC	64 x 5 x 7	500	n/a	-14, -28	250	-25 to +85	v	0.0075
		32 x 5 x 14							
Intersil	IM7601C	256 x 4	600	600	±12	250	0 to 75		req
Intersil	IM7602M	128 x 8	600	600	±12	250	-55 to +125		req
Intersil	IM7601M	256 x 4	600	600	±12	250	-55 to +125		req
Intersil	IM7602C	128 x 8	600	600	±12	250	0 to 75		req
National	MM4240	512 x 5	600	n/a	±12	ina	-55 to +125	v	3.00
		64 (5 x 8)							
National	MM521	256 x 4	600	n/a	±12	ina	-25 to +70	v	2.00
National	MM421	256 x 4	600	n/a	±12	ina	-55 to +125	v	4.00
National	MM522	128 x 8	600	n/a	±12	ina	-25 to +70	v	2.00
National	MM5240	512 x 5, 64 (5 x 8)	600	n/a	±12	ina	-25 to +70	v	1.50
National	MM422	128 x 8	600	n/a	±12	ina	-55 to +125	v	4.00
TI	TMS2600JC	256 x 8	600	n/a	-12	200	-55 to +85		0.0075
		512 x 4							
TI	TMS2800JC	256 x 4	600	n/a	-12, -24	200	-55 to +85		0.006
Mostek	MK2400	256 x 10	700	1000	+5, -12	350	-55 to +85		0.014
Philco	pMS2240C	64 x 7 x 5	700	1000	-13, -27	300	0 to 70	pz	req
Intersil	IM7603M	256 x 8	750	750	±12	350	-55 to +125		req
Intersil	IM7605C	256 x 10	750	750	±12	400	0 to 75		req
Intersil	IM7603C	256 x 8	750	750	±12	350	0 to 75		req
Intersil	IM7604M	512 x 5	750	750	±12	400	-55 to +125		req
Intersil	IM7605M	256 x 10	750	750	±12	400	-55 to +125		req
Intersil	IM7604C	512 x 5	750	750	±12	400	0 to 75		req
American	MA51	256 x 10	800	700	+5, -12	350	-55 to +125	ry	0.015
Mostek	MK2000	64 x 5 x 7	800	800	-14, -18	350	-55 to +85	v	0.012
Mostek	MK2100	64 x 7 x 5	800	800	-12, -24	350	-55 to +85	v	0.012
Philco	pMS2048C	256 x 8	800	1000	-13, -27	250	0 to 70	pz	0.017
		512 x 4							
		1024 x 2							
		2048 x 1							
TI	TMS4300JC	512 x 8	800	n/a	-14, -28	300	-25 to +85		0.011
		1024 x 4							
		2048 x 2							
		4096 x 1							
El Arrays	EA3500	512 x 5	850	850	-24	90	-55 to +85	h	0.01
National	MM423	256 x 8	850		±12 vdc		-55 to +125	v	3.00
National	MM523	256 x 8	850	n/a	±12	ina	-25 to +70	v	1.50
American	MB51	248 x 1	1000	1000	-15, -27	ina	-55 to +125	ry	0.01
El Arrays	EA3100	256 x 10	1000	1000	-24	90	-55 to +85	g	0.01
GI	MEM 2048	64 x 32	1000	ina	-24 to -28	120	-55 to +85	an	0.05
Mostek	MK2200	16 x 5 x 7	1000	5000	+5, -12	250	0 to 75		0.025
Mostek	MK2300	64 x 5 x 7	1000	5000	+5, -12	350	0 to 75		0.013
El Arrays	EA3300	512 x 8	1500	1500	-24	90	-55 to +85	i	0.008
American	512 x 4	512 x 4	2000	2000	-15, -27	300	-55 to +125	ry	0.01
American	256 x 4	256 x 4	2000	2000	-15, -27	300	-55 to +125	ry	0.01
Philco	pMS1024C	128 x 8	2000	2200	-25, -30	150	0 to 70	pz	0.02
		256 x 4							
Philco	pM1024C	128 x 8	2000	4000	-25, -30	100	0 to 70	pz	0.02
		256 x 4							
Fairchild	3501	128 x 8	2500	n/a	-13, -27	250	-55 to +85		0.03

Electronic Desk Top Calculators

This product Source Directory covers Electronic Desk Top Calculators.

Units covered are separated into two categories: Non-programmable and programmable calculators. Programmable calculators are listed in ascending order of addressable registers. Non-programmable calculators are listed in alphabetical order by manufacturers name.

Unless otherwise noted in the tables, all calculators have input requirements of 95-135 Vac, single phase. The following abbreviations apply to all instruments listed.

ina—information not available
n/a—not applicable
req—request

Manufacturers are identified by abbreviation. The complete name of each manufacturer can be found in the Master Cross Index below.

Abbrev.	Company	Information Retrieval No.
Canon	Canon 64-10 Queens Blvd. Woodside, N.Y. 11377 (212) 478-5600	**460**
Cintra	Cintra 440 Logue Ave. Mountain View, Calif. 94040 (415) 969-9230	**461**
Comm	Commodore 390 Reed St. Santa Clara, Calif. 95050 (408) 538-7900	**462**
Dicta	Dictaphone Corp. 267 Broadway New York, N.Y. 10007 (212) 233-0510	**463**
Friden	Friden Inc. 2350 Washington Ave. San Leandro, Calif. 94577 (415) 357-6800	**464**
H-P	Hewlett-Packard Co. 1501 Page Mill Rd. Palo Alto, Calif. 94304 (415) 326-7000	Contact local sales office
IME	IME, Inc. One IME Plaza N. Bergen, N.J. 07047 (201) 861-3900	**465**
Math	Mathatronics 241 Crescent St. Waltham, Mass. 02154 (617) 893-1630	**466**

Abbrev.	Company	Information Retrieval No.
Monroe	Monroe Int'l Div. Litton Industries 550 Central Ave. Orange, N.J. 07051 (201) 673-6600	**467**
NCR	National Cash Register Dayton, Ohio 45409 (513) 449-2000	**468**
Olivetti	Olivetti Underwood Corp. One Park Ave. New York, N.Y. 10016 (212) 679-3400	**469**
Remington	Remington Rand Office Equip. 333 Wilson Ave. Norwalk, Conn. 06856 (203) 838-4301	**470**
SCM	SCM, Inc. 299 Park Ave. New York, N.Y. 10017 (212) PL 2-2700	**471**
Sharp	Sharp Electronics 178 Commerce St. Carlstadt, N.J. 07072 (201) 933-4200	**472**
Toshiba	Toshiba America, Inc. 447 Madison Ave. New York, N.Y. 10022 (212) 758-8161	**473**
Wang	Wang Labs, Inc. 836 North St. Tewksbury, Mass. 01876 (617) 851-7311	**474**

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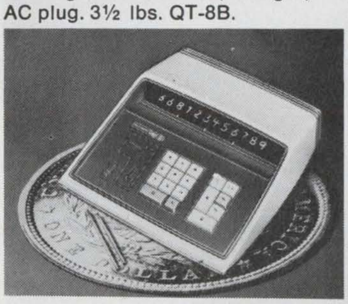
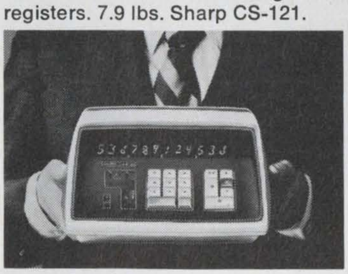
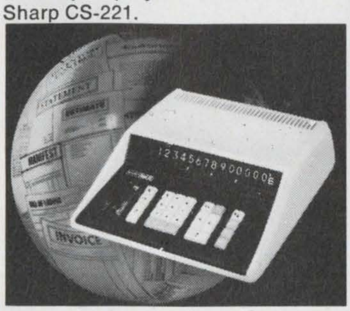
1&2 Sharp MICRO. 3 pound genius. Subtracts, adds, divides, multiplies. Mixed calculations. Floating decimal. Sharp QT-8D. Sharp MICRO II. With built-in, rechargeable batteries, charger, AC plug. 3½ lbs. QT-8B.



3 Sharp MINI II. At a mini price. Performs successive multiplication and division automatically and by constant. Automatic decimal. 2 working registers. 7.9 lbs. Sharp CS-121.

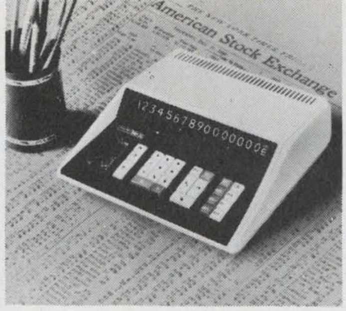


4 Sharp MIDI II. Newest "Midi." Full memory bank. 2 working registers. Constant key. High visibility display. 7.9 lbs. Sharp CS-221.

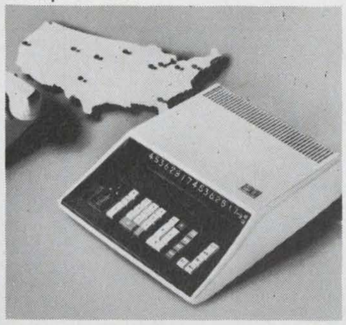


5 Sharp MIDI. 14 digit capacity. 2 working registers. Round-off capability. Memory light. Function light. Recall key. Automatic decimal. Chain calculation.

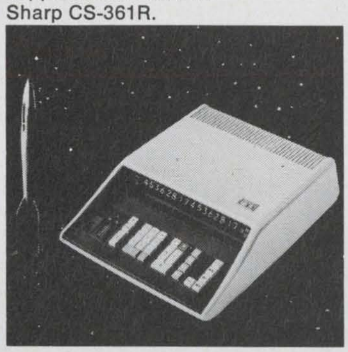
6 Sharp MAXI. 16 digit capacity. Automatic drop-off. Pre-set or floating decimals. Dual decimal systems for memory and display. Automatic squaring. Round-off, up



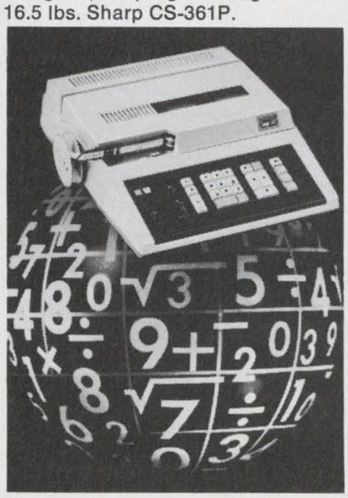
7 Sharp MAXI II. With 2 memory banks. Full 16 digit capacity. Pre-set decimal. Memory light. Function light. Round-off capability. Chain calculation. Automatic squaring. 8½ lbs. Sharp CS-362.



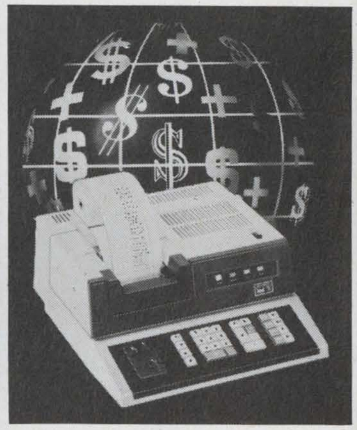
8 Sharp MAXI III. Extracts square roots instantly. 3 working registers. 2 memories. Pre-set and floating dual decimal systems. Chain calculation. Zero suppression. 14.5 lbs. Sharp CS-361R.



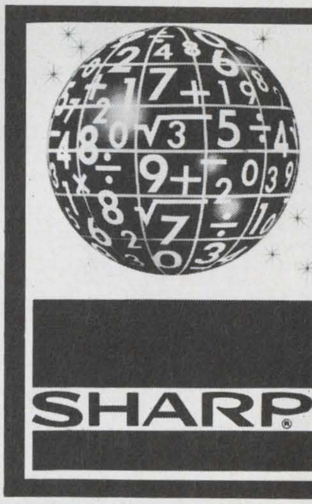
9&10 Sharp MAGNI. 6 memory banks. Square root capacity. Automatic accumulation of multiplicands. Automatic item count. 16.9 lbs. Sharp CS-361M. Sharp MAGNI II. All the sophistication of the "Magni" plus programming. 16.5 lbs. Sharp CS-361P.



11 Sharp PRINT-RONIC. Prints electronically. Silent. Speedy. Trouble-free—only 1 moving part. 16 digits. 2 working registers, memory bank, memory light. Pre-set decimal. Recall key.



12&13 Sharp PRINTMASTER. Electronic mechanical printer. 16 digits. 2 working registers and memory. Round off/down. Pre-set decimal. Recall key. 26.4 lbs. Sharp CS-661. Sharp PRINTMASTER II. Same features as "Printmaster" plus 2 memory banks. 26.4 lbs. Sharp CS-761.



Sharp Electronics Corporation
Dept. ED-1, Carlstadt, N. J. 07072
Gentlemen: Please provide me full information on the full Sharp line.

Name________________

Company________________

Street________________

City________________

State________ Zip________

Non-Programmable Calculators

Manufacturer	Model	Number of Input Digits	Number of Output Digits	Keyboard Functions	Display Type	Hard Copy (yes, no)	Weight	Notes	Price $
Canon	120	12	12	+ - x ÷	neon	no	8.82		req
Canon	121	12	12	+ - x ÷	neon	no	8.82	(14)	req
Canon	163	16	16	+ - x ÷	neon	no	13.89	(7)(14)	req
Canon	162	16	16	+ - x ÷	neon	no	13.67	(7)(14)	req
Comm	1121	12	12	m	nixie	no	10.6	m	845
Comm	1161	16	16	m	nixie	no	10.6	m	995
Comm	512	12	12	m	nixie	no	ina	m	499
Comm	612	12	12	m	mosaic	no	6.58		599
Dicta	1401	14	14	+ - x ÷	mosaic	no	9.7		695
Dicta	1412	14	14	n	mosaic	no	9.7	n	875
Dicta	1620	16	16	p	mosaic	no	16.1	p	1075
Dicta	1630	16	16	p	printer	yes	33		1295
Friden	1154	13	13	+ - x ÷	printer	yes	42	q	1095
Friden	1166	13	13	+ - x ÷	crt	no	24	q	935
Friden	1162	14	14	+ - x ÷	crt	no	24	r	1095
Friden	1114	14	14	+ - x ÷	nixie	no	12	q	895
Friden	1115	12	12	+ - x ÷	nixie	no	10		695
Friden	1116	16	16	+ - x ÷	nixie	no	12	r	1195
IME	120	12	12	m	nixie	no	14	ms	745
IME	121	12	12	m	nixie	no	14	mst	845
IME	122	12	12	m	nixie	no	14	msu	945
IME	122S	12	12	m	nixie	no	14	mrsu	1045
IME	86-2B	16	16	m	nixie	yes	35	mst	1195
IME	86S	16	16	m	nixie	no	35	msv	1395
IME	86SR	16	16	m	nixie	no	35	mrsv	1495
Monroe	1650	13	10	+ - x ÷	nixie	no	12	jy	2750
Monroe	1660	13	10	+ - x ÷	printer	yes	22	jy	3450
Monroe	1260	14	14	+ - x ÷ % change, %+, %-	printer	yes	22		1395
Monroe	820A	14	14	+ - x ÷	crt	no	14.5		895
Monroe	920	12	12	+ - x ÷	nixie	no	8.8		595
Monroe	925	13	13	+ - x ÷	nixie	no	8.8		req
Monroe	950	16	16	+ - x ÷	nixie	no	15	(1)	950
Monroe	990	16	16	+ - x ÷	nixie	no	15	(1)	1150
NCR	18-2	16	16	+ - x ÷	nixie	no	15.4	(2)	1095
NCR	18-3	16	16	+ - x ÷	nixie	no	15.4	(3)	1275
NCR	18-1	14	14	+ - x ÷	digitron	no	8.8		875
NCR	18-12	12	12	+ - x ÷	itron	no	6.6		595
Olivetti	Logos 270	22	22	+ - x ÷	printer	yes	34	(3)	1195
Olivetti	Logos 250	22	22	+ - x ÷	printer	yes	34		995
Olivetti	Logos 328	22	22	+ - x ÷	printer	yes	55	(3)	995
Remington	EDC-1D	13	13	+ - x ÷	nixie	no	18		695
Remington	EDC-J	13	13	+ - x ÷	nixie	no	18		600
Remington	EDC III	20	20	+ - x ÷	nixie	no	18		970
Remington	EDC-3A	20	20	+ - x ÷	nixie	no	18		895
SCM	414	14	14	+ - x ÷	nixie	no	6	q(4)	895
SCM	516	14	14	+ - x ÷	printer	yes	35	(5)	985
SCM	616	14	14	+ - x ÷	printer	yes	35	q(5)	1150
Sharp	QT8D	8	8	+ - x ÷	digitron	no	3.5		395
Sharp	QT8B	8	8	+ - x ÷	digitron	no	3.5	(8)	495
Sharp	121	12	12	+ - x ÷	digitron	no	8.14	(9)	575
Sharp	221	12	12	+ - x ÷	digitron	no	8.14	(9)	675
Sharp	241	14	14	+ - x ÷	nixie	no	8	(5)(9)(10)	795
Sharp	361R	16	16	+ - x ÷	nixie	no	16.5	(3)(7)(9)	1145
Sharp	361M	16	16	+ - x ÷	nixie	no	16.5	(3)(7) (9)(11)	1245
Sharp	662	16	17	+ - x ÷	printer	yes	17	(5)(9)(12)	895
Sharp	661	16	17	+ - x ÷	printer	yes	26.4	(5)(13)	1095
Sharp	761	16	17	+ - x ÷	printer	yes	26.4	(5)(7)(13)	1195
Toshiba	1612	16	16	+ - x ÷	nixie	no	11.8	(14)	895
Toshiba	1211S	15	15	+ - x ÷	nixie	no	6	(14)	395
Toshiba	1202	15	15	+ - x ÷	nixie	no	6	(14)	495
Toshiba	1623	16	16	+ - x ÷	nixie	no	11.8	(3)(7)(15)	1195
Toshiba	1624	16	16	+ - x ÷	nixie	no	11.8	(3)(7)	1095
Toshiba	1212	15	15	+ - x ÷	nixie	no	6		595

Programmable Calculators

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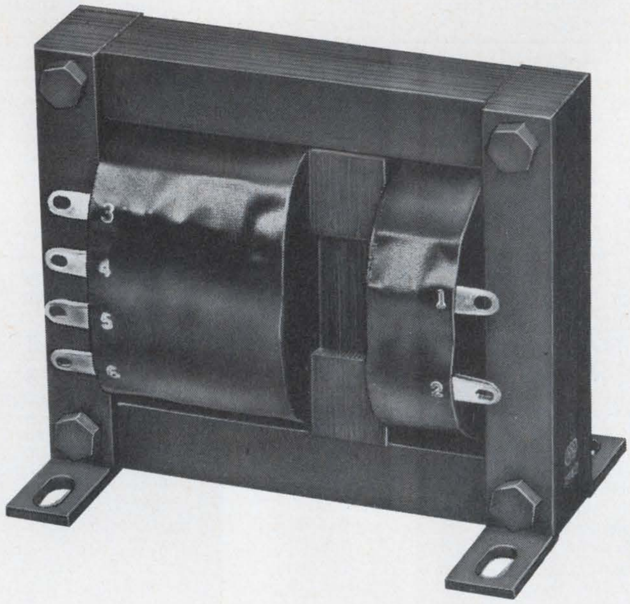
Manufacturer	Model	Number of Input Digits	Number of Output Digits	Number of Addressable Registers	Display Type	Number of Program Statements	Method of Preprogramming	Input/ Outputs Available	Hard Copy (yes, no)	Notes	Weight	Price
Wang	320	14	10	2	nixie	320	(19)	printer	yes		5	1282
Sharp	361P	16	16	2	nixie	64	learn	none	no	(3)(7)	16.5	1395
Canon	162P	16	16	2	neon	32	(19)	ina	no		13.89	req
Toshiba	1623G	16	16	3	nixie	17	manual	yes	no	(16)	11.8	1395
Friden	1151	13	13	4	printer	30	keyboard	keyboard	yes	q	42	1395
Comm	AL-1000	14	14	4	nixie	30	keyboard	no	no		23	1495
SCM	566PR	16	16	5	printer	66	keyboard	no	yes	(7)	65	1795
IME	86-2B DG-408	16	16	5	nixie	512	x	bg	yes	bgwx	59	2890
IME	86-2B DG-308/D	16	16	5	nixie	1024	x	bg	yes	bgxw	68	3545
Friden	1152	13	13	5	printer	30	keyboard	keyboard	yes	r	42	1495
IME	86-2B DG-308	16	16	5	nixie	512	x	bg	yes	bgxw	59	2540
Wang	360	14	10	6	nixie	320	(19)	printer	yes		5	1497
SCM	1016PR	14	14	7	printer	100	(6)	yes	yes		35	2495
IME	86SRDG-408	16	16	7	nixie	512	x	bg	yes	bgwx	59	3190
IME	86SRDG-308/D	16	16	7	nixie	1024	x	bg	yes	bgwx	68	3845
IME	86SRDG-308	16	16	7	nixie	512	x	bg	yes	bgwx	59	2840
IME	86S DG-408	16	16	7	nixie	512	x	bg	yes	bgwx	59	3090
IME	86S DG-308/D	16	16	7	nixie	1024	x	bg	yes	bgwx	68	3745
IME	86S DG-308/D	16	16	7	nixie	1024	x	bg	yes	bgwx	68	3745
IME	86S DG-308	16	16	7	nixie	512	x	bg	yes	bgwx	59	2740
Monroe	1265	14	14	8	printer	128,256	punched cards	card reader	yes	o	22.5	2495
Olivetti	P101	22	22	10	printer	120	mag cards	yes	yes			3850
Monroe	1665	13	10	10	printer	128, 256	punched cards	card reader	yes	y	22.5	3950
Monroe	1655	13	10	10	nixie	128	punched cards	card reader	no	y	12.5	3250
H-P	9100A	12	12	16	crt	196	z	z	yes	yz	40	4400
Wang	362	14	10	24	nixie	32	(19)	printer	yes		5	2395
Cintra	909-00	10	10	26	nixie	85	bcd	efghij	yes	ak	24	3780
Cintra	909-01	10	10	26	nixie	256	bcd	cefghi	yes	ak	24	4030
H-P	9100B	12	12	32	crt	392	z	z	yes	yz	40	4900
Cintra	909-02	10	10	100	nixie	85	bcd	cefghi	yes	ak	24	4570
Cintra	909-03	10	10	100	nixie	256	bcd	cefghi	yes	ak	24	4820
Wang	700	12	12-24	122	nixie	960	core, mag tape	(17)	yes		38	4900
Math	III	9	9	128	printer	L	manual b	bhx		bhxy	ina	L
Wang	720A	12	12-24	248	nixie	1984	core, mag tape	(17)	yes		38	6700
Wang	380	14	10	268	nixie	1280	mag tape	gh	yes		18	3395
Wang	370	14	10	268	nixie	960	(18)	(18)	yes		18	3095

a. Input/output plus 2 guard digits and 2 digit exponent of 10.
b. Paper tape
c. Optical card reader
d. 937 programmer, magnetic tape
e. x-y plotter
f. Column printer
g. I-O selectric
h. ASR33 teletype
i. A-D/D-A
j. Keyboard functions include, a^x, $\log_{10}$ $\log_e$ sine/cosine, $\sin^{-1}$, $\cosine^{-1}$, square root, x!, 1/4, rad to degree
k. 25,600 program statements with 927 programmer
L. 4K memory, up to 2816 steps. Price, 5 systems from $10,920
m. Keyboard functions, ×, ÷, +, −, constant, grand total
n. Keyboard functions, ×, ÷, +, −, Σ, RC, K, M_1.
o. Options, extra 128 steps, $300, card reader $250
p. Keyboard functions, ×, ÷, +, −, Σ, RC, K, M_1, M_2.
q. Keyboard functions include grand total
r. Keyboard functions include grand total and automatic square root.
s. Keyboard functions A, B, T accessible working registers for recall of 3 multiplication factors
t. Keyboard functions include complete calculation and store or accumulate answer to memory I., clear register I, display total in register I
u. Keyboard functions include complete calculation and store or accumulate answer in memory I, clear memory I, display total in register I, complete calculation and store or accumulate in memory II, display total in register II
v. Same as note u with the addition of memory III, IV, and register III, IV.
w. Additional registers can be added in 60 register increments.
x. Punch card or keyboard.
y. Input/output digits plus 2 digit exponent
z. Method of preprogramming, magnetic card, manual, marked sense card. Input/outputs available, x-y plotter, printer, typewriter, teletype, inputs-marked sense card, keyboard.

(1) Separate memory
(2) Automatic constant multipliers, two memories, floating and preset decimal system.
(3) Keyboard functions include square root.
(4) MOS, LSI
(5) 1 memory
(6) Method of preprogramming, keyboard or magnetic tape cartridge.
(7) Two memories
(8) Battery operated
(9) Keyboard function includes constant
(10) Automatic chain multiplication
(11) Six memories
(12) Hard copy is chemically treated paper
(13) Printer is mechanical
(14) Other keyboard functions available check with manufacturer
(15) Contains 31 outputs, displays 16
(16) Contains 32 outputs, displays 16
(17) Input/outputs available, output writer, plotting output writer, punch paper tape input, on line input/output
(18) Preprogrammed by IBM prescored card. input/outputs available, output writer, teletype, storage display, punched tape input, on line input.
(19) Paper punched IBM card

Nixie is a registered trademark of the Burroughs Corp.

Most engineers know ADC Products builds custom ferro-resonant transformers for constant-voltage power supplies.



But do you know... ADC Products also builds "Blue-Chip" transformers for P.C. applications, special filters and chokes, tape head and solenoid coils, plus complete power supply assemblies?

ADC Products has hundreds of stock, off-the-shelf components for computer applications. But we also design special transformers—custom designs for your particular problem—with the help of our computer. For example, if you need a special ferro-resonant transformer for a constant voltage power supply, we have a special computer program that can help our design team analyze your parameters and establish the optimum design. The background of 19,897 other designs helped us establish the program—and if we need to, we have any of these prior designs at our fingertips.

Our computer is an important part of our design team . . . How about using ADC Products for real-time reliability in your computer system? Write today for complete information.

ADC PRODUCTS
A DIVISION OF MAGNETIC CONTROLS CO.

4900 West 78th Street, Minneapolis, Minnesota 55435
(612) 929-7881

INFORMATION RETRIEVAL NUMBER 72

New Products

Pin-programmable op amps vary gain from 0.004 to 250

Zeltex Inc., sub. of Redcor Corp., 1000 Chalomar Rd., Concord, Calif. Phone: (415) 686-6660. P&A: $25; August, 1970.

Offering over 500 selectable gain configurations in a single package, two new Zel-Cell pin-programmable operational amplifiers provide gains ranging from 0.004 to 250. Both devices also feature selectable-mode operation—they can be used in follower, inverter or summing configurations.

The two models are the ZC741E with a bipolar monolithic input circuit, and the ZC801E with FET-input hybrid circuitry. Both units are hermetically sealed in 14-pin dual-in-line packages.

Each amplifier incorporates a precision input/feedback resistor network to eliminate the need for external resistors. This feature saves time not only in design and manufacturing, but also in test and procurement.

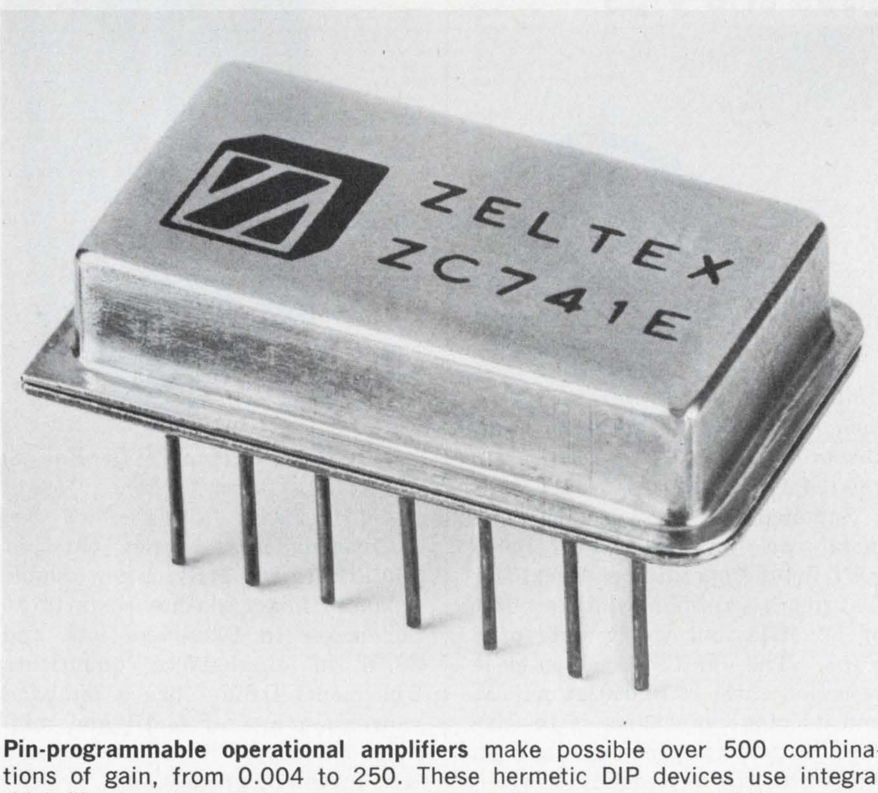
The resistor network employs thick films applied to an alumina substrate. It has an over-all network tolerance of 0.1% and a temperature coefficient of 10 ppm/°C.

Conductor paths between resistors and tie points are made of thick-film gold. The network is then over-glazed with thick-film screenable glass. All resistors are screened simultaneously for reliable temperature tracking characteristics.

Dc gain for both models is 100,000, while gain-bandwidth product is 1 MHz for the ZC741E and 4 MHz for the ZC801E. Minimum rated output is ±10 V at 5 or 7 mA, respectively.

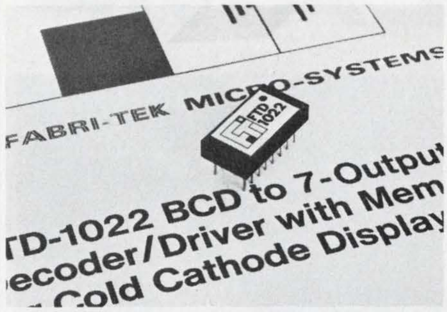
The ZC741E slews 0.5 V/μs; the ZC801E slews 6 V/μs. Operating temperature range is −25 to +85°C for both units.

CIRCLE NO. 250



Pin-programmable operational amplifiers make possible over 500 combinations of gain, from 0.004 to 250. These hermetic DIP devices use integral thick-film input/feedback resistor networks for temperature stability.

7-output decoder/driver has quad-latch memory

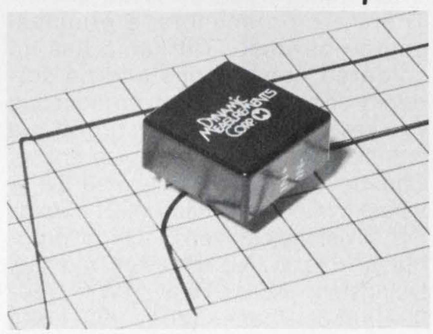


Fabri-Tek Micro-Systems, Inc., 1150 N. W. 70 St., Fort Lauderdale, Fla. Phone: (305) 933-9351. Price: $13.75.

The FTD-1022 is a BCD-to-7-segment decoder/driver featuring quad-latch memory. The quad latch allows continuous transfer of 4-bit BCD input data to the decoder when the memory strobe is high. When the strobe is low, data is retained until another strobe transition takes place.

CIRCLE NO. 251

Operational amplifiers reach 0.01% in 0.6 μs

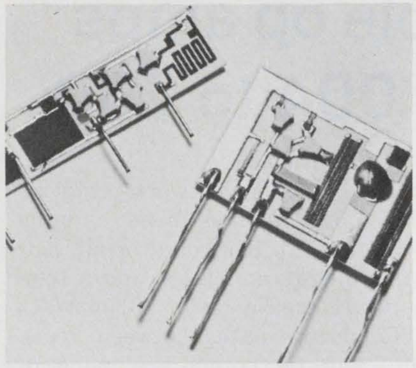


Dynamic Measurement Corp., 108 Summer St., Arlington, Mass. Phone: (617) 648-3610. P&A: $52, $62; stock.

Featuring input impedance of 10^5 MΩ, common-mode rejection of 40,000, gain of 250,000 and slew rate of 100 V/μs, model FST-151A,B operational amplifiers settle to 0.01% in 0.6 μs. Stability is 35 mV/°C for the 151A and 15 mV/°C for the 151B. Input bias is 0.1 nA for the 151A and 0.05 nA for the 151B.

CIRCLE NO. 252

Thick-film hybrid slashes down costs

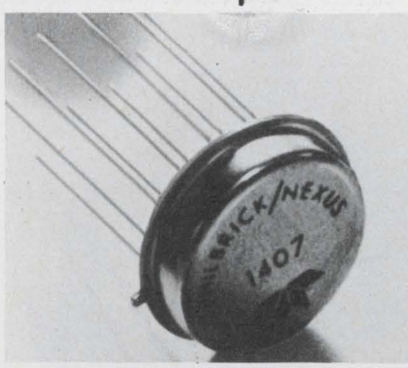


Circa Tran, Inc., P.O. Box 832, Wheaton, Ill. Phone: (312) 858-3727.

Known as the Circa-Film Alpha, a new custom-engineered thick-film hybrid microcircuit offers low-cost advantages through the use of mechanized assembly methods which eliminate costly hand assembly. Advantages include improved temperature stability, higher power levels and increased circuit density over comparable PC boards.

CIRCLE NO. 253

FET-input op amp slews at 8 V/μs

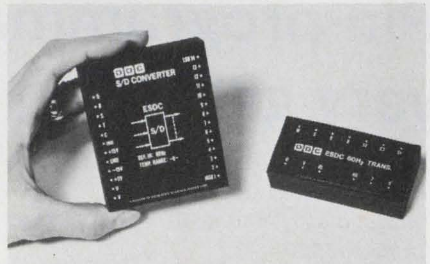


Philbrick/Nexus Research, a Teledyne Co., Allied Dr. at Route 128, Dedham, Mass. Phone: (617) 329-1600. P&A: $72 or $80; stock.

Supplied in a low-profile TO-8 metal can, the model 1407/14070 FET-input operational amplifier features a gain-bandwidth product of 30 MHz and a slew rate of 8 V/μs. The unit's common-mode rejection ratio is 10,000 at ±10 V, and its input impedance is 10^5 MΩ. The output is protected against short circuits to ground.

CIRCLE NO. 254

Synchro converter resolves 14 bits

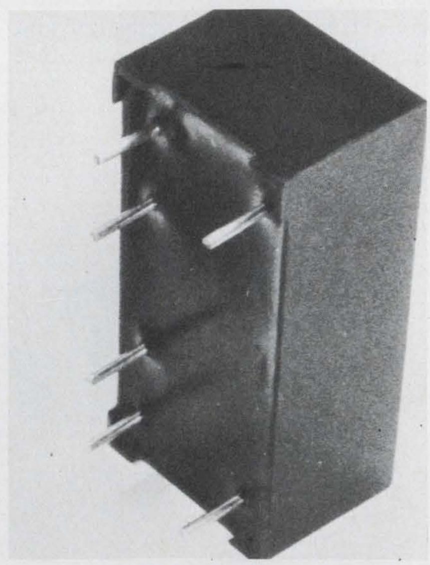


DDC, 100 Tec St., Hiscksville, N. Y. Phone: (516) 433-5330. P&A: $795 or $895; stock to 4 wks.

Designed for 50-to-60-Hz operation, the ESDC-6 converts synchro-angle input information to continuously available digital output data with 14-bit resolution. Accuracy over its entire operating temperature range is ±4 minutes ±0.9 the least significant bit. Synchro input is 90 V rms into 4 MΩ and reference input is 115 V rms at 2.5 mA.

CIRCLE NO. 255

Double balanced mixer drops cost to $6

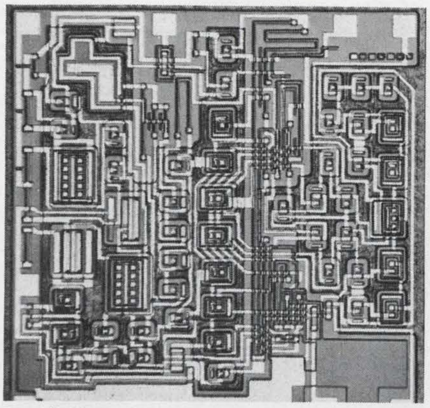


Andus Engineering, P.O. Box 8, Arlington, Mass. Phone: (617) 646-2121. P&A: $6 to $8.50; 2 wks.

Covering a frequency band of 150 kHz to 200 MHz, a new double balanced mixer slashes costs to $6 per mixer in 1000-piece lots, and $8.50 in single-piece quantities. The model DBM-1 has a midband conversion loss of 5 dB and midband balance of 50 dB. It will accept inputs of up to 0.5 W.

CIRCLE NO. 256

Wideband op amp has 2-nA offset

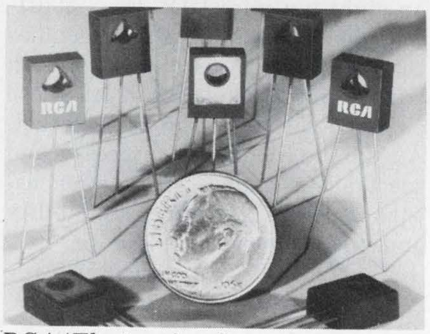


Radiation Inc., Microelectronics Div., P.O. Box 37, Melbourne, Fla. Phone: (305) 727-5430. P&A: $10.70 or $17.85; stock.

Offering typical bias and offset currents of 2 nA, a new operational amplifier provides a gain-bandwith product of 60 MHz at 20-dB closed-loop gain and 100 MHz for 40 to 100 dB of gain. Model RA-2620 is internally compensated for closed-loop gains of greater than three with a unity-gain cross-over frequency at 35 MHz.

CIRCLE NO. 257

Plastic transistor dissipates 25 W

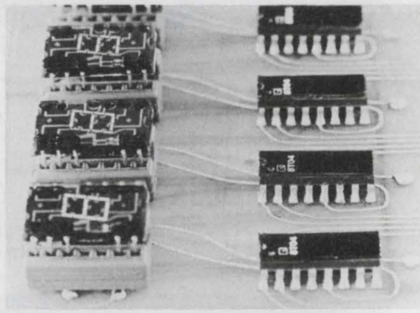


RCA/Electronic Components, 415 S. Fifth St., Harrison, N.J. Phone: (201) 485-3900.

Said to offer the advantages of a TO-5 metal-can-packaged device, a new plastic power transistor can furnish up to 25 W of dissipation (with a single screw mount to its heat sink) or can be lead-mounted (similar to a standard TO-5 can). After a double insulating overcoat, the transistor chip is mounted on a copper slug for direct contact with any available heat sink.

CIRCLE NO. 258

Decoder/drivers operate from 5 V

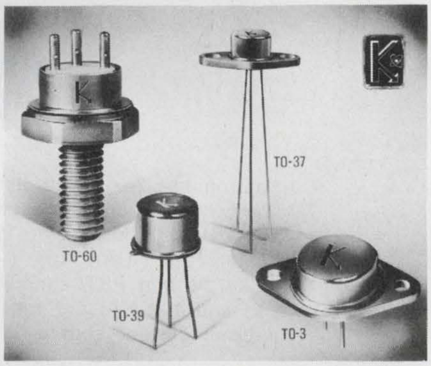


Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. Phone: (408) 739-7700. P&A: $4.84 or $5.62; stock.

Two new seven-segment decoder/drivers, which feature high output sink currents, can operate directly from 5-V sources. Model N8TO4B decoder/lamp-driver has a current-sinking capability of 40 mA per segment. Model N8TO5B decoder/transistor-driver provides a resistive pull-out output circuit.

CIRCLE NO. 259

Power transistors switch in 35 ns

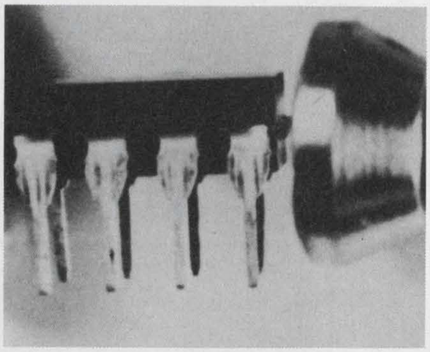


Kerton Inc., 7516 Central Industrial Dr., Riviera Beach, Fla. Phone: (305) 848-9606. P&A: $2 to $30; stock to 1 wk.

A new series of power transistors can switch operating currents as high as 0.25 to 20 A with typical on and off times of 35 and 85 ns, respectively. Operating voltages for these units range from 20 to 100 V. Packages vary from a TO-39 housing for low-current devices to a TO-3 can for currents above 5 A.

CIRCLE NO. 260

Half-size op amp is eight-pin DIP

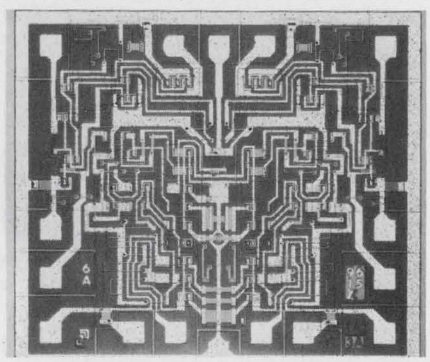


National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. Phone: (408) 732-5000. P&A: $4.85; stock.

Housed in a new type of package, an eight-pin mini-DIP, the LM301-AN operational amplifier doubles the capacity of standard 16-pin dual-in-line sockets—two of these op amps can fit in the same socket. A unique molding process and special lead-frame construction assure moisture resistance, reliability and environmental resistance.

CIRCLE NO. 261

Driver & receiver use 5-V supplies



Fairchild Semiconductor, 313 Fairchild Dr., Mountain View, Calif. Phone: (415) 962-3563. Price: $11.40 to $22.80.

Able to operate directly from 5-V supplies, a new dual differential line driver and a new dual differential line receiver provide uncommitted collector outputs. The model 9614 driver features a current sinking capability of 40 mA, while the model 9615 receiver features a common-mode rejection of 15 V.

CIRCLE NO. 262

Frequency divider is a single chip

International Telephone and Telegraph Corp., 3301 Elex Way, West Palm Beach, Fla. Phone: (303) 842-2411. P&A: $3.60; stock.

A complete seven-stage frequency divider circuit is now available in a package measuring just 3/4 by 1/2 in. Reportedly, the circuitry necessary for a seven-stage divider of this complexity would require at least one printed circuit board of 5 by 10 in. Although primarily designed for use in eletcronic organs, the model SAJ110 frequency divider is useful in various sequential circuits.

CIRCLE NO. 263

Bright red LEDS need only 10 mA

Plessey Co. Ltd., Microelectronics Div., Optoelectronic and Microwave Unit, Wood Burcote Way, Towcester, Northants, England.

Guaranteeing an optical power of 120 or 40 μW, two new red light-emitting diodes give a typical brightness of 225 foot-lamberts (the GPL 2) or 90 foot-lamberts (the GPL 1) with only 10 mA of operating current. Continuous operation is possible up to 25 mA with increased brightness. Both diodes can be pulsed at operating currents as large as 1 A.

CIRCLE NO. 264

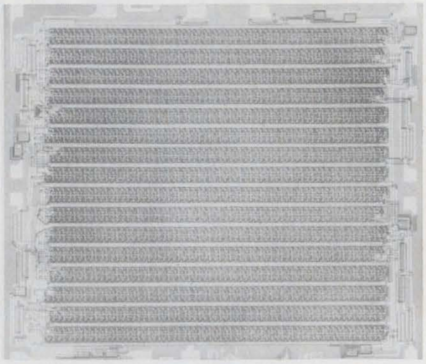
Tiny infrared LED mounts on PC boards

Monsanto Electronic Special Products, 10131 Bubb Rd., Cupertino, Calif. Phone: (408) 257-2140. Price: $2.30.

Housed in a double-ended flat-lead package for PC-board mounting, a new infrared light-emitting diode is subminiature in size for use in array applications requiring center-to-center spacings as small as 0.087 in. Model ME60 delivers a 550-μW total irradiated power at a forward current of 50 mA. In addition, its novel molded lens design results in a highly directional radiation pattern, thus eliminating crosstalk in dense-array applications.

CIRCLE NO. 265

1024-bit registers can clock to 5 MHz

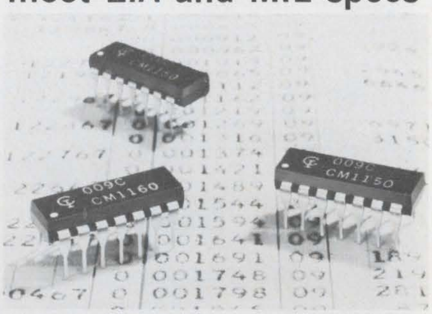


Intel Corp., 365 Middlefield Rd., Mountain View, Calif. Phone: (415) 969-1670. P&A: $25.60; stock.

Three monolithic LSI shift registers, which handle 1024 bits, have a power dissipation of only 500 mW at 5-MHz clock rates, dropping to 200 mW at 1 MHz. Model 1402 is a 16-lead DIP with four 256-bit registers; model 1403 is a TO-5 package with two 512-bit registers; and model 1404 is also a TO-5 can with a single 1024-bit register. They all are DTL/TTL compatible.

CIRCLE NO. 266

Interface circuits meet EIA and MIL specs

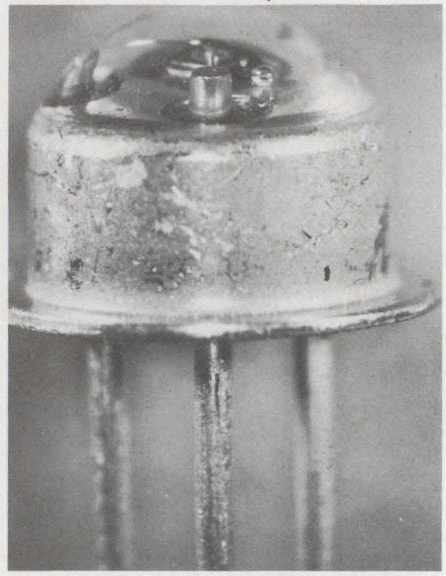


Cermetek, Inc., 660 National Ave., Mountain View, Calif. Phone: (415) 969-9433. P&A: $8.45; stock.

Dual transmitter and receiver interface circuits are said to be the first monolithic devices capable of meeting both B and C revisions of the EIA (Electronic Industries Association) specification RS232 and MIL-STD-188B. The CM1150 dual transmitter and the CM1160 dual receiver offer the designer of computer equipment flexibility in input/output interface design.

CIRCLE NO. 267

Photo-transistor works at 150 μA



Siemens Corp., Components Div., 186 Wood Ave., South Iselin, N. J. Phone: (201) 494-1000. P&A: $3.80; 4 to 6 wks.

A new npn-type photo-transistor features a typical photo-current of 150 μA for an illumination of 1000 lux. The unit, which is designated as model BP 101, is packaged in a TO-18 case with a translucent epoxy cover. Initial applications include automatic electronic flashlight units and electronic toys.

CIRLE NO. 268

IC display drivers block up to 400 V

Unitrode Corp., 580 Pleasant St., Watertown, Mass. Phone: (617) 926-0404. P&A: $1.85; 2 to 3 wks.

Series EL20 and EL200 solid-state switches are specially designed drivers for electroluminescent displays. They have forward and reverse blocking voltages from 200 to 400 V with high reverse gain for minimum power consumption. All units can be driven directly from low-level ICs. They are available in standard TO metal cans.

CIRCLE NO. 269

LINEAR

The best of Linear

For the past several months, we've presented a profusion of facts, specs and applications on Linear Integrated Circuits.

It's time for a recap. Just in case anybody missed something they shouldn't have.

The following two pages contain the most significant product information we've presented in this ad series. Not that everything else wasn't important.

But, if we only had one ad to run this year, this is the ad we'd run.

Introducing the World's First Monolithic J-FET Input Op Amp

Punch-through op amps are solete.

Fairchild's new μA740 now ers 150 pA (max.) current into her input. While some manu-:turers are talking about super ta or punch-through transistors th current gains of 1000, irchild technology now makes ssible J-FET devices with uivalent betas of over 15,000. ıd, they're completely compat-e with standard monolithic ocessing.

The μA740 is a simple two-ıge design similar to the μA741, t employs J-FET input tran-tors to obtain extremely low out currents.

740 Electrical Performance

ɔut Current .... 150pA max.
(either input)
ity Gain Slew Rate 6V/μS
ɔut Resistance .... 10^{12} Ohms
ltage Gain 120dB
ɔut Offset Current 30pA

The new linear has all the convenience of the μA741: internal frequency compensation for unity gain, input over-voltage protection to either supply, output short circuit protection to ground or either supply, and the absence of "latch-up."

Balanced offset null is easily obtained with a 10KΩ potentiometer and does not affect other parameters.

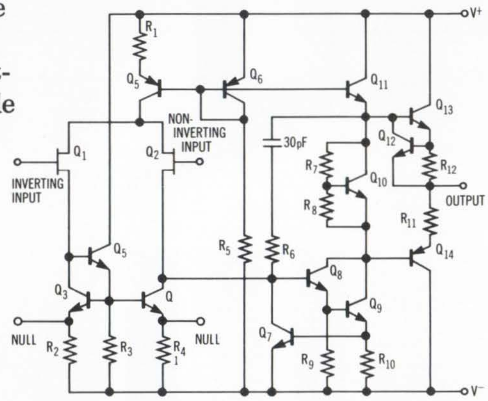
Other μA740 features include a wide common mode range of ± 12 volts, high differential voltage range of ± 30 volts, and wide operating supply range of ± 5V to ± 22V.

The μA740 is directly interchangeable with the μA741, μA748 or μA709.

The new Fairchild device provides circuit designers with superior performance in such applications as active filters, voltage followers, integrators, summing amplifiers, sample and holds, transducer amplifiers and other general-purpose feedback applications.

The μA740 is now available in TO-99 packages (both military and industrial temperature ranges) from any Fairchild Distributor.

Reader Service Number 63



μA740 FET INPUT OP AMP

The New μA796:

We Knew It Was Going To Be Versatile, But We Didn't Know How Versatile.

The new low-cost μA796 Doubly ılanced Modulator/Demodu-:or is finding its way into an ıazing variety of systems.

Communications-gear engi-ers are taking advantage of its eat versatility and high carrier ppression in modulators and modulators for single sideband, ppressed carrier and phase ift key transceivers. It's also ing used as a synchronous AM modulator, a quadrature FM modulator, and as a phase mparator for phase locked loop :eivers.

Digital tape/disc memory signers are utilizing the μA796's ique properties in fast differ-tiators and phase correcting circuits for NRZ or phase encoding systems, while remote D.C. R-G-B gain controls, color shade and keystone corrections are practical for color TV broadcast equipment use. Other possibilities lie in signal chopping, frequency changing, linear mixing and more.

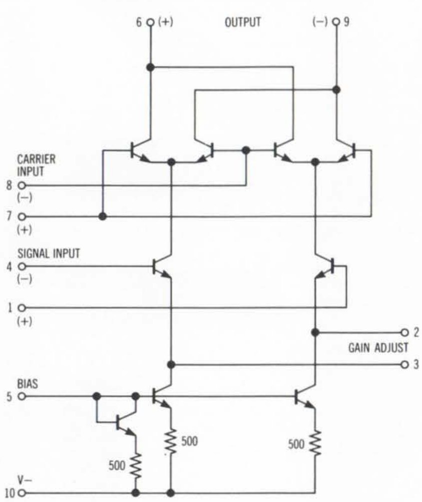
Here Are The Specs:

Carrier Suppression	65dB
Transadmittance Bandwidth	
Carrier Port	300MHz
Signal Port	80MHz
Signal Gain	3.5V/V
Input Impedance (signal port)	200KΩ
Input Offset Current	0.7μA
Differential Output Swing	8.0 volts p-p

Here Are The Prices:

U5F7796312 −55°C to +125°C	$4.80 @ 100 pcs.
U5F7796393 0°C to 70°C	$2.25 @ 100 pcs.

μA796 DOUBLY BALANCED MODULATOR/DEMODULATOR



Reader Service Number 64

FAIRCHILD SEMICONDUCTOR

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

New Op Amp has Gain of 3,000,000.

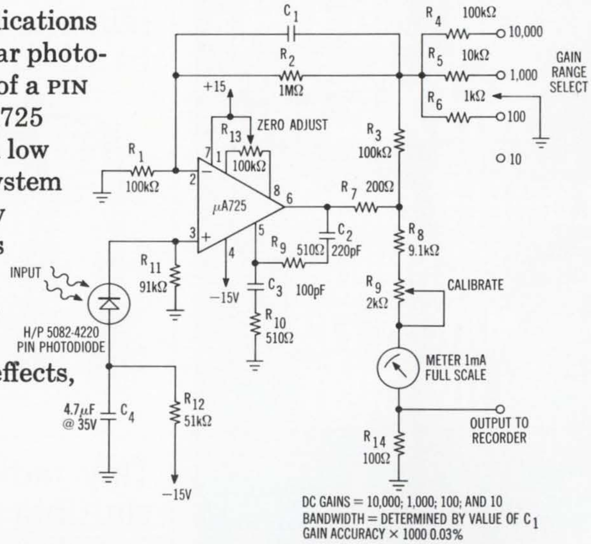
Fairchild's new μA725 Instrumentation Operational Amplifier can do the same jobs that used to require expensive chopper-stabilized or complex discrete component amplifiers. The μA725 is ideally suited for use in Low Level Signal Conditioners, Instrumentation Amplifiers, Precision Measuring Equipment, Process Control Systems and Data Acquisition Equipment.

Electrical Performance/Features

Low Input Noise Current . . . 0.6pA/Hz
High Open Loop Gain 3,000,000
Low Input Offset Current 3nA
Low Input Offset Voltage Drift . . . . 0.5μV/°C
High Common Mode Rejection . . 120dB

One of the many applications for the μA725 is in Linear photo-detection systems. Use of a PIN Photodiode with the μA725 provides the user with a low noise linear detection system which operates from low voltage supplies and has none of the inherent disadvantages of photo-multiplier tubes (high voltage supplies, aging effects, large physical size, high power dissipation).

Reader Service Number 61



μA725 PIN PHOTODIODE AMPLIFIER

Micropower Exists-μA735

Minimizing power drain, weight and space gives design engineers ulcers (how come the system power supply designer is the last one to know you've overrun the allotted system power consumption?).

Here's good news. Relief exists:

The μA735 micropower operational amplifier uses only 100μW at ± 3.0 volts.

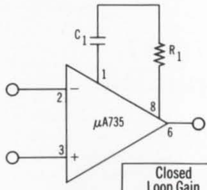
Systems such as space vehicles, aircraft, and portable medical equipment will benefit from the use of the μA735 by shrinking bulky batteries. It gives you low quiescent currents. It also gives you versatile, accurate and cool operation without the customary design tradeoffs.

In addition, the μA735 simplifies design of high impedance instrumentation circuits due to its extremely low input currents.

Here are some typical device specifications:

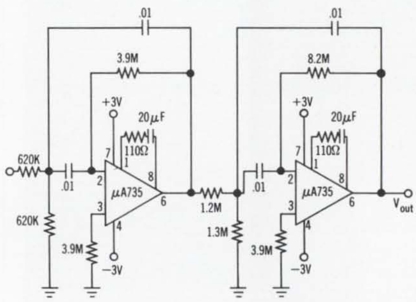
input offset current	500 pA
input bias current	5.0 nA
input offset voltage	1.0 mV
supply voltage range	± 3 volts to ± 18 volts
power consumption	100 μW
open loop voltage gain	20,000
input impedance	10 mΩ
noise	.5 pA / √ Hz

Smart engineers who like to minimize component count can now take advantage of a new simplified frequency compensation scheme that applies over the entire supply voltage range of the μA735.



Closed Loop Gain	C_1	R_1
1	20nF	110Ω
10	2nF	1.1kΩ
100	680pF	11kΩ

Most engineers like to eliminate those large, expensive, hard-to-find capacitors that hog space and dollars. Here's a nifty little application which will avoid large capacitors in low frequency, active filter design. And with very low supply current drain!



This circuit has a center frequency at 10 Hz, 12 dB rolloff with −3 dB points at 6.5 Hz and 14 Hz. The μA735 lets you use small capacitor values and large resistors for frequency shaping at a few Hz, due to the μA735's low input offset current.

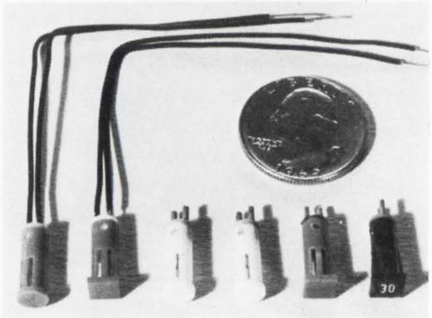
The new price is low, too –

μA735	−55°C to +125°C	$37.50 @ 100
μA735B	−20°C to +85°C	$22.50 @ 100
μA735C	0°C to +70°C	$15.00 @ 100

See? Micropower does exist; alive and in quantity at your Fairchild distributor.

Reader Service Number 62

Miniature indicators fit 16 to a square in.

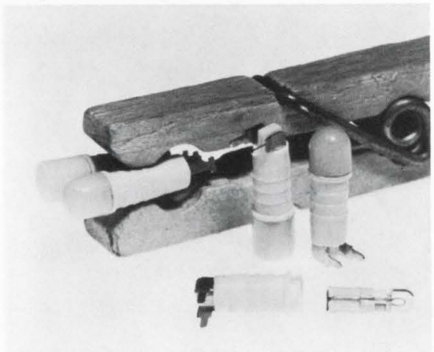


Nucleonic Products Co., 6660 Variel Ave., Canogo Park, Calif. Phone: (213) 887-1010.

Extending only 0.039 in. from the front of a mounting panel and 0.649 in. from the back of the panel, series 1.69508 indicator lights are so tiny that 16 of them require one square in. of panel space. Connection to these built-in 6, 12 or 24-V bulbs can be in the form of solder pins or with 4-in. wire leads. Housings mount into 0.197-in.-dia. holes.

CIRCLE NO. 270

Tiny indicators clip into place

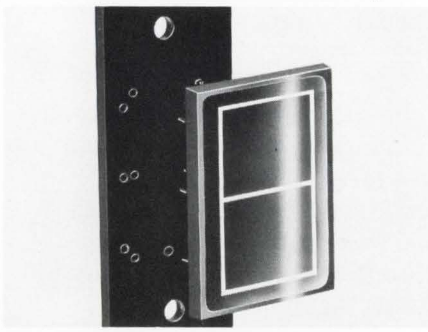


Oak Electro-/Netics Corp., Marco-Oak Industries Div., P.O. Box 4011, Anaheim, Calif. Phone: (815) 459-5000.

Series QT miniature indicator lights now come with a special retaining clip to ease installation and ensure positive retention. The clip, which fits over the light's base behind the panel, eliminates installation difficulties caused by drilling or stamping oversize mounting holes. The lamps are 7/32 in. in diameter.

CIRCLE NO. 271

Alphanumeric readout is about 0.175-in. deep

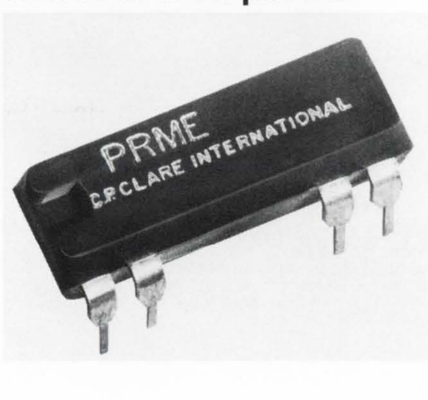


Pinlites Inc., 1275 Bloomfield Ave., Fairfield, N. J. Phone: (201) 226-7724. Price: $7.95.

Maxi-Lite series 10-50 is a digital and alphanumeric readout with an incandescent filament, featuring 5/8-in.-high characters at an overall depth of 0.175 in. It also has a 120-degree viewing angle, variable brightness, and low operating voltage and current of 5 V and 20 mA, respectively. A matching connector and a decoder/driver are available.

CIRCLE NO. 272

IC-compatible relay comes in a 14-pin DIP

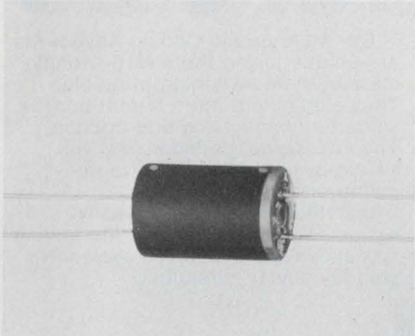


C. P. Clare International N. V., Gen.-Graty 102-1040, Brussells, Belgium. Availablity: August, 1970.

The Picoreed is a subminiature sealed-contact 14-pin DIP relay that is fully compatible with ICs. It can be driven by series 54/74 TTL without a buffer or an amplifier, and is available for 6, 12 and 24-V dc operation. Sensitivity is 35 mW with ICs, and 45 to 130 mW with other types of circuits. It operates within 500 μs and releases within 100 μs.

CIRCLE NO. 273

Optical isolators withstand 5000 V

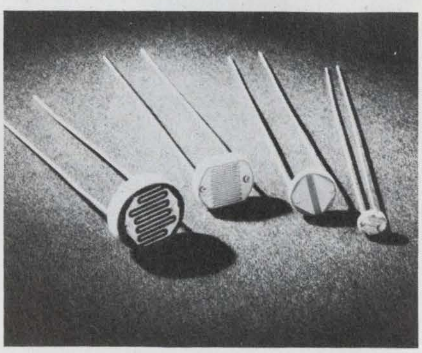


Optron, Inc., 1201 Tappan Circle, Carrollton, Tex. Phone: (214) 242-6571. P&A: $11.73 or $13.49; stock.

Designed for interfacing data, a new series of optically coupled isolators provide input/output isolation of up to 5000 V. Each isolator consists of a GaAs input diode driving a silicon photodetector. The OP1060 has a minimum output of 0.25 mA. The OP1020 offers fast response while the OP1030 offers high gains. The OP1090 is a photodiode detector.

CIRCLE NO. 274

Plastic photocells span 0.45 to 166 kΩ



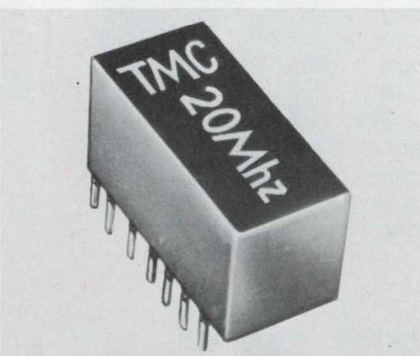
Clairex Electronics Div. of Clairex Corp., 560 S. Third Ave., Mount Vernon, N.Y. Availability: stock.

Available in plastic-encapsulated cases, a new line of low-cost CdS and CdSe photoconductive cells range in resistances from 450 to 166,000 Ω at two foot-candles of light. They are available in four sizes ranging from 0.07 to 0.435 in. in diameter. Custom tailoring of sensitivity and slope characteristics is possible.

CIRCLE NO. 275

COMPONENTS

IC crystal oscillator comes in a 14-pin DIP

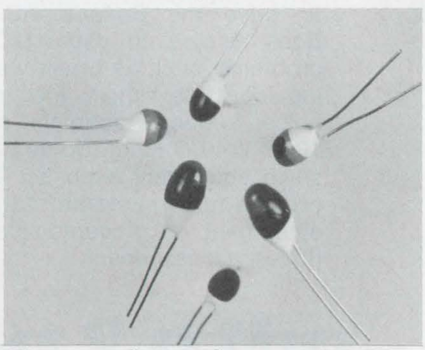


TMC Systems, Inc., 930 W. 23 St., Tempe, Ariz. P&A: from $18.45; 2 to 10 wks.

Covering the frequency range of 18 to 25 MHz, the XO-2007 IC crystal oscillator features a 14-pin dual-in-line package configuration. Stability is ±50 ppm over 0 to 50°C. Input power is 5 V dc ±10% at 22 to 30 mA. Output is a squarewave which drives TTL loads. Special ranges of 10 to 18 MHz and 26 to 30 MHz are available.

CIRCLE NO. 276

Tantalum capacitors reach 100 μF at 35 V

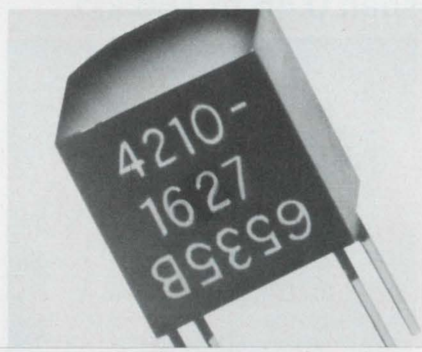


Siemens Corp., Components Div., 186 Wood Ave. South, Iselin, N.J. Phone: (201) 494-1000.

A line of miniature tantalum capacitors come with capacitance values of 0.1 to 100 μF, and in voltage ratings from 3 to 35 V dc. Reportedly priced competitively with miniature aluminum electrolytics, series B45134 units can operate over a temperature range of −55 to +85°C without derating. These epoxy-coated devices have radial leads.

CIRCLE NO. 277

Miniature transformer has 0.4-μs rise time



Bourns Pacific Magnetics Corp., 28151 Highway 74, Romoland, Calif. Phone: (714) 657-5195

Designed to operate over the full temperature range of −55 to +125°C, the model 4210-1627 miniature high-voltage blocking oscillator transformer has rise and fall times of 0.4 and 1 μs, respectively. Specifications include insulation resistance of 10^4 MΩ, rated power of 1500 mW at a 30% duty cycle, and dielectric strength of 1120 V ac.

CIRCLE NO. 278

Security terminal contains computer

Saber Laboratories, Inc., 1150 Bryant St., San Francisco, Calif. Phone: (415) 431-4707.

As easy to use as a typewriter and packaged in a standard attache case, the Mark IV data terminal may be used for business communications and messages of a high-security nature. It has a computer, a keyboard and an alphanumeric tape printer. The built-in computer generates the programs necessary to encipher (code) and decipher (decode) messages.

CIRCLE NO. 279

Portable terminal prints alphanumerics

Electronic Arrays, Inc., 9060 Winnetka Ave., Northridge, Calif. Phone: (213) 882-9610.

A new portable computer terminal can accept and printout either fixed or variable alphanumeric data and/or query/responses with simultaneous printout of the alphanumeric data. Model CT-100 communicates with the computer in ASCII code and format. It contains a 12-pushbutton keyboard, a reader for plastic punched cards, a strip printer, and a coupler.

CIRCLE NO. 280

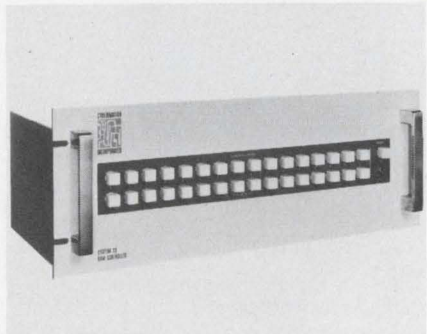
CRT display terminals sell for only $1280

TEC, Inc., 6700 S. Washington Ave., Eden Prairie, Minn. Phone: (612) 941-1100. Price: $1280.

Priced from $1280 in quantities of 100, a new line of CRT display terminals offers a repertoire of 68 dot-matrix characters available in a variety of formats—up to 1536 characters per page—displayed on a standard TV monitor. Series 400 Data-Screen terminals are available in single or multi-station configurations. They are self-contained with a detachable keyboard.

CIRCLE NO. 281

Rack-mount controller links minicomputers

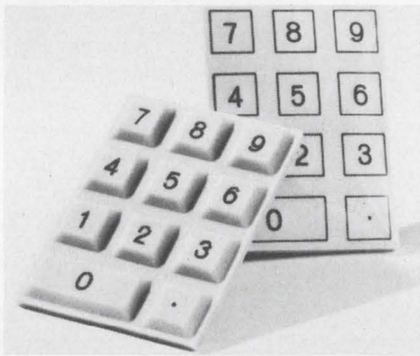


Cybermation Inc., River Rd., Washington Crossing, Pa. Phone: (215) 493-3686. P&A: $10,000; 8 to 12 wks.

A self-contained rack-mounted random - access - memory controller permits direct communication between any minicomputer and moving-head, removable disc, bulk-data storage devices. Called System 23, the unit is a full I/O processor/selector channel controller, and is capable of connecting a minicomputer with up to eight drives.

CIRCLE NO. 282

Sealed keyboards have thin profile



Flex Key Corp., 1277 Main St., Waltham, Mass. Phone: (617) 891-1320. P&A: $9.95 or $12.95; stock.

With a total thickness of 1/8 in. (model DK-1L) or 1/4 in. (model DK-1M), two new sealed-construction keyboards occupy no behind-the-panel space beyond their 1/8-in.-long terminations. Pressing a key moves a conductive membrane through a thin aperture film and into contact with a PC board. Each key is effectively a single-pole momentary-closure switch.

CIRCLE NO. 283

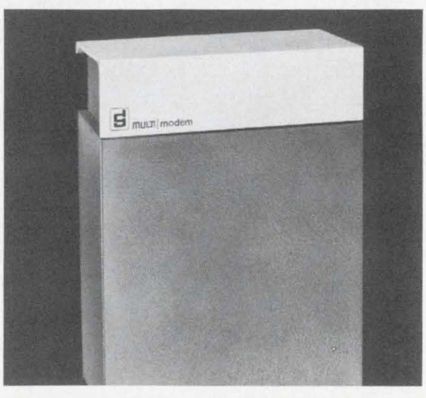
On-line data terminal types 17 characters/s

Anderson Jacobson, Inc. 1065 Morse Ave., Sunnyvale, Calif. Phone: (408) 734-4030.

Model AJ 841 on-line conversational terminal can handle typing speed bursts of up to 17 characters per second, so that a fast typist cannot cause a misprint, even on computer log-in. The unit can be connected to any computer providing 2741 Selectric software, and it features the Selectric heavy-duty I/O keyboard-printer. A built-in modem is included.

CIRCLE NO. 284

Family of modems is truly modular

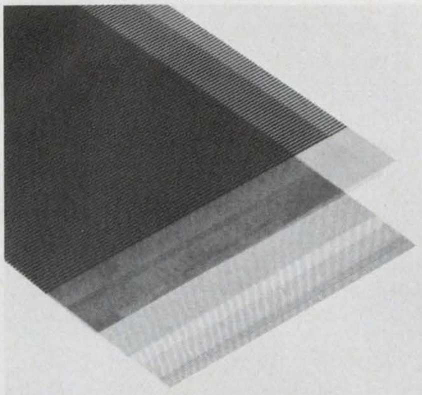


General DataComm Industries, 537 Newton Ave., Norwalk, Conn. Phone: (203) 847-2445.

Featuring ServiSnap construction, Multimodem data sets completely snap-apart and all their printed circuit cards, their card nests, and their power supplies are removable without using any tools. Series 103 units transmit serial asynchronous data, while series GDC-202 modems handle asynchronous binary data. Series 402C models are simplex (transmit-only) data sets.

CIRCLE NO. 285

Stable wire memory uses epoxy-fiber



Memory Systems, Inc., 3341 El Segundo Blvd., Hawthorne, Calif. Phone: (213) 772-4220. P&A: 35¢/square in. (0.025-in. wire centers); stock to 2 wks.

A new family of tunnel structures using epoxy-fiber materials allows plated-wire memory planes exceptional dimensional uniformity, freedom from cold flow and improved mechanical strength.

The structures use a combination of epoxy and a randomly-oriented polysaccharide fiber material supported in a urethane medium.

The material contains no abrasive glass fibers and withstands processing temperatures to 350°F. It is bondable with a wide variety of adhesives, and is insensitive to most cleaning solvents, thus allowing conventional handling.

The use of epoxy-fiber material results in superior plated-wire memory mechanical properties and low costs, compared to the use of conventional Kapton/Teflon laminates which cost more and have cold flow problems.

Tightly controlled spacing of the tunnels assures the precise alignment to PC mounting pads without artwork compensation.

Tunnel structures are available with plated-wire memory plane and stack assemblies, or as separate items, forming wires that are still in position.

A standard line is available with lengths up to 16 in. and widths up to 12 in. Center-to-center spacings range from 10 to 50 mils, and tunnel diameters range from 3 to 10 mils.

CIRCLE NO. 286

Portable low-cost VOM has 50-kΩ/V impedance

Unimetrics, Inc., 23 West Mall, Plainview, N. Y. Phone: (516) 694-9171. P&A: $27.95; stock.

The Omnimeter-50K is a 50-kΩ/V portable low-cost volt-ohmmeter that measures dc voltages up to 1 kV in 12 ranges and ac voltages up to 1 kV in 10 ranges. It also measures resistances up to 1000× in 4 range with 65 kΩ at center scale. Dc currents and decibels can also be measured. The meter includes a mirror scale, and a diode-protected meter movement.

CIRCLE NO. 287

True-rms voltmeter checks many waveforms

Scientific-Atlanta, Inc., Box 13654, Atlanta, Ga. Phone: (404) 938-2930. P&A: $3600; 4 wks.

Measuring true rms or peak values of continuous waveforms, or bursts of complex waveforms, is the 1166 sampling digital voltmeter. Its square-law detector can measure a waveform over an interval of 10 μs with a sample period of 3.3 ms. It reads out in linear and logarithmic scales with accuracies of 3% of reading and 0.25 dB, respectively.

CIRCLE NO. 288

10-MHz pulse generator has 3-ns rise time

Dytech Research Corp., Box 162, Santa Clara, Calif. Phone: (408) 241-4333. P&A: $160; stock.

The model 701 is a low-cost pulse generator that features pulse rise and fall times of under 3 ns from 10 Hz to 8 MHz. Output amplitude is variable from 0 to +5 V into a 50-Ω load. Pulse width is adjustable from 80 ns to 100 ms. Maximum duty factor is over 90% and minimum duty factor is 85%.

CIRCLE NO. 289

DVM with 5-1/2 digits is accurate to ±0.005%

Systron Donner Corp., 888 Galindo St., Concord, Calif. Phone: (415) 682-6161. Price: $1295.

Retailing at $1295, the 7005 digital voltmeter features a 5-1/2-digit readout, 10-μV resolution (optional to 1 μV) and an accuracy of ±0.005% of reading. Measurements are made at a rate of 5 samples per second, and readings include an autopositioned decimal point, a polarity sign, and an annunciator. Overrange factor is 20%. The meter uses a combination of a dual-slope integrating technique and a high-speed active filter for measurements.

CIRCLE NO. 290

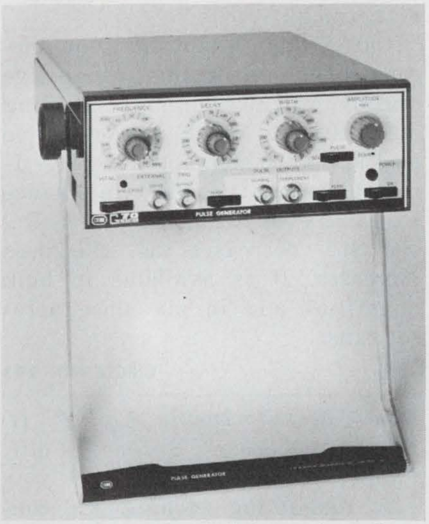
200-MHz counter-timer retails at only $895

Itron Corp., 11675 Sorrento Valley Rd., San Diego, Calif. Phone: (714) 453-5300. P&A: $895; stock.

Reading frequencies from dc to 200 MHz, and period and time intervals from 1 μs to 2000 s, the model 680 counter-timer retails for only $895. Its circuitry is composed of TTL ICs mounted on plug-in sockets for easy maintainability. Sensitivity is 50 mV up to 2 MHz and 100 mV up to 200 MHz.

CIRCLE NO. 291

$395 pulse generator delivers 5 V at 50 MHz



E-H Research Laboratories, Inc., 515 11th St., Oakland, Calif. Phone: (415) 834-3030. P&A: $395; stock.

Satisfying performance requirements without straining budget allocations, a new pulse generator provides a repetition rate of 50 MHz at an amplitude of ±5 V for only $395. The model G 710 is the first instrument in a new series of Generation 70 equipment, a completely innovative line for this decade.

No calibration adjustments and standard non-selected parts are inherent features of the new generator. All replacement parts are available from local dealers. The manual provided with the G 710 is all that is needed to trouble-shoot the instrument.

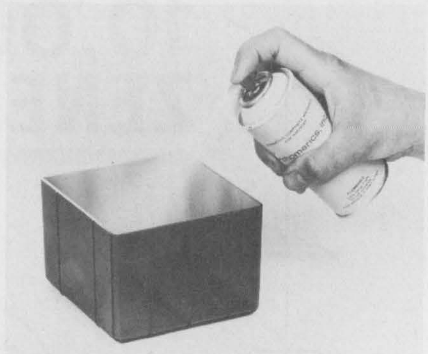
Since the G 710 has internal 50-Ω terminations for driving non-50-Ω lines, it eliminates mismatch effects and reflections. Rise and fall times for the new instrument are less than 5 ns, and pulse duty factor is greater than 50%.

Pulse delay and pulse width are controlled from the front panel and are variable from 10 ns to 50 ms. Waveform distortion is less than 5% pk-pk.

External triggering, single-cycle operation, and either single or double-pulse modes are other features. The G 710 is a human-engineered product—all its front-panel controls are color coded for simple operation.

CIRCLE NO. 292

Spray-on acrylic paint gives rfi/emi shielding

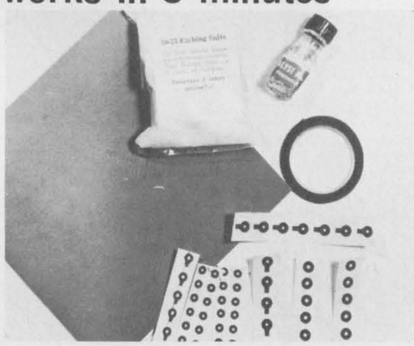


Chomerics, Inc., 77 Dragon Court, Woburn, Mass. Phone: (617) 935-4850. Price: $45/lb or $16.20/6-oz. can.

Called 4900, a new spray-on one-component air-drying conductive coating provides emi/rfi shielding on plastic or other nonconductive enclosures. When applied in a 1-mil thickness, it exhibits a surface resistivity of 0.05 Ω/square. Resistivity decreases as thickness increases. It is available in bulk quantities and in six-ounce aerosol cans.

CIRCLE NO. 293

Speedy etching kit works in 3 minutes

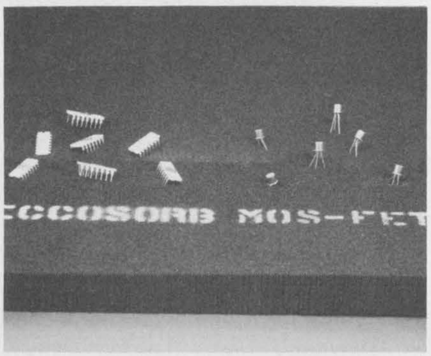


Houle Manufacturing Co., P. O. Box 276, Santa Susana, Calif. Phone: (805) 526-8118.

A fast-acting etching kit consisting of a 1/4-lb package of amonium persulfate and a bottle of catalyst allows PC-board etching in 3 to 5 minutes. Over 25 square inches of a one-sided copper board as well as a roll of 0.062-in. black tape and strips of 0.25 and 0.312-in.-diameter donuts and teardrops are included.

CIRCLE NO. 294

Conductive foam grounds out static

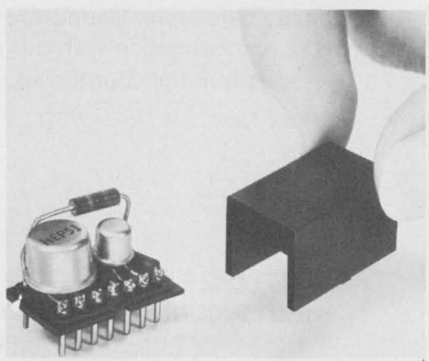


Emerson & Cuming, Microwave Products Div., Canton, Mass. Phone: (617) 828-3300. Price: $12 to $15.75.

Eccosorb MOS-FET is an electrically-conductive semi-rigid foam material with a low volume resistivity. It is used to prevent electrical overloads of solid-state devices such as MOSFETs, and LSI and MSI circuits. It can be used as a grounding medium for any device susceptible to damage by static electricity.

CIRCLE NO. 295

IC/component carrier is a plug-in 14-pin DIP



Design & Production Assoc., 1600 N. Arrowhead, San Bernadino, Calif. Phone: (714) 886-8612. P&A: 75¢ to $1; stock.

A new component carrier for mounting subminiature components and IC packages features a 14-pin dual-in-line plug-in configuration. The DIC-14 may be used as a simple carrier or with any of three sizes of detachable caps. It plugs directly into standard dual-in-line sockets or into 0.1-by-0.3-in. grid patterns in PC boards.

CIRCLE NO. 296

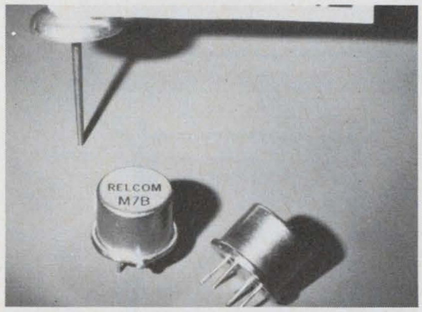
Plug-in-free generator sweeps out to 12.4 GHz

SpaceKom, Inc., P.O. Box 10, Goleta, Calif. Phone: (805) 967-7114. P&A: $5500 to $6800; 60 days.

Without any plug-ins, the model 103 sweep generator covers the frequency range from 10 to 12,400 MHz. This range is divided into three bands (0.01 to 4.2 GHz, 4.2 to 8 GHz and 8 to 12.4 GHz), and is selected by a front-panel control. Continuous sweeping is possible up to 4200 MHz, including the 10-to-4200-MHz range.

CIRCLE NO. 297

Balanced mixers reach 2500 MHz

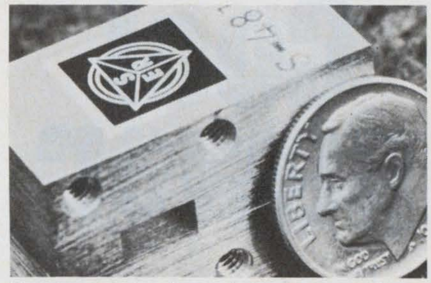


Relcom, 2329 Charleston Rd., Mountain View, Calif. Phone: (415) 961-6265. P&A: $30 or $60; stock.

Designed for low-noise applications, the M7B and the M7C high-frequency balanced mixers have upper frequency ranges of 2500 and 800 MHz, respectively. At 1500 MHz, the noise figure for the model M7B is typically 6 dB. Both mixers are packaged in a hermetically sealed TO-5 metal can.

CIRCLE NO. 298

Miniature circulators reach out to 40 GHz

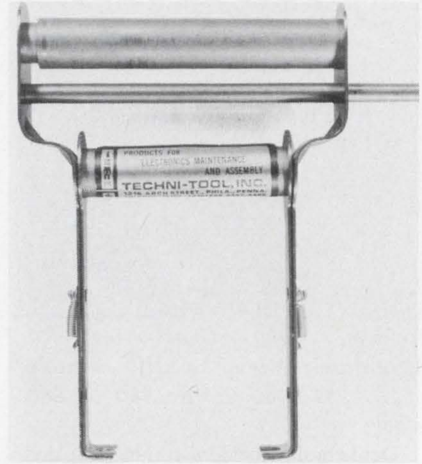


Sonoma Engineering & Research, 760 Montecito Center, Santa Rosa, Calif. Phone: (707) 539-2702.

Operating over the frequency range of 26 to 40 GHz, a new family of miniature circulators offers bandwidths from 100 to 400 MHz with 20 to 30 dB of isolation. A typical unit is the model S-4812 with a 200-MHz bandwidth, centered at 40 GHz, providing 20-dB isolation, 0.3-dB insertion loss and a maximum VSWR of 1.25. The unit measures 1.25 by 0.65 by 0.75 in.

CIRCLE NO. 299

Easy-to-use extractor removes connectors

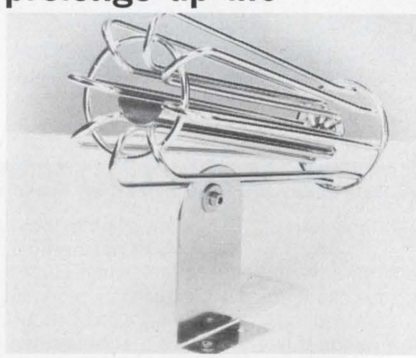


Techni-Tool, Inc., 1216 Arch St., Philadelphia, Pa. Phone: (215) 568-4457.

Designed to eliminate the struggle of disengaging 25 to 50-pin connectors, a new connector extractor, the model 4925, exerts an even pressure to eliminate the chance of damaging individual connector pins. A slight pressure of the fingers easily separates connectors. The tool is made of stainless steel.

CIRCLE NO. 335

Solder-iron holder prolongs tip life

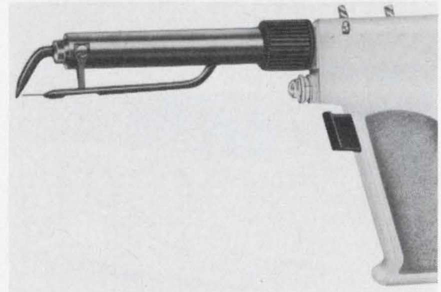


E. H. Titchener & Co., 1 Titchener Pl., Binghamton, N. Y. Phone: (607) 772-1161.

A new welded-wire soldering-iron holder provides easy access for soldering irons, when hot or cold. The unit's design is said to prolong element life since it allows for free passage of air around the soldering iron. An integral shield and cup prevent solder from dripping through the holder. The airy wire design speeds heat dissipation.

CIRCLE NO. 336

Single-hand gun auto-feeds solder

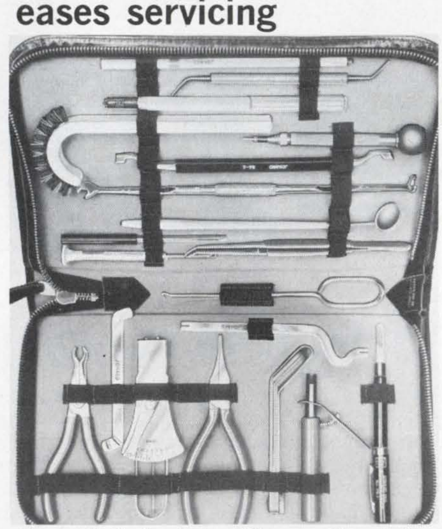


Ernest Spirig Consulting Engineers, P.O. Box 131, Zurich, Switzerland.

Able to be manipulated with just one hand, the L200 soldering gun features an automatic solder feed to its tip, thereby allowing the other hand to move the workpiece. This automatic solder feed is controlled by pressure on the actuating button. Plug-in heating elements are interchangeable and have ratings from 20 to 60 W.

CIRCLE NO. 337

Compact tool kit eases servicing

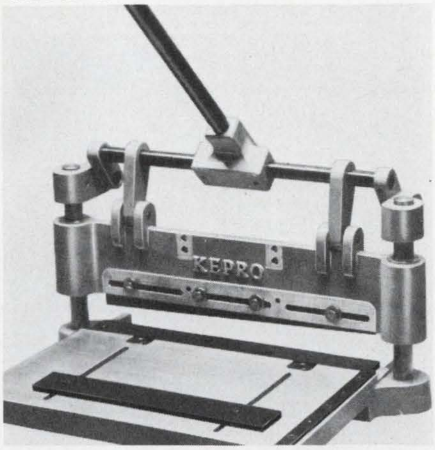


Jonard Industries Corp., Precision Tools Div., 3047 Tibbet Ave., Bronx, N. Y. Phone: (212) 549-7600.

A new 20-piece precision tool kit is specifically designed for servicing of business and central-office equipment. Kit K-77 includes dielectric tools that allow adjusting and repair on live equipment. It is supplied in a leather zippered case. Some tools are a pocket burnisher, a lamp extractor, and a thickness gauge.

CIRCLE NO. 338

PC-board tool shears and drills



Kepro Circuit Systems, Inc., 3630 Scarlet Oak Blvd., St. Louis, Mo. Phone: (314) 225-5166.

With appropriate attachments, a new benchtop tool can perform almost every mechanical process required in the production of etched circuit boards. The model MS-6 Multi-6 can shear, punch, notch and drill PC boards. The unit is basically a 12-in. shearing tool for precision cutting of clad or unclad plastic materials and sheet metals.

CIRCLE NO. 339

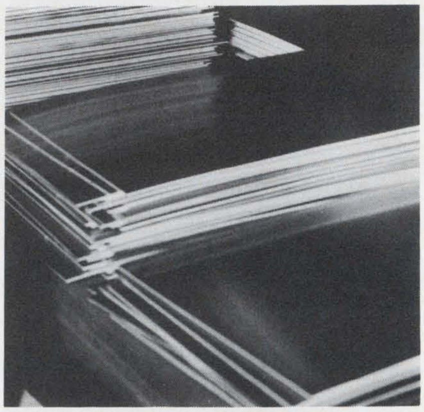
Work positioner holds connectors

Line-Master Products, Div. of Sandefur Engineering Co., Inc., 14507 S. Hawthorne Blvd., Lawndale, Calif. Phone: (213) 772-5255.

The LM 204B connector work positioner holds electrical connectors and lead wires in position so that solder flows down into the joint during wiring. The lead-wire holder keeps the wires separated and positions them vertically for maximum assembly efficiency and accuracy. The vise has reversible jaw pads.

CIRCLE NO. 340

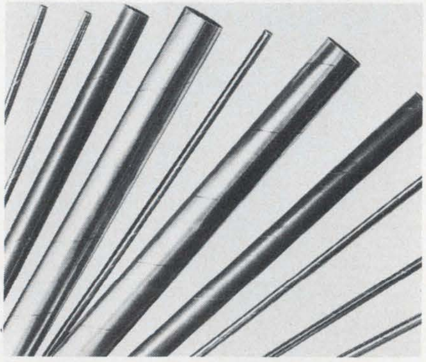
Evaluation Samples



Copper-clad laminates

Samples are available of two new glass epoxy copper-clad laminates with exceptionally good-drilling and measle-resistance characteristics in printed-circuit board materials. The new laminates are 65M27 and 65M28. Both are warp-free, have a high impact strength and high insulation resistance glass epoxy copper-clads which can be drilled or punched as easily as ordinary G-10 and FR-4 laminates. Westinghouse Electric Corp.

CIRCLE NO. 341



Spirally wound tubing

A sample of a new spirally wound thin-wall tubing made of copper, mu metal, or metal/plastic-film combination is available. It offers designers effective space-saving and cost-saving shielding for reed relays and other application where rfi or emi must be contained. Tubing is available with inside diameters from 0.09 to 1 in., with wall thicknesses from 1/2 mil, and in lengths of 36 in. Niemand Bros. Inc.

CIRCLE NO. 342

Design Aids

Data chatter platter

Sung by that famous duo of Randy Z and Bongo Jack, a new 33-1/3-rpm record honoring data processing makes its entry in the hit-record field. This stereo recording has six songs on both sides with titles such as "Push The Magic Button," "When I Was A Bachelor" and "Memory D'Amour," put to the tunes of such oldies-but-goodies as "Puff The Magic Dragon," "Foggy Foggy Dew" and "Melody D'Amour." Versatec, Inc.

CIRCLE NO. 345

Dielectric materials

Two unique and useful full-color charts show the dielectric constant and loss tangent at microwave frequencies of over 300 materials. Values for dielectric constants are given on an ordinate axis, while an abscissa axis lists loss tangent values. Density and heat capabilities for each material are also shown. Photographs illustrate physical characteristics and uses. Definitions of commonly used terms are also presented with helpful dielectric formulas. Emerson & Cuming, Inc.

CIRCLE NO. 344

Decimal equivalents

Equivalents of common fractions, expressed in decimals for inches and millimeters, are contained on a handy pocket-sized card. It treats fractions that range from 1/64 in. to 1 in. in 1/64-in. steps. Equivalents are given for each fraction, in decimal form, for both inches and millimeters. Industrial Electronic Engineers, Inc.

CIRCLE NO. 343

INFORMATION RETRIEVAL NUMBER 92

Annual Reports

American Electronic Laboratories, Inc., Richardson Rd., Colmar, Pa.
Broadcasting equipment, CATV, microwave components, electronic countermeasure systems.
1969: net sales, $21,484,741; net income (loss), ($849,623).
1968: net sales, $24,989,897; net income, $492,555.

CIRCLE NO. 346

AMP Inc., Eisenhower Blvd., Harrisburg, Pa.
Terminals and splices, connectors and interconnection systems, tooling, programming systems.
1969: net sales, $211,256,000; net income, $24,280,000.
1968: net sales, $167,172,000; net income, $16,227,000.

CIRCLE NO. 347

Burroughs Corp., Detroit, Mich.
Small, medium and large-scale computers, peripheral devices, on-line data systems, data encoders, calculators.
1969: revenue, $759,335,910; net income, $55,198,755.
1968: revenue, $655,560,491; net income, $43,301,352.

CIRCLE NO. 348

Dearborn Computer & Marine Corp., 6 N. Michigan Ave., Chicago, Ill.
Computer leasing, offshore petroleum drilling, marine services.
1969: total revenue, $38,335,000; net income, $2,727,000.
1968: total revenue, $10,613,000; net income, $1,250,000.

CIRCLE NO. 349

Electronic Memories & Magnetics Corp., 3435 Wilshire Blvd., Los Angeles, Calif.
Semiconductor, core and disc memories, magnets and PC boards.
1969: net sales, $84,440,000; net income, $4,983,000.
1968: net sales, $66,168,000; net income, $3,792,000.

CIRCLE NO. 350

The Electron Machine Corp., P.O. Box M, Umatilla, Fla.
Liquid-blending instruments, rafractometers, gauging instruments, flaw detectors.
1969: sales and other income, $873,584; net income, $66,984.
1968: sales and other income, $718,292; net income, $40,503.

CIRCLE NO. 351

High Voltage Engineering Corp., Burlington, Mass.

Shunt reactors, electrical insulation and plastics.

1969: net sales, $23,654,625; net income (loss), ($534,236).

1968: net sales, $21,308,668; net income, $1,434,402.

CIRCLE NO. 352

Polarad Electronics Corp., 5 Delaware Dr., Lake Success, N. Y.

High-frequency instrumentation, spectrum analyzers.

1969: net sales, $8,747,086; net income (loss), ($408,330).

1968: net sales, $8,627,497; net income (loss), ($1,500,130).

CIRCLE NO. 353

Sybron Corp., 1100 Midtown Tower, Rochester, N. Y.

Medical, process, control and water and waste-treatment equipment, chemicals.

1969: net sales, $299,757,000; net income, $16,735,000.

1968: net sales, $267,523,000; net income, $14,920,000.

CIRCLE NO. 354

Texscan Corp., 5330 E. 38th St., Indianapolis, Ind.

Sweep generators, oscilloscopes, medical and television test equipment, microwave components.

1969: net sales, $1,758,800; net income, $197,791.

1968: net sales, $1,376,367; net income, $111,404.

CIRCLE NO. 355

The Wheelabrator Corp., Mishawaka, Ind.

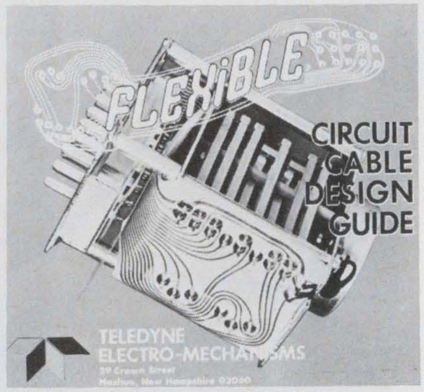
Air-pollution control, metals cleaning, aircraft assemblies and components, lubrication systems.

1969: net sales, $87,848,930; net income, $4,183,417.

1968: net sales, $81,434,494; net income, $3,957,314.

CIRCLE NO. 356

Application Notes



Cable design guide

A 24-page design guide shows packaging and cable designers how to use flexible etched cables in their component and system designs. It shows many graphic examples of good high-density low-volume interconnection and cable designs. Of interest to managerial personnel is the substantial cost reduction shown that can be achieved using flexible etched cable. Electro-Mechanism.

CIRCLE NO. 357

Packaging specifications

A technical paper titled "General Specifications for Composite Packages" states all the standards which apply to ceramic composite packages. These include physical, dimensional, visual, hermetic, electrical, plating, environmental and mechanical standards. Insert sheets for standard operating procedures on such processes as etching and cleaning are included. American Lava Corp.

CIRCLE NO. 358

MOSFETs and static

A technical article deals with the phenomenon of static electricity and its role in damaging sensitive electronic devices such as MOSFETs. It describes the basic concepts of static electricity, and shows in detail a method of offsetting it. Also included are specific handling precautions used by manufacturers of MOSFET devices. Custom Materials, Inc.

CIRCLE NO. 359

Converter principles

The principles underlying the advanced performance of modern resolver/synchro-to-digital converters are described in a four-page article. Besides discussing the basic principles of the conversion technique, it highlights some of the inherent advantages. Specifically shown is the closed-loop servo which automatically minimizes the error effects caused by noise, harmonics, and quadrature that are inevitably superimposed on the data signal. North Atlantic Industries, Inc.

CIRCLE NO. 360

IC pocket dictionary

Integrated-circuit terminology is completely listed in a handy pocket dictionary. It includes all IC terms from A to Z with definitions, an appendix of abbreviation standardizations, semiconductor symbols, multiple and submultiple prefixes, waveform notations and logic symbols. Sylvania

CIRCLE NO. 361

Solenoids

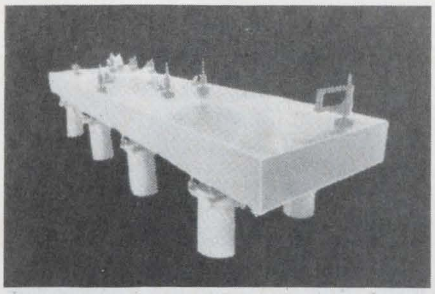
A general discussion on solenoids, what they are, and how to use them, is contained in a new booklet. It includes a general discussion of the various types of solenoids, their operation, and installation problems to be avoided. Dormeyer Industries, Inc.

CIRCLE NO. 362

Composite metals

"Designing Electrical Parts With Composite Metals" is a report that deals with the problem of conserving precious metals, and proposes the multimetal system, or cladding as it is sometimes called, as one solution. Discussions on cladding vs plating, the selection of base metals, and how to join composites, plus a detailed section of five forms of cladding techniques are included. Texas Instruments Inc.

CIRCLE NO. 363



Optical surfaces

A booklet entitled "Deflection of Optical Working Surfaces" discusses optical deflection, methods of making measurements and computations relative to deflection, and the advantageous nature of ferro-magnetic metalclad honeycomb optical table tops. Illustrations and equations are included. Modern Optics.

CIRCLE NO. 364

Standards

A new 128-page standards catalog lists 4000 American National Standards and 1700 international recommendations approved through January 15, 1970. International standards are from the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Commission for Rules for the Approval of Electrical Equipment (CEE), and the Pan American Standards Commission (COPANT). American National Standards Institute, Inc.

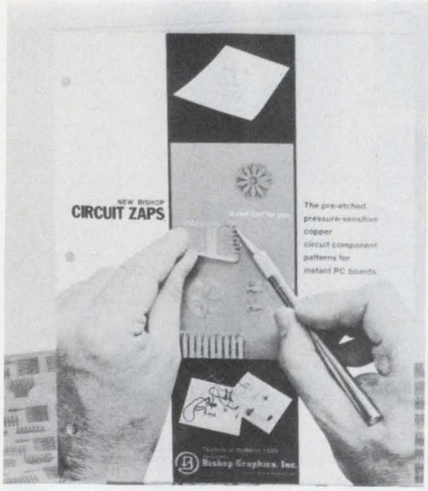
CIRCLE NO. 365

Fluidic governors

Application notes on fluidic governors for air motors are contained in a new brochure. It discusses the advantages that air motors have over other types of drive systems. Included is a block diagram of a fluidic governor system layout. Also included are torque-versus-speed and horsepower-versus-speed percent charts. Typical applications include automated drilling, explosive mixing, precision hand-held drills and constant-speed drives. General Electric Co., Specialty Fluidics Operation.

CIRCLE NO. 366

New Literature



PC-board process

A new technical bulletin gives full-color step-by-step illustrations of a new PC-board process. The process eliminates artwork, photography, photoprinting, touch up, etching, stripping, and other time-consuming steps in PC-board development. Bishop Graphics.

CIRCLE NO. 367

Computer manual

A compact 40-page user's manual and a trim catalog of library programs describing the Honeywell 1648 computer system are available. Programming languages include FORTRAN, BASIC, SOLVE, and TEACH. The library catalog groups by applications area: management sciences, engineering, education, games and demonstrations, information and advanced uses. Honeywell Information Services Division.

CIRCLE NO. 368

Tekscope

The June 1970 Issue of Tektronix's Tekscope is available. It contains articles on pulse and general-purpose signal sources, the use of oscilloscopes as signal sources, and oscilloscope versatility with the use of plug-ins. A "Service Scope" section contains helpful troubleshooting and servicing hints for instrument servicing. Tektronix, Inc.

CIRCLE NO. 369

Filters

Low-pass, high-pass, bandpass, telegraph tone channel and custom-designed filters are described in a new brochure. Custom designs include notch, noise-weighting, constant-delay, and constant-phase networks. BG Electronics, Inc.

CIRCLE NO. 370

Coaxial cables

Bulletin 470-1 gives features, typical applications and choice of materials for center conductors, dielectrics, shields and jackets to meet specifications and requirements in the use of microminiature coaxial cables. The cables are ideal for use in interconnecting electronic systems of reduced size and for keeping crosstalk down to a minimum. Berk-Tek, Inc.

CIRCLE NO. 371

Microelectronics

"Hybrid Microelectronics Review" is a new monthly technical news letter that condenses thin/thick-film microcircuit information. It is designed to assist personnel involved in the hybrid microelectronics field. A scanning service, under the direction of a technical review board, summarizes current technical, marketing, financial and production information concerning thin/thick-film technology. Hybrid Microelectronics Review

CIRCLE NO. 372

Time-sharing

"The Changing Costs of Time-Sharing" is the title of a special report that focuses on the price changes of five time-sharing vendors. These vendors are Allen-Babcock Computing, Applied Logic Corp., Com-Share, Inc., General Electric and Tymshare, Inc. The report quotes comments from a cross section of time-sharing vendors and users. Time-Sharing Enterprises, Inc.

CIRCLE NO. 373

Heathkit catalog

The 1970 issue of the Heathkit catalog is now available. It is crammed with 116 pages of consumer electronic equipment, electronic test instruments, hobbyist items, Citizen's-Band equipment and electronic devices for marine applications. Heath Co.

CIRCLE NO. 374

Zener diodes

A full line of zener diodes is shown in a quick-reference six-page guide. It covers power ranges from 400 mW through 75 W in units with 5% tolerance. The line includes 183 types available from stock, and brief data on pertinent characteristics for each diode, plus dimensional outlines. Mullard Inc.

CIRCLE NO. 375

Computer plots

Samples of a unique data terminal's X-Y plots known as Typagrams are shown in a new 36-page scrapbook. It contains Typagram plots of voltage and phase angle vs frequency and undamped transient response. Other plots include power level and impedance vs frequency and polynominal and cycloid patterns. Most Typagrams shown were produced in less than 3 minutes by conversing with a remote time-shared computer. Typagraph Corp.

CIRCLE NO. 376

Wire and cable

A new illustrated 35-page catalog contains specifications for a line of cable, wire, insulating materials and irradiated shrinkable tubing. Products featured are structurally designed for power, communications, military and industrial applications. Coleman Cable Electronic Products Div.

CIRCLE NO. 377

Delay lines

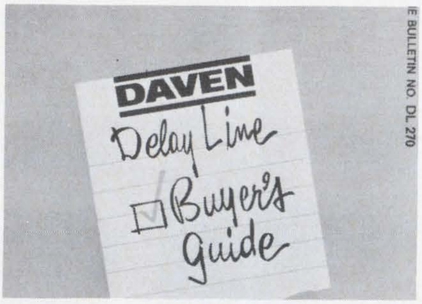
Fourteen standard electromagnetic delay lines for digital circuitry applications are described in an eight-page brochure. Delays range from 7 to 1000 ns and the smallest delay line measures 0.49 by 0.49 by 0.37 in. Impedances are 100 Ω and all units meet applicable portions of MIL-D-23859A. The brochure contains detailed physical and electrical schematics for all units. ESC Electronics, a div. of General Laboratory Associates.

CIRCLE NO. 378

Pulsed rf measurements

A new technique for instantaneous frequency measurement and its application to measuring the frequencies of pulsed rf signals is described in a 16-page application note. It tells how to use a computing counter to make these measurements easily and accurately. Hewlett-Packard.

CIRCLE NO. 379



Delay line guide

Delay lines are the subject of a four-page two-color buyer's guide. It discusses in detail seven prime parameters that must be considered in specifying a delay line. These are: delay time, rise time, attenuation, impedance, distortion, temperature coefficient and package design. These factors are then related to determine varying delay line complexities and costs. Daven Div., McGraw-Edison Co.

CIRCLE NO. 380

Variable filters

Three notes on the use of a line of variable filters are available. Filters include active, general-purpose, laboratory instrument, operational and high-pass/low-pass types. Rockland Systems Corp.

CIRCLE NO. 381

Microwave tubes

A condensed 48-page catalog describing a line of microwave tubes gives specifications on more than 200 magnetrons, klystrons, crossed-field amplifiers, traveling-wave tubes, and backward-wave oscillators operating at various frequency bands and power levels. Much of the information is illustrated and cross referenced. Raytheon Co.

CIRCLE NO. 382

Coaxial connectors

The latest mechanical and electrical data on stainless-steel SAM connectors per MIL-C-39012 is shown in a new nine-page catalog. Included in the catalog are miniature connectors for semi-rigid and flexible cable, striplines, solder pots, printed circuits and tees. Applied Engineering Products Div. of Samarius, Inc.

CIRCLE NO. 383

Rf connectors

Covering all major rf connector classifications and subtypes is a 161-page fully illustrated catalog. It includes comprehensive part number cross-reference tables, cable data and cable assembly instructions. Dimensions and engineering data for each connector, adapters, terminations and diagrams of mounting holes and plates are included. Bendix Corp.

CIRCLE NO. 384

Interconnections

A comprehensive line of industrial connectors, plugs and sockets is presented in a 32-page catalog. This full-color publication contains photographs, line drawings, electrical characteristics and mechanical specifications. A selection guide completes the information needed to find the right component for any equipment or circuit application. Amphenol Industrial Div., The Bunker-Ramo Corp.

CIRCLE NO. 385

Packaging parts

Standard industry packaging for integrated circuits, photodiodes, phototransistors, and crystal frequency and crystal filter devices is detailed in a 12-page brochure. Both window and lens-type photocovers plus subminiature photodevice housings are shown. Coldweld packages for crystals include flatpacks for monolithic filters and larger transistor-type packages. GTI Corp., Saegertown Products Div.

CIRCLE NO. 386

Silicones

"Ideas" is the title of a 32-page, four-color booklet describing the basic functions performed by silicones, fluorosilicones, semiconductor-grade silicon and solid-film lubricants. It includes sections on bonding, sealing, adhering, encapsulating, potting and molding. Dow Corning.

CIRCLE NO. 387

Pollution control

"Pollution Control, a Kit for Concerned Citizens," is the title of a general information packet on water pollution and the means available for its solution. Included in the packet is a general statement of concern about the environment, a glossary of terms used to describe the water pollution problem and a regional analysis of water pollution problems. Rex Resource Bureau.

CIRCLE NO. 388

High-voltage capacitors

Information on a new line of high-voltage, fixed and variable gas dielectric capacitors, with voltage ratings to 20 kV peak and capacitances to 3000 pF is provided in a 48-page catalog. Included in the catalog is a chart giving type numbers which are fully interchangeable with vacuum-type capacitors. Energy Laboratories, Inc.

CIRCLE NO. 389

Transmission lines

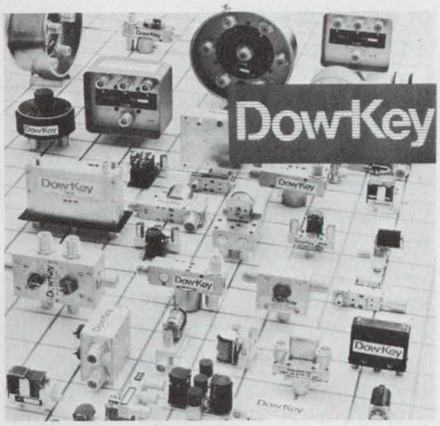
A new rigid 800 coaxial transmission-line catalog contains complete electrical and mechanical specifications on a full line of copper and aluminum transmission lines. It also includes a complete listing of accessory items. Prodelin

CIRCLE NO. 390

High-Q capacitors

High-Q variable capacitors are featured in a new catalog. It details miniature, subminiature, air, general-purpose, microcircuit-trimmer, PC, high-voltage and rf quartz types. Johanson Manufacturing Corp.

CIRCLE NO. 391



Coaxial relays

A new line of vacuum coaxial relays is listed in a 20-page general catalog. It contains detailed electrical and mechanical specifications that are completely indexed for ready reference. Dow-Key Co.

CIRCLE NO. 392

Ac/dc converter

The design evolution of a precision ac/dc converter is described in an eight-page application note. The design starts with a precision rectifier using two chopper-stabilized operational amplifiers. Measurements of conversion linearity, output ripple and step response are described and the results are graphed. The converter output filter is then changed in steps with the performance changes illustrated on the graphs. The final circuit uses an active three-pole Butterworth low-pass filter with a 0.25-Hz cutoff frequency. Testronic Development Laboratory.

CIRCLE NO. 393

Computer plots

A series of very informative booklets entitled "Easy Plotting Procedures" is available. The booklets give a simple step-by-step description of how all types of X-Y plots can be produced automatically using software packages now available through major time-sharing services. Anyone who can use a teleprinter can produce single or multiple X-Y plots from computer lists by merely following the procedures outlined in these booklets. Typagraph Corp.

CIRCLE NO. 394

Bulletin board

of product news and developments

A frequency synthesizer that covers the 1 to 12.4-GHz range in a single band (1-MHz steps) is now in the breadboard stage at Watkins-Johnson. Tentative specifications include an accuracy of five parts in 10^7 (using the internal standard) and a leveled output of 1 mW ±2 dB across the full band. Unleveled outputs are expected to vary greatly—from 25 mW at 2 GHz to 1 mW minimum at 12.4 GHz.

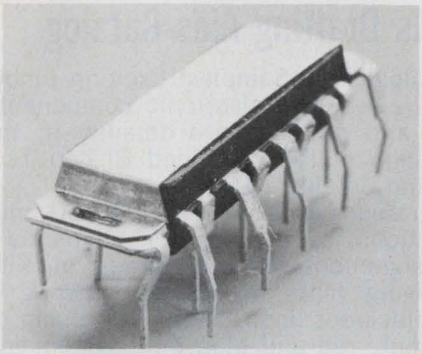
Integrated color processing circuitry for color television receivers has been developed by the Zenith Radio Corp. for use in its 1971 line. Heart of the new system is three matched ICs: a chroma amplifier, a subcarrier regenerator and a color demodulator circuit.

Second-source pin-for-pin replacement rf power transistors are now available for users of mobile, maritime and military communications equipment. The manufacturer, Solid State Scientific, Inc., of Montgomery, Pa., says the new devices will be cost-competitive with those supplied by Motorola, TRW, and RCA. The transistors will cover the 100 to 500-MHz frequency range with power ratings of 5 mW to 50 W.

CIRCLE NO. 395

Assuring telephone privacy, a new device called Phone-Censor allows the user to talk with another person in the same room without interrupting the party on the line. Pressing a small button on the device cuts off the phone transmitter, but does not affect audio reception. Phone-Censor can be easily installed in the mouthpiece of any standard telephone in a matter of minutes. Suggested retail price is $2.95. The manufacturer is Multimanufacturing Inc., El Segundo, Calif.

CIRCLE NO. 396



Three developmental linear ICs have been introduced by the RCA Solid State Div. for the video and chroma sections of color television receivers. One circuit, the TA5914, is a complete television video i-f system that performs ten separate functions on a single monolithic chip. The other two circuits form a complete chroma system—the TA5625 is a chroma control system, and the TA5752 is a chroma demodulator. Evaluation quantities are available now, while production quantities will be ready the first quarter of 1971.

CIRCLE NO. 397

Called ALICE, a program for the simulation of digital logic networks can be used to verify the behavior of a logic network or to analyze network timing problems. ALICE can simulate circuits implemented in any form, from completely asynchronous designs to synchronous two and four-phase MOS designs. Network input is simplified by the program's catalogs of standard logic families. Originated by Applicon Inc., Burlington, Mass., ALICE is intended for remote-access and remote-batch use from a Teletype or similar terminal.

CIRCLE NO. 398

Price reductions of about 50% are now in effect for the EDAC series of d/a converter modules from DDC, a div. of Solid State Scientific Devices Corp. Costs, which were $150 to $400, range from $79 to $189 for accuracies of 8 to 11 bits.

CIRCLE NO. 399

Electronic Design

ELECTRONIC DESIGN'S function is:

- To aid progress in the electronics manufacturing industry by promoting good design.
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- To provide a central source of timely electronics information.
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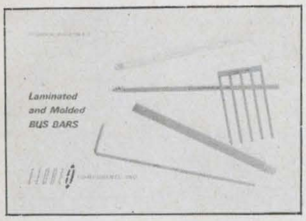

A 16 page Technical Bulletin is now available, describing a new concept in power or signal distribution. Basic mechanical and electrical design principles, along with descriptive pictures and diagrams, are included in this bulletin. These compact buses can replace bulky cable harnesses and repetitive 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.

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FREE APPLICATION NOTES ON 12 BIT MONOLITHIC IC D/A CONVERTER CIRCUITS

A multipage application note is offered free by Analog Devices on the new μDAC monolithic IC D/A converter circuits. Both theory of operation and practical applications data is supplied for up to 12 bit ($\pm 1/2$LSB) converters through the use of circuit diagrams, photographs and comprehensive text. Descriptions of circuit applications for new monolithic current and voltage switches in DIP and flatpacks are included. Reply card offering evaluation samples is included with the application note.

ANALOG DEVICES
221 FIFTH ST., CAMBRIDGE, MASS. 02142
TEL: 617/492-6000

175

NEW Integrated Circuit Techniques

A new problem-solving handbook from **Westinghouse Defense and Space Center** on both digital signal processing and linear integrated circuits. Stresses **systems applications** of integrated circuit devices and techniques to radar signal processing, indicator-display symbol generation, UHF communications, and TV camera developments. Extensively uses examples to help you select the optimum design to realize your specific system requirements. Pub. March 1970, 448 pp., 300 illus., 7x9¼", $16.95. Circle the reader-service number below for a 15-day examination copy.

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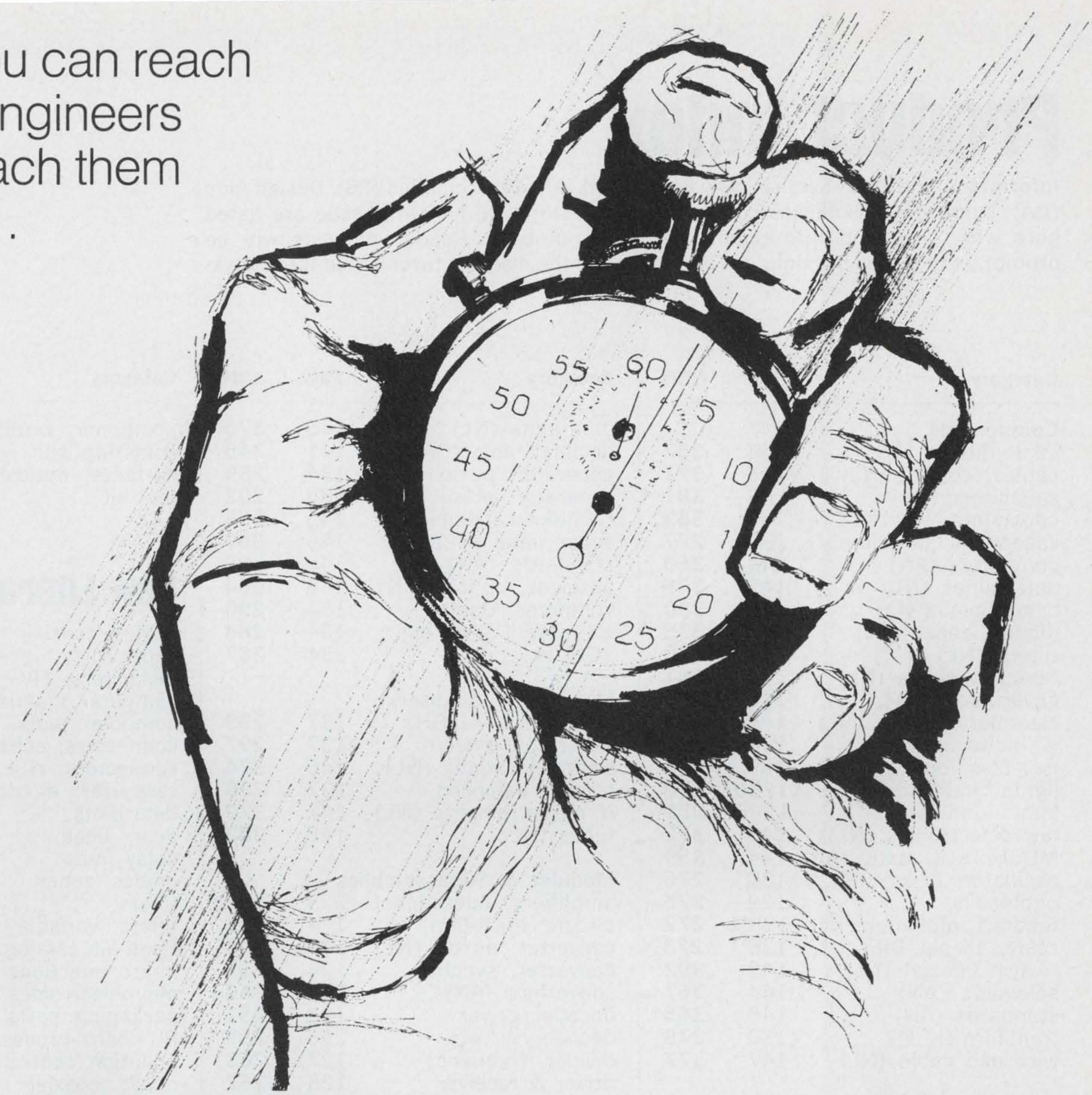

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ELECTRONIC DESIGN FAST CLOSE SCHEDULE

(Post on your production bulletin board.)

ISSUE DATE	REGULAR CLOSING	FAST CLOSE	
		ORDER IN N.Y. OFFICE	FILM POS. AT PRINTER
June 7	May 4	**May 22**	**May 25**
June 21	May 18	**June 5**	**June 8**
July 5	June 1	**June 19**	**June 22**
July 19	June 15	**July 3**	**July 6**
Aug. 2	June 29	**July 17**	**July 20**
Aug. 16	July 13	**July 31**	**Aug. 3**
Sept. 1	July 27	**Aug. 14**	**Aug. 17**
Sept. 13	Aug. 10	**Aug. 28**	**Aug. 31**

ISSUE DATE	REGULAR CLOSING	FAST CLOSE	
		ORDER IN N.Y. OFFICE	FILM POS. AT PRINTER
Sept. 27	Aug. 24	**Sept. 11**	**Sept. 14**
Oct. 11	Sept. 8	**Sept. 25**	**Sept. 28**
Oct. 25	Sept. 21	**Oct. 9**	**Oct. 12**
Nov. 8	Oct. 5	**Oct. 23**	**Oct. 26**
Nov. 22	Oct. 19	**Nov. 6**	**Nov. 9**
Dec. 6	Nov. 2	**Nov. 20**	**Nov. 23**
Dec. 20	Nov. 16	**Dec. 4**	**Dec. 7**

Product Index

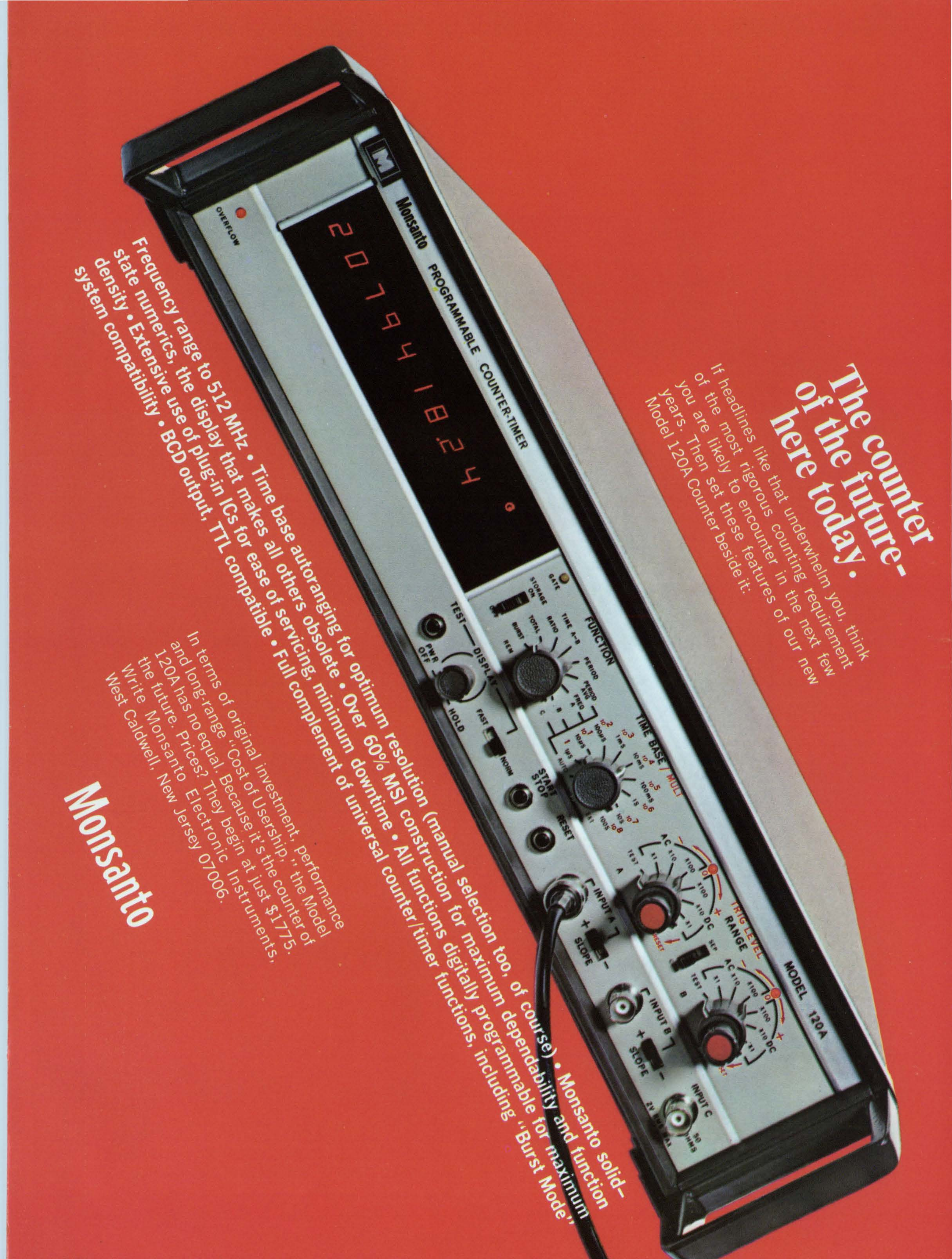
Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within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

New Literature

Application Notes

Design Aids

Evaluation Samples



The counter of the future-here today.
If headlines like that underwhelm you, think of the most rigorous counting requirement you are likely to encounter in the next few years. Then set these features of our new Model 120A Counter beside it:
Frequency range to 512 MHz • Time base autoranging for optimum resolution (manual selection too, of course) • Monsanto solid-state numerics, the display that makes all others obsolete • Over 60% MSI construction for maximum dependability and function density • Extensive use of plug-in ICs for ease of servicing, minimum downtime • All functions digitally programmable for maximum system compatibility • BCD output, TTL compatible • Full complement of universal counter/timer functions, including "Burst Mode".
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Monsanto PROGRAMMABLE COUNTER-TIMER
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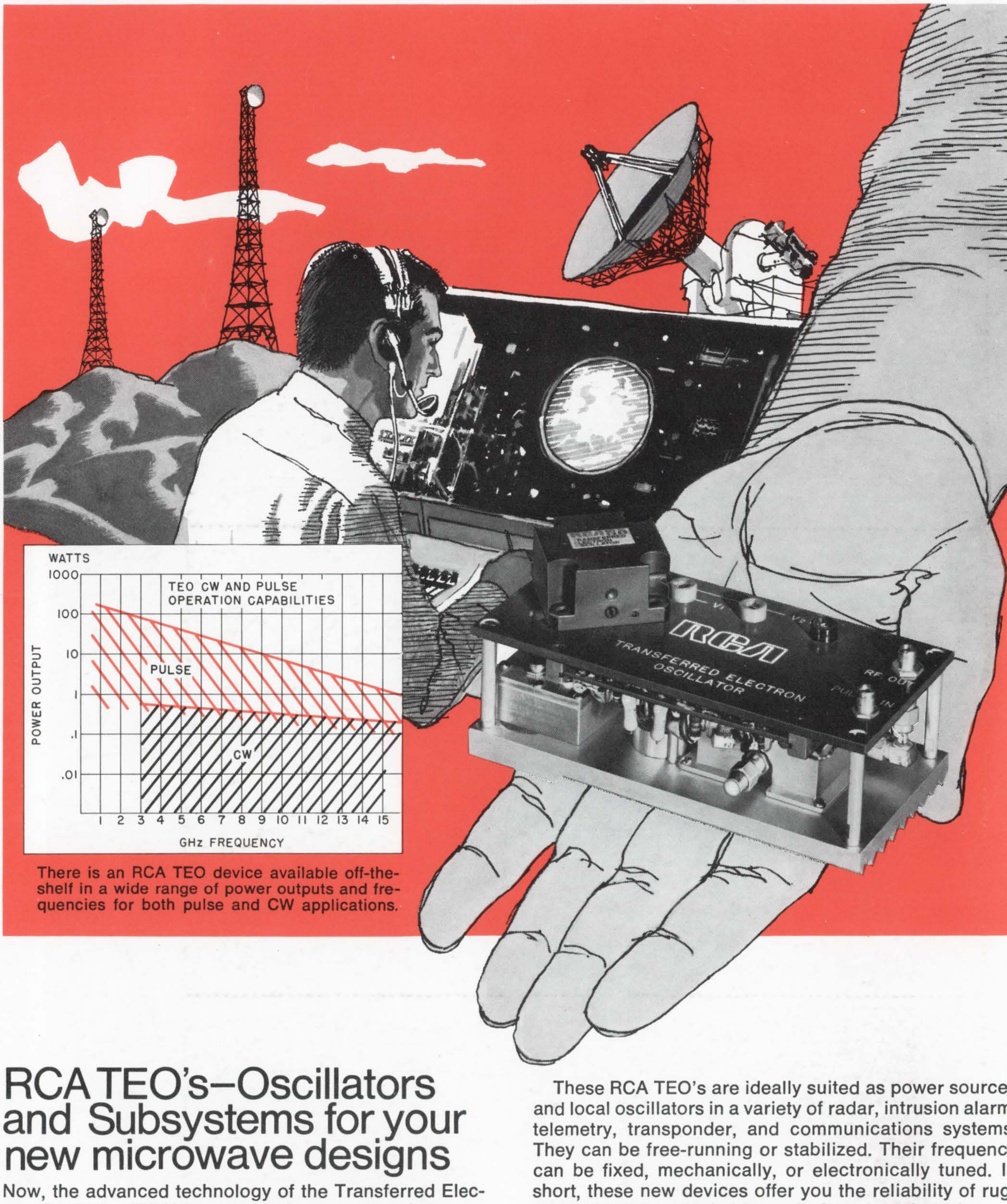

There is an RCA TEO device available off-the-shelf in a wide range of power outputs and frequencies for both pulse and CW applications.

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Now, the advanced technology of the Transferred Electron Oscillator (TEO) is available for your new microwave designs. RCA announces immediate delivery of standard-line oscillators and subsystems for pulsed and CW applications from L-band to Ku-band.

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